

Final Work Plan

Former Gun and Mortar Range Munitions Response Site (RFAAP-002-R-01) Site Investigation at Radford Army Ammunition Plant, Virginia

May 2018



Submitted to:

**United States Army Corps of
Engineers, Baltimore District**
10 South Howard Street
Baltimore, MD 21201



Submitted by:

Bering Sea Environmental, LLC.
615 E, 82nd Avenue, Suite 200
Anchorage, AK 99518

Contract No. W912QR-13-D-0001

Task Order 0001

This page intentionally left blank.

TABLE OF CONTENTS

1.0	Introduction.....	1-1
1.1	Project Objectives	1-1
1.2	Work Plan Organization	1-1
2.0	Site Description and History	2-1
2.1	RFAAP History.....	2-1
2.2	Physiography, Geology, and Hydrology.....	2-1
2.3	Surface Water.....	2-1
2.4	Previous Investigations	2-2
3.0	Historical Records Review	3-1
3.1	RFAAP Records.....	3-1
3.1.1	Explosive Ordnance Incident Reports	3-1
3.1.2	RFAAP Safety Incident Reports.....	3-1
3.1.3	The Radford Plant Weekly.....	3-2
3.1.4	Narrative Plant History of the Radford Ordnance Works.....	3-2
3.2	Personnel Interviews.....	3-2
3.3	National Archives Records	3-5
3.4	Aerial Photography Review	3-5
3.5	Munitions and Explosives of Concern and Munitions Constituents Characteristics.....	3-5
4.0	Conceptual Site Model.....	4-1
4.1	Munitions Response Profile.....	4-1
4.2	Potential Human and Ecological Receptors.....	4-1
4.2.1	Current and Future Site Workers	4-2
4.2.2	Current and Future Construction Workers.....	4-3
4.2.3	Current and Future Trespassers	4-3
4.2.4	Current or Future Visitors.....	4-4
4.2.5	Ecological Receptors	4-4
4.3	Pathway Analysis.....	4-6
4.3.1	Transport Processes	4-11
4.3.2	Exposure Media and Accessibility.....	4-12
4.3.3	Munitions and Explosives of Concern Exposure Receptors.....	4-12
4.3.4	Groundwater Migration Pathway Analysis for Munitions Constituents.....	4-13
4.3.5	Surface Water Migration Pathway Analysis for Munitions Constituents.....	4-13
4.3.6	Soil Migration Pathway Analysis for Munitions Constituents	4-14
5.0	Data Quality Objectives	5-1
5.1	Rationale and Design	5-5
5.1.1	Analog Instrument-Assisted Visual Survey.....	5-5
5.1.2	Munitions Constituents Surface Soil Sampling.....	5-6
6.0	Field Sampling Plan.....	6-1
6.1	Introduction.....	6-1
6.1.1	Project Organization, Responsibilities, and Training	6-1
6.1.2	Qualifications and Training of Project Personnel.....	6-1

6.2	Assisted Visual Survey Plan	6-3
6.2.1	Introduction.....	6-3
6.2.2	Description of Work	6-3
6.2.3	General Field Work Procedures.....	6-5
6.3	Soil Sampling Plan.....	6-6
6.3.1	Project Purpose and Scope.....	6-6
6.3.2	Field Activities.....	6-16
6.3.3	Field Operations Documentation	6-23
6.4	Sample Identification	6-24
6.5	Sample Labels.....	6-24
6.6	Chain-of-Custody Records.....	6-25
6.6.1	Documentation Procedures/Data Management and Retention	6-27
6.6.2	Field Data Quality Control Assessment.....	6-29
6.6.3	Corrective Action Process.....	6-30
6.7	Deliverables	6-31
7.0	Accident Prevention Plan	7-1
8.0	Explosives Management Plan	8-1
9.0	Anomaly Avoidance	9-1
10.0	Environmental Protection Plan	10-1
10.1	Potential MRS Resources	10-1
10.1.1	Vegetation and Wildlife.....	10-1
10.1.2	Water Resources	10-1
10.1.3	Cultural and Archaeological Resources.....	10-1
10.2	Environmental Impact Mitigation Procedures	10-2
10.2.1	Coordination with Environmental Office	10-2
10.2.2	Waste Disposal.....	10-2
10.2.3	Burning Activities.....	10-2
10.2.4	Dust and Emissions Control	10-2
10.2.5	Spill Control and Prevention.....	10-2
10.2.6	Munitions Storage Areas and Temporary Facilities	10-3
10.2.7	Access Routes	10-3
10.2.8	Vegetation Removal.....	10-3
10.2.9	Vegetation Restoration.....	10-3
10.2.10	Water Run-On and Run-Off Control	10-3
10.2.11	Equipment Decontamination and Disposal.....	10-3
10.2.12	Minimizing Disturbance	10-3
10.2.13	Post-Activity Clean-Up.....	10-4
10.2.14	Air Monitoring Plan.....	10-4
11.0	Installation Security.....	11-1
11.1	Communication.....	11-1
11.1.1	Emergency Numbers.....	11-1
11.1.2	Non-Emergency Numbers	11-1
12.0	Project Schedule.....	12-1
13.0	References.....	13-1

Tables

Table 3-1	Munitions Constituents.....	3-6
Table 4-1	Threatened and Endangered Species in Montgomery and Pulaski Counties, Virginia	4-4
Table 4-2	Common Ecological Receptors Present at Radford Army Ammunition Plant.....	4-5
Table 5-1	DQO Process	5-1
Table 6-1	RFAAP AVS Survey	6-4
Table 6-2	Project Analyte List and Comparison Values.....	6-9
Table 6-3	Project Analyte List and Comparison Values, Metals.....	6-11
Table 6-4	Increment Locations- NAD_1983_UTM_Zone_17N	6-19
Table 6-5	Estimated Soil Samples by Type	6-21
Table 6-6	Requirements for Soil Sample Preservation, Maximum Holding Times, and Containers	6-22
Table 6-7	Chain-of-Custody Procedures.....	6-25
Table 6-8	Final COC Distribution.....	6-26

Figures

Figure 1-1	Project Organization Chart	1-3
Figure 2-1	Radford Army Ammunition Plant and Former Gun and Mortar Range (RFAAP- 002-R-01) MRS Location	2-3
Figure 3-1	Facilities on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS	3-3
Figure 4-1	Graphical Representation of Conceptual Site Model for Munitions Constituents Exposure	4-7
Figure 4-2	Graphical Representation of Conceptual Site Model for Munitions and Explosives of Concern and Materials Potentially Presenting an Explosive Hazard Exposure.....	4-9
Figure 5-1	Assisted Visual Survey Proposed Coverage of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS	5-9
Figure 6-1	Sampling Locations, Former Gun and Mortar Range (RFAAP-002-R-01) MRS..	6-14

Appendices

- A. Technical Project Planning (TPP) Minutes
- B. Interview Documentation
- C. Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)
- D. Accident Prevention Plan (APP)
- E. Unexploded Ordnance Personnel Qualifications Certification Letter

ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
AVS	Assisted Visual Survey
bgs	Below Ground Surface
BSEn	Bering Sea Environmental Inc.
°C	degrees Celsius
CAMBL	Continuous Automated Multi-Base Line
CAR	Corrective Action Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter(s)
cm ³ /g	Cubic centimeters per gram
COC	Chain-of-Custody
CPR	Cardiopulmonary Resuscitation
CSM	Conceptual Site Model
CTL	CTL Laboratories, LLC
DMM	Discarded Military Munitions
DNT	Dinitrotoluene
DoD	Department of Defense
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
DU	Decision Unit
EcoSSL	Ecological Soil Screening Level
EM	Engineer Manual
EOD	Explosive Ordnance Disposal
ERDC/CRREL	Engineer Research and Development Center/ Cold Regions Research and Engineering Laboratory
Fe ⁺²	Ferrous Iron
FSP	Field Sampling Plan
g/cc	grams per cubic centimeter
GIS	Geographic Information System
GOCO	Government-Owned/Contractor-Operated
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
H _c	Henry's Law Constant
HDR	HDR Environmental, Operations and Construction, Inc.
HE	High Explosive
HMX	Cyclotetramethylene Tetranitramine
HQ	Hazard Quotient
HRR	Historical Records Review
HSM	Health and Safety Manager

IAW	In Accordance With
ID	Identification
IDW	Investigative Derived Waste
ISM	Incremental Sampling Methodology
IVS	Instrument verification strips
K _d	Soil/Water Partition Coefficient
K _{oc}	Organic Carbon/Water Partition Coefficient
Lat	Latitude
Long	Longitude
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
mm	Millimeter
MMA	Main Manufacturing Area
MMRP	Military Munitions Response Program
Mn ⁺²	dissolved Manganese
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MWP	Master Work Plan
NC	Nitrocellulose
NFA	No Further Action
NG	Nitroglycerin
NO ₃	Nitrate
NRHP	National Register of Historic Places
OE	Ordnance and Explosives
OSHA	Occupational Safety and Health Administration
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability and Sensitivity
PCN	Polychlorinated Naphthalene
PCV	Project Comparison Value
PETN	Pentaerythritol tetranitrate
PM	Project Manager
POC	Point of Contact
PPE	Personal Protective Equipment
PX	Post Exchange
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RFAAP	Radford Army Ammunition Plant
RCRA	Resource Conservation and Recovery Act

RDX	Royal Demolition Explosives (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
RFI	RCRA Facility Investigation
RSD	Relative Standard Deviation
RSL	Regional Screening Level
SI	Site Investigation
SIM	Simple Ion Monitoring
SLERA	Screening Level Ecological Risk Assessment
SMWU	Solid Waste Management Unit
SO ₄ ²⁻	Sulfate
SOP	Standard Operating Procedure
SOW	Statement of Work
SSHO	Site Safety and Health Officer
SVOC	Semi-Volatile Organic Compound
TCL	Target Compound List
TNT	Trinitrotoluene
TOC	Total Organic Carbon
THI	Target Hazard Index
TPP	Technical Project Planning
TR	Target Risk
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
VA	Virginia
VDEQ	Virginia Department of Environmental Quality
WP	White Phosphorous
%	percent

1.0 Introduction

This Work Plan has been developed in support of United States Army Corps of Engineers (USACE) Military Munitions Response Program (MMRP) Site Investigation (SI) activities to be conducted at the Former Gun and Mortar Range (RFAAP-002-R-01) Munitions Response Site (MRS) located at the Radford Army Ammunition Plant (RFAAP), Virginia. Overall coordination of activities described within this Work Plan is provided by the USACE Baltimore District. Bering Sea Environmental, LLC (BSEn) is the contractor performing this work on behalf of the USACE Baltimore District. HDR Environmental, Operations and Construction, Inc. (HDR) is a sub-contractor to BSEn and will perform the project execution tasks. HDR's Vienna, Virginia (VA) office (2600 Park Tower Drive, Suite 100, Vienna, VA 22180-7342) will perform or direct HDR tasks.

RFAAP operates under a Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (USEPA, 2000); however, RCRA has no special provisions for dealing with explosive safety. The Department of Defense (DoD) primarily uses the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to perform munitions responses. Therefore, this effort is titled SI. This SI Work Plan is not a Work Plan Addendum prepared directly under the RFAAP Master Work Plan (MWP) (URS, 2003); however, the work performed as part of this SI will be in accordance with (IAW) the RFAAP MWP (URS, 2003) whenever possible to avoid conflicts between this SI and other environmental work performed at RFAAP. The resulting SI Report will be used to determine the proper path forward under the RCRA permit.

1.1 Project Objectives

The presence of munitions and explosives of concern (MEC) (i.e., unexploded ordnance [UXO], discarded military munitions [DMM], or munitions constituents [MC] in sufficient quantities to present an explosive hazard) at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was established during the reconnaissance site walk performed December 2014 when a 60mm mortar was discovered lying on the ground surface. As such, further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping). The primary objective of this SI is to gather sufficient information to identify potential types of MEC/MC and Material Potentially Presenting and Explosive Hazard (MPPEH), and to recommend further characterization activities, such as a RCRA Facility Investigation (RFI). The only possible recommendation for No Further Action (NFA) resulting from this SI could be for diffuse MC in surface soils. It is not the intent of this SI to confirm all types of MEC present, nor to define the nature and extent of MEC or MC contamination.

1.2 Work Plan Organization

This Work Plan is compliant with, and developed IAW, the requirements of Engineer Manual (EM) EM-200-1-3, Requirements for the Preparation of Sampling and Analysis Plans (USACE,

2001). Other guidance documents that may be applicable to the SI at RFAAP are identified in **Section 13.0** of this Work Plan. The Technical Project Planning (TPP) Minutes are included in **Appendix A**. This Work Plan contains the following sections and appendices:

Section 1: Introduction

Section 2: Site Description and History

Section 3: Historical Records Review (HRR)

Section 4: Conceptual Site Model (CSM)

Section 5: Data Quality Objectives (DQOs)

Section 6: Field Sampling Plan (FSP)

Section 7: Accident Prevention Plan (APP)

Section 8: Explosives Management Plan

Section 9: Anomaly Avoidance

Section 10: Environmental Protection Plan

Section 11: Installation Security

Section 12: Project Schedule

Section 13: References

Appendix A: TPP Minutes

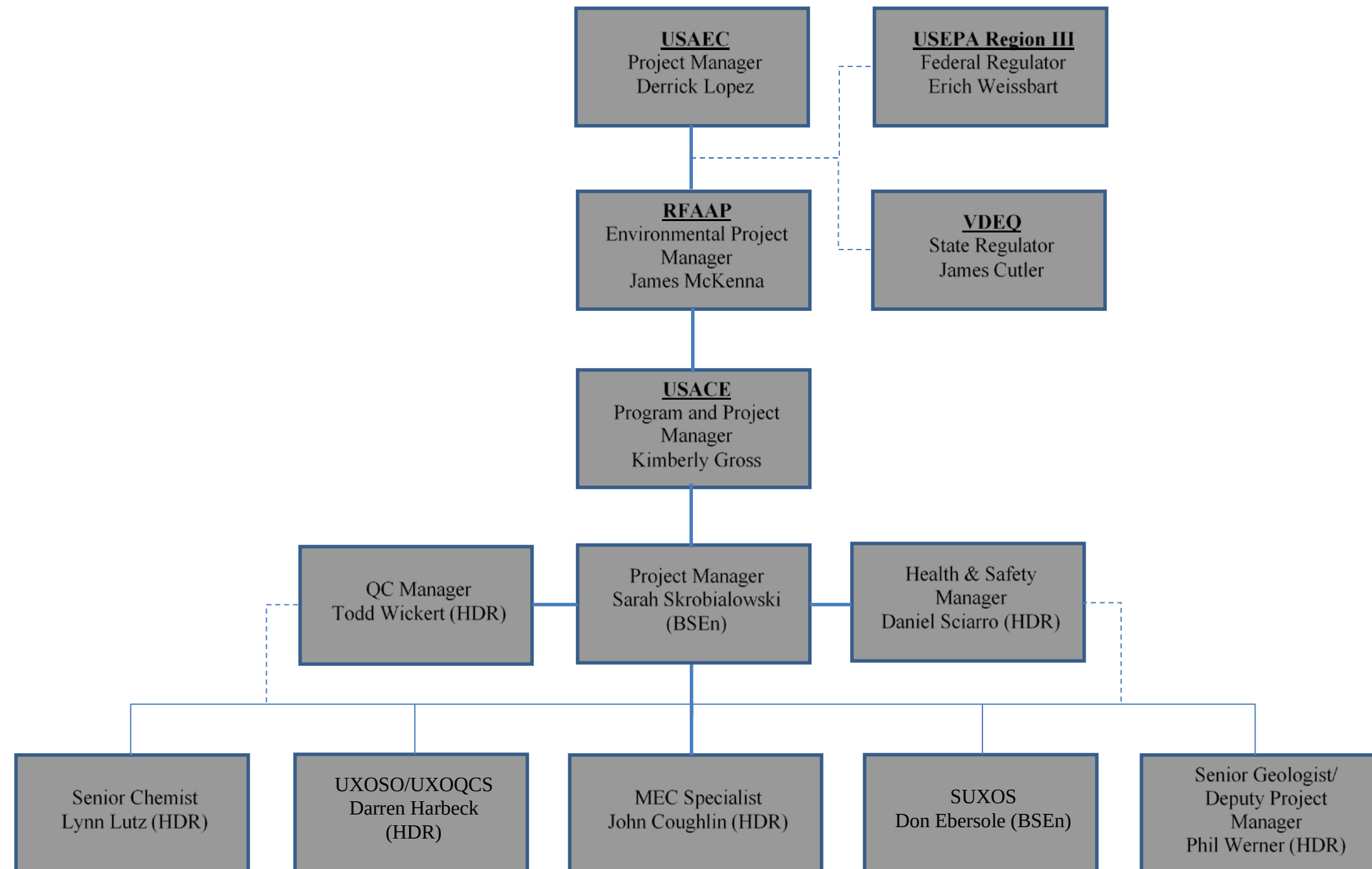
Appendix B: Interview Documentation

Appendix C: Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP)

Appendix D: APP

Appendix E: UXO Personnel Qualifications Certification Letter

Figure 1-1 Project Organization Chart



This page intentionally left blank

2.0 Site Description and History

2.1 RFAAP History

RFAAP is a government-owned/contractor-operated (GOCO) facility that lies in one of a series of narrow valleys typical of the eastern range of the Appalachian Mountains. Oriented in a northeast-southwest direction, the valley is approximately 25 miles long, is 8 miles in width at the southeast end, and narrows to 2 miles in width in the northeast end (**Figure 2-1**). RFAAP lies along the New River in the relatively narrow northeastern corner of the valley. The Horseshoe Area of RFAAP (which is part of the Main Manufacturing Area [MMA]) exists within a meander of the New River. The Former Gun and Mortar Range (RFAAP-002-R-01) MRS lies within the Horseshoe Area.

The primary mission of RFAAP, the manufacturing of propellants, began in 1941 and continues today. Since 1968, RFAAP has also produced Trinitrotoluene (TNT) on an intermittent basis. The RFAAP property has controlled and monitored entry and 24-hour surveillance. There are approximately 2,500 buildings within a 2-mile radius, including RFAAP and residential buildings. There are tenants on RFAAP other than the GOCO (e.g., BAE Systems ATK, Alexander Arms, Pyrotechnique by Grucci, etc.), but none of the tenants are located inside the MRS. All RFAAP tenants are involved with industrial enterprises and none of them are commercial businesses with customer traffic, such as a Post Exchange (PX) or post office. Land usage surrounding RFAAP is primarily agricultural with some residential and industrial use. Land usage in and near RFAAP is not projected to change (URS, 2003).

2.2 Physiography, Geology, and Hydrology

The MWP (URS, 2003) describes the general physiography of RFAAP and the MMA in Section 3.2. The Former Gun and Mortar Range (RFAAP-002-R-01) MRS is located within a portion of the MMA that is characterized by gently to steeply sloping ridges, the presence of landforms indicative of karst topography (e.g., sinkholes), and a general downward slope toward the northwest. Information on the soil types found in the MMA of RFAAP is presented in Section 3.5.1 of the MWP (URS, 2003). Regional and general geology at RFAAP are discussed in Sections 3.6 and 3.7 of the MWP, respectively (URS, 2003). Regional hydrogeology and general hydrogeology information for RFAAP is included in Section 3.8 of the MWP (URS, 2003). Groundwater exists at approximately 70 feet below ground surface (bgs), and groundwater is believed to eventually discharge to the New River (URS, 2003).

2.3 Surface Water

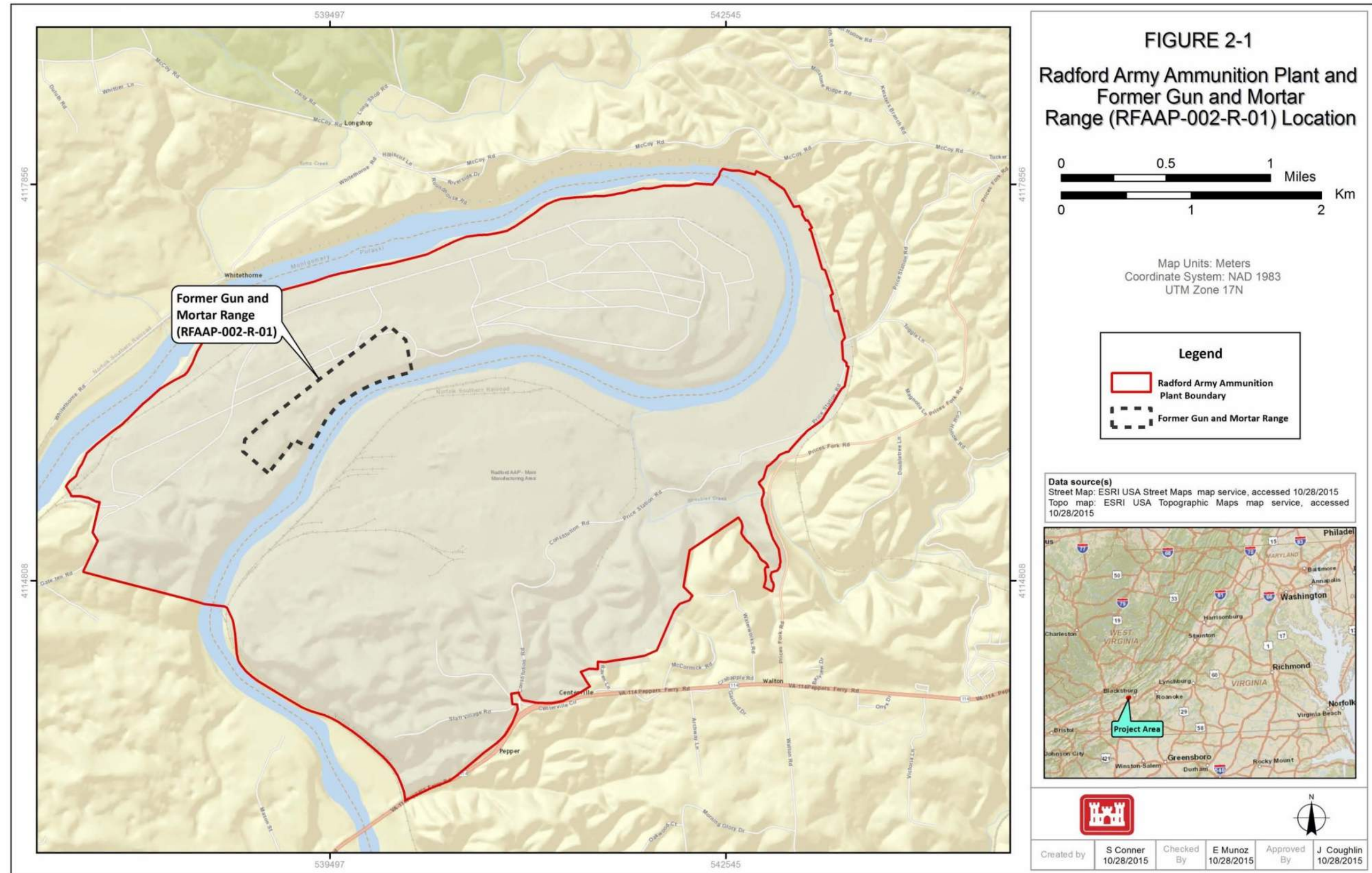
No permanent surface water bodies are present within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, and storm water drainage occurs primarily via infiltration and overland flow in ditches along engineered roadways. The Former Gun and Mortar Range (RFAAP-002-R-01) MRS borders the New River, which flows along the southern boundary of the MRS. The river

flow varies due to water management at Claytor Dam, approximately 9 miles up-gradient (south) of RFAAP (URS, 2003).

2.4 Previous Investigations

Although there have been no previous investigations of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, there have been numerous environmental investigations of the surrounding RFAAP property to include soil, surface water, and groundwater investigations. Efforts are underway to delineate the occurrence and flow of groundwater at RFAAP. The efforts are complicated by the presence of karst geology (highly fractured and channelized limestone).

Figure 2-1 Radford Army Ammunition Plant and Former Gun and Mortar Range (RFAAP-002-R-01) MRS Location



This page intentionally left blank.

3.0 Historical Records Review

An HRR was performed at RFAAP, but did not focus on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. As part of this SI effort, an additional limited HRR was performed to gather records at RFAAP. Interviews of employees were performed in person and via telephone. The following subsections document the findings of this limited HRR. The interview notes are included in **Appendix B**.

3.1 RFAAP Records

In December 2014, personnel traveled to RFAAP to perform the HRR. The following documents were discovered during the investigation:

3.1.1 Explosive Ordnance Incident Reports

Three Explosive Ordnance Incident Reports, dated April 10, 2012, September 9, 2012, and May 28, 2014 were provided by the BAE Systems Security Manager. The BAE Systems Security Manager also provided numerous photos of the munitions found at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. These reports detailed multiple discoveries of mortar rounds within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, and the subsequent actions taken to resolve the incidents. The reports detailed findings of two 60 millimeter (mm) mortars and one unknown round, found on September 9, 2012, May 28, 2014, and April 10, 2012, respectively. On all three occasions, an Explosive Ordnance Disposal (EOD) unit was called in from Fort Bragg in North Carolina to handle the removal of the munitions.

The September 9, 2012 report includes an email from an unnamed source, copied into an email sent by RFAAP personnel, stating that an inert 60mm mortar was discovered near a building within the location of the Former Gun and Mortar Range [RFAAP-002-R-01] MRS. The mortar was reported to likely be filled with concrete. There was no indication of the final disposal of the item. The May 28, 2014 EOD Report states that an unidentifiable 60mm item (referred to as UXO) was safely removed from the area and disposed of via demolition at an undisclosed location on RFAAP. The report dated April 10, 2012 states that an unidentified item (referred to as UXO) was found and disposed of with no additional details presented in the report.

3.1.2 RFAAP Safety Incident Reports

Safety Incident Reports dating back to 2006 were collected during this HRR investigation. These reports, and their accompanying documentation, such as emails and photos, detailed the discovery of three incidents where mortar rounds were unearthed through routine construction and maintenance within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Dated February 3, 2006, July 10, 2010, and April 10, 2012, all three mortar finds were handled by EOD teams from Fort Belvoir, Virginia, and Fort Bragg, North Carolina. Only one report (July 2010) stated the round that was found was determined to be inert. The other reports did not make a

determination of whether the round was inert or not. None of the reports mentioned what size mortars were found in any of the three incidents.

3.1.3 The Radford Plant Weekly

The Radford Plant Weekly was a weekly news publication which detailed current events at the plant. Two articles, published in June and October 1941, mentioned powder being tested on the plant cannon range in the Horseshoe area. The June article detailed the construction of the Gun Range, including “two tunnels...to be used for testing powder made on the plant for large caliber guns.” These tunnels were located in the Horseshoe Area near limestone caves which were dry packed during the construction process. The October article stated that the cannon range was used to test larger caliber powder using trench mortars, howitzers, and cannons with 100-pound shells.

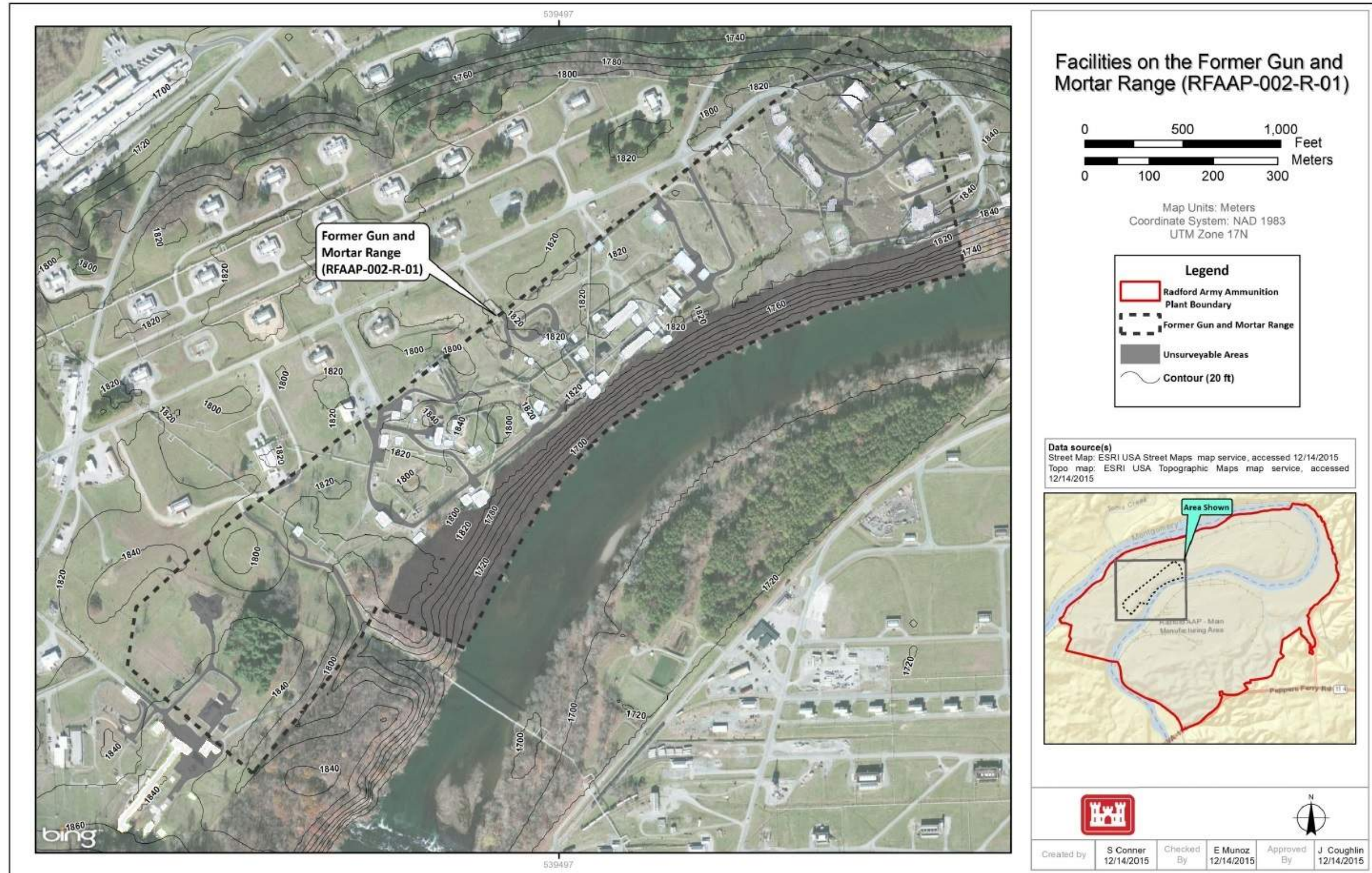
3.1.4 Narrative Plant History of the Radford Ordnance Works

Published in 1941, the plant history is a two part historical narrative of the manufacturing plant’s history. The report lays out in extensive detail the circumstances leading to the plant’s construction, including the contractual agreements for the building of the plant, and a description of the MRS and the surrounding area. The historical narrative also includes details about the creation of support services for the plant workers, such as housing and transportation, as well as the design process for the plant. Mention is made on pages 724 and 728 of the existence of the Gun Range and Trench Mortar Range located in the Horseshoe Area of the plant.

3.2 Personnel Interviews

Seven interviews were conducted with current and former RFAAP employees. A full listing of interviews and their transcriptions are available in **Appendix B**. Information gathered from the interviews indicated that only recently (within approximately the last decade) had procedures been altered to treat the discovered mortar rounds as potentially live ordnance. Based on information provided by those interviewed, the procedures regarding ordnance safety were changed after BAE Systems assumed control of the facility. Prior to these changes, personnel (including some that had worked on the RFAAP for decades) recalled gathering discovered mortars and placing them in the back of a pickup truck for disposal. These personnel had always operated under the assumption that mortars and ordnance were fired upward at the mortar range and into tunnels in the gunnery range simply to test propellants, and that no ordnance items were ever “live” and contained explosives. During interviews with personnel working in the current manufacturing area (where the Former Gun and Mortar Range was located) (**Figure 3-1**), it was learned that mortar rounds had been unearthed during previous excavations at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. As noted previously, the EOD reports did not mention whether or not the items were considered MEC. It is possible, although unconfirmed, that the observation of a large explosion and white smoke made by an observer away from the demolition activity (which ultimately led to the unconfirmed

Figure 3-1 Facilities on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS



This page intentionally left blank

report of White Phosphorus [WP] in a mortar item), may have been a larger explosion due to additional demolition charges used by EOD. Mr. Chuck Williams, Explosive Safety Officer for BAE Systems, suggested that the mortar round considered to contain WP may have contained antifreeze instead, as mortar rounds were known to have been filled with various materials to simulate the weight of a live mortar round to properly test the propellants.

The warheads of inert mortar projectiles frequently contain a wax filler, referred to as Halowax, as a weight replacement for high explosive (HE). It is possible the filler is degraded Halowax, which contains polychlorinated naphthalene (PCN) compounds (USEPA, 2012).

Few official records or other written documentation are available regarding the past use of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. It is believed that the MRS was operated by Hercules Powder (the initial GOCO of RFAAP) as far back as 1941. During the RFAAP visit, Mr. Matt Alberts, (Environmental Specialist for BAE Systems), stated that a large number of records were removed or lost from RFAAP when the GOCO responsibility transitioned from Alliant Technical Systems to the current GOCO, BAE Systems. The contents of those records and whether they contained any information regarding operations at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS are unknown. This information was verbally confirmed by other contractor and government staff at RFAAP.

3.3 National Archives Records

Initial searches through the National Archive databases revealed little to no information specific to the Former Gun and Mortar Range (RFAAP-002-R-01) MRS facilities at RFAAP. Research efforts were refocused towards further local repository and plant library research and additional personnel interviews.

3.4 Aerial Photography Review

Numerous sets of aerial photography were discovered and digitized during the HRR. The sets included aerial surveys from 1975 and 1990. All of the aerial photographs were taken after use of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was discontinued. The aerials show past and present use of the MRS by the Continuous Automated Multi-Base Line (CAMBL) manufacturing facility (which never went into active use) and a manufacturing facility, which are located within the accessible area of the MRS (**Figure 3-1**). Also within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS there is a steep slope, shown on **Figure 3-1**, which is unsafe to access without repelling equipment and fall protection. That slope is considered unsurveyable for the purposes of this SI.

3.5 Munitions and Explosives of Concern and Munitions Constituents Characteristics

EOD reports prepared by the EOD unit at Fort Bragg, North Carolina, document the discovery of 4.2-inch and 60mm mortar items in the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Historical research revealed that howitzers and cannons with 100-pound shells were also fired to

test propellants within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS when it was active. These mortar items are routinely found during excavation and after heavy rain periods.

The Former Gun and Mortar Range (RFAAP-002-R-01) MRS may contain the munitions items listed above, as the direction and angle of fire during propellant testing at the Trench Mortar Range are unknown. Personnel working at the current manufacturing facility noted during interviews that mortar rounds are routinely found during excavation activities, and EOD has responded to mortar discoveries numerous times. Historically, the discovered mortars were treated as non-HE, collected immediately, and placed in the back of a truck for transport and disposal. Since the specific types of munitions used at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS are unknown, a list of potential MC that could be associated with this MRS is presented in Table 3-1. Calcium, iron, magnesium (including magnesium powder), sodium, and potassium are not included in the list. These constituents function as nutrients in organisms, serving as physiological electrolytes. Also, iron often is naturally occurring at elevated levels. Arsenic, as a naturally occurring constituent, was also not included in the list. Nitrocellulose (NC) has been omitted because it is likely not specific to MRS activities, and the available data on human health effects and mammalian toxicity suggest that NC is virtually nontoxic (Ellis, et al, 1980).

Although the inert filler Halowax is known to contain PCN compounds (USEPA, 2012), no special analysis is being performed to look for PCN constituents. A few PCN compounds that are detectable during analysis for semi-volatile organic compounds (SVOCs) using United States Environmental Protection Agency (USEPA) SW-846 Method 8270D Simple Ion Monitoring (SIM) are included in **Table 3-1**.

Table 3-1 Munitions Constituents

Analyte	Abbreviation	CAS Number
<i>Explosives, USEPA SW-846 Method 8330B</i>		
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4
1,3,5-Trinitrobenzene	1,3,5-TNB	99-35-4
1,3-Dinitrobenzene	1,3-DNB	99-65-0
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	479-45-8
Nitrobenzene	NB	98-95-3
2,4,6-Trinitrotoluene	2,4,6-TNT	118-96-7
4-Amino-2,6-dinitrotoluene	4-Am-DNT	19406-51-0
2-Amino-4,6-dinitrotoluene	2-Am-DNT	35572-78-2
2,4-Dinitrotoluene	2,4-DNT	121-14-2
2,6-Dinitrotoluene	2,6-DNT	606-20-2
2-Nitrotoluene	2-NT	88-72-2

Table 3-1 Munitions Constituents (Continued)

Analyte	Abbreviation	CAS Number
Explosives, USEPA SW-846 Method 8330B		
3-Nitrotoluene	3-NT	99-08-1
4-Nitrotoluene	4-NT	99-99-0
Nitroglycerin	NG	55-63-0
Pentaerythritol tetranitrate	PETN	78-11-5
3,5-dinitroaniline	3,5-DNA	618-87-1
Perchlorate, USEPA SW-846 Method 6850		
Perchlorate	N/A	14797-73-0
Semi-volatile Organic Compounds (SVOCs), USEPA SW-846 Method 8270D SIM		
Di-n-butylphthalate	N/A	84-74-2
Diphenylamine ¹	N/A	122-39-4
N-Nitrosodiphenylamine ¹	N/A	86-30-6
2-Chloronaphthalene	N/A	91-58-7
Metals, USEPA SW-846 Methods 6010C and 7471A		
Antimony	Sb	7440-36-0
Beryllium	Be	7440-41-7
Cadmium	Cd	7440-43-9
Chromium	Cr	7440-47-3
Cobalt	Co	7440-48-4
Copper	Cu	7440-50-8
Lead	Pb	7439-92-1
Lithium	Li	7439-93-2
Manganese	Mn	7439-96-5
Molybdenum	Mo	7439-98-7
Nickel	Ni	7440-02-0
Selenium	Se	7782-49-2
Silver	Ag	7440-22-4
Strontium	Sr	7440-24-6
Thallium	Tl	7440-28-0
Tin	Sn	7440-31-5
Vanadium	V	7440-62-2
Zinc	Zn	7440-66-6
Mercury	Hg	7439-97-6

¹ The two constituents co-elute and will be reported as a total.

This page intentionally left blank

4.0 Conceptual Site Model

4.1 Munitions Response Profile

The Former Gun and Mortar Range (RFAAP-002-R-01) MRS (107 acres) comprises two adjacent ranges: the Former Gun Range (20 acres) and the Former Trench Mortar Range (87 acres). Both ranges were operational during World War II (opening in 1941). The Former Trench Mortar Range, currently closed, was used to test-fire various mortar rounds to verify the quality of propellants manufactured at the facility. Little is known of the exact procedures used to test mortar rounds. Records confirming or refuting the use of HE were found, although personnel interviews (**Appendix B**) indicate that HE was not used. Anecdotal information from interviews also indicated that the mortars were generally fired in an upward direction for testing, suggesting the impact area was near the firing point. With development of the area after its discontinued use, the firing and impact areas of the MRS may be located underneath the current manufacturing facility and the defunct CAMBL facilities (**Figure 3-1**).

The current manufacturing facility is actively used for manufacturing of explosives; the CAMBL facility was built, but never went into production and is being scrapped. The original 28-acre footprint of the Former Gun Range has historically been used to test projectile propellant by test-firing projectiles into tunnels dug into the hillside. The Former Gun Range footprint was reduced by 8 acres from the 28-acre area specified in the statement of work (SOW) of this project to approximately 20 acres. The 8-acre property, located directly southwest and adjacent to the MRS, was removed from the SOW because it is currently used for testing propellant by firing inert projectiles.

The Former Gun and Mortar Range (RFAAP-002-R-01) MRS includes a steep slope, shown on **Figure 3-1**, which is unsafe to access without repelling equipment and fall protection. That slope is considered unsurveyable for the purposes of this SI.

Surface water samples have previously been collected from the New River and are summarized in *Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final 2008* (USACE, 2008). The baseline analytical parameters included: explosives; perchlorate; total organic carbon (TOC) and dissolved inorganic carbon; dissolved ferrous iron (Fe^{+2}) and dissolved manganese (Mn^{+2}) using field test methods; nitrate (NO_3); and sulfate (SO_4^{2-}). None of the surface water samples collected to date at RFAAP have indicated releases of contaminants (including MC) to the New River. All samples were collected from locations downstream of Areas A and B of Solid Waste Management Unit (SMWU) 54, which is downstream from the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

4.2 Potential Human and Ecological Receptors

RFAAP is an actively guarded facility with perimeter fencing that is patrolled by armed guards. The Former Gun and Mortar Range (RFAAP-002-R-01) MRS is not completely fenced; however,

all visitors must be escorted by RFAAP personnel while inside the MRS boundary. Potential human receptors include site workers, construction workers, trespassers, visitors, and biota. The exposure scenarios for each category of receptors are discussed below.

4.2.1 Current and Future Site Workers

The Current and Future Site Workers receptor includes all those personnel working at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS (inside the fence) that are part of daily RFAAP GOCO operations. This includes BAE Systems and future contractor personnel, U.S. Army personnel, and others involved in the day-to-day activities occurring at the MRS. Based on this definition, Current and Future Site Workers are anticipated to only encounter surficial MPPEH, MEC, or MC. Workers who are engaged in construction and excavation activities, and therefore may contact subsurface MPPEH, MEC, or MC, are addressed as Current and Future Construction Workers.

Current and Future Site Workers have the potential to tread on and handle MPPEH and MEC on the ground surface, and MPPEH and MEC that have been exposed from the subsurface as a result of erosion, construction activities, or frost heave. Temperatures below freezing occur at the MRS, and the frost line extends up to 30 inches (MCPSA, 2015). MEC/MPPEH may be buried above the frost line. It is possible that frost heave may cause the migration of MEC/MPPEH in the MRS. MEC/MPPEH may also be brought to the surface after erosion due to periods of heavy rainfall as confirmed during interviews with current RFAAP workers. MEC/MPPEH also may be brought to the surface as a result of construction activities.

Current and Future Site Workers may come into contact with MC in surface soil via the dermal contact, incidental ingestion, and inhalation (dust) exposure routes. Dermal contact with MC may occur when handling MC contaminated surface or subsurface soils on the MRS.

Although MC has not been detected in surface water samples in the New River, runoff from the Former Gun and Mortar Range (RFAAP-002-R-01) MRS may transport MC through drainage ditches. This may result in exposure via dermal contact and incidental ingestion of MC in surface water present in drainage ditches.

Hunting is allowed on a limited basis at RFAAP and is restricted to site personnel who have obtained an RFAAP-specific hunting permit. Hunting does not occur on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS; however, game animals are not restricted from the MRS. A subset of the Current and Future Site Worker receptor category may be exposed to MC through the ingestion of game animals harvested from RFAAP that have bioaccumulated MC from the MRS. Hunting conducted at RFAAP is not suspected to be for subsistence purposes, but it is likely that game animals harvested from RFAAP are consumed. Therefore, this pathway is potentially complete for a subset of site workers.

4.2.2 Current and Future Construction Workers

The Current and Future Construction Workers receptor includes all those personnel involved in construction, excavation, demolition, or repair to current or future infrastructure or facilities inside the fence line at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Based on this definition, Current and Future Construction Workers may encounter MPPEH, MEC, and MC in the surface and subsurface soils.

Current and Future Construction Workers have the potential to tread on and handle MPPEH and MEC on the ground surface, and MPPEH and MEC that have been exposed from the subsurface as a result of erosion, construction activities, or frost heave.

Current and Future Construction Workers have the potential to excavate, tread on, and handle subsurface MPPEH and MEC during performance of construction, excavation, demolition or repair to infrastructure and facilities at the MRS.

There is the potential for Current and Future Construction Workers to come into contact with MC in surface and subsurface soil via the dermal contact, incidental ingestion, and inhalation (dust) exposure routes.

Current and Future Construction Workers also have the potential to come into contact with MC in surface water in drainage ditches via dermal contact or incidental ingestion of runoff from the MRS.

4.2.3 Current and Future Trespassers

The Current and Future Trespassers receptor includes all those individuals who may access the Former Gun and Mortar Range (RFAAP-002-R-01) MRS without authorization. Potential motivations for unauthorized access to RFAAP could include theft, vandalism, or unauthorized hunting activities. A potential avenue for accessing the MRS is from the New River, climbing the ridge (unsurveyable slope) and progressing over (climbing), under (digging), or through (cutting) the fence line.

Current and Future Trespassers have the potential to tread on and handle MPPEH and MEC on the ground surface, and MPPEH and MEC that have been exposed from the subsurface as a result of erosion, construction activities, or frost heave.

There is the potential for Current and Future Trespassers to come into contact with MC in surface soil via the dermal contact, incidental ingestion, and inhalation (dust) exposure routes.

Current and Future Trespassers also have the potential to come into contact with MC in surface water in drainage ditches via dermal contact or incidental ingestion of runoff from the MRS.

Trespassers may access the Former Gun and Mortar Range (RFAAP-002-R-01) MRS for the purpose of unauthorized hunting. A subset of the Current and Future Trespassers receptor category

may be exposed to MC through the ingestion of game animals harvested from on or near the MRS that have been impacted by bioaccumulation of MC. Hunting conducted at RFAAP is not suspected to be for subsistence purposes, but it is likely that game animals harvested from RFAAP are consumed. Therefore, this pathway is potentially complete for a subset of trespassers.

4.2.4 Current or Future Visitors

Visitors are able to access the MRS, but do not have unrestricted access. Visitors must be cleared through RFAAP Security, and must be escorted at all times while on the MRS itself. Although unlikely, Current and Future Visitors may encounter surficial MPPEH, MEC, or MC.

Current and Future Visitors have the potential to tread on and handle MPPEH and MEC on the ground surface, and MPPEH and MEC that have been exposed from the subsurface as a result of erosion, construction activities, or frost heave.

Current and Future Visitors may come into contact with MC in surface soil via the dermal contact, incidental ingestion, and inhalation (dust) exposure routes.

Current and Future Visitors also have the potential to come into contact with MC in surface water in drainage ditches via dermal contact or incidental ingestion of runoff from the MRS.

4.2.5 Ecological Receptors

The U.S. Fish and Wildlife Service (USFWS) does not list any critical habitat for threatened or endangered species within the boundaries of, or in the nearby vicinity of, the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. The USFWS Environmental Conservation Online System (USFWS, 2014) lists the following species (**Table 4-1**) as present in Pulaski and/or Montgomery Counties based on published historical range and population.

Previous biological surveys have not observed any of these species on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS or the RFAAP (URS, 2003); however, based on USFWS data presented in **Table 4-1**, it is possible that *Polygyris virgatus* and *Echinacea laevigata* may be present at or near the MRS.

Table 4-1 Threatened and Endangered Species in Montgomery and Pulaski Counties, Virginia

Species	Listing Name	Status	Notes
Animals			
Bat, Indiana	Myotis sodalis	Endangered	The Indiana bat is found along small to medium stream corridors with well-developed riparian woods; woodlots within 1 to 3 miles of small to medium streams; and upland forests. Caves and mines are critical for hibernation. (USFWS, 2014)

Table 4-1 Threatened and Endangered Species in Montgomery and Pulaski Counties, Virginia (Continued)

Species	Listing Name	Status	Notes
Animals (Continued)			
Bat, Virginia big-eared	Corynorhinus (=Plecotus) townsendii virginianus	Endangered	The Virginia big-eared bat is known to occur in Bath, Bland, Buchanan, Floyd, Highland, Pulaski, Rockingham, Scott, Shenandoah, Tazewell, Warren, and Washington counties in Virginia. Caves are critical for this species for hibernation and for rearing their young. (USFWS, 2014)
Bean, Cumberland (pearlymussel)	Villosa trabalis	Endangered	The Cumberland Bean pearlymussel is known to occur in Virginia; however, critical habitat has not been designated. (USFWS, 2014) As an aquatic organism, it would not be present on the MRS, but may be present in the adjacent New River.
Logperch, Roanoke	Percina rex	Endangered	The Roanoke Logperch prefers large sized, warm, clear streams and riffles, runs, and pools with sand, gravel, and boulders. It is known to occur in Goose Creek in Virginia, as well as in Montgomery County. (USFWS, 2014) As an aquatic species, the Roanoke Logperch would not be present on the MRS.
Snail, Virginia Fringed Mountain	Polygyriscus virginianus	Endangered	The Virginia fringed mounted snail is found exclusively below dolostone bluffs on the west side of the New River in Pulaski County near Fairlawn, Virginia, mostly beneath scree or in talus on the lower or foot of slopes (USFWS, 2014). Fairlawn, Virginia is approximately 2 miles from the MRS.
Spiny mussel, James	Pleurobema collina	Endangered	This fresh water mussel is found in the James River drainage and the Dan/Mayo River systems within the Roanoke River drainage in Virginia, North Carolina, and West Virginia, and is known to occur in Montgomery County. No critical habitat has been designated for this species. (USFWS, 2014)
Plants			
Coneflower, Smooth	Echinacea laevigata	Endangered	The Smooth Coneflower is known to occur in both Montgomery and Pulaski counties in Virginia. No critical habitat has been designated for this species. (USFWS, 2014)

In 2001, as part of the RCRA permitting process, a Screening Level Ecological Risk Assessment (SLERA) was performed at RFAAP for the Virginia Department of Environmental Quality (VDEQ) (Franklin Engineering Group, 2001). This SLERA developed a list of receptors potentially present at RFAAP. **Table 4-2** presents a partial table from the 2001 SLERA (aquatic animals have not been included).

Table 4-2 Common Ecological Receptors Present at Radford Army Ammunition Plant

Receptor Category	Receptor Species	Critical Ecological Attributes
Soil Invertebrates	Arachnida, Diplopoda, Insecta, Chilopoda	Soil invertebrates provide an important food source for many higher trophic level species. As decomposers/detrivores they play a critical role in nutrient cycling. They also aid in soil aeration and infiltration by increasing macro, and micro porosity.

Table 4-2 Common Ecological Receptors Present at Radford Army Ammunition Plant (Continued)

Receptor Category	Receptor Species	Critical Ecological Attributes
Herbivorous Mammals	Meadow vole, White-tailed deer, Eastern fox squirrel, Eastern chipmunk, Eastern gray squirrel, Woodchuck, Meadow jumping mouse	Herbivorous mammals are an important prey item for many higher trophic level predators. They provide an important link for energy transfer between primary producers and higher trophic level consumers. In addition, these organisms generally comprise the majority of the terrestrial tissue biomass, and are important in seed dispersal and pollination for many plant species.
Herbivorous Birds	Mourning dove, Canada goose, Wild turkey, Chipping sparrow, Northern cardinal	Herbivorous birds are an important prey item for many higher trophic level predators. They are important in seed dispersal for many plants in both terrestrial and aquatic ecosystems. Aquatic herbivorous birds may also play an important role in egg dispersion for fish and invertebrate species.
Omnivorous Mammals	Least shrew, Virginia opossum, Striped skunk, Northern short-tailed shrew,	Omnivorous mammals are an important prey item for higher trophic level predators, and influence lower trophic level populations through predation. They play an important role in seed dispersal for many types of terrestrial vegetation and aquatic plants.
Omnivorous Birds	American robin, Mallard, Carolina wren, Blue jay, American crow, Yellow warbler, Pileated woodpecker	Omnivorous birds are an important prey item for higher trophic level predators. They play an important role in seed dispersal and pollination for many types of terrestrial vegetation and aquatic plants. In addition, aquatic species provide egg dispersal for some fish and invertebrate species.

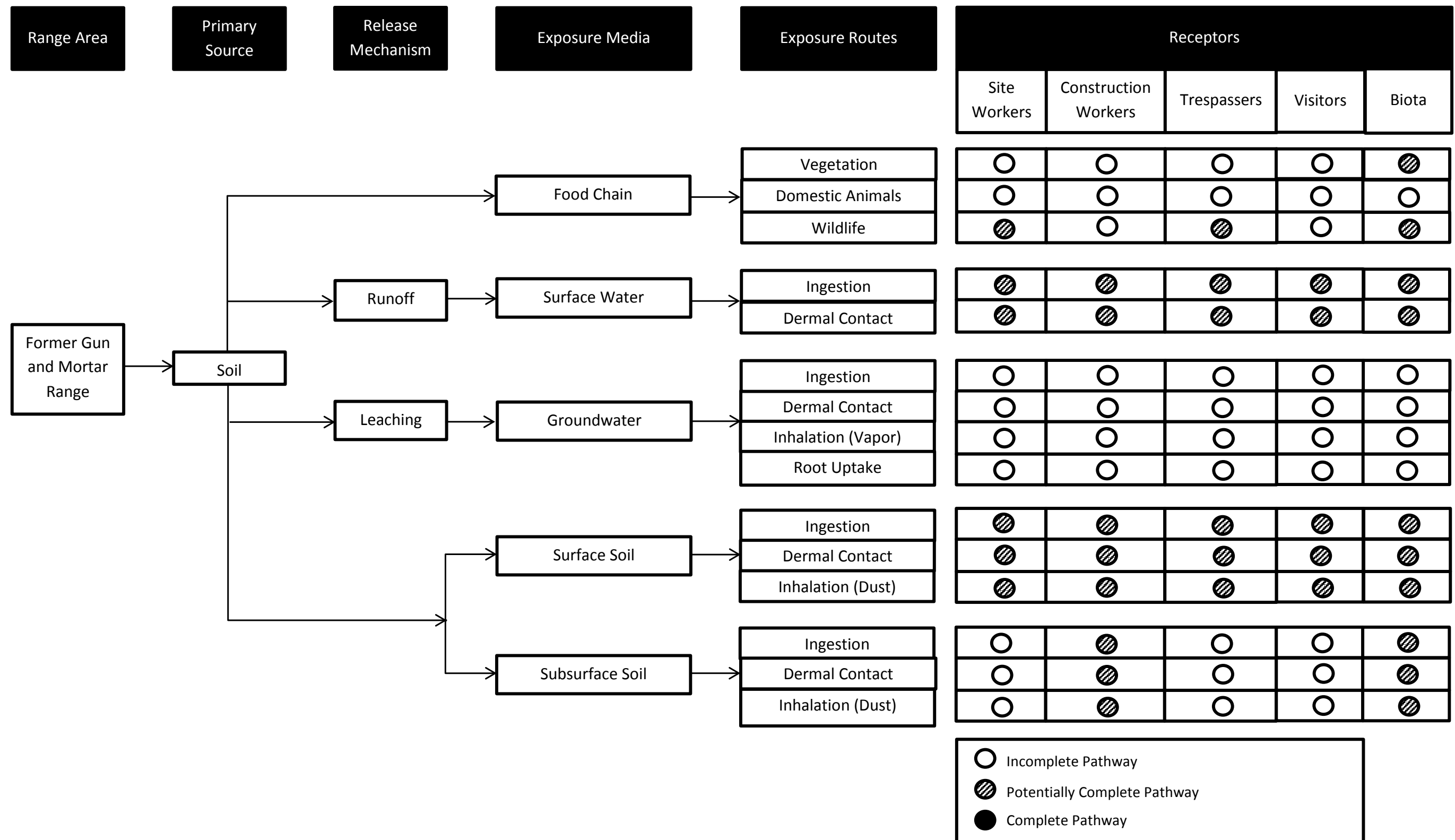
The primary exposure of terrestrial mammalian and avian ecological receptors to chemical constituents is through ingestion of contaminated soil and ingestion of chemicals in food items. The potentially complete exposure pathway of concern for plants is uptake of chemical constituents from surface and subsurface soil. Direct (dermal) contact with surface and subsurface soils is only considered a potentially complete exposure pathway for terrestrial invertebrates and burrowing mammals.

4.3 Pathway Analysis

The information presented in the CSM was used to identify all actual, potentially complete, or incomplete source-receptor interactions for the Former Gun and Mortar Range (RFAAP-002-R-01) MRS for both current and reasonably anticipated future land uses. An exposure pathway is the course a chemical or physical agent takes from a source to a receptor. Each MEC pathway includes a source, access, activity, and a receptor. Each MC pathway includes a source, an exposure medium, an exposure route, and a receptor. The MC pathways may also include a release mechanism (e.g., volatilization) and a transport medium (e.g., air) if the point of exposure is not at the same location as the source.

Figure 4-1 and **Figure 4-2** represent a graphical representation of the CSM, transport mechanisms, and exposure routes between the source contaminants and receptors. MC receptors are human and ecological. MEC/MPPEH receptors are human only.

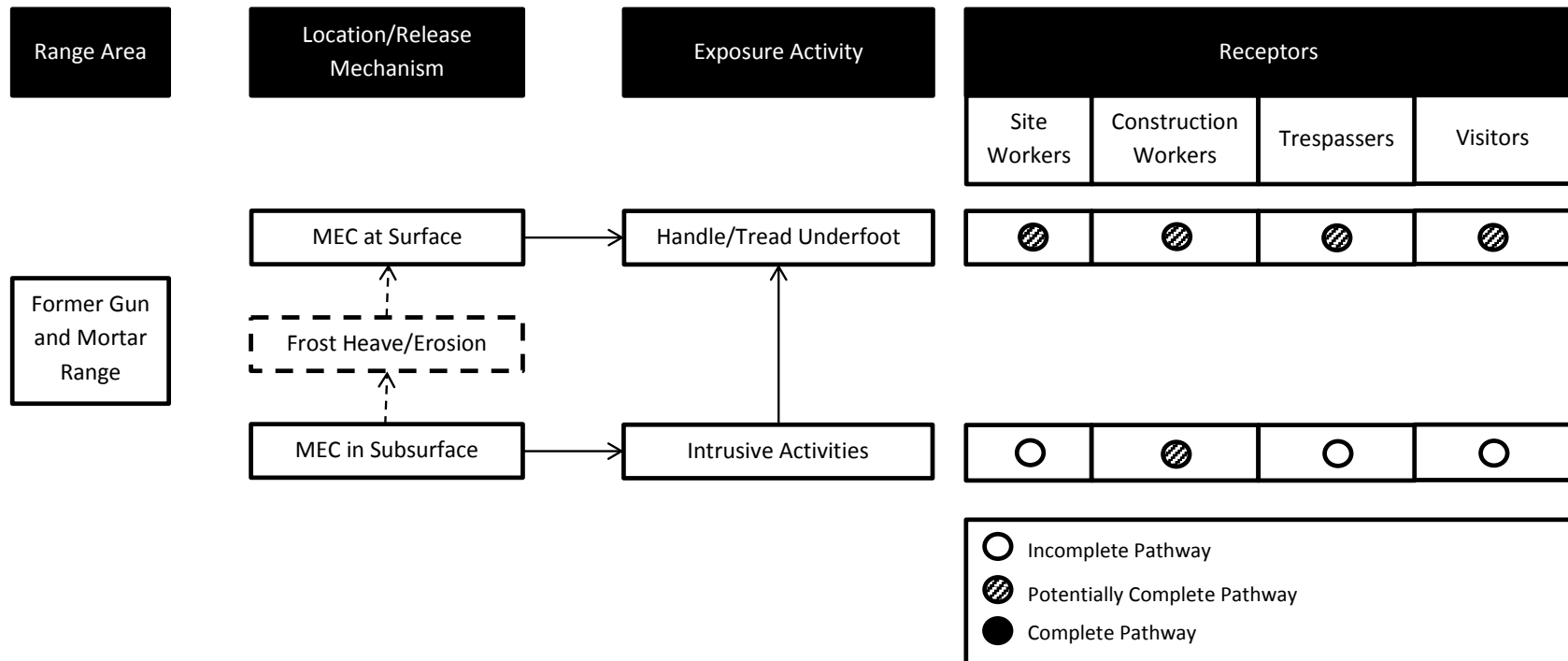
Figure 4-1 Graphical Representation of Conceptual Site Model for Munitions Constituents Exposure



Note: Surface Water refers to water in drainage ditches and does not include the New River

This page intentionally left blank

Figure 4-2 Graphical Representation of Conceptual Site Model for Munitions and Explosives of Concern and Materials Potentially Presenting an Explosive Hazard Exposure



This page intentionally left blank

4.3.1 Transport Processes

A combination of naturally occurring and human activities increases the risk of exposure to MC. Natural occurrences, such as soil erosion due to high winds or water action, can loosen and displace soils, causing MC located on or beneath the ground surface to be moved or exposed. The frost line at the MRS is approximately 30 inches (MCPSA, 2015), and MEC/MPPEH buried shallower than 30 inches may be subject to frost heave. Man-made transport processes, such as excavation, may also transport MEC/MPPEH. Interviewees mentioned that mortars were found during previous construction activities. None of the interviewees could remember the location of the mortars discovered during construction or the location and method of disposal for those mortars. The potential source area at RFAAP is the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Based on the type of historic activities at the MRS, the medium initially receiving MC releases into the environment, if they occurred, was surface soil.

In general, MC migration pathways involve movement via air, water, soil, and the interfaces between these media. Based on the types of releases and the characteristics of MC, the fate and transport of contaminants at RFAAP are expected to occur mainly in the terrestrial environment, but there is potential for migration by aquatic and atmospheric pathways as well.

In the terrestrial environment, if the contaminant is released to soil, it may volatilize, adhere to the soil by sorption, leach into the groundwater with precipitation, or degrade due to chemical (abiotic) or biological (biotic) processes. If the contaminant is volatilized from soil, it may be released to the atmosphere or migrate to groundwater. There are no known aquatic environments present within the Former Gun and Mortar Range (RFAAP-002-R-01) MRS except for occasional surface water represented by runoff from the MRS that drains via ditches toward the unsurveyable slope adjacent to the New River.

In the atmospheric environment, contaminants may exist as vapors or as suspended 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. After completion of the SI activities, a determination will be made, based on the evaluation of potential MC found in soil, as to whether or not compete pathways exist for the atmospheric environment.

Henry's Law Constant (H_c) is a measure of the volatility of a compound from water and is related to the vapor pressure and water solubility of the compound. Compounds exhibiting high vapor pressures and low water solubilities tend to have high volatilization rates from water (and therefore, high H_c values). The organic carbon/water partition coefficient (K_{oc}) value is a measure of the tendency of an organic chemical to partition to the organic fraction of soil from water. The soil/water partition coefficient (K_d) value is an analogous value for whole soil used for metals. The higher the values, the greater is the sorption potential of the compound.

The potential fate and transport of MC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS is strongly influenced by the physical and chemical properties of the MC, as well as by environmental factors such as vadose zone characteristics. Metals have relatively high values of H_c and K_{oc} (or K_d).

Some HEs and oxidizer constituents have greater solubility than metals. The K_{oc} values for HEs such as RDX (195 cubic centimeters per gram [cm^3/g]) indicate a limited potential for leaching to groundwater. Ammonium perchlorate, a common oxidizer used in rocket fuels, is highly soluble and very mobile in the environment. The water solubility of ammonium perchlorate is roughly 200,000 milligrams per liter. The average depth to groundwater at RFAAP is approximately 70 feet bgs (URS, 2003). Movement of chemical constituents from surface soil to subsurface soil is generally mediated by infiltration of precipitation, with the greatest movement expected for the compounds with higher water solubility. Even relatively insoluble compounds such as metals can be transported to subsurface soils via mixing of the soil column by soil invertebrates and burrowing animals. Plant roots and invertebrate and mammal burrows/tunnels create preferential infiltration pathways along which downward transport of particle-bound contaminants can occur.

4.3.2 Exposure Media and Accessibility

Environmental contaminants, such as MC, often undergo various processes (e.g., migration) such that media at locations other than the source area can become contaminated. Therefore, all potentially contaminated media (exposure media) were considered. The primary exposure media at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS are surface soils, subsurface soils, and surface water in ditches. Previous studies indicated no MC releases to the adjacent New River, and MC has not been detected in surface water samples in the New River. Consequently, exposure by receptors in the New River to MC is not considered likely. Runoff may transport MC along drainage ditches in the accessible areas of the MRS towards the unsurveyable slope, located on the MRS, adjacent to the New River. This may result in exposure to MC in surface soils, subsurface soils, and surface water in the drainage ditches and the unsurveyable slope of the MRS.

4.3.3 Munitions and Explosives of Concern Exposure Receptors

A receptor is an organism (human or ecological) that potentially contacts a chemical or physical agent in one or more environmental media. Anticipated receptor categories for the Former Gun and Mortar Range (RFAAP-002-R-01) MRS were described in **Section 4.2**.

Biota is generally not considered when evaluating MEC risk, because, with the exception of threatened and endangered species, risk to biotic receptors is usually evaluated at the population level. Though an ecological receptor may experience a negative affect from encountering MEC, MEC does not pose risk to biotic populations unless a large area of habitat were to be destroyed, for example, by a large detonation.

All potential access and activities were considered in evaluating the source–receptor interactions at the MRS. The media considered for MEC exposure at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS are soil, both surface and subsurface. Potential MEC hazards in surface soil are anticipated to impact the current and future site worker, current and future construction worker, current and future trespasser, and current and future visitor receptor categories. Potential MEC hazards in subsurface soil are anticipated to impact the current and future construction worker receptor category.

4.3.4 Groundwater Migration Pathway Analysis for Munitions Constituents

There is no present-day human exposure to groundwater at RFAAP. The aquifers beneath RFAAP consist of an alluvial aquifer in the New River floodplain, with water levels controlled by the level of water in the New River, and a fractured bedrock/karst aquifer. Depth to groundwater is approximately 70 feet bgs (URS, 2003). Depending on future land use, there is a possibility that groundwater supply wells could be put in place for domestic or industrial uses; however, water used for domestic and industrial purposes in the RFAAP area is currently drawn from the New River.

Metals generally have limited mobility in soil, due to low solubility and their tendency to bind to soil particles. Some of the explosives and propellant compounds associated with potential MEC have greater solubility, and therefore greater potential to migrate to groundwater. As described in **Section 4.3.1**, K_{oc} values for these compounds are on the order of $100 \text{ cm}^3/\text{g}$ or higher. Therefore, while some leaching from soil might occur over time, the probability of appreciable groundwater impact from past munitions related activities is low, and detectable residual concentrations of these compounds in the receiving medium (soil) can be expected if in fact releases to soil have occurred. Groundwater exposure pathways will be evaluated if potential MC contamination is found in surface soil. At that time a determination will be made as to whether groundwater sampling will be necessary at this MRS in future response actions. Ecological exposure to groundwater is incomplete due to the depth of groundwater at RFAAP (70 feet bgs).

4.3.5 Surface Water Migration Pathway Analysis for Munitions Constituents

Surface water at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS consists solely of runoff during and immediately following heavy rains. The runoff flows through drainage ditches located in accessible areas of the MRS toward the unsurveyable slope, adjacent to the New River. Although previous New River water sampling for MC indicated no releases from the MRS, exposure by receptors to the occasional surface water in the drainage ditches cannot be excluded. Consequently, all receptors in **Figure 4-1** (i.e., site workers, construction workers, trespassers, visitors, and biota) are considered potentially exposed to surface water through ingestion and dermal contact.

4.3.6 Soil Migration Pathway Analysis for Munitions Constituents

All of the human receptors identified in **Figure 4-1** are potentially exposed to MC in surface soils through incidental ingestion, inhalation of dust, or dermal contact. In addition, construction workers and biota may be exposed to MC in subsurface soils. Construction workers may be exposed to ingestion, inhalation, or dermal contact with MC in subsurface soils during performance of construction, excavation, demolition or repair to infrastructure and facilities at the MRS.

The primary exposure of biota to MC is through ingestion of contaminated soil and ingestion of chemicals in food items. The potentially complete exposure pathway of concern for plants is uptake of chemical constituents from surface and subsurface soil. Terrestrial invertebrates, birds, and mammals are potentially exposed to MC through ingestion, dermal contact, and inhalation of surface and subsurface soils.

5.0 Data Quality Objectives

The presence of MEC at the MRS was established during the reconnaissance site walk performed in December 2014, when a 60mm mortar was discovered lying on the ground surface. As such, further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping). Therefore, this SI will include a MEC assisted visual survey (AVS) that will be conducted with the objective of gathering sufficient information to identify potential types of MEC, MEC disposal areas (areas with DMM lying on the ground surface), impact areas, and to identify potential sample locations biased toward drainage features to determine the potential of MC migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River. The AVS will include the ridgeline adjacent to the New River and unsurveyable slope to identify additional drainages. Further, the AVS will include areas around buildings in the current active facility to identify surface MEC that could pose a hazard to workers. The information gathered during this SI will be used to support the planning of future investigations (e.g., RFI Work Plan).

The objective of the incremental sampling is to determine the presence or absence of diffuse MC contamination related to historical activities conducted at the MRS. Biased discrete samples will be collected from drainages to evaluate the potential migration of MC from the MRS, while discrete samples will be collected from locations where compromised surface MEC are discovered. The intent of the discrete samples is to determine if a release of MC has occurred at the location of the compromised MEC item.

DQOs for the SI were developed IAW the procedures outlined in the USEPA DQOs Process for Hazardous Waste SIs (EPA, 2000). **Table 5-1** depicts the DQO process for the Former Gun and Mortar Range (RFAAP-002-R-01) MRS at RFAAP.

Table 5-1 DQO Process

Step	Description	DQO for RFAAP
Step 1. State the Problem	Define the problem that necessitates the study; identify the planning team, examine budget, schedule.	The Former Gun and Mortar Range (RFAAP-002-R-01) MRS at RFAAP requires an SI due to the discovery of mortars at the MRS in the past. The preliminary CSM indicates that there is potential for exposure of MEC, MPPEH and MC to human receptors, and MC to ecological receptors. The planning team for this SI includes the USACE Baltimore District (Project Management) and the executing contractors. Stakeholders include the VDEQ, the USEPA Region 3, and RFAAP.

Table 5-1 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 2. Identify the Goal of the Study	State how environmental data will be used in meeting objectives and solving the problem, identify study questions, define alternative outcomes.	Environmental data collected during this investigation will be utilized to determine answers to the following study questions: 1) what types of MEC are present on the ground surface and can be inferred for the subsurface; 2) can MEC disposal or impact areas be identified; 3) has MC been released to drainages on the MRS and, if so, is there potential for MC to migrate off site; and 4) is diffuse MC contamination present as a result of the presence of MEC and/or MPPEH, and are levels of MC (if present) of a sufficient concentration to warrant further investigations for MC at the MRS? Dependent on the findings of the soil investigation, several outcomes may be possible, including eliminating from consideration surface diffuse MC contamination from future investigations and focusing of future MC subsurface investigations. An RFI for MPPEH and/or MEC is already merited based on the site walk and historical record review.
Step 3. Identify Information Inputs	Identify data & information needed to answer study questions.	This is a new data collection effort. An HRR and interviews have been conducted for the MRS. Visual surveys will be performed by a team consisting of a UXO Technician III (who will act as team leader and Site Safety and Health Officer [SSHO]) and either an Environmental Professional or second UXO Technician. The UXO personnel will be equipped with metal detectors (a process referred to as AVS) to determine the presence or absence of MPPEH, MEC, and/or Munitions Debris (MD) lying on the ground surface in areas with dense vegetation being sampled for MC and around buildings within the active facility, and to identify potential sample locations biased toward drainage features to see if MC is potentially migrating off the MRS towards the unsurveyable area adjacent to the New River. The AVS will also include the ridgeline adjacent to the New River and unsurveyable slope to identify additional drainages. Soil sampling will be conducted to evaluate the presence or absence of diffuse MC (ISM samples), MC migration (discrete), and point source MC (discrete) where compromised MEC is discovered. USEPA Method SW846 8330B will be used for explosives. USEPA Method SW846 6010C/7471A will be used for target analyte list metals. USEPA Method SW846 8270D will be used for a short list of SVOCs, and USEPA Method SW846-6850 will be used for perchlorate analysis. The ISM analytical results will be compared to USEPA Regional Screening Levels (RSLs) and Ecological Soil Screening Levels (EcoSSLs), while discrete sample results will be compared to RSLs, EcoSSLs, and RFAAP-specific metal background levels to assess potential risks to human health and the environment.

Table 5-1 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 4. Define the Boundaries of the Study	Specify the target population & characteristics of interest, define spatial & temporal limits, scale of influence.	The target population for MEC and MPPEH are those items present on the ground surface and in the subsurface contained within the MRS boundaries. The characteristics of interest include the hazards associated with contact with MEC or MPPEH. AVSs for MEC/MPPEH/MD will be performed only within the areas being sampled for MC, around buildings within the active facility, to identify potential sample locations biased toward drainage features to see if MC is potentially migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River, and the ridgeline adjacent to the New River to identify additional drainages. The boundary of the MEC/MPPEH study area is the MRS, excluding the very steep unsurveyable slopes. AVSs will not be conducted on the steep slopes. The target populations for MC include the concentration of diffuse MC in surface soil across the MRS, concentration of MC where compromised MEC or MPPEH is discovered, and the concentration of MC in sediment within potential surface water and sediment migration routes. Table 3-1 includes the list of MC. All field work will occur during favorable climatic conditions void of snow cover or frozen surface soils that could impede AVS and surface soil sampling activities. The boundary of the MC study area includes the entire MRS (~ 107 acres).
Step 5. Develop the Analytic Approach	Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from findings.	The focus of this SI is to identify the types of MEC, locations of potential MEC disposal areas (areas with DMM lying on the ground surface), impact areas, and to determine the potential of MC migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River. Characteristics of disposal areas (areas with DMM) will be noted to determine if they are indicative of a firing point to support and concentrate future investigations. Since the presence of MEC has already been established, future investigations will be required. The presence of MC concentrations in incremental samples that exceed RSLs, or Project Comparison Values (PCVs), is of primary interest. The presence of ISM and discrete MC concentrations in surface soils exceeding RSLs will require the subsequent determination of the extent of MC in surface soils and potentially subsurface soils, and whether the presence of MC in surface and/or subsurface soil presents an unacceptable risk to human health and the environment. Incremental surface soil sample MC results that are below RSLs will be interpreted to indicate that diffuse soil contamination is not present. The presence of MC concentrations in surface sediment exceeding RSLs will require the subsequent determination of the extent of MC in surface water/sediment migration routes, whether the MC is migrating off the MRS, and whether the presence of MC in sediment presents an unacceptable risk to human health and the environment. Sediment sample MC results that are below RSLs will be interpreted to indicate that MC are not migrating off the MRS. The presence of MC concentrations in soil samples collected adjacent to compromised surface MEC exceeding RSLs will require the subsequent determination of the extent of MC in the soils surrounding the compromised MEC and whether the presence of MC in these soils present an unacceptable risk to human health and the environment. MC soil sample results from compromised surface MEC that are below RSLs will be interpreted to indicate that MC soil contamination is not present. The PCVs are presented in Table 6-2 and Table 6-3.

Table 5-1 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 6. Specify Performance or Acceptance Criteria	Specify probability limits for false rejection and false acceptance decision errors. Develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use.	AVS activities will be performed IAW the procedures set forth in Section 5.1.1 and quality assurance/quality control (QA/QC) standards presented in Appendix C . Sampling and analysis will be performed IAW the procedures set forth in Section 5.1.2 and Section 6.0 and the QA/QC standards presented in Appendix C . Data need to be capable of accurately characterizing the presence of contaminants less than the comparison values. All data are anticipated to be definitive. Samples will be analyzed by an analytical laboratory following USEPA SW-846 methodologies specified in the QAPP worksheets. Sample results sent off-site for analysis will undergo data verification and validation IAW the National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2014) and Inorganic Superfund Data Review (USEPA, 2014) to assure its usability for making decisions regarding the site. Data qualified as rejected (R) will not be used. Data usability will be determined by evaluating sample collection and analysis results to the precision, accuracy, representativeness, completeness, comparability and sensitivity (PARCCS) parameters as discussed in Worksheet #37 of the QAPP.
Step 7. Develop the Plan for Obtaining Data.	Select the resource-effective sampling and analysis plan that meets the performance criteria.	The field sampling activities are presented in Section 6.0 . QA/QC procedures for data collection are presented in Appendix C .

An Analog Instrument AVS will be conducted to determine the presence of surface MEC/MPPEH/MD at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Approximately 1.5 linear miles of transects will be covered by the survey within the incremental sample decision units (DUs) (2 – 0.75 miles per unit). The buildings of the active facility will be surveyed (1.6 linear miles) to identify surface MEC that could pose a hazard to workers. Finally, potential sample locations biased toward drainage features will be surveyed to determine if MC is potentially migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River (approximately 1.1 miles) and the ridgeline adjacent to the New River and unsurveyable slope to identify additional drainages (approximately 1.8 miles). As previously stated, the presence of MEC has already been established at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. As such, data collected during the SI will be focused on developing and supporting future investigations.

The Former Gun and Mortar Range (RFAAP-002-R-01) MRS will be evaluated to determine if an impact has occurred by the use, storage, or disposal of military munitions resulting in the potential for the diffuse release of MC contamination to surface soils. Surface soil sampling will be performed as follows:

- Biased discrete surface soil sampling (0-6 inches bgs) will be performed adjacent to any compromised MEC or MPPEH identified during the AVS to identify point source releases.
- Biased discrete surface soil sampling (0-6 inches bgs) will be performed within drainage features where MEC or MPPEH has been identified, biased towards identifying possible MC transportation routes (i.e., drainages leading from the accessible area of the MRS towards the unsurveyable slope, located on the MRS, and adjacent to the New River).
- Surface soil sampling (0-2.5 cm bgs) will be performed using an Incremental Sampling Methodology (ISM) to determine whether past activities resulted in diffuse releases of MC to surface soils.

If MC concentrations in surface soils exceed the PCVs presented in **Table 6-2** and **Table 6-3**, then an evaluation will be conducted to determine if further characterization of the nature and extent of MC in surface soils at the MRS is warranted. Again, screening values for ISM results will include the RSLs and EcoSSLs, while discrete sample results will be compared to RSLs, EcoSSLs, and background values.

5.1 Rationale and Design

The DQOs were developed based on the findings of the HRR and CSM. Personnel interviews and records indicate the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was used as a testing range for mortar rounds and artillery fired to evaluate the quality of propellant charges. The limited number of historical records, photographs, and figures discovered during the HRR process substantiate these reports. The presence of MEC at the MRS was established during the reconnaissance site walk performed December 2014, when a 60mm mortar was discovered lying on the ground surface. As such, further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust geophysical survey methods (e.g., through digital geophysical mapping).

The AVS and MC sampling methods described in the following sections will provide sufficient data to focus and scope possible further actions to determine the nature and extent of potential surface and subsurface MPPEH, MEC, and MC beyond this SI. The ISM sampling will support the determination regarding the presence or absence of diffuse surface MC.

5.1.1 Analog Instrument-Assisted Visual Survey

An AVS will be conducted to evaluate the presence or absence of MEC, MPPEH, and MD lying on the ground surface at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Mortars have routinely been discovered during facility operations, construction activities, or exposed by heavy rains. Personnel interviews and records indicate the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was used as a testing range for mortar rounds and artillery fired to evaluate propellant charges. Visual surveys and metallic anomaly detection using analog metal detectors will be conducted as part of the AVS to identify types of MEC, MEC disposal areas

(areas with DMM lying on the ground surface), impact areas, and to identify potential sample locations biased toward drainage features and the ridgeline to determine the potential of MC migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River. The AVS will include areas around buildings in the current manufacturing area to identify surface MEC that could pose a hazard to workers. The AVS survey areas and transect lengths were not selected based on the Visual Sample Plan (VSP), but rather identifying areas that could present an immediate threat to onsite workers (NG2 area), sampling personnel collecting discrete and ISM samples, and drainages that could potentially carry MC off the MRS. It should be noted that the VSP Remedial Investigation Module is used to establish the size of the target area for the smallest munitions item suspected of being used on the site (already identified as a 60mm mortar). VSP then defines the transect spacing required to ensure a 100% chance of traversing a target area representative of a 60 range. Because munitions were already detected at the site and further investigation has already been established, VSP is not being used to determine the AVS distances and transect separations.

All identifiable range and MEC/MPPEH/MD features will be recorded. AVSs will be conducted along 10-foot wide transects in the areas shown on **Figure 5-1**. The 10 foot wide transect is based on the approximate distance between two UXO technicians employing analog metal detectors.

Equipment anticipated to be used during the AVS includes:

1. Schonstedt GA-52Cx analog metal detector. This is the industry standard technology for anomaly avoidance. Target discrimination is not required, so the analog metal detector will provide sufficient information to evaluate the potential for subsurface MPPEH or MEC. A device with similar or greater detection capabilities may be substituted if necessary.
2. Trimble GeoXT or GeoXH handheld Global Positioning System (GPS). Both GPS units are capable of sub-meter accuracy (post-processed). These will be used to record points, lines, and areas in order to provide an accurate spatial characterization of the MRS.

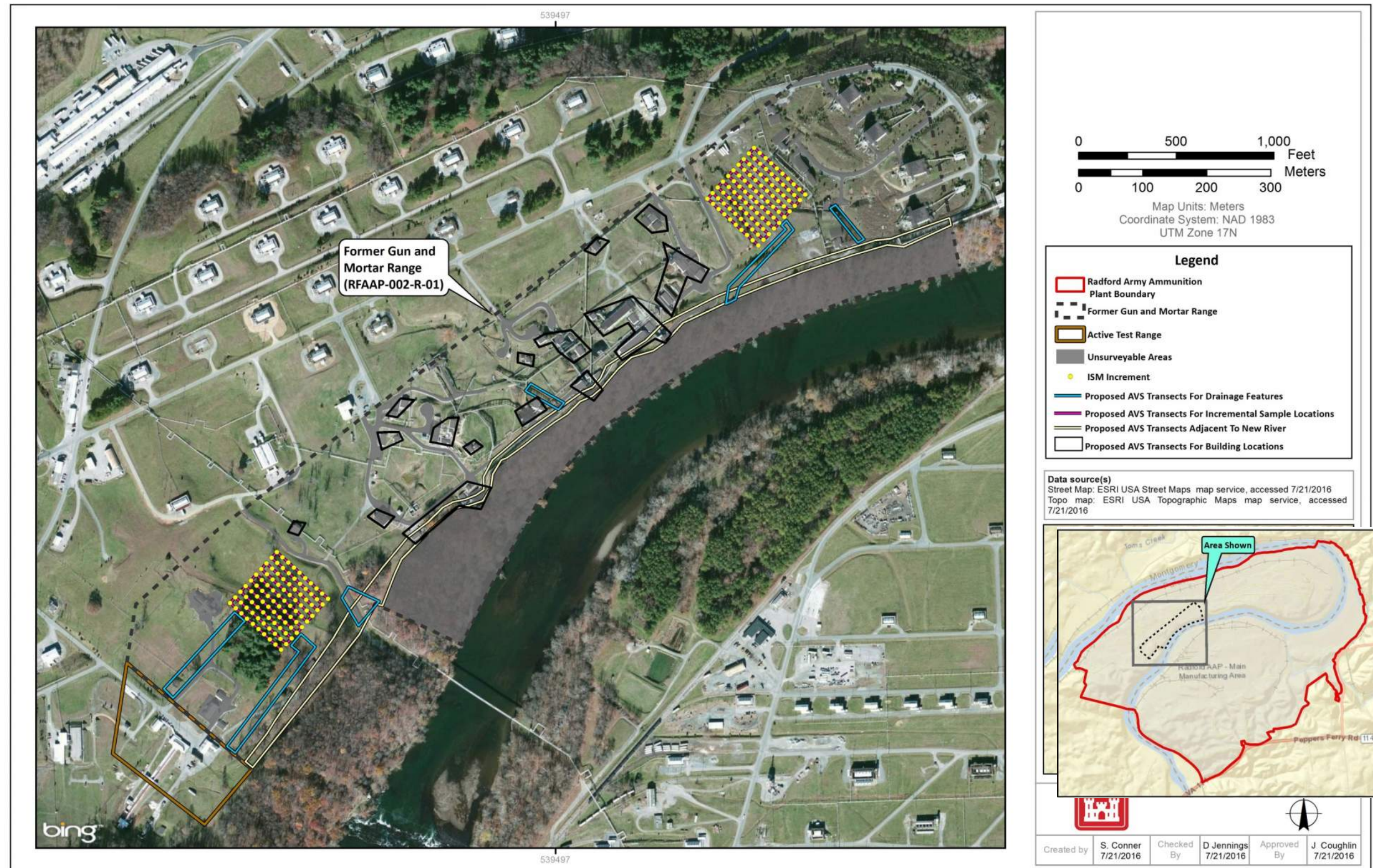
5.1.2 Munitions Constituents Surface Soil Sampling

Surface soil samples will be collected using ISM, as presented by the Interstate Technology Regulatory Council (ITRC, 2012), from two areas of the MRS (See **Figure 5-1**). Discrete soil samples will be collected from drainage features along the MRS boundary closest to the New River to assess whether contamination is moving off the MRS to the unsurveyable slope, located on the MRS and adjacent to the New River. Following the AVS, discrete, biased surface soil samples will be collected at locations where MPPEH or MEC has been positively identified during the AVS and MC is expected to have been released (e.g., UXO with exposed filler, low order detonation, etc.). Intact MEC or MPPEH would not indicate a release and MC will not be sampled at those locations. Surface soil samples will be collected IAW Section 5.2.9 of the MWP and **Section 6.3** of this Work Plan, within the depth interval of 0-6 inches bgs (URS, 2003). ISM increments will

be collected from a depth of 0-2.5 cm bgs IAW **Section 6.3** of this Work Plan. The vegetation and root mat will be removed prior to collecting discrete surface soil samples IAW the MWP [(URS, 2003), (USEPA, 2012)]. The vegetation and root mat will not be removed during the collection of ISM increments IAW standard operating procedure (SOP) HDR MMRP-300 and ISM (ITRC, 2012).

This page intentionally left blank

Figure 5-1 Assisted Visual Survey Proposed Coverage of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS



This page intentionally left blank

6.0 Field Sampling Plan

6.1 Introduction

6.1.1 Project Organization, Responsibilities, and Training

This FSP has been developed to support the USACE SI to be conducted at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. The Former Gun and Mortar Range (RFAAP-002-R-01) MRS was determined to have the potential presence of MEC and MC. The activities associated with this FSP include an analog instrument AVS and soil sampling.

All field activities will be coordinated with the USACE Baltimore District Project Manager (PM) and RFAAP personnel and security. The Project Delivery Team is supported by a Project Geographic Information System (GIS) Technician who will coordinate all positional activities for the SI and review all mapping data collected; and a Project Chemist who will assist in overseeing the soil sampling activities and analyze all soil sampling results.

Field survey teams will consist of the following personnel:

- **AVS Team:** The AVS Team will consist of a UXO Technician III and either an Environmental Professional or second UXO Technician, at a minimum. The UXO Technician III will act as the ordnance and explosives (OE) escort for the AVS team, SSHO, and Team Leader. Two team members (second UXO Technician and Environmental Professional) will be qualified to use GPS equipment. The UXO Tech III will be responsible for the collection of visual survey data IAW this FSP (see **Section 6.2**).
- **Soil Sampling Team:** The Soil Sampling Team will consist of the same team members as the AVS Team. The UXO Technician III will be responsible for inspecting/clearing each sampling location prior to taking a sample. The Environmental Professional or second UXO Technician will be responsible for collecting the soil samples IAW this FSP (see **Section 6.3**).

The SI sampling and analysis element of the project will be implemented using a three-phase QC system: Preparatory, Field, and Follow-up. The Preparatory Phase includes preparation and approval of this FSP, laboratory procurements, and training and orientation of personnel. The Field Phase will include the AVS and soil sampling at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, plus daily QC of metal detectors and collection of QC samples. The Follow-up Phase will include data validation of analytical results, and analysis and evaluation of all data collected and documentation of all field activities conducted.

6.1.2 Qualifications and Training of Project Personnel

All project personnel will be qualified and adequately trained to perform the work assigned to them. The PM will determine the minimum qualifications and training required for project personnel. UXO Technicians will at least meet the minimum requirements, as specified in Department of Defense Explosives Safety Board Technical Paper 18, for their assigned position.

The PM may request documentation of qualifications from subcontractors prior to their starting work.

All field personnel assigned to the project will receive the appropriate guidance plans, including this FSP, for thorough review prior to commencing work in the field. The PM will document, prior to the start of work, that all field personnel have received, read, and understood all procedures pertinent to the work that project personnel are assigned to perform.

Training will include:

- Briefings on site-specific technical and quality issues and procedures as they relate to each worker's duties. Examples include project mission, objectives and quality requirements, sampling and shipping protocols, chain-of-custody (COC) requirements, project safety and biological/cultural resources issues, and management of investigative derived waste (IDW).
- Site specific orientation/training for all field personnel (to be provided by the SSHO).
- Daily "tailgate" meetings to discuss planned activities for the day, health and safety issues specific to the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, and QA/QC concerns related to specific daily work assignments.

The PM will review personnel qualifications for each staff member to ensure that the following training has been completed, as required:

- 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard and a current annual 8- hour refresher for all workers.
- Three days of on-the-job field training for field personnel.
- Current first aid and cardiopulmonary resuscitation (CPR) training for most workers (at least 2 team members will have current training).
- Documentation of experience or training for specific field equipment to be operated by workers. This includes equipment operation, field calibration (as applicable), and maintenance/repair.

Personnel training will be periodically reviewed by the BSEn Corporate Health and Safety Manager (HSM) to verify that the training is appropriate, adequate, and current. Personnel who have allowed their training to expire (e.g., OSHA 8-hour refresher, etc.) will not be allowed to conduct any type of field activities at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS until their training is updated. The PM will verify that this periodic review of personnel training is being performed and documented by the BSEn Corporate HSM prior to initiation of onsite activities.

Project analytical laboratories will provide training and maintain training files for all laboratory personnel. CT Laboratories LLC. (CTL), a National Environmental Laboratory Accreditation Program, Environmental Laboratory Accreditation Program, and USACE-certified laboratory, has been retained for sample analysis (see **Section 6.3**). Copies of training for laboratory personnel are available upon request.

6.2 Assisted Visual Survey Plan

6.2.1 Introduction

AVS data will be collected over the ground surface to evaluate and document the presence of MEC/MPPEH/MD, or other munitions-related finds at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. The MEC and/or MPPEH discovered to date have been found on the surface and in the subsurface during excavation, and are generally of the same types and condition. The historical record and anecdotal evidence indicate that the MRS was used for a specific purpose with a specific subset of munitions, and nothing found to date invalidates that information. The purpose of the AVS is to determine the presence or absence of MEC/MPPEH/MD lying on the ground surface in areas being sampled for MC and select areas within the current manufacturing area to identify potential sample locations biased toward drainage features and ridgeline to determine if MC is potentially migrating off the MRS towards the unsurveyable area adjacent to the New River. The extremely steep slopes on the southern edge of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS will not be surveyed. These areas, outside the installation fence, between the fence line and the New River, are too steep to safely access.

BSEn will furnish all required labor, equipment, and materials (except where specified otherwise) to perform approximately 6 linear miles of AVS (see **Section 6.2.2**). All work will be conducted IAW this Work Plan/FSP and the MWP for RFAAP. The work will be performed consistent with the MMRP under the Defense Environmental Restoration Program.

6.2.2 Description of Work

Selected portions of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS will be visually surveyed as part of the SI field activities. The estimated amount of AVS miles to be conducted at the MRS is 6 linear miles. The total distance of AVS miles may change based on site conditions. Terrain (e.g., slopes too steep to safely walk, or open excavation/trenches), infrastructure (e.g., buildings, fences, and aboveground pipelines), and vegetation (e.g., patches of vegetation too dense to safely walk through, or patches of hazardous vegetation such as poison ivy) may determine the extent of AVS at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Changes due to terrain and vegetation will be at the discretion of the field team. The field team will record the obstacle in the GeoXT or GeoXH with a brief description, then proceed around the obstacle until the original bearing/path can be resumed.

The AVS survey acreage is shown in **Table 6-1**:

Table 6-1 RFAAP AVS Survey

Location	Total Acreage	Total Proposed Survey Acreage	Linear Miles of AVS
Former Gun and Mortar Range (RFAAP-002-R-01) MRS	107	7.3	6

At a minimum, the field inspection team will be comprised of a UXO Technician III (who will act as SSHO and Team Leader) and a second UXO Technician or Environmental Professional. During the AVS, the team will walk transects identified on **Figure 5-1**, nominally spaced at 10-foot apart, with the separation distance dictated by site conditions (e.g., terrain and vegetation cover). The AVS team will identify, locate, and record all MEC/MPPEH/MD or other evidence of military munitions observed along their path.

Trimble GeoXT or GeoXH GPS units, both capable of sub-meter accuracy for post-processed data, will be used to record the track of each individual transect. Additionally, in areas of dense ground cover (e.g., vegetation or leaves) field personnel will use Schonstedt GA-52Cx metal detectors as a safety measure and to aid in their search for munitions and related debris lying on the ground surface. The manufacturer website (www.schonstedt.com) describes the GA-52Cx as their most sensitive model, but does not provide information regarding the depth of detection. However, the manufacturer instruction manual for the similar Schonstedt GA-52Cd states that it is generally capable of detecting UXO items the size of an 81mm mortar or hand gun up to a depth of 12 inches (Schonstedt, 2012). The handheld metal detector will be used to sweep the area in front of the UXO Technician so that they will be alerted to any ferrous anomaly (potentially representing MEC/MPPEH/MD in dense vegetation) and will avoid disturbing the item. Intrusive investigation of subsurface anomalies will not be permitted; however, the locations of subsurface anomalies detected using the handheld metal detectors in undeveloped areas will be logged via GPS.

A suitable survey control point (e.g., a survey benchmark that is part of the National Geodetic System, or a previously established survey control point) will be identified within or nearby the Former Gun and Mortar Range (RFAAP-002-R-01) MRS and used as a spatial reference point.

If an existing survey control point cannot be found near the MRS (e.g., the benchmark was severely damaged or destroyed, or could not be found at the provided coordinates with the aid of a Schonstedt), a temporary survey control point will be established by placing a stake with survey flagging (or similar temporary marker) in a location free of metallic anomalies using the GeoXT or GeoXH to record the position. This initial recording will be of at least one-minute duration, with the understanding that the longer the GPS records a position the more accurate the recorded coordinates will be. This initial temporary survey control point data should be post-processed for maximum achievable accuracy.

GPS units will be checked against the survey control point at the beginning and end of each workday. The relative position of the unit will be in Universal Transverse Mercator coordinates, unless otherwise specified, and compared to the known survey control point coordinates. The difference between the two coordinate sets will be recorded in a field logbook, and the GPS will pass the accuracy test if the difference is less than or equal to the in-field accuracy reported on the GeoXT or GeoXH.

6.2.3 General Field Work Procedures

Detailed maps of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS will be provided to members of the AVS team to record the relative frequency/density of MEC/MPPEH/MD lying on the ground surface; to mark all munitions-related finds deemed relevant by the UXO Technician III at the time of observation, based on training and prior experience (e.g., physical features typical of munitions use such as berms, craters, remains of possible firing points, remains of possible targets, etc.); and to determine soil sample locations (see **Section 6.3**). The map will be of sufficient scale to allow the survey crew to track their locations using terrain features such as roads, buildings, structures, drainages, hillsides, or other recognizable topographic or anthropogenic features.

The SI field team will use a handheld metal detector in areas with dense ground cover to assist in the identification (ID) of metal items lying on the surface and not readily visible that may be MEC/MPPEH/MD. The position of munitions-related features (e.g., MEC, MPPEH, MD suspected firing points, suspected target areas, range-related debris) will be captured as GPS waypoints and recorded in a field log. If GPS coordinates cannot be acquired, the team will record the location of the find along with a bearing to, and approximate distance from, an identifiable landmark (e.g., a unique terrain feature or a specific building). Digital photographs will be taken of any munitions related feature identified in the field.

If any MEC/MPPEH item is observed in the field, the item will be left undisturbed. The UXO Technician III will collect as much information (e.g., type, model, condition, etc.) as possible without handling or disturbing the item prior to contacting the USACE PM, RFAAP point of contact (POC), and BSEn PM to report the find. WP is not expected to be encountered, but UXO Technicians are trained to identify WP and will note its location if observed in the field. WP samples will not be collected because of its thermodynamic nature. The reporting procedures are detailed in Section 11.8 of the APP (**Appendix D**).

The Schonstedt will be tested against a metallic source at the beginning of each work day, mid-day, and at the end of the work day to ensure the device is working properly. This check consists of a basic operations test in which a ferrous metallic object (such as a small section of steel pipe) is placed on the ground and the Schonstedt is waved over and around the object. The operator (the UXO Technician III) listens to the tone produced to ensure that the Schonstedt is detecting the metallic object. Instrument verification strips (IVS) are not applicable to AVS and will not be

employed during the SI field activities; IVS is typically used for digital geophysical mapping which is not planned for this SI effort.

GPS data will be downloaded and archived each evening at the conclusion of the daily survey and sampling activities. A field map showing the locations of all MEC/MPPEH/MD and related points of interest will be compiled from the GPS data as the investigative field work progresses. Digital photographs will also be downloaded, correlated with the field map, and archived daily. The team members will review and compare their field logs with the digital photographs taken in the field and the flagged data points to resolve any discrepancies of field data so that each item listed in the field log corresponds to a GPS point and digital photograph. As the SI field investigation proceeds, the SI field team will compile a field log documenting any MEC/MPPEH/MD and points of interest identified, and note any issues encountered while conducting the AVS. The log will also contain any sketches, images, or survey maps indicating portions of the MRS covered and any inaccessible portions of the MRS. These maps and images will be included as part of the survey record.

6.3 Soil Sampling Plan

6.3.1 Project Purpose and Scope

This Soil Sampling Plan provides the procedures associated with the collection, analysis, and evaluation of soil samples to determine if MC soil contamination from previous facility activities is present at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

The samples to be collected include: two ISM samples from DUs in order to assess the open, undeveloped portion of the MRS; up to five discrete samples biased toward drainage features to look for MC potentially migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River but still within the MRS; and up to five field-determined discrete samples biased toward suspected MC sources at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. QC sampling will occur as prescribed in the UFP-QAPP (**Appendix C**) and discussed in **Section 6.3.2.4**.

6.3.1.1 APPLICABLE REGULATION/STANDARD

Sampling procedures for the Former Gun and Mortar Range (RFAAP-002-R-01) MRS will be in conformance with *EM 200-1-3* (USACE, 2001), *Guide for Characterization of Sites Contaminated with Energetic Materials*, 2002, *Technical Report*, Engineer Research and Development Center/Cold Regions Research and Engineering Laboratory (ERDC/CRREL) TR-02-1, *RFAAP MWP* (URS, 2003), and *Incremental Sampling Methodology* (ITRC, 2012).

6.3.1.2 PROJECT SCHEDULE

A project schedule is presented in **Section 12.0**. The following are the schedule requirements specific to soil sampling:

- Approximately one week prior to mobilizing to the field, the project chemist will coordinate with the laboratory to obtain appropriate sampling containers and coordinate delivery of samples. The project staff will verify that all equipment necessary to collect samples is in working order and that personal protective equipment (PPE) is available, and will review all sampling procedures described in this Soil Sampling Plan.
- Soil samples will be collected over a period of several days. As necessary for method-specific holding times, soil samples will be shipped overnight to the laboratory for analysis on a daily basis.
- Typical turn around time for analysis will be 21 to 30 days depending on the available resources at the laboratory.
- Approximately 30 days will be required to complete the validation process for all sample results prior to incorporation into the SI report.

6.3.1.3 DATA QUALITY OBJECTIVES

DQOs were developed following the procedures discussed in **Section 5.0**.

6.3.1.4 PROBLEM STATEMENT

Soils at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS may have been impacted by test firing of munitions items to test propellants; however, there are no existing data to substantiate the presence or absence of MC. This SI has been designed to identify areas of potential diffuse and direct (i.e., samples collected adjacent to MEC or MPPEH) soil impacts from these past military operations and presence of MC, and to determine if further investigation is required to delineate the nature and extent of the contamination. This Soil Sampling Plan is not designed to define the full extent of contamination, but rather will:

- Provide limited data to assess whether former military munitions activities have impacted the near surface soils.
- Assess the nature of contamination with respect to explosives, perchlorate, SVOCs and/or metals.

6.3.1.5 DECISION STATEMENT

Further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping). Data collected during this investigation will be utilized to provide answers to the following study questions:

1. what types of MEC are present on the ground surface and can be inferred for the subsurface;
2. can MEC disposal or impact areas be identified;
3. has MC been released to surface soil and drainages from compromised MEC or MPPEH found on the MRS and, if so, is there potential for MC to migrate off site; and

4. is diffuse MC contamination present as a result of the presence of MEC and/or MPPEH, and are levels of MC (if present) of a sufficient concentration to warrant further investigations for MC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

6.3.1.6 DECISION INPUTS

Decision inputs for the SI at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS include AVS data and surface soil chemical data. The AVS will be conducted with the objective of identifying the type of MEC/MPPEH/MD within select areas of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Any identifiable range features (e.g., firing point or impact areas) will be recorded, in addition to any MEC/MPPEH/MD observed. Surface soils will be collected using ISM and biased discrete sampling methods and will be analyzed by a laboratory. The ISM analytical results will be compared to USEPA Region III RSLs (USEPA, 2016) and USEPA EcoSSLs (USEPA, 2003), while discrete sample results will be compared to RSLs, EcoSSLs, and RFAAP background levels (IT Corporation, 2001). Comparison of site ISM data to background discrete data will only be done using simple graphical analysis (e.g., plots grouping ISM results by study area) as a semi-quantitative method for comparing background to site distributions (ITRC, 2012). It should be noted that ISM sample results are not statistically comparable to a discrete sample (e.g., background) collected from the same area.

Table 6-2 Project Analyte List and Comparison Values

Analyte	Abbrev.	CAS Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁴
Explosives, USEPA SW-846 Method 8330B						
1,3,5-trinitrobenzene	1,3,5-TNB	99-35-4	N/A	N/A	32,000	N/A
1,3-dinitrobenzene	1,3-DNB	99-65-0	N/A	N/A	82	N/A
2,4,6-trinitrotoluene	2,4,6-TNT	118-96-7	N/A	96	510	N/A
2,4-dinitrotoluene	2,4-DNT	121-14-2	N/A	7.4	1,600	N/A
2,6-dinitrotoluene	2,6-DNT	606-20-2	N/A	1.5	250	N/A
2-amino-4,6-dinitrotoluene	2-Am-DNT	35572-78-2	N/A	N/A	2,300	N/A
2-nitrotoluene	2-NT	88-72-2	N/A	15	1,100	N/A
3,5-dinitroaniline	3,5-DNA	618-87-1	N/A	N/A	N/A	N/A
3-nitrotoluene	3-NT	99-08-1	N/A	N/A	82	N/A
4-amino-2,6-dinitrotoluene	4-Am-DNT	19406-51-0	N/A	N/A	2,300	N/A
4-nitrotoluene	4-NT	99-99-0	N/A	140	3,300	N/A
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4	N/A	28	3,300	N/A
Nitrobenzene	NB	98-95-3	N/A	22	1,300	N/A
Nitroglycerin	NG	55-63-0	N/A	140	82	N/A
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0	N/A	N/A	57,000	N/A
Pentaerythritol tetranitrate	PETN	78-11-5	N/A	570	1,600	N/A
Trinitrophenylmethyl-nitramine	Tetryl	479-45-8	N/A	N/A	2,300	N/A
Perchlorate, USEPA SW-846 Method 6850						
Perchlorate		14797-73-0	N/A	N/A	820	N/A
Semi-volatile Organic Compounds (SVOCs), USEPA SW-846 Method 8270D SIM						
Di-n-butylphthalate		84-74-2	N/A	N/A	82,000	N/A
Diphenylamine ⁵		122-39-4	N/A	N/A	21,000	N/A
N-Nitrosodiphenylamine ⁵		86-30-6	N/A	470	N/A	N/A
2-Chloronaphthalene		91-58-7	N/A	N/A	60,000	N/A

¹ Background level from Facility-Wide Background Study Report (IT Corporation, 2001)

² From the RSL Composite Worker Soil Table (Target Risk [TR]=1E-6, Hazard Quotient [HQ]=1) June 2015, Carcinogenic Screening Level

³ From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, Target Hazard Index (THI)=1

⁴ From Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005

⁵ Analytes coelute and will be reported as a total

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

Table 6-3 Project Analyte List and Comparison Values, Metals

Analyte	Abbrev.	Chemistry Abstracts Service (CAS) Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁴
Metals, USEPA SW-846 Method 6010C/7471A						
Antimony	Sb	7440-36-0	N/A	N/A	470	Soil Invertebrates: 78 Mammalian Wildlife: 0.27
Beryllium	Be	7440-41-7	1.02	6,900	2,300	Soil Invertebrates: 40 Mammalian Wildlife: 21
Cadmium	Cd	7440-43-9	N/A	9,300	980	Soil Invertebrates: 140 Mammalian Wildlife: 0.36 Avian Wildlife: 0.77 Plants: 32
Chromium	Cr	7440-47-3	65.3	N/A	N/A	As Cr(III): Mammalian Wildlife: 34 Avian Wildlife: 26
Cobalt	Co	7440-48-4	72.3	1,900	350	Mammalian Wildlife: 230 Avian Wildlife: 120 Plants: 13
Copper	Cu	7440-50-8	53.5	N/A	47,000	Soil Invertebrates: 80 Mammalian Wildlife: 49 Avian Wildlife: 28 Plants: 70
Lead	Pb	7439-92-1	26.8	N/A	800	Soil Invertebrates: 1,700 Mammalian Wildlife: 56 Avian Wildlife: 11 Plants: 120
Lithium	Li	7439-93-2	N/A	N/A	2,300	N/A
Manganese	Mn	7439-96-5	2,543	N/A	26,000	Soil Invertebrates: 450 Mammalian Wildlife: 4,000 Avian Wildlife: 4,300 Plants: 220
Molybdenum	Mo	7439-98-7	N/A	N/A	5,800	N/A
Nickel	Ni	7440-02-0	62.8	64,000	22,000	Soil Invertebrates: 280 Mammalian Wildlife: 130 Avian Wildlife: 210 Plants: 38

Table 6-3 Project Analyte List and Comparison Values, Metals (Continued)

Analyte	Abbrev.	Chemistry Abstracts Service (CAS) Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁴
Selenium	Se	7782-49-2	N/A	N/A	5,800	Invertebrates: 4.1 Mammalian wildlife: 0.63 Avian Wildlife: 1.2 Plants: 0.52
Silver	Ag	7440-22-4	N/A	N/A	5,800	Mammalian Wildlife: 14 Avian Wildlife: 4.2 Plants: 560
Strontium	Sr	7440-24-6	N/A	N/A	700,000	N/A
Thallium	Tl	7440-28-0	2.11	N/A	12	N/A
Tin	Sn	7440-31-5	N/A	N/A	700,000	N/A
Vanadium	V	7440-62-2	108	N/A	5,800	Mammalian Wildlife: 280 Avian Wildlife: 7.8
Zinc	Zn	7440-66-6	202	N/A	350,000	Soil Invertebrates: 120 Mammalian Wildlife: 79 Avian Wildlife: 46 Plants: 160
Mercury	Hg	7439-97-6	0.13	N/A	46	N/A

¹ Background level from *Facility-Wide Background Study Report* (IT Corporation, 2001).

² From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Carcinogenic Screening Level*

³ From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, THI=1*

⁴ From *Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005*

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

6.3.1.7 STUDY BOUNDARIES

The study area boundary is presented in Error! Reference source not found.. Pre-planned soil sampling locations are presented on **Figure 6-1**. Additional soil sampling locations may be designated following project team discussion based on AVS results (within the existing MRS boundaries). The temporal boundary of the SI consists of the contractual period of performance; the schedule presented in **Section 12.0** outlines the anticipated timelines required to maintain the temporal boundaries of this project.

6.3.1.8 DECISION RULE

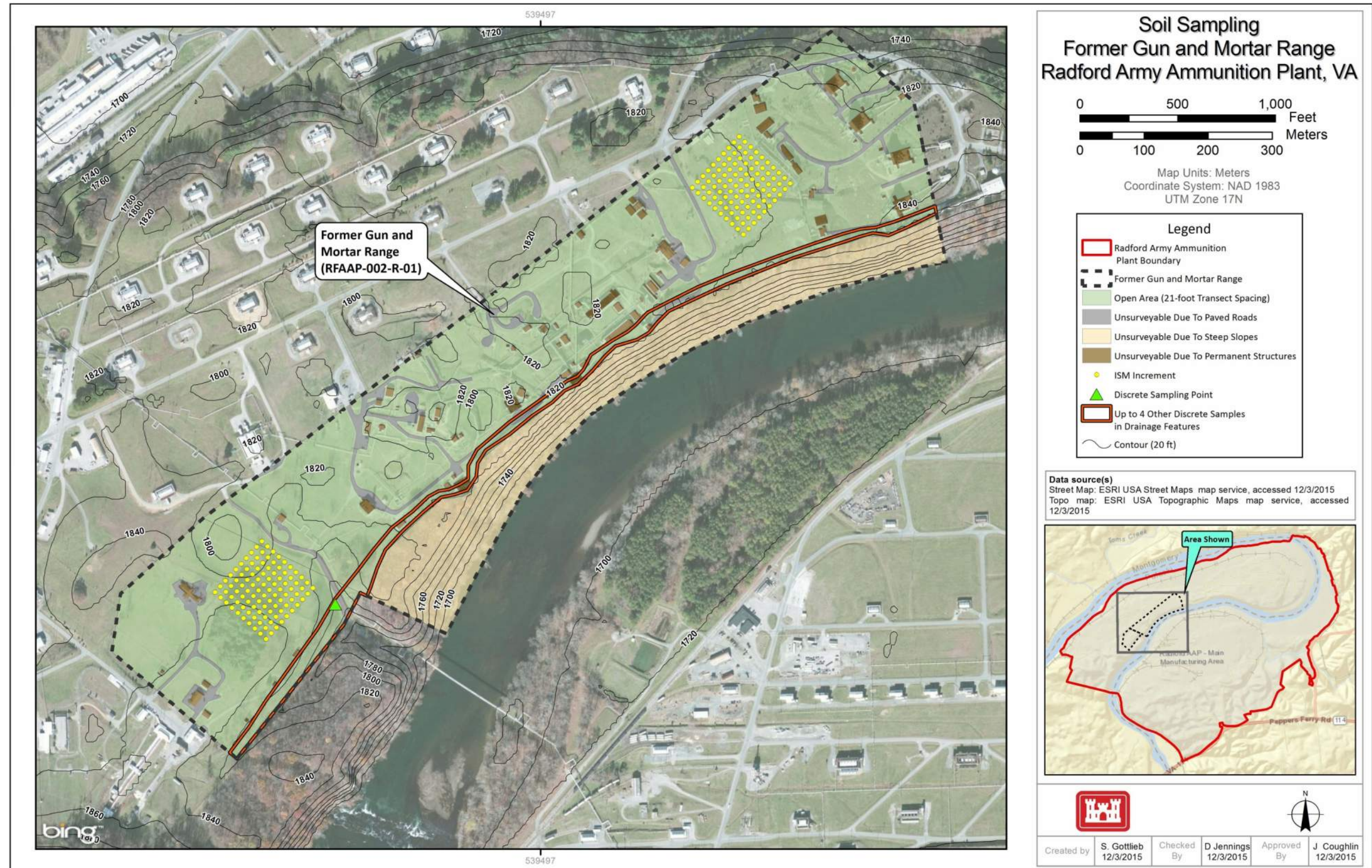
The decision rules guiding this SI are as follows:

- If the AVS results in no observations of MPPEH/MEC/MD, further action beyond this SI will still be required to characterize the nature and extent of subsurface MPPEH/MEC/MD at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping).
- If MEC or MPPEH are observed on the surface, then the location will be flagged and proper notification of the USACE PM, RFAAP POC, and BSEn PM will occur.
- If MC concentrations in surface soils exceed the PCVs presented in **Table 6-2** and **Table 6-3**, then an evaluation will be conducted to determine if further characterization of the nature and extent of MC in surface soils and/or subsurface soils at the MRS is warranted.

The following decision rules will guide the selection of biased discrete surface soil samples during field work:

- If a drainage feature is observed leading offsite toward the New River, then a surface soil sample will be collected from within that drainage.
- If a MPPEH or MEC item is observed and is intact, with no evidence of exposed or leaking filler, then no MC release is suspected and soil sampling is not necessary.
- If an MPPEH or MEC item is observed and is damaged, with evidence of exposed or leaking filler, then an MC release is suspected and soil sampling is necessary.
- If an item is partially buried, such that a determination of condition cannot be made, then one of the following three rules will apply:
 - If responding EOD personnel report that the item was undamaged, soil sampling will not be conducted.
 - If responding EOD personnel report that the item was damaged, a soil sample will be collected.

Figure 6-1 Sampling Locations, Former Gun and Mortar Range (RFAAP-002-R-01) MRS



This page intentionally left blank

- o If responding EOD personnel do not indicate the condition of the item, the worst-case scenario would be assumed and a soil sample will be collected.
- No soil sampling is required when an MD item is observed.

6.3.1.9 CHARACTERIZATION OF POTENTIAL DECISION ERRORS

Decision errors possible in this investigation include:

- Making the determination that MC contamination is present when none exists.
- Making the determination that MC contamination is not present when it does exist.
- Making the determination that MPPEH or MEC are present and pose an explosive hazard, when no explosive hazard exists.
- Making the determination that MPPEH or MEC are not present and no explosive hazard exists, when an explosive hazard does exist.

6.3.1.10 SAMPLING DESIGN

Sample locations will include areas where MPPEH or MEC have been positively identified and MC may have been released. Intact MPPEH or MEC do not indicate a release and will not lead to sampling. Field observations and characterization of potential locations will be used to determine whether sufficient assessment of the different types of releases has been performed. Samples will be collected IAW procedures presented in **Section 6.3.2**. The samples will be analyzed for the analytes listed in the analytical methods identified in **Table 6-2** and **Table 6-3**. The purpose of the sampling is to determine if MC are, or are not, present in surface soil at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

6.3.2 Field Activities

Sample locations will include areas where MPPEH or MEC have been positively identified and MC may have been released. The location and number of soil samples collected will be determined in the field based primarily on AVS observations. The number of samples collected from the Former Gun and Mortar Range (RFAAP-002-R-01) MRS will vary depending on the number of areas where MPPEH or MEC are observed.

Sampling procedures will be in conformance with *Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents*, ERDC/CRREL TR-07-10 (CRREL, 2007) and *Incremental Sampling Methodology* (ITRC, 2012). Sampling equipment will consist of disposable, pre-cleaned scoops or pre-cleaned Oakfield corers/push tube devices. Mixing of soils will be completed in disposable plastic bags. PPE will consist of Level D, with nitrile gloves (per the APP in **Appendix D**). The Soil Sampling Team will include the UXO Technician III and either a second UXO Technician trained in sample collection, an environmental professional, or a field technician.

If explosives are visible in soils based on inspection by the UXO Technician III, the find will be treated as MPPEH and will be reported up the chain of communication described in **Section 8.0**.

6.3.2.1 RATIONALE/DESIGN

Propellant testing activities at the MRS may have released MC to surface soils. All soil sampling conducted during this SI will follow one of three designs:

- Discrete biased surface soil sampling (0-6 inches bgs) collected adjacent to any damaged MEC or MPPEH item identified during the AVS to identify point source releases;
- Discrete biased surface soil sampling (0-6 inches bgs) collected from drainage features biased towards identifying prospective MC transportation routes (i.e., drainages leading off the MRS toward the New River); and
- Surface soil sampling (0-2.5 cm bgs) will be performed using ISM to determine whether past activities resulted in diffuse releases of MC to surface soils.

Biased discrete sampling, one at each damaged MEC/MPPEH item, was selected to assess point sources of MC. The results, of as many as five samples, will represent specific points within the MRS (the surface soil immediately beneath/adjacent to a compromised MEC or MPPEH) with the highest likelihood of MC contamination. This data will be used to determine whether MC contamination is present in surface soils as a result of munitions use at the MRS. Firing projectiles to test propellant mixtures does not indicate a release of MC to the subsurface and no subsurface soil samples will be collected during the SI. No MC was detected in surface water samples collected previously from the New River, downstream of the MRS. No surface water samples will be collected during the SI.

Up to five additional discrete samples will be biased toward surface soils in drainages leading off the MRS toward the New River. Discrete sampling was selected for this set of samples in the interest of biasing the samples to represent the highest likelihood of MC contamination within the drainage, and thereby answer whether MC is present in ditches and being transported to the unsurveyable area of the MRS, adjacent to the New River. One discrete ditch soil sample location has been predetermined and shown on **Figure 6-1**. This predetermined biased discrete soil sample is located in the largest drainage feature running from the accessible areas of the MRS towards the unsurveyable slope, also located within the MRS.

ISM will be conducted at two DUs located within open, undeveloped portions of the MRS shown in **Figure 6-1**. ISM analytical data is used to estimate the mean contaminant concentration in a defined volume of soil. Each DU is a square, comprised of 100 increments, with 12 meters between each increment. A systematic random sampling pattern will be employed for collection of the increments due to its relative ease of implementation in the field. Each increment collected will be 2.5 cm in diameter and 2.5 cm in depth (bgs). With an estimated soil density of 1.6 grams per cubic centimeter (g/cc), the total mass expected to be collected is 2,100 grams

(http://www.itrcweb.org/ISM-1/5_3_Field_Collection.html). The total sample weight can vary from 20 percent (%) below to 300% above the target weight depending on soil moisture and density. In the absence of any known firing and target points, the locations of the DUs were selected for the following reasons:

- The areas are largely undisturbed, with no buildings or other improvements, and therefore represent the most likely locations to determine if releases to the surface soils from historical activities at the MRS have occurred.
- The open areas lend themselves well to establishing a large, easily navigable DU for ISM that will result in a more representative sample of the DU.

6.3.2.2 SAMPLE LOCATION

Pre-planned sampling locations are presented in **Figure 6-1**. This figure shows the locations of the two DUs, developed based on a systematic-random sampling plan. Each DU is a square with 120 meter sides and comprised of 100 increments. The increment locations provided in **Table 6-4** are the latitude (Lat) and longitude (Long) (NAD_1983_UTM_Zone_17N) for the center of each 12 x 12 meter square (for both DU 1 and DU 2). Additionally, one proposed location was added for biased discrete sampling of the large drainage feature identifiable in aerial photographs running from the accessible areas of the MRS towards the unsurveyable slope adjacent to the New River. This location will likely be adjusted in the field to the point with the highest likelihood of MC contamination (e.g., a point bar feature in the drainage resulting from previous runoff events).

Additional sampling locations will be selected based on site observations. The MRS was not previously walked by SI personnel and drainage features are not well known. Four other surface soil samples, not shown on **Figure 6-1**, will be collected at drainage features (ditches or swales), if observed at the MRS. Additionally, five discrete surface soil samples are to be collected adjacent to any compromised MEC or MPPEH, one at each MEC/MPPEH location, identified during the AVS. **Table 6-5** presents the estimated number of soil samples by sample type.

Table 6-4 Increment Locations- NAD_1983_UTM_Zone_17N

DU 1		RFAAP-FGMR-SSI-001A, RFAAP-FGMR-SSI-001B, and RFAAP-FGMR-SSI-001C									
		A	B	C	D	E	F	G	H	I	J
1	Lat	37.18869	37.18877	37.18885	37.18892	37.189	37.18908	37.18916	37.18924	37.18932	37.189401
	Long	-80.5607	-80.5606	-80.5605	-80.5604	-80.5604	-80.5603	-80.5602	-80.5601	-80.56	-80.55989
2	Lat	37.18861	37.18869	37.18877	37.18885	37.18893	37.18901	37.18909	37.18917	37.18925	37.189328
	Long	-80.5606	-80.5605	-80.5604	-80.5603	-80.5603	-80.5602	-80.5601	-80.56	-80.5599	-80.55979
3	Lat	37.18854	37.18862	37.1887	37.18878	37.18886	37.18894	37.18902	37.1891	37.18917	37.189254
	Long	-80.5605	-80.5604	-80.5603	-80.5602	-80.5602	-80.5601	-80.56	-80.5599	-80.5598	-80.55969
4	Lat	37.18847	37.18855	37.18863	37.1887	37.18878	37.18886	37.18894	37.18902	37.1891	37.189181
	Long	-80.5604	-80.5603	-80.5602	-80.5601	-80.5601	-80.56	-80.5599	-80.5598	-80.5597	-80.55959
5	Lat	37.18839	37.18847	37.18855	37.18863	37.18871	37.18879	37.18887	37.18895	37.18903	37.189107
	Long	-80.5603	-80.5602	-80.5601	-80.56	-80.56	-80.5599	-80.5598	-80.5597	-80.5596	-80.55949
6	Lat	37.18832	37.1884	37.18848	37.18856	37.18864	37.18872	37.1888	37.18888	37.18895	37.189034
	Long	-80.5602	-80.5601	-80.56	-80.5599	-80.5599	-80.5598	-80.5597	-80.5596	-80.5595	-80.5594
7	Lat	37.18825	37.18833	37.1884	37.18848	37.18856	37.18864	37.18872	37.1888	37.18888	37.18896
	Long	-80.5601	-80.56	-80.5599	-80.5598	-80.5598	-80.5597	-80.5596	-80.5595	-80.5594	-80.5593
8	Lat	37.18817	37.18825	37.18833	37.18841	37.18849	37.18857	37.18865	37.18873	37.18881	37.188887
	Long	-80.56	-80.5599	-80.5598	-80.5597	-80.5597	-80.5596	-80.5595	-80.5594	-80.5593	-80.5592
9	Lat	37.1881	37.18818	37.18826	37.18834	37.18842	37.1885	37.18858	37.18865	37.18873	37.188813
	Long	-80.5599	-80.5598	-80.5597	-80.5596	-80.5596	-80.5595	-80.5594	-80.5593	-80.5592	-80.5591
10	Lat	37.18803	37.1881	37.18818	37.18826	37.18834	37.18842	37.1885	37.18858	37.18866	37.18874
	Long	-80.5598	-80.5597	-80.5596	-80.5595	-80.5595	-80.5594	-80.5593	-80.5592	-80.5591	-80.559

Table 6-4 Increment Locations- NAD_1983_UTM_Zone_17N (Continued)

DU 2		RFAAP-FGMR-SSI-001A, RFAAP-FGMR-SSI-001B, and RFAAP-FGMR-SSI-001C									
		A	B	C	D	E	F	G	H	I	J
1	Lat	37.19435	37.19443	37.19451	37.19459	37.19467	37.19475	37.19483	37.19491	37.19498	37.195064
	Long	-80.5523	-80.5522	-80.5521	-80.552	-80.5519	-80.5518	-80.5517	-80.5516	-80.5516	-80.55146
2	Lat	37.19428	37.19436	37.19443	37.19451	37.19459	37.19467	37.19475	37.19483	37.19491	37.194991
	Long	-80.5522	-80.5521	-80.552	-80.5519	-80.5518	-80.5517	-80.5516	-80.5515	-80.5515	-80.55136
3	Lat	37.1942	37.19428	37.19436	37.19444	37.19452	37.1946	37.19468	37.19476	37.19484	37.194917
	Long	-80.5521	-80.552	-80.5519	-80.5518	-80.5517	-80.5516	-80.5515	-80.5514	-80.5514	-80.55126
4	Lat	37.19413	37.19421	37.19429	37.19437	37.19445	37.19453	37.19461	37.19468	37.19476	37.194844
	Long	-80.552	-80.5519	-80.5518	-80.5517	-80.5516	-80.5515	-80.5514	-80.5513	-80.5513	-80.55116
5	Lat	37.19406	37.19414	37.19421	37.19429	37.19437	37.19445	37.19453	37.19461	37.19469	37.19477
	Long	-80.5519	-80.5518	-80.5517	-80.5516	-80.5515	-80.5514	-80.5513	-80.5512	-80.5512	-80.55107
6	Lat	37.19398	37.19406	37.19414	37.19422	37.1943	37.19438	37.19446	37.19454	37.19462	37.194697
	Long	-80.5518	-80.5517	-80.5516	-80.5515	-80.5514	-80.5513	-80.5512	-80.5511	-80.5511	-80.55097
7	Lat	37.19391	37.19399	37.19407	37.19415	37.19423	37.19431	37.19438	37.19446	37.19454	37.194623
	Long	-80.5517	-80.5516	-80.5515	-80.5514	-80.5513	-80.5512	-80.5511	-80.5511	-80.551	-80.55087
8	Lat	37.19384	37.19391	37.19399	37.19407	37.19415	37.19423	37.19431	37.19439	37.19447	37.19455
	Long	-80.5516	-80.5515	-80.5514	-80.5513	-80.5512	-80.5511	-80.551	-80.551	-80.5509	-80.55077
9	Lat	37.19376	37.19384	37.19392	37.194	37.19408	37.19416	37.19424	37.19432	37.1944	37.194476
	Long	-80.5515	-80.5514	-80.5513	-80.5512	-80.5511	-80.551	-80.5509	-80.5509	-80.5508	-80.55067
10	Lat	37.19369	37.19377	37.19385	37.19393	37.19401	37.19409	37.19416	37.19424	37.19432	37.194403
	Long	-80.5514	-80.5513	-80.5512	-80.5511	-80.551	-80.5509	-80.5508	-80.5508	-80.5507	-80.55057

Table 6-5 Estimated Soil Samples by Type

Sample Method	No. of Samples ¹	Analytical Method
ISM	2 DUs with 3 replicate samples each – 6 total	Explosives: USEPA SW-846 Method 8330B Metals: USEPA SW-846 Method 6010C/7471A Target Compound List (TCL): SVOCs USEPA SW-846 Method 8270D SIM Perchlorate: USEPA SW-846 Method 6850
Biased Discrete Drainage Samples	5 ¹	Explosives: USEPA SW-846 Method 8330B Metals: USEPA SW-846 Method 6010C/7471A TCL SVOCs USEPA SW-846 Method 8270D SIM
Biased Discrete MEC/MPPEH Samples	5 ¹	Perchlorate: USEPA SW-846 Method 6850

¹= does not include QA/QC samples

No soil samples will be collected until the UXO Technician III has inspected the prospective soil sample location with a handheld metal detector and determined the area is safe to conduct the sampling activities. Should a subsurface anomaly (i.e., metallic object) be detected at that location, the sample will be moved to the closest location without a subsurface metallic anomaly. No soil sampling activities will be conducted directly over a subsurface anomaly. In the event that the closest safe location would not be representative of the data required (e.g., a biased discrete soil sample had to be moved too far from the original MPPEH or MEC location), the soil sample will not be collected, and the reason for not collecting the sample will be documented in the field notes. Field notes will document all areas selected for biased discrete sampling locations, the rationale for selecting the location, and a determination of whether the location is safe for sampling. Similarly, deviations from the planned ISM increment and/or DU locations will be noted and explained.

6.3.2.3 SAMPLE COLLECTION

Procedures for collection of the surface soil samples are described in SOP HDR MMRP-300 included in **Appendix C**. ISM samples will be collected in triplicate to calculate a 95% upper confidence limit for the DU and limit the effects of natural heterogeneity. Any deviation from the DU and/or increment locations (i.e., due to anomaly avoidance or impervious/inaccessible soil) will be recorded with an explanation. Replicate samples will be collected using a systematic-random pattern that complies with SOP HDR MMRP-300 included in **Appendix C**. **Table 6-6** lists requirements for soil sample preservation, maximum holding times, and containers.

Table 6-6 Requirements for Soil Sample Preservation, Maximum Holding Times, and Containers

Analyte	Analytical Methods	Preservation	Maximum Holding Time	Number and Sample Container Type
Metals	USEPA SW-846 Method 6010C/7471A	NA	180 days to digestion	One 8-ounce glass jar or stainless steel liner with Teflon-lined lid/end caps
Explosives	USEPA SW-846 Method 8330B	Cool to 4°C	14 days from sample collection to extraction/40 days from extraction to analysis	
SVOCs	USEPA SW-846 Method 8270D SIM	Cool to 4°C	14 days from sample collection to extraction/40 days from extraction to analysis	
Perchlorate	USEPA SW-846 Method 6850	Cool to 4°C	28 days from sample collection to extraction/28 days from extraction to analysis	1x4-ounce amber glass jar, Teflon-lined lid

6.3.2.4 QUALITY ASSURANCE AND QUALITY CONTROL SAMPLE COLLECTION

The collection frequency of QA/QC samples for discrete soil samples collected at the MRS is shown below, based on Appendix C of the Environmental Field Sampling Handbook (DoD, 2013):

- Duplicate samples will be collected at a frequency of 10 percent (minimum of 1)
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of 5 percent (minimum of 1)

QA/QC samples will be collected and shipped to CTL. The following sampling methods apply:

1. QA/QC samples are collected (split) from the thoroughly mixed sample collected at the chosen location. Enough soil volume should be obtained so that all required sample containers (8 ounce glass jars) can be filled. Two jars will be required for field duplicates. MS/MSD samples will be submitted in triplicate (i.e., one original sample, one MS sample, and one MSD sample), unless the laboratory specifically states that less volume is required.
2. Transfer sample into an appropriate sample jar.
3. Secure the lid of the jar tightly. Do not interchange the container lids. Chemical preservation of the soil is not required. Temperature preservation is required.
4. Fill out the sample label IAW the requirements in **Section 6.5** and affix the label to the sample containers. Be sure to label the tag carefully and clearly. QA/QC samples will be given an ID label as described in **Section 6.3.3.3**. QC samples may be placed in the same

shipment container with all of the other field samples. Place all sealed sample containers in the sample cooler, on ice. Complete all COC documents and record the sample in the field logbook.

QA/QC samples will be collected, labeled, packaged, and shipped IAW **Section 6.6**. The list of analytes will be provided to the laboratory as part of contract negotiation.

Laboratory replicates are recommended to assess the precision of the ISM subsampling processes. ISM protocols require three replicate samples (one original and two replicates). For this project, a relative standard deviation (RSD) of 35% for the replicates from each DU will be used as the upper limit for precision. An RSD of less than 35% will be interpreted to mean there is acceptable homogeneity in the distribution of constituent concentrations in the DU and the distribution of replicate results are approximately normal.

Explosives and metals analysis will occur after particle reduction by milling or grinding. Other than explosives and metals, most organics (SVOCs) analytical methods using ISM do not use particle reduction by grinding or milling prior to analysis. The primary purpose for grinding is reduction of the particle size and eliminating nuggets that can be the cause for extreme heterogeneity.

6.3.3 Field Operations Documentation

6.3.3.1 FIELD LOGBOOK AND DATA SHEETS

All field measurements, observations, and sampling activities will be recorded by field personnel in daily field logbooks. Field data will be recorded directly and legibly in indelible ink, with all entries signed and dated. Field data documentation will be collected and reviewed daily by the team leader. The field data records will be sufficiently detailed to allow the reconstruction of field activities by an independent party at a later date. If an entry must be changed, the change will not obscure the original entry, and will be initialed and dated by the individual making the change. Field data records will be retained in project files. At a minimum, the following data should be recorded in the field logbook:

- Date, time, unique identifier, and brief description of the location of each sample collected.
- General weather conditions, description of soil conditions such as any visible evidence of impact or discolored soil indicating potential contamination.
- ID number of photographs taken, GPS point location ID number.

6.3.3.2 PHOTOGRAPHIC RECORDS

Photographs of the sampling locations will be taken and logged into the field logbook. The photograph number (i.e., as indicated on the camera, if available) will be recorded in the logbook and referenced to the sample ID number.

6.3.3.3 SAMPLE DOCUMENTATION

6.4 Sample Identification

All samples will be surface soils (0-2.5 cm for ISM and 0-6 inches for discrete), therefore a depth indicator within the sample ID is unnecessary and will be omitted in the interest of keeping the ID as concise as possible. The sample numbering system for each soil sample will be coded to the installation name, a location identifier, and a sample identifier based on the matrix type and sequential order in which the sample was collected.

The components of the sample ID format for the SI at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS are as follows:

- Installation ID: RFAAP (Radford Army Ammunition Plant)
- Location ID: FGMR (Former Gun and Mortar Range)
- Media ID: SSI (Surface Soil, ISM) or SSD (Surface Soil, Discrete)
- Sequential Number: 001, 002, 003, etc.

For example, sample RFAAP-FGMR-SSD-001 would be the first discrete surface soil sample collected at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS at RFAAP.

MS/MSD samples will share the same ID as the parent sample, with a note on the label indicating “MS” or “MSD.”

Field duplicates will be blind. Therefore, the duplicate ID will be:

- RFAAP-FGMR-DUP1.

In this ID, “1” is a sequential number. This ID does not link the duplicate to the parent sample. Additionally, the sample collection time will be adjusted to preclude comparing the collection times to match a duplicate pair. The adjustment will be a field-determined number of minutes (but less than an hour) added to or subtracted from the original sampling time and shall be noted in the field logbook.

ISM protocols require three replicate samples (one original and two replicates), therefore the Sample IDs will be followed by a letter to indicate the primary (A), the duplicate (B), and the triplicate (C) as shown below:

RFAAP-FGMR-SSI-001A, RFAAP-FGMR-SSI-001B, and RFAAP-FGMR-SSI-001C

6.5 Sample Labels

A sample label identifies samples with the following information recorded:

- Project name and location;
- Unique field sample ID;

- Date and time of collection;
- Analyses requested;
- Type of preservative used (if any); and
- Sampler's name or initials.

Sample labels will be affixed by the sampler to the sample containers used. Labels will be affixed by the laboratory to the sample containers specifying the type of preservatives used, where applicable.

6.6 Chain-of-Custody Records

In order to maintain and document sample custody, the following COC procedures will be strictly followed. A sample is considered to be under custody if:

- It is in actual possession of the responsible person.
- It is in view, following physical possession.
- It is in the possession of a responsible person and is locked or sealed to prevent tampering.
- It is in a secure area.

Sample custody is maintained by the COC record. The COC record is completed by the individual designated as being responsible for sample shipment and must be completed at the sampling location. The information recorded on the COC record will be provided as described in **Table 6-7**.

Table 6-7 Chain-of-Custody Procedures

COC Field	Information Required
Laboratory	The laboratory name and address where the samples are being sent.
Contact	The primary contact at the laboratory along with the phone and e-mail address.
Client	USACE Baltimore District
Shipment Number	A unique identifier applied to the shipment.
Method of Shipment	e.g., FedEx, Courier.
Air Bill Number	Shipper's unique identifier for the shipment.
Cooler Number	A unique identifier for the cooler in which the samples are sent to the laboratory.

Table 6-7 Chain-of-Custody Procedures (Continued)

COC Field	Information Required
Custody Seal No.	A unique identifier for the seal on the cooler.
Contract Number	The contract number under which the samples were collected.
Contract Name	A description contract name.
Project Contact	The PM's name along with the phone and e-mail address.

Sampler's Signature	Signature of the person responsible for the collection of the samples and filling out the COC form.
Lab Job	This field is filled in by laboratory personnel after the samples have been logged in.
Ship Date	The date the samples are shipped to the laboratory.
Page	The page number of the COC form (e.g., page 1 of 2).
Sample	A unique sample number is generated for each field sample ID listed, which helps to distinguish samples across multiple lines and pages of the COC form.
Field Sample ID	The unique sample identifier.
Sampling Date	The date the sample was collected.
Sampling Time	The time the sample was collected.
Matrix Type	The matrix type of the sample (e.g., SO for soil).
Type/Size of Container	e.g., 8-ounce glass jar.
Preservation - Temp	e.g., 4 degrees Celsius (°C)
No. of Containers	Enter the number of sample containers.
Analyses Requested	List all analyses that are to be performed on the samples listed and then check the boxes under each analysis on the lines for each sample.
Remarks	Enter any sample or analysis-specific remarks (e.g., MS/MSD requests, short holding time).
Relinquished By - Signature	Signature of the person relinquishing the shipment of samples.
Relinquished By - Printed	Printed name of the person relinquishing the shipment of samples.
Relinquished By - Company	Company the person that is relinquishing the shipment of samples works for.
Relinquished By - Date/Time	Date and time the samples are relinquished.
Received By - Signature	Signature of the person receiving the shipment of samples.
Received By - Printed	Printed name of the person receiving the shipment of samples.
Received By - Company	Company the person that is receiving the shipment of samples works for.
Condition of Sample	Brief statement as to the condition of the sample container (to be completed by laboratory).
Received By - Date/Time	Date and time the samples are received.
Comments	Enter any shipment related comments (e.g., level of data requested, QC sample designation, special sample handling instructions, high concentration sample information, turnaround time, etc.).

A copy of the completed and signed COC form will be a permanent part of the project records. Final COC form distribution is as documented in **Table 6-8**.

Table 6-8 Final COC Distribution

Copy	Destination
White Copy	Analytical Laboratory Report

Yellow (Canary) Copy	Laboratory File
Pink Copy	Courier/Delivery Service of Field Office
Gold (Goldenrod) Copy	Project File

The white original and yellow (canary) copy will accompany the samples to the laboratory to document transfer. The laboratory will eventually return the white original in the laboratory data report, and retain the yellow copy for its records. The courier or delivery service will retain the pink copy if they require it, otherwise the pink copy may be retained by the Soil Sampling Team. The golden (goldenrod) copy of the COC form should be retained by the Soil Sampling Team, and forwarded to and stored in the project files at the home office. If the samples are transported to the laboratory by the sampler, no transfer need be recorded on the pink or yellow copies. If a courier or person other than the sampler takes custody in order to transport the samples to the laboratory, the pink and yellow copies should be annotated to show this transfer prior to separation from the white original.

The SI field team personnel initially taking the samples are responsible for the care and custody of the samples until they are properly transferred or delivered to laboratory personnel. All samples will be accompanied by a COC form. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. The company from which the samples are relinquished and to which it they are delivered and the reason for transfer will be noted. This record documents the transfer of samples from the custody of the sampler to that of another person, or the permanent laboratory.

The relinquishing individual will record specific shipping data (air bill number, company, time, and date) on the original and duplicate custody records. It is the team leader's responsibility to verify that all shipping data are consistent and are made part of the permanent project files. Finally, all custody records will be reviewed by field personnel prior to shipping samples.

6.6.1 Documentation Procedures/Data Management and Retention

Field data records will be collected by the field team and verified daily by the team leader, who will review the data for completeness, accuracy, legibility, and comparability with other data collected, and will verify the field data records have been signed and dated. The team leader will direct field staff to make necessary corrections to the record and to initial and date the corrections. Any omissions or inconsistencies discovered will be resolved by the team leader, who will seek clarification from the field personnel responsible for data collection. After data reduction and entry into the project database, field data will be verified by qualified personnel for completeness, consistency with hardcopy records, and anomalous values.

Field data, including both electronic and hardcopy documentation will be reviewed by the PM, the Project QA Manager, or by the technical designee as part of ongoing QA review of project activities.

All project records, documents, and files will be stored or archived in secure locations at BSEn's project office. The integrity of files and databases will be assured by limited access. Non-laboratory project data (e.g., field data) may be temporarily stored at BSEn's field office until the completion of field activities, after which the data will be archived at BSEn's project office. Project data will be stored at BSEn's project office or at a secure off-site storage facility for a period of not less than 3 years after the final report is issued.

6.6.1.1 SAMPLE PACKING AND SHIPPING REQUIREMENTS

All samples sent to an off-site laboratory will be packaged carefully to avoid breakage or contamination, and will be shipped to the laboratory at proper temperatures. The following sample packaging requirements will be followed:

- Sample bottle lids will not be mixed. All sample lids will stay with the original containers.
- If the sample volume level is low because of limited sample availability, the level will be marked on the outside of the container with a grease pencil. This procedure will help the laboratory determine if any leakage occurred during shipment.
- Custody seals will be utilized on sample containers or on plastic bags containing multiple sample containers when there is a chance that custody seals or sample containers may be tampered with, such as if the sample container must be stored for any period of time in an unsecured location or refrigerator, or if the sample container must leave the custody of BSEn for any reason either unpackaged or in a cooler or shipping container not otherwise custody sealed.
- All glass sample bottles will be wrapped in bubble pack or equivalent and sealed in self-sealing plastic bags to minimize the potential for contamination and breakage during shipment. Plastic bottles will not be wrapped, but will be sealed in self-sealing plastic bags. Soil samples contained in stainless steel liners will be sealed in self-sealing plastic bags.
- All samples will be cooled unless "no cooling" has been specified. The sample containers will be packed in coolers. The coolers will then be filled with ice within self-sealing bags. Sufficient ice shall be included for the samples to arrive at $4^{\circ}\text{C} + 2^{\circ}\text{C}$. A temperature blank will be included in each cooler for temperature determination upon receipt at the laboratory.
- Empty space in the cooler will be filled in with inert packing material such as vermiculite or bubble wrap. Under no circumstances will locally obtained material (sawdust, sand, etc.) be used.
- The original COC record will be sealed in a self-sealing plastic bag, taped to the inside lid of the cooler, and transported along with the coolers to the laboratory. Also included with the COC should be a table identifying the samples at a minimum by number and location

that allows the collector to indicate the desired analysis.

- All samples should be shipped upright.
- All shipping containers will be locked and custody sealed for shipment to the laboratory.

The custody seal will consist of a laboratory-provided custody seal or filament tape wrapped around the shipping container at least twice, that is signed and dated before the sample is shipped. The shipping containers will be transported as environmental samples to the laboratory as expeditiously as possible, most likely by Federal Express overnight delivery service or courier.

Due to the analytical holding times, identified in **Table 6-5**, samples must be shipped overnight for next day delivery at the end of each day of sampling. Friday shipments must be marked for Saturday delivery and the lab must be notified in advance to expect a Saturday delivery.

6.6.1.2 INVESTIGATIVE DERIVED WASTE

No IDW is expected to be generated by the soil sampling procedures. All PPE and disposable sampling equipment is considered non-hazardous. PPE will be placed in a plastic bag and disposed of in an appropriate refuse container. Excess soils from surface soil sampling will be returned to their original sampling locations. In the case of excess soils from the ISM, they will be spread out across the DU from which they were collected. Since the ISM soils represent the mean contaminant concentration of the soils across the DU, this will not result in a change in the characteristics of the DU or the risk level associated with the MRS. If IDW is generated it will be properly containerized and characterized prior to disposal. For non-explosive soil, containerization would consist of plastic or steel drums or pails with secure covers. Characterization of the wastes will be as required by the receiving site.

6.6.2 Field Data Quality Control Assessment

Data quality assessment of field data are described in QAPP Worksheet #31, 32 & 33: and will include QC assessment of field data associated with environmental samples submitted for analysis. Specific field data QC assessment activities performed in support of data quality assessment include checking the completeness of associated field data forms and daily field logbooks or other documentation; adherence to sample collecting and testing procedures; and confirmation that required numbers of field duplicates/replicates, equipment blanks, and ambient condition blanks were prepared or collected. COCs will be checked for signatures and dates at each transfer of custody, consistency with daily field logbooks/data sheets, preservation documentation, and analyses requests. Field data QC assessment will be performed by the PM or a project chemist experienced in performing data quality assessments. The Project QA Manager has final authority over field data QC assessment.

All analytical data will be collected IAW USACE Chemical Data Quality Management Program requirements and guidance specified in Engineering and Design Requirements for the Preparation of Sampling and Analysis Plans (EM 200-1-3, February 2001), TPP Process (EM 200-1-2, August

1998), and the DoD Quality System Manual for Environmental Laboratories – Version 5.0 (July, 2013).

All reporting limits and control limits are based on review of the regulatory limits and currently established laboratory capabilities for similar samples. These reporting and control limits will be confirmed with the selected analytical laboratory prior to start of the project. The use of programmatic limits allows for a more uniform data product from analytical laboratories and for more uniform data assessment for the project. All primary and QC samples will be sent to CTL.

6.6.3 Corrective Action Process

The corrective action process is described in the QAPP Worksheet #31, 32, and 33 Corrective Action Report (CAR). The CAR and the laboratory anomaly reporting system are used to centralize the reporting of all conditions that adversely impact the quality of project data, and to document the corrective actions taken to address these conditions for the corrective action program.

When Project Team members identify conditions that may adversely impact project data quality, they will initiate the CAR process. The Project QA Manager is ultimately responsible for the documentation, tracking, response to, and closure of all CARs, but will typically seek input and concurrence from field personnel and USACE when developing or closing out a corrective action. CARs and corrective action documentation will be included in the permanent project files. A copy of all CARs shall be provided to the USACE PM and USACE Project Chemist.

6.6.3.1 FIELD ACTIVITIES

For the duration of the project, it will be the responsibility of the BSEn PM and field team members to see that all procedures are followed as specified in this SI Work Plan, and that measurement data meet the prescribed acceptance criteria. In the event that a problematic or potentially problematic condition arises, it is imperative that prompt action be taken to correct the condition. Potentially problematic conditions include deviation from, or nonconformance with:

- Contract specifications
- Applicable USEPA or USACE guidance
- Investigation program requirements, QA program requirements, or field method procedures specified in this SI Work Plan.

Problematic conditions also include major errors in documented analysis, data or results, and deficiencies in documentation or any other aspect of the project that affect quality. Personnel who identify existing or potentially problematic conditions will report the conditions by completing the CAR, and distributing it to the team leader, BSEn PM, and Project QA Manager.

The number of samples, known or estimated, affected by the condition should be noted on the CAR. The CAR will be used to document the condition, the corrective actions taken, the resolution of the problem, and the return to field program control.

Upon initiation, the BSEn PM and Project QA Manager will review the CAR to determine if:

- Ongoing work should be stopped.
- The condition involves a major deviation from the contract or client-approved work plans, may significantly impact the cost or schedule of the work, or may significantly impact the quality of the resulting data, in which case the condition will be reported to the client.
- The condition has any impact on previously obtained data or reports submitted to the client or other organizations. If previous data or reports are impacted, the BSEn PM will note the impact in the remarks section of the CAR and notify in writing all individuals and organizations that may be affected by the problem, explaining resulting impacts to project data.

The evaluation will be documented by completing Part B of the CAR. The supervisor will recommend corrective action to resolve the problem by completing Part C of the CAR, and the recommended corrective action will be reviewed and approved by the BSEn PM, or Project QA Manager. The approved corrective action will be implemented by appropriate personnel, and reviewed and approved by the BSEn PM and Project QA Manager. The approval will be documented on Part D of the CAR.

6.7 Deliverables

Daily field deliverables will be turned over to the BSEn PM and include field logs, sketches and maps, digital photographs, and GPS data. A daily status map of the field data (GPS tracks and recorded features) will be developed and delivered to the BSEn PM to track progress. The BSEn PM will review these materials and submit a summary of the daily activities (including any available representative field photographs and status maps) to the USACE PM as part of daily reporting for the SI.

An exit briefing, consisting of a final discussion including a list of all MEC/MPPEH/MD and other points of interest; a summary of completed soil sampling; and a projected schedule for reporting will be delivered after data collection has been completed. The exit briefing will be coordinated between the BSEn PM, the USACE PM, and the RFAAP POC. The final data will be included in the SI Report.

The following is a list of deliverables that will be provided to the BSEn PM:

- Field Logs, including any sketches and maps utilized during the field survey.
- A map showing survey tracks and points showing locations of MEC/MPPEH/MD and other points of interest (following visual surveys).

- Digital photographs.
- A List of MEC/MPPEH/MD and other munitions related items identified during visual surveys.

The following deliverables will be provided to the USACE PM:

- Daily Summary Reports (including Daily Quality Control Reports [DQCRs], Daily UXO Reports, any representative photographs, and any status maps).
- An Exit Briefing, to be presented to the RFAAP POC at their convenience at the conclusion of the field work.
- A SI Report, documenting the results and conclusions of the SI.

This page intentionally left blank

7.0 Accident Prevention Plan

An APP is included as **Appendix D** to this Work Plan. The APP provides specific details relating to the procedures that will be used during the SI field activities to ensure worker safety.

This page intentionally left blank

8.0 Explosives Management Plan

No explosives will be brought on site or handled by BSEn or subcontractor personnel during the execution of this project; therefore, an Explosives Management Plan is not necessary for the SI activities. Anomaly avoidance will be practiced during AVS and sampling activities, as described in **Section 9.0**.

If MPPEH or MEC is discovered:

- Work will stop;
- The UXO Technician III will visually inspect the MPPEH or MEC item to obtain as complete a description as possible, without handling, moving, or disturbing the item;
- The location will be recorded using GPS and marked using a pin flag or survey tape placed nearby, but not on or immediately adjacent to, the MPPEH or MEC item;
- The MPPEH or MEC item will be recorded in a field logbook and documented with digital photographs;
- Personnel will move away from the MPPEH or MEC item to a location designated by the SSHO/UXO Technician III.

MPPEH and MEC will be reported up the following chain:

- The SSHO/UXO Technician III will report the find to the BSEn PM;
- The BSEn PM will notify the USACE PM;
- The BSEn PM will notify the RFAAP POC;
- The RFAAP POC will report the find according to RFAAP protocol (including notification to the RFAAP Security Office and subsequent notification to the EOD group responsible for responding to RFAAP).

BSEn or subcontractor personnel will guard the area of the MPPEH or MEC find to warn anyone attempting to access the vicinity of the potential explosive hazard until relieved by RFAAP personnel (or as directed by the RFAAP POC or RFAAP Safety Office). The SSHO/UXO Technician III will guide responding EOD personnel to the MPPEH or MEC item if requested.

This page intentionally left blank.

9.0 Anomaly Avoidance

Anomaly avoidance refers to techniques used by personnel at sites with known or suspected MEC. The purpose of anomaly avoidance is to avoid any potential surface MPPEH or MEC and subsurface anomalies during sampling activities. SI activities that have the potential for encountering MPPEH or MEC include AVS and surface soil sampling. Intrusive anomaly investigation is not permitted during anomaly avoidance operations.

For anomaly avoidance during SI field activities on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, compliance with anomaly avoidance procedures will be the responsibility of the UXO Technician III. The SSHO/UXO Technician III will be responsible for conducting safety briefings for all site personnel and visitors.

Prior to the initiation of SI field activities, the UXO Technician III will provide the field team with information to aid in the recognition of items that may be anticipated at the MRS. The UXO Technician III will emphasize that although the potential for certain MPPEH and MEC items may exist at an MRS, the field team must be prepared to recognize all potential MPPEH and MEC. Additionally, the team leader will be provided with a field guide that contains data sheets and photos of potential MPPEH or MEC.

SI field activities will be conducted by a field team consisting of a minimum of two members. One of these members will be a UXO Technician III (at a minimum), who will act as the munitions specialist and SSHO. The other members of the team may be additional UXO-qualified personnel, environmental professionals, or field technicians. The UXO Technician III is primarily responsible for providing MEC recognition, location, and safety functions during AVS and surface soil sampling. Non-UXO qualified team members must be escorted by the UXO Technician III at all times. Schonstedt GA-52Cx hand-held metal detectors will be used to enhance visual sweep procedures and to locate potentially buried MPPEH or MEC items to ensure worker safety.

To protect workers against potential explosive hazards from buried MPPEH or MEC, anomaly avoidance procedures will be implemented during surface soil sampling. The UXO Technician III will inspect surface soil sampling locations using a Schonstedt GA-52Cx. If a metallic anomaly is detected, the sample location will be moved to the closest point without a metallic anomaly.

MPPEH and MEC may be obscured under leaf litter, site debris, or dense vegetation. Therefore, personnel conducting AVS will implement anomaly avoidance procedures when walking across areas where the ground surface is obscured. The UXO Technician III will inspect the path ahead of the team for metallic anomalies, and suggest a safe path around any metallic anomalies obscured by leaf litter, site debris, or dense vegetation.

Under no circumstances will field personnel (including the UXO Technician III) attempt to excavate metallic anomalies found during the course of anomaly avoidance and AVS.

If MPPEH or MEC is discovered, the response described in **Section 8.0**, above, will be implemented. Information regarding MEC, MPPEH, and munitions-related features identified during SI field activities will be documented in field logs, within the GeoXT or GeoXH GPS devices utilized by the field team, and in DQCRs and Daily UXO Reports. The information will be provided as needed to assist EOD in locating and identifying the MPPEH or MEC item. Records will be provided to the RFAAP POC as needed.

10.0 Environmental Protection Plan

10.1 Potential MRS Resources

10.1.1 Vegetation and Wildlife

Vegetation and wildlife anticipated at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, including sensitive, endangered, and threatened species, are discussed in detail in **Section 4.2.5**. No Threatened and Endangered species are known to occur on the MRS, but there is the potential for the smooth coneflower (*Echinacea laevigata*) to be present on or near the MRS, and the Virginia fringed mountain snail (*Polygyriscus virginianus*) may be present in the New River adjacent to the MRS (USFWS, 2014).

10.1.2 Water Resources

Surface water is intermittent on the MRS, and is only present during and immediately following heavy rains. The MRS drains into the New River, which borders the MRS to the south.

Water used on RFAAP is taken from the New River. Intake 1 is located upstream of the mouth of Stroubles Creek, and Intake 2 is located downstream of the mouth of Stroubles Creek. RFAAP Intake 1 is located just upstream from the Former Gun and Mortar Range (RFAAP-002-R-01) MRS, on the opposite side of the New River. Intake 2 is located downstream of the MRS. The towns of Blacksburg and Christiansburg also draw drinking water from the New River, but this occurs upstream from RFAAP (URS, 2003).

Groundwater at RFAAP exists in alluvial aquifers, located within the floodplain of the New River, and in fractured bedrock. The hydrogeology of fractured bedrock aquifers is dominated by karst features. The hydraulic gradient underlying RFAAP generally trends toward the New River and away from the higher areas of RFAAP, with evidence of communication between groundwater and the New River. (URS, 2003)

No known jurisdictional wetlands have been identified within the boundaries of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS; therefore, no wetland impacts are anticipated.

10.1.3 Cultural and Archaeological Resources

Cultural and archaeological resources have not been evaluated on a facility wide basis at RFAAP. No facilities on RFAAP are currently listed in the National Register of Historic Places (NRHP, 2015), although it is possible that some of RFAAP may be eligible based on the long history of operation of the plant. It is not anticipated that any of the infrastructure located on the Former Gun and Mortar Range (RFAAP-002-R-01) MRS is eligible for inclusion in the NRHP.

10.2 Environmental Impact Mitigation Procedures

10.2.1 Coordination with Environmental Office

Action will be taken during field activities to minimize or mitigate any adverse impact to the environment. In order to minimize potential impacts to federal and state listed plants and animals, BSEn and its subcontractors will consult with the RFAAP Environmental Office and other natural resource managers, as appropriate, before beginning any field activities. These actions are described in subsequent sections.

10.2.2 Waste Disposal

Solid waste generated during field activities will be collected and placed in a proper trash receptacle staged at an approved area on the MRS. PPE used during field activities (including latex or nitrile gloves, paper towels, etc.), will be bagged and disposed of as municipal waste. Pin flags, wooden stakes, and other materials used to mark locations will be removed when they are no longer needed. All wastes generated during the SI are expected to be non-hazardous, and will therefore be disposed of in a trash receptacle designated by RFAAP personnel.

10.2.3 Burning Activities

Burning activities are not anticipated as part of the SI field work.

10.2.4 Dust and Emissions Control

SI field work will generate little to no fugitive dust emissions. No heavy equipment will be used, and vehicles will remain on established roadways unless off-road travel is absolutely necessary. Soil sampling will be completed using non-powered hand tools and will therefore result in little to no dust emission. Therefore, a dust control plan will not be developed for the SI field work.

10.2.5 Spill Control and Prevention

Minimal quantities of chemicals will be brought on-site during the field activities. Vehicle refueling will be completed at commercial off-site facilities. Field procedures will focus on minimizing or preventing spills during field activities; however, if a spill of hazardous chemicals were to occur, the operating contractor will contain the spill and contact the RFAAP Environmental Office. All spill management and resolution will be completed according to RFAAP guidelines.

Currently, no sample preservatives are required for this field effort. If chemical preservation of samples becomes necessary, any samples requiring preservation will be collected in sample containers with the preservative added by the laboratory to minimize the on-site handling of acids or other chemicals.

10.2.6 Munitions Storage Areas and Temporary Facilities

Munitions storage will not be required as part of the SI field activities. In the unlikely event that MEC is encountered, it will be reported to RFAAP personnel as described in **Section 8.0**.

10.2.7 Access Routes

Field personnel will only use established roadways (dirt or paved) to the extent possible to gain access to the MRS. If motorized vehicles must travel across the MRS, field personnel will strive to confine motorized traffic to established access routes to reduce potential impacts to surface topography and vegetation.

10.2.8 Vegetation Removal

Other than grass for surface soil samples, vegetation removal will not be required in order to complete the SI field work.

10.2.9 Vegetation Restoration

Vegetation removal will not be required in order to complete the SI field work. Therefore, vegetation restoration will not be required.

10.2.10 Water Run-On and Run-Off Control

No excavation will be completed as part of the SI. Therefore, no alteration of the existing drainage patterns will occur. Water run-on and run-off control will not be required. If it becomes necessary, sand bags, wattles, and silt fence will be employed to mitigate any run-on or run-off issues caused by SI activities.

10.2.11 Equipment Decontamination and Disposal

Disposable sampling equipment will be used; therefore, decontamination will not be necessary. Disposable sampling equipment will be handled as non-hazardous waste, and disposed of in a trash receptacle designated by RFAAP personnel.

10.2.12 Minimizing Disturbance

Precautions will be taken to minimize any impacts to natural resources during soil sampling. Soil sample locations will be moved to avoid large or sensitive vegetation whenever possible. If vegetation must be disturbed, the vegetation (including root mat) will be carefully removed, set aside, and replaced once the sample has been collected. Holes at sample locations will be backfilled using the excess soil removed from the location during sampling. The ISM sampling will be collected with a 2.5 cm cylinder using a push core device. Backfilling will not be necessary.

10.2.13 Post-Activity Clean-Up

Stakes and pin flags will be removed from the MRS. Solid waste will be removed after field activities have been completed and prior to leaving the MRS. All waste is anticipated to be non-hazardous, and will be disposed of in a trash receptacle designated by the RFAAP POC.

10.2.14 Air Monitoring Plan

Soil sampling and AVS activities are not anticipated to result in significant amounts of dust or other fugitive emissions. Therefore, air monitoring will not be required.

11.0 Installation Security

RFAAP is a secure facility and access to the installation must be obtained through the main gate. The field team will coordinate with the RFAAP POC or a designee to gain access to the installation and the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

11.1 Communication

Communication with the RFAAP Installation POC will include an in-brief meeting on the first day of field activities and an out-brief meeting on the last day. Additionally, during field activities, the project team will inform the RFAAP POC, USACE PM, and BSEn PM of any discoveries of MPPEH or MEC items. The project team will contact the RFAAP Security Office on a daily basis to inform them of the location of field activities for that day.

Communication among field team members while conducting field activities will include the use of hand held radios and cellular phones when necessary, as well as the use of hand and audible signals. Communications will be checked at the start of each workday and after breaks when work resumes. Regular communication checks will be conducted throughout the day by the SSHO. The following two sections provide the RFAAP contact numbers.

11.1.1 Emergency Numbers

- 540-639-7163
- 16 (only from a 639 number)

11.1.2 Non-Emergency Numbers

- Environmental 540-230-8970
- Security 540-639-8289
- Safety Hotline 540-639-7374

This page intentionally left blank.

12.0 Project Schedule

The following provides a tentative schedule for the activities to be conducted under this SI project:

- SI Field Work – End of September 2016
- Draft SI Report – January 2017
- Final SI Report – March 2017
- Final TPP Session – March 2017

A schedule will be developed and provided to the installation detailing day-to-day activities for the field work so that notification can be provided to appropriate offices and individuals throughout the installation. It should be noted that this schedule may change depending on field conditions and the RFAAP POC will be provided daily updates on the field activities.

This page intentionally left blank.

13.0 References

- ANSI/ASQ. (2004, February). Requirements with guidance for use. ANSI/ASQ E4.
- DoD/DOE. (2013, July). Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.0.
- DoD. (2013, April). Environmental Field Sampling Handbook, Revision 1.0.
- EPA. (2000, January). *Data Quality Objectives Process for Hazardous Waste Site Investigation, EPA QA/G-4HW, Final*. Retrieved from EPA, Quality System for Environmental Data and Technology: <http://www.epa.gov/quality/qs-docs/g4hw-final.pdf>
- ERDC/CRREL. (2007, July). *Protocols for Collection of Surface Soil Samples at Military Training and Testing Ranges for the Characterization of Energetic Munitions Constituents*. TR-07-10.
- Franklin Engineering Group. (2001). *Radford Army Ammunition Plant Screening Level Ecological Risk Assessment*. Virginia.
- IT Corporation. (2001, December). Facility-Wide Background Study Report. Radford Army Ammunition Plant , Virginia: USACE.
- IT Corporation. (2001, December). Facility-Wide Background Study Report, Radford Army Ammunition Plant, Virginia . USACE Baltimore District.
- ITRC. (2012, February). *Incremental Sampling Methodology*. Retrieved 2015, from Interstate Technology Regulatory Council: <http://www.itrcweb.org/ism-1/>
- MCPSA. (2015). Montgomery County Public Service Authority. Retrieved from <http://www.montgomerycountymva.gov/content/15989/16055/16753/default.aspx>.
- NRHP. (2015). *National Register of Historic Places*. Retrieved August 2015, from National Park Service, U.S. Department of the Interior: <http://www.nps.gov/nr/research/index.htm>
- OSHA. (2009, July 1). *Code of Federal Regulations (CFR) Title 29 Part 1910.120 - Hazardous waste operations and emergency response*. Retrieved 2011, from Government Printing Office, CFR: <http://www.gpo.gov/fdsys/pkg/CFR-2009-title29-vol5/pdf/CFR-2009-title29-vol5-sec1910-120.pdf>
- OSHA. (2010, July 1). *Code of Federal Regulations (CFR) Title 29 Part 1926.650-651, Subpart P - Excavations*. Retrieved 2011, from Government Printing Office: <http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol8/pdf/CFR-2010-title29-vol8-part1926-subpartP.pdf>
- OSHA. (2013, July 1). *Code of Federal Regulations Title 29 Part 1910 - Occupational Safety and Health Standards*. Retrieved 2014, from Government Printing Office: <http://www.gpo.gov/fdsys/pkg/CFR-2013-title29-vol6/pdf/CFR-2013-title29-vol6-subtitleB.pdf>
- Schonstedt. (2012, April). Instruction Manual Model GA-72Cd Magnetic Locator.
- Thiboutot, S., Ampleman, G., & Hewitt, A. (2001, February). Guide for characterization of sites contaminated with energetic materials. *ERDC/CRREL TR-02-1*. Hanover, NH: U.S. Army Engineer Research and Development Center.

- U.S. Army. (1992, October 9). Field Manual No. 7-90, Tactical Employment of Mortars, Appendix B, Figure B-5. Washington, D.C.: Department of the Army.
- URS. (2003). *Radford Army Ammunition Plant Master Work Plan*.
- USACE. (2001, February 1). *Engineering and Design - Requirements for the Preparation of Sampling and Analysis Plans (CEMP-RA, EM 200-1-3)*. Retrieved 2010, from USACE, Headquarters, Engineering Manuals: <http://140.194.76.129/publications/engineering-manuals/em200-1-3/entire.pdf>
- USACE. (2008) *Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final 2008*
- USEPA. (1989, December). Human Health Evaluation Manual (Part A), EPA/540/1-89/002. *Risk Assessment Guidance for Superfund: Volume I*.
- USEPA. (2000, October 31). Permit Number VA1210020730. *United States Environmental Protection Agency Permit for Corrective Action and Waste Minimization; Pursuant to the Resource Conservation and Recovery Act as Amended by the Hazardous and Solid Wastes Amendments of 1984*. Radford Army Ammunition Plant, Virginia.
- USEPA. (2003). *Guidance for Developing Ecological Soil Screening Levels*. OSWER Directive 9285.7-55,
- USEPA. (2012, January). Site Characterization for Munitions Constituents.
- USEPA. (2016, May). *Regional Screening Tables*. Retrieved July 2016, from USEPA Regional Screening Levels (RSLs) - Generic Tables (May 2016): <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016>
- USFWS. (2014). *Environmental Conservation Online System*. Retrieved from U.S. Fish & Wildlife Service: <http://www.fws.gov/endangered/>
- Data Item Descriptions (DIDs):
- MR-001, Type I Work Plan
 - MR-005-01, Type II Work Plan
 - MR-005-04, Explosives Siting Plan
 - MR-005-05, Geophysical Investigation Plan
 - MR-005-06, Accident Prevention Plan
 - MR-005-07, Geospatial Information and Electronic Submittals
 - MR-005-10, Munitions Constituents Chemical Data Quality Deliverables
 - MR-005-11, Quality Control Plan
 - OE-005-14.01, Geographic Information System Plan
- DoD Directive 4715.11, Environmental and Explosives Safety Management on Department of Defense Active and Inactive Ranges within the United States.
- Engineer Manuals (EMs):
- EM-200-1-1, Technical Project Planning (TPP) Process, August 1998.
 - EM-200-1-3, Requirements for the Preparation of Sampling and Analysis Plans, February 2001

Appendix A

Technical Project Planning Minutes

This page intentionally left blank.



Kickoff Meeting Memo:

Subject: Documentation of Kickoff Meeting Team Concurrence for Former Gun and Trench Mortar Range Site Investigation (SI)

Site: Radford Army Ammunition Plant, Radford, Virginia

Contract: Contract Number W912QR-13-D-0001 Delivery Order 0001

This document is intended to provide a record of the first Kickoff meeting for the **Radford Army Ammunition Plant Former Gun and Trench Mortar Range Site Investigation (SI)**. The Radford Army Ammunition Plant is located five miles northeast of Radford, Virginia.

The Kickoff meeting participants were provided an opportunity to comment on the SI technical approach as presented during the Kickoff meeting held at the Radford Army Ammunition Plant (RAAP) Administration Building, in Radford, Virginia, on November 6, 2014. An initial technical approach (as presented during the Kickoff meeting) was developed using the collaborative experience of Bering Sea Environmental, LLC, (BSEn), HDR, Inc. (HDR), and the USACE technical experts. The technical approach was prepared using information contained in the 2003 Final Master Work Plan, the 2008 Historical Records Review, the 1992 Preliminary Assessment Report Addendum, and other pertinent documents. The Kickoff Team discussed and refined the initial technical approach during the course of the Kickoff meeting, yielding a final technical approach for implementation at Radford Army Ammunition Plant. The Kickoff Team's agreed-upon final technical approach is documented herein and will be further detailed in the forthcoming SI Work Plan. The SI Work Plan will be submitted to the Kickoff Team members for review to ensure that the key aspects of the Kickoff meeting resolutions are fully captured.

Attendees:

The Kickoff meeting began at 2:30 p.m. in the conference room of the RAAP Administration Building. The meeting was attended by persons from the USACE – Baltimore District (CENAB), U.S. Army, BAE Systems, Bering Sea Environmental, LLC, (BSEn), and HDR, Inc. (HDR). A copy of the sign-in sheet is attached.

Presentation:

The meeting began with introductions of the various attendees. BSEn/HDR conducted a presentation that included an overview of the SI process, objectives for this SI effort, a summary of previous investigations, and the proposed technical approach. A copy of the presentation, as presented, is attached.



The discussion focused on the MMRP project site associated with the Radford Army Ammunition Plant which includes two adjacent areas; the Gun Range Area and the Trench Mortar Range Area.

As part of the Kickoff meeting process, the participants discussed the proposed technical approach for the SI. The general topics discussed and the associated resolutions are described in the following bullets:

- The Kickoff Team agreed with the proposed technical approach, as presented at the Kickoff meeting, with minor revisions and comments (presented below):
- The breakdown for the completion of work will be two people doing interviews and data collection for two days. At least one contractor will be badged and made available to escort the crew. When transferring is being conducted, the badged contractor and all BSEn/HDR personnel will not be allowed in the area.
- Ms. Karen Gunter will review the restrictions for the photography pass at the pre-work meeting.
- All BSEn and HDR personnel on site will not have any items on their person that may cause striking or sparking. All equipment to be used on site shall be provided on a list for the pre-work meeting for approval, this includes metal detection equipment. All contractor personnel will use plastic spoons when conducting site sampling.
- Claytor Lake is located upstream from the RAAP, periodically the spillway is opened to release overflow from the lake. When the spillway is scheduled to be opened, RAAP will be notified the day of. There will be 26 minutes to relocate to higher ground after the spillway is opened.
- BSEn and HDR will be provided with the BAE Subcontractor Manual at the Pre-work meeting.
- Any vehicles brought on site will either be rental or company cars. No personal vehicles will be allowed on site. All company trucks will need to display identifying signage.
- Safety for the installation is available at all times.
- Mr. Tom Meyer confirmed that there is a Resource Conservation Recovery Act (RCRA) permit for military munitions.
- Mr. Chuck Williams summarized a brief history of the types of munitions that have been found on the property. Mr. Williams stated that munitions are typically found after rainstorms and along the New River. He heard that at one point, dump trucks took loads of mortars out of the area to the east. Mr. Williams believes he has a document that states the inactive area was cleared.



- To date, no firm count of the munition types and the locations found has been made. According to Mr. Chuck Williams the munitions found have included:
 - Smoke rounds, thought to be White Phosphorous (WP), and later characterized as having antifreeze or wax inside, no WP was found.
 - Some paper wrapped mortars marked HE, but instead contained metallic pellets. Some of the mortars were x-rayed by Fort Bragg EOD and were found to contain either metallic pellets or dirt.
 - Some found mortars have had flat noses instead of rounded noses.
 - Only one of the munitions found may have included High Explosive (HE) filler: The possible 60 mm HE mortar was disposed of by detonation, but the donor charge was too large to determine if the round contained HE.
- According to Mr. Williams, the gun and mortar ranges existed only to test the gunpowder manufactured by the plant. He believes that test shooting occurred from the southwest edge of the MRS and directed toward the northeast of the site. Mr. Williams noted that a pit of Jet-Assisted Take Off (JATO) mortars was recently found on site. He has a sketch of that shows how to set up the mortar equipment but it does not provide a location on site for the setup. Mortars were only tested at the facility, not manufactured, bodies of the mortars were sent to the installation specifically for testing purposes.
- TNT at one point was manufactured at the facility, but only for a short time and it was shipped out afterwards, not stored on site.
- Mr. Williams stated that they have been conducting remote pulls to bring any found items up to the demo area. To date, there are no recollections of any munitions being found on the south side of the New River. Mr. Williams has photos of previous finds on the installation.
- Mr. Williams confirmed that neither of the Munitions Response Sites overlays a Solid Waste Management Unit (SWMU).
- Ms. Cindy Burton confirmed that EOD Reports are available upon request from Lieutenant Colonel Ortiz. Mr. Jim McKenna also has site background levels for metals available.

Procedural details of the field work will be provided in an SI Work Plan for stakeholder review and comment. All findings of the SI will be documented in SI Reports for the Kickoff Team and other stakeholders' review. The Technical Approach described within this Memo Packet will not be modified without consultation and agreement by the Kickoff Team whose names appear below.



Kickoff Meeting Attendees		
Mr. Tom Meyer U.S. Army Corps of Engineers Baltimore District 10 South Howard Street, Baltimore, Maryland 21201	Mr. Jim McKenna U.S. Army Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141	Ms. Karen V. Gunter U.S. Army Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141
Ms. Cindy A. Burton U.S. Army Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141	Mr. Jeffery Howell U.S. Army Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141	Mr. Chuck Williams BAE Systems Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141
Mr. Matthew Alberts BAE Systems Radford Army Ammunition Plant 4050 Peppers Ferry Road Radford, Virginia 24141	Ms. Bonnie Morris Bering Sea Environmental, LLC. 615 E. 82nd Avenue, Suite 200 Anchorage, Alaska 99518	Ms. Sarah Skrobialowski Bering Sea Environmental, LLC. 4624 Carriage Drive Circle Charlotte, North Carolina 28205
Mr. John Coughlin HDR, Inc. 2600 Park Tower Drive, Suite 100 Vienna, Virginia 22180-7342		

Appendix B

Interview Documentation

Chucky Williams, Safety Manager	B-1
Dave Hurley, Safety Assistant Level III	B-8
Dennis Kits, Manager of Training and Development	B-10
George Gimmelmorgan, Chief Ballistics Instrument Operator	B-14
Jeremy Flint, Environmental Engineer (ATK)	B-17
Mark Childress, NG2 Area Worker	B-20

This page intentionally left blank.

RAAP SI Interviews – Transcription [Information has been redacted for security reasons]

December 15, 2014

Chucky Williams – Safety Manager, RAAP

Interviewers: Sarah Skrobialowski (BSEn) and Derek Jennings (HDR)

Question (Q): Will you state your name?

Answer (A): Chucky Williams

Q: What is your job at the installation?

A: I am the Safety Manager.

Q: Any previous jobs here?

A: Yes, I worked here from 1988 through 1992 in Hazards Analysis, and then I came back in 1997 and worked until 2011 as a supervisor of Hazards Analysis, and then I came back in 2012 as the BAE Safety Manager.

Q: What responsibilities did you have?

A: In Hazards Analysis, our goal or our job's responsibility was to address risk, do process hazards analysis and all the operations here, so that's what I started out doing as a supervisor, of course then not only did I oversee the process hazards analysis work, but also we did the explosive testing for the facility. Currently as the supervisor of hazards we did all of the sensitivity and reactivity testing for all of the explosives. We also did all of the Department of Transportation testing for shipping classifications, so we also did many DoD (Department of Defense) tests for explosives for to meet (IM and Brusants – Indecipherable at 1:34-1:36) and a few other things. So we also did Operation Bearface, which is our training, explosives training, where we show people what explosives look like when they burn. And that's a training that everybody goes through. As BAE Safety Manager, I am responsible for the safety and health of the facility and the programs that go along with that. I also have the medical department reports to me and then also the hazards testing has remained under me, there's no longer a hazards department, but we have a hazards testing group. We have a hazards test person. Laughter. We don't have a group any more.

Q: And this is site-wide?

A: For the entire Radford facility yes, which would also include Dublin.

Q: To the best of your knowledge, can you describe the history of the site? Long pause. As briefly as you want, just so we can get it on the record.

A: Ok, I'll go back to my history because you can get other history from other places. The arsenal started in 1940, actually in 1939. 1941 they started production in A Line. A lot of that is documented already. I came in 1988, there were around 8,000 employees at the facility at the time. I came in as a hazards analyst. At that point in time B-Line was still running, C-Line was running, actually first-roll was still running, fourth-roll was running, and all the rocket area was up and running. As a matter of fact, I think even the igniter line was running over there on the other side of squirrel hollow, so we had a bag igniter line that was also running. From 1988 through 1992, basically we went through a downturn. There were a lot of layoffs due to defense cuts at that point in time. B-Line was put into moth-balls, first-roll was put into moth-balls, and there were several modernization projects at that time, I think NG went through a few, but they went from about 8,000 to 6,500 before I was laid off in 1992. 1997 I came back, in hazards, NRE had transferred from Kenvil down here under ATK and they were occupying A-Line, Medium Cal was just coming up and getting started when I got here over in the rocket area over in the old warehouses, so we started up the 25 and 30 mm production lines. Between 1997 and 2011, basically it was maintaining the facility as it was, most of C-Line was up and running, all the Rocket Area, Fourth Roll at that point in time. Around 1999 Grucci came on board, one of our other explosives tenants, so they came and then... (Chucky trails off at this point). I left in 2011 after the previous contractor lost the contract, and then came back in 2012 as the safety manager for BAE and we've been maintaining the current capabilities for BAE since then.

Q: Do you know anything about the history of the Trench Mortar Area or the Gun Area?

A: The information that I've gathered, basically, I would say since about, well at least since 1997, I've been involved with most, if not all, of the mortars that have been found. All of them have been found over in the NG1 area, or close to it. There have been a few that have been found just outside the fence of the CAMBL Area. To my knowledge, there haven't been any that have been found in the CAMBL Area proper since I've been back. They vary in different shapes and sizes. Back earlier when I was in Hazards in 1988 through 1992, the mortars were dug up, basically relocated to the Hazards Area, put into a cage and they sat there until the Army came and picked them up in a truck and drove them off down the road. When I came back in 1997, the rules had changed and they had decided not to do that. To my knowledge we have never found a live round on this facility. All of them have been filled with inert materials such as wax, or antifreeze or even clay and gravel. Some of them have gravel and little lead cylinders in them and so that's what I know about, mostly about the trench mortar area. Recently we found the one map where it sort of outlined where it was. Knowledge that I have gained has been that this was an area where they tested the propelling charge. So they would load a specific mortar or specific round to the right weight and then they would shoot it or launch it down range just to see how the propellant would react and they would measure the characteristics of what was the speed of the mortar coming out of the tube. We have found mortars that were definitely not the result of a round being fired down range. We found two earlier in 2012... probably late 2012, that were probably greater than eight feet maybe even ten feet below ground. And they had probably been buried there. They still had what looked like wax paper wrapped around them and there was no indication that they had ever been fired out of a tube, no erosion, no impact on the nose. They were in fairly good shape. So we had a variety of materials that have either been fired and left or buried. And we don't know where exactly

they could have... this happened to be near a water break line and that's how we found them, ten feet in the ground. We have found everything from 60 mm to 81 mm to the 4inch, which could either be representing HE or White Phosphorus or smoke. And they aren't limited to being within the limited area, we have found several outside our gate, outside our fence-line, on the bank going down to the New River.

Q: I know Dave Hurley mentioned earlier that he thought there was a White Phosphorus round found on site.

A: We have found several... they think that was WP. The problem is, that unless you test, you don't know it is. And that particular round, they said hey there's a lot of white smoke coming out of there. This is one that was found while I was not here between 2011 and 2012, so we have found several other rounds that were sub marked that could have been WP but after you open them up, there is a lot of smoke and then the antifreeze does burn and sometimes when the antifreeze burns it comes out white, so the only other thing that you could do is go in there and actually take a sample and have the lab to review it, but I think, in my professional opinion they jump to a conclusion without adequate testing.

Q (Derek Jennings – HDR): Who is they? Could you identify they please?

A: In that particular case it was the people who were in charge of getting rid of the round at that point in time under ATK.

Q (DJ): So it wasn't any EOD from... (Trails off)

A: EOD would have been involved, but EOD does not give us their records. You have to get those from the U.S. Army. I have tried, just for our records, but they will not give us those records.

Q (DJ): Do you have a date range for when this particular one (referring to the WP round) occurred?

A: I would have to go back and look, but that was not in the time when I was here. I can go back and find tentative date ranges based upon photography and where I have stored things, but I know we have had at least three or four in 2012, at least one in 2014, maybe 2, I would have to go back and look. And they've been anything from a 60 mm to an 81 mm to a 4 inch. And the 4 inch in diameter mortar rounds, they can either be WP, smoke, or HE, it depends on the markings. Unfortunately none of the ones we've had, had enough markings on them to identify what they were, for the 4 inch ones. One of the 4 inch ones, when we picked it up, well it "sloshed" so they didn't make the EOD guy very happy.

Q: And nothing you've come across in your readings?

A: No, I think there may have been something in CAMBL, there may have been an old landfill up there but that was cleaned out when they put CAMBL in, they had to completely dig that out. History or information that I got third and fourth hand, was that during the CAMBL construction they took mortars out by the truckload. But I have not found anything in the CAMBL proper area, the ones I have found in that area have been over the fence on the bank. Now whether they got there by being tossed at some

later date and covered up or whether or not they're now surfacing, I can't tell. I know they've been in the ground a long time because all of the markings are gone.

Q (DJ): Could you walk us through - just for the record - what kind of research you've done for the Trench Mortar Range (unclear) and the Gun Range?

A: Basically what I have tried to do was go through all of our drawings and see if I could find anything of a historical value. The only thing that I have come across is a sketch of what the firing location would have looked like. I have an indication by looking at the map that I just looked at of where I think the particular building where they've stored material may have been located and that's just guess. And then, other than the map and the historical blurb that I found in that one book that you already have a copy of, I have not found any other reference to, or find anything in our documentation that even mentions a mortar range. Other than us digging them up and finding them, until we found this one map, and this one map is basically just something that says "this is where it may be" because the map and the information was generated prior to the construction of the facility.

Q (DJ): Do you know who generated that map?

A: That would have been the U.S. Army.

Q (DJ): The Army Corps?

A: Don't know whether it would have been the Corps. I don't know who it would have been at that point in time back in the 40s because the Corps didn't exist in the 40s.

Q: You said you had a sketch of the direction that they fired in?

A: Not the direction that they fired in, I have a sketch of what they may have used or had set up as a firing point. It's just a sketch of what the building looked like or something like that with a few things. There's nothing on it that I can find that leads me to... I was hoping it was going to give me a coordinate, but it didn't do that. I think I can try to dig that up. That's the only thing in the drawing files that even comes close to it. And I have went back and looked at the particular magazine that I think they may have used, and there is nothing associated with that magazine either. So the two magazines I think may have been associated with it would have been 224-11 and 224-5. Those are old buildings that were around when the mortar range was in existence and could have been used to house the particular powders or whatever they were going to use to fire. And if you look at where those are positioned, they are positioned at the western end of what would have been the mortar trench range so at that point they could have launched in the general direction of where we've been finding everything. Now I have not been out there to look at those two buildings to see if there is any other evidence that may be out there that someone looking for may find, but I haven't been over there in years and I haven't had a chance to go back over there and look. I don't even know if the topography allows for it.

Q (DJ): Do you have a GIS system here?

A: Yes, there is a GIS system.

Q (DJ): Ok, we took the coordinates from the map that you found and dropped the coordinated in to present day so we can send you that if you'd like.

A: That would be alright. My comment on that is: because there has been so much earth moved over the years, I cannot guarantee that something has not been dug up and relocated over the years. We have a dirt pile that sits out there, it is five feet now, it used to be six, seven feet of dirt; and someone was out there one day fooling with some of the rocks and one of the four inch fell out of it [meaning the dirt pile] and that pile had been relocated from somewhere else. And then history has it that one of them came out of the dirt in an old barricade when they were tearing an old barricade down over there. I've got nothing to corroborate that one with though.

Q (DJ): Do you have anything on the first one? With the four inch in the dirt pile? Reports, location maybe?

A: Oh yeah, don't know about reports, but I know about the location. The reports would have been strictly government. I know where that one come from because I worked on that.

Q (DJ): Ok, where was that one?

A: Over there in between CAMBL and slurry in a field. I can try to help locate some of those spots where we have found things. If you have a GIS map the best thing for me to do is to show you where it's at on that.

Q: Any other MEC issues on the property for the sites?

A: I don't know of any

Q: Are you aware of any explosions on the property?

A: From the mortars?

Q: Yes, or otherwise.

A: We've had several explosions on the property, but they had nothing to do with the mortars or anything like that - they were all process related events.

Q: Are you aware of any past activities or events, or have you made any observations that you think might be useful to this study?

A: No. Most of what I do is in the safety world, I don't have much to do with these guys and their cleanups.

Matt Alberts: I didn't know there was an existing area like this until maybe six months ago.

A: You talking about the mortar trench?

Matt Alberts: yeah.

A: I'm still trying to figure out what they had up there on top of the hill, they had something up top before they put CAMBL in. There used to be something there that used to be like a dump site, because I found something that said they had to clean that up, clean it out, before they built CAMBL.

Matt Alberts: It might have been what we call an inert debris pile, where we just dump clean concrete, dirt, soil, gravel, stuff like that because there's another one on the other side of the bridge that way.

Q: Are there any other people that might have knowledge of activities at the site?

A: I can't think of anyone.

Matt Alberts: I was going to try and set up an interview with Dennis Kits.

A: Well Dennis has a lot of history, he might be able to find bits and pieces of the history but he's not been too involved with the EOD and the mortars. The other thing you need to do is go through the Powder Press from the forties. That was the plant magazine— every now and then you can gain some things out of there.

Q: Are there any other documents that you can think of that might prove useful?

A: A lot of the documentation has been archived or gotten rid of and the people who archived it are no longer working here – at least from my perspective.

Q: And you don't know where those archives are?

A: I don't know where they might have put them. And if they were archived under the previous contractor, that contractor would still have them.

Q: And that's ATK?

A: Yes. I mean I've even looked through all the accident records, and there's nothing in those. They never had an accident over there so nothing ever got written down.

Matt Alberts: You have accident records that go all the way back to the forties?

A: Yes. I even have incident history for lost times that goes all the way back to the forties, and I haven't found anything in them that is related to the mortar range.

Q: Or the gun area?

A: Nope.

[End of Interview]

RAAP SI Interviews – Transcription

December 15, 2014

Dave Hurley – Safety Assistant Level III

Interviewers: Sarah Skrobialowski (BSEn) and Derek Jennings (HDR)

Q: Can you state your name?

A: Name is David Hurley

Q: And what is your job title and responsibility?

A: Right now I'm a Safety Assistant Level III.

Q: And your responsibility at the installation?

A: Well I'm a radiation safety officer, I respond also to running permits or safety incidents or injury investigations as needed. I'm also the employee safety committee coordinator for the company. And that's it in a nut shell unless other duties come up.

Q: This is site wide?

A: Yes, this is site wide – for BAE here.

Q: How long have you been working here?

A: With BAE, since July of 2012.

Q: And prior to that?

A: Prior to that I worked with [ATK] from February 2000 to 2012 when they were no longer the contractor. Prior to that, I worked here with Hercules from 1986 to about 1992 some when ATK came in and I was furloughed. I came back in 2000 with ATK.

Q: Can you to the best of your knowledge describe the history of the mortar range and the gun range?

A: From what I understand, that's where they tested mortar rounds, they would test fire. [Tape gets fuzzy] In the old days, this is a true story, they basically picked them up in a little Dodge Rampage and transported them [meaning the mortar shells] [Tape is fuzzy]

Q: So when you say disposed of, what do you mean by that?

A: From what I understood, they took them to the Hazards Area ... [Tape is fuzzy]

Q: What kind of ammunitions were used?

A: To my knowledge just mortar rounds.

Q: On Monday you mentioned something about white phosphorus, can you talk about that?

A: From what I recall, there was one round in particular that was explode – and [Tape is fuzzy] it took a long time for us to be able to enter the barricaded area because of the smoke that was given off [Tape is fuzzy again].

Q: Do you know which direction of fire they use? So when they shot off the rounds, which direction did they shoot from?

A: From what I can tell you, it was maybe from the south of the river to the north or from the [Tape is fuzzy]

Q: Can I go back to the White Phosphorus? Did you talk to any of the EOD that were involved with the detonation?

A: There were EOD techs there, but no, I did not clarify with them what they thought, I'm saying I thought it was White Phosphorus.

[Tape is fuzzy]

[End of Interview]

RAAP SI Interviews – Transcription [Information has been redacted for security reasons]

December 15, 2014

Dennis Kits – Manager of Training and Development for the Radford Army Ammunition Plant

Interviewers: Sarah Skrobialowski (BSEn) and Derek Jennings (HDR)

Q: Can you state your name for the record?

A: Dennis Kits

Q: What is your job title at the installation?

A: My job title is Manager of Training and Development for the Radford Army Ammunition Plant.

Q: Is that site wide or is that a specific area?

A: That is site wide.

Q: How long have you worked here?

A: 29 long years.

Q: In your 29 years here, have you ever heard or witnessed any kind of incident with mortars in the mortar range or gun range area?

A: Four or five times in my tenure here, we've had contractors out playing in the ground over there and have discovered so far, entirely inert rounds. I think, someone can back me up on this, I know the only mortar propellant we manufactured here during the forties was for 60 mm, 81 mm and 4.2 mm mortars. And so we made them in the rolled powder area, if that's familiar to you yet. And then, these sheets were stacked up on one another to make pads, 60 mm increments generally had between 23 and 26 sheets on them. They looked like little square with a hole in the middle of them. And the hole in the middle of them was what the soldiers pushed the increment on to the base of the rocket, it was like a head of a nail sticking out. And so at the end of the rocket, at the bottom between the fins, there was a chemical there that was strikingly similar to the material that's on the end of a strike anywhere match, and so when they would drop it down this tube, it would slide down the tube and at the bottom of the tube there was a contrivance that was standing out like a nail sticking up and the mortar rocket would contact that highly flammable propellant ignitor with that nail if you will, it would ignite itself and that would in turn ignite the mortar propellant and blow the mortar missile out the tube and across the hill and after the bad guys. Essentially we made three different types of those mortar increments, the 60 mm, 81 mm, and 4.2 inch mortars. That went on from 1941 until about 1993 or 1994, when the last order of 60 mm mortar increments was produced in our other rolled powder, which is called fourth powder, which is at the other end of the plant, and I was fortunate enough to be the other supervisor that supervised the last run of those 60 mm mortar increments. The trench mortar range was essentially

used from early part of 1942 until the war was over in 1945. When February 1946 came along, Hercules was released from its contract to operate this facility and the ordnance corps in combination with the Corps of Engineers took over the operation of what was left. If you go back to when the war was over in August of 1945, there was about 12,000 people employed here and by the time that March 1949 rolled around, there were 89 people employed here. So the greatest generation of basically said that's it, so the GOCO plants that were built during the war were, except for six, were shut down completely. Radford was one of the shining six that were kept open in a lesser capacity, just to make ammonium nitrate fertilizer for the rebuilding of Europe and the Pacific. So that involved just a few changes to our acid manufacturing area, and a contract was given from the ordnance corps to the Hercules powder company in 1946 to run the acid area to make ammonium nitrate and we did that until 1950/1951. The other things that were going on at the plant at the time, was there was a whole lot of propellant that was in the pipeline leading up to the perfect functioning of the atomic bombings in Japan in August. Something had to be done with that propellant, so a new burning ground was built in 1946 – the one that we currently have now – and over twenty million pounds of powder had to be burned during that time. For all intents and purposes, the mortar and gun range they let the grass grow over in those areas. In a propellant manufacturing world, that is referred to as some pretty hot stuff. It was about 48 thousand pound pallet lot made there, and when that was tested out at the Picatinny testing grounds, fall along contracts were issued for some different types of stick propellant because we were beginning to get into rocket manufacturing. Given the limited amount of real-estate that was here at the time, the Goodyear Aircraft Corporation was approached by the army and convinced to move their cast rocket motor manufacturing facility here to Radford. They decided to put it over top where the mortar range areas. That building was begun in 1948-1950 so we started manufacturing the cast rocket motor segments for the Nike Hercules missile and the Honest John. The trench mortar range area was located over in part of what was the NG2 area and part of the rocket manufacturing area. And that's pretty much a delineation of where it was, now they probably fired a few that went a little astray. But as best as we can determine, and it just makes common sense, they never fired any live rounds. Now about five commanders ago, that philosophy changed, and I think it's still true to Commander Ortiz's regime today, if we uncover a round over there, we just pull back and call someone from Ft. Bragg or bomb disposal unit to come up, check it out and take it away. We're erring on the side of caution.

Q: How many years ago was five commanders?

A: Probably mid-1990s.

Q: So any items found potentially before the mid-90s, were just deemed to be practice rounds and were just destroyed and handled onsite without calling EOD, so once the decision was made to treat them as potentially live is when we started to get EOD reports?

A: Right. Now I'll tell you a good source for confirming that date would be Don Evans downstairs.

Q: Do you know the firing point? Was there one firing point used for all the testing? And do you know where that might be?

A: The firing range was round about the area of the gun range. The gun tunnels, essentially what they did was they set the guns out here and fired them into the hillside.

Q: Over in the environmental records they had a binder that had similar testing results for M72s, do you think, they would have been fired and tested somewhere else on the facility?

A: What time are you talking about?

Q: Early 1970s, I think about 1972.

A: When the rocket manufacturing area was constructed, the ballistics range was pretty much left intact. What you see when you go to the ballistics range, is what you would have seen if you had been there in 1941, 1951, 61, 71, and so on today. Of course with the appropriate upgrades for modern technology such that it is. So most likely those were fired from the gun range because that was the only testing area we use for testing anything gun related or rocket related. Of course we tie the rockets down before we light them because that's just good practice.

Q: Can you point out where you think the tunnels were?

A: Gestures to map, the tunnels, I think, if I'm not badly mistaken, are in this configuration. Originally they were firing into the hillside from this direction. There is a road, where you turn left at downtown rocket area and you go out that road, that's the road where originally they had the cannon set where they were firing into the hillside where the tunnels now are.

Q: So in the beginning they were firing from the northwest to the southeast?

A: yes, in this direction, with the howitzers and whatnot. But when we get into more of the 25 and 30 mm chain guns they moved into tunnels in this configuration.

Q: So they changed it from Northeast to firing southwest?

A: Pretty much because of the difference in the guns they were using back then compared to now. If you're around when they're testing those 25 to 30 mm chain guns they'll go boom, boom, boom depending on how many rounds they're testing , and those rockets they'll go [swoosh sound] for about 95 hundreds of a second or so.

Q: You mentioned that any rounds found prior to the 1990s were just treated as practice and disposed of by the installation, were there any reports kept on those items that were found?

A: To my knowledge, if they were they were kept by people in the ACO. Hercules Powder Company, I'm not going to say they didn't give a damn, but we're trying to build something here, we found a dummy round, hey come look at this 60 mm dummy round. Don Evans might have some record of that, but unless it's hidden deep down in the archives, that would be looking for a needle in a haystack.

Q: One of the EOD response in the last few years, we've heard that one of the EOD techs said that they thought there was white phosphorus in one of the rounds based on the smoke after they detonated in a

controlled demolition. No sampling, no testing, or anything to confirm that, but is there any indication that you've come across that would confirm that?

A: To my knowledge, no.

[End of Interview]

RAAP SI Interviews – Transcription

December 15, 2014

George Gimmelmorgan - Chief Ballistics Instrument Operator

Interviewers: Sarah Skrobialowski (BSEn) and Derek Jennings (HDR)

Transcript Note* George has a thick Southeastern accent, so there are times when the tape is indecipherable.

Q: Can you state your full name for the record?

A: George Gimmelmorgan

Q: And what is your job title at the installation?

A: Chief Ballistics Instrument Operator.

Q: What is it that you do?

A: We shoot Mk 90 motors, we used to shoot [indecipherable], we burn strands, we shoot closed bomb, we run the heat of the explosions, we run compatibility tests on [indecipherable] , pull tinsels, that's the basic now, but years ago we used to shoot Super [indecipherable] and MI 80s back in the mid to late 1980s.

Q: How long have you been here?

A: I've been in ballistics for 29 years.

Q: Any other jobs here?

A: I was three years in the finisher.

Q: So you've been on this side [of the river] for most of your...

A: Well we used to be across the river, next to the garage over there. But the range has always been here and they used to have a separate group then. But in 1993 they combined it and they went down in numbers, so therefore they downsized.

Q: To the best of your knowledge, can you describe the history of this area, what happened here in the past.

A: Let me put it this way, I toured this plant when I was six years old when they had the open house. And I watched them shoot the little johns on the flight range over here. And I always wanted to work here,

so when I come here I finally got on, but I got to shoot M180s, I got to shoot the Super [indecipherable], but the mortar rounds was a thing of the past by the time I got in the system. They must have went, didn't need it or whatever at the time. But my understanding, if I ain't mistaken, they found up there close to 266-7 on the NRE range they found some mortar shells if I remember correctly in the early 2000s. And then they found some next to the water tower in the last few years, that I don't know how they done it, how they disposed of them, because they had a better grip on it when I got here that you had to have accountability, not like back in the forties that anything goes.

Q: So you said you used to test the powder and the propellant, can you describe that process a little bit, like how you did it, where you did it, was it open air or was it in the tunnels?

A: Which process do you want me to describe first?

Q: Whichever one you want.

A: Ok, the Mk 90, we get the motors, we check the igniters, and then we put them in the box. You're allowed 48 hours to test it. And you test it at 150 and minus 50. Twenty-two motors each, and you shoot 20 each to get what you need. You have extras in case something happens to one of the motors and the government signs off on it after we do the paperwork and stuff. Let see, the quality...Rick Aldridge and Jessica Dick, our supervisor, signs off on it. On the government stands, we burn 150 and minus 50 to give the engineer what to expect when we burn minus 65 and 165 on government strands. To know, they burn pretty close, he knows that it's going to be ok to do the government strands. Heat of explosions on the government, you run eight bottles, they're in sheets, sheet six, twelve, eighteen, twenty-four, thirty-one, thirty-six, forty-two, forty-eight. You run two heats and then they have to be within a range of 1.0054 calculation. That's when you divide the low into the high for the readout.

Q: Ok. And where do you do that at?

A: In 64-1, in the strand burning room and the heat room.

Q: In your tenure here, have you had any experience, or heard of any mortars or anything being found in the gun area or the mortar range area?

A: Like I said, at the range up there, they were doing some digging and found some.

Q: Any beyond those?

A: Not to my knowledge. But that's not to say it's not there. I would say just from my opinion, you would have to cover where the dyno gun, it's extinct now, all the way back around through that area, through here was the range. That's the circumference, I would say is where to look.

Q (DJ): Testing the propellants, mainly – no testing of explosive payloads, does that happen here?

A: No.

Q (DJ): To your knowledge, has that ever happened here?

A: The only thing I can say on that would be the MI80s where they tested them, I would say that was a payload because it jarred the whole...

Q (DJ): Yeah, but just by mass...

A: No.

Q (DJ): Firing in the tunnels, we heard from Dennis that there were tunnels here, and sometimes projectiles were tested in tunnels.

A: That's the NRE side, because they come in roughly, the late 1990s. They build the tunnels in the early 2000's and we turned it to them to shoot in the tunnels. The projectiles go into sand, and they used to go in and recover them. In times past, yes.

Q: One account that has been repeated several times, is that there was a mortar found that had white phosphorus in it, do you know of anything regarding that.

A: All I know is that our boss told us about it and I looked at it, but I didn't what, they just told us about it and showed it a little but...

Q: And your boss is?

A: Well at the time was Russ Miller, but he's retired now.

Q (DJ): And what did he tell you?

A: He just said that they found it up there and if we knew anything about it, and we didn't.

Q: And where was that found?

A: It was up there on the range, when they was doing the tunnels setting the tunnels up.

Q: Now are those the same tunnels that have always been used?

A: No, them there was put in roughly around 2000.

Q: So have there only been two sets of gun range tunnels to your knowledge?

A: Well had a tunnel out there on the range, it was called the open range, where they shot projectiles into the sand. That's the only other place. Now I ain't saying they ain't there, but I ain't going to say there is because I don't know, I can't tell you. But if you dig in the sand, you might be surprised.

Q: Well I won't be doing any digging!

A: I would say, just in this area here is where you want to look mostly. If that's a help.

[End of Interview]

RAAP SI Interviews – Transcription [Information has been redacted for security reasons]

December 15, 2014

Jeremy Flint – Environmental Engineer

Interviewers: Derek Jennings (HDR) and Sarah Skrobialowski (BSEn)

Q: Can I get your name please?

A: Jeremy Flint

Q: Affiliation?

A: I'm with ATK

Q: So what is your job title at the installation?

A: Environmental Engineer, December 2005

Q: And what do you do as an Environmental Engineer here?

A: Solve problems.

Q: Environmental problems?

A: Yeah. I did waste from 2005 till July of 2012, and now I do it all for ATK.

Q: So you started at the facility in 2005?

A: Yeah, December 5 2005.

Q: What is your area of oversight?

A: Site wide waste compliance. Mostly focusing on the burning ground and incinerator. Supporting IRP, supporting offsite waste.

Q: To the best of your knowledge, please describe the history of the site.

A: When you say the site, you mean the mortar range?

Q: Yes

A: Started in 1940s with construction, but the mortar range we were involved in, they've dug up some stuff doing water line repair and that sort of stuff. The EOD guys have come in and blown them up, most of them have been inert, some of them have had something in them that reacted.

Q: Where did you learn about the items that were dug up? Did you witness any of these items being blown up? Are there records anywhere?

A: There's some records in the safety incident reports. Hurley should have those since he was involved in most of those. When they dug them up, the EOD guys came in from Ft. Belvoir I think and hit them with C4.

Q: And you said some of them reacted?

A: Yeah, they had something in them so the EOD guys said it reacted, I think once you put a C4 charge on it and blow it to bits it's hard to tell what's the C4 and what's actually inside of it. But they thought there was something inside of it.

Q: And do you know when that occurred?

A: Sometime between December 2005 and July 2012.

Q: That information should be in the safety incident...

A: The SIR's, I don't know if Safety kept all the SIR's or they stayed with us. I can see if I can find them. I distinctly remember reading about one of them, just because I thought we were going to have to institute our emergency detonation stuff.

Q: Have you done that before?

A: We do it over at Medium Cal. We have some projectiles that get stuck and you have to safe them, they're not safe to go down the road, so you have to get our hazards people to blow them up in place or take them to the hazards test range and blow them up.

Q: With regard to the trench mortar and gun range and the munitions related items that have been found out there, do you know of any other items similar to that, that have been found outside of that area or in the vicinity?

A: I mean, sort of in the NG2 area. I think we just found some doing some construction, somewhere close to ballistics, they were inert of some sort and I can't remember what those were, but they dug them up doing something.

Q: And this was just recently?

A: In the last year.

Q (SS): Can you give a specific location for those?

A: I'm sure our safety guys can tell you where those were.

Q: West of the gun range, but not by a lot.

A: I don't know if they were the mortars or something else.

Q (SS): Are you aware of any other people who might have knowledge of any other activities in the area?

A: Jerry Redder, Dave Hurley who was involved in some of those, and the recent one would be Craig Elsey or Joe Beddik on the ATK staff.

Q: Have you seen any reports, paperwork, narrative histories of any kind that discusses the trench mortar range or gun range?

A: Nope

Q (SS): Any reference to white phosphorus?

A: I've heard mention that white phosphorus is what might be in the mortars, when they did that, the EOD guy said there was a reaction, but I've not heard anything else.

Q: Is white phosphorus part of the process here? Are any of the munitions...?

A: Not since 2005. I mean we do tracers, but they're not phosphorus based, they've got something else in them.

Q: But prior to 2005 there's a record?

Q: So you've not seen records of it being shipped in and then...

A: I haven't no, what they did in the forties – who knows.

[End of Interview]

RAAP SI Interviews – Transcription [Information has been redacted for security reasons]

December 15, 2014

Mark Childress – Works in the current manufacturing area

Interviewers: Derek Jennings (HDR) and Sarah Skrobialowski (BSEn)

[Taping starts in the middle of the interview]

Q: In the last few years have you come across anything during your excavations?

A: Oh yeah, they've dug them up almost every time they dig extensively, they find a mortar.

Q: And it's mainly in the current manufacturing area and CAMBL area?

A: yeah, it's usually right here, I don't think they've found them too deep into CAMBL.

Q: What about heading towards the old gun range? Any found out there?

A: No, see really I've only been here my whole career – so I can tell you, I don't remember finding any when we built the office – this was built, I'm not good with years. I remember when it was built but I don't remember them finding any mortars. It seems like it was always from about the operating area all the way down to the premix buildings, they've found mortars.

Q: And to your knowledge, have they all been inert or ...

A: Well now we were taught many years ago that they were all inert, there was nothing to worry about, just throw them in a pile so we did that. Well since BAE took over, they wanted to prove this to themselves and they say that some of them are some kind of sol...

Q: White phosphorus?

A: There you go.

Q: What's the standard procedure now?

A: Well we just stop and we wait for someone from the DC area, is where I think they come from. And that's what their job is, they're military.

Q: You've been here for a while, so in the recent history, its changed to treating them as if they're live, but prior to that you treated them as inert?

A: Oh yeah. We joked about taking them home, of course nobody ever did I think, we'd just throw them in a pile. We'd pick them up ourselves. I mean there was actual piles of them back in the 80s.

Q (SS): Do you know where those piles were?

A: Well they just hauled them off, I don't know what happened to them.

Q (SS): But when you were piling them up, do you know where the locations of the piles where?

A: Well they were basically just anywhere they were building new buildings. Any time they dug, they'd find them and they find them pretty regularly now when they dig.

Q: Have you witnessed any activities of EOD when they come out?

A: No, they send us away when they come out, we have a control room that's kind of underground and that's where we're usually at. A boss goes with them, I can't remember which one, but they go out – he has his suit on, you know like you see on TV, and they take it away from here and they look at it, blow them up and haul them off. So is there a question as to more out there? I assure you there is more out there, you dig any significant hole, and you're going to find one.

Q: I think the question is, is there any hazard posed by them. The process is, once there is a question of hazard, we need to determine whether there is or is not a hazard and whether there is or is not a risk posed by constituents within the munitions. But if they're all inert, then there's nothing in them and there would be no chemical risk and there would be no explosive hazard. You would take a different route through the processes that have been established to deal with these sites.

A: There has to be records ever since BAE took over, and they actually, because you know they come in from DC, we wait on them. Sometimes we're down for almost 24 hours. We just stop.

Q: Mark, how long have you worked here?

A: I have been here 32 years.

Q: Have you heard or witnessed any activities or events in the property adjacent to the current manufacturing area?

A: No, I have no knowledge of anything except right here.

[End of Interview]

This page intentionally left blank.

Appendix C

Uniform Federal Policy

Quality Assurance Project Plan

This page intentionally left blank.

Uniform Federal Policy Quality Assurance Project Plan

**Former Gun and Mortar Range
Munitions Response Site (RFAAP-002-R-01)**

Site Investigation

at

Radford Army Ammunition Plant, Virginia

May 2018

Submitted to:



**United States Army Corps of
Engineers, Baltimore District**
10 South Howard Street
Baltimore, MD 21201

Submitted by:



Bering Sea Environmental, LLC.
615 E, 82nd Avenue, Suite 200
Anchorage, AK 99518

**Contract No. W912QR-13-D-0001
Task Order 0001**

This page intentionally left blank.

Executive Summary

This final, approved Quality Assurance Project Plan (QAPP) is designed to be a stand-alone document containing all specifications and procedures necessary for project personnel to carry out their assigned responsibilities. For example, the field team should be able to rely on the QAPP for complete sampling instructions, including how to sample, where to sample, how many samples to collect, the types of bottles, preservatives, related Quality Control (QC), etc. Where the approved QAPP provides insufficient procedures to carry out all tasks, then the Standard Operating Procedures (SOPs), attached to the QAPP (**Attachment C2**), should be followed. If required elements are contained in other documents, those documents are referenced and available to all personnel responsible for reviewing and implementing the QAPP.

This Workbook for Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) is Part 2A of the UFP-QAPP, Requirements with guidance for use, ANSI/ASQ E4 (February 2004).

The ultimate success of an environmental program or project depends on the quality of the environmental data collected and used in decision-making, and this may depend significantly on the adequacy of the QAPP and its effective implementation. The use of the worksheets will aid in identifying the critical project information that will ensure that the right type, quality, and quantity of data are collected to meet all of the project's quality objectives.

References used in the development of this UFP-QAPP are included in the Radford Army Ammunition Plant (RFAAP) Former Gun and Mortar Range (RFAAP-002-R-01) Site Investigation (SI) Work Plan, Section 13.0.

Table 1 Crosswalk: UFP-QAPP Workbook to USEPA 2106-G-05 QAPP

Optimized UFP-QAPP Worksheets		USEPA 2106-G-05 QAPP Guidance Section	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7 & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and MPC
12	Measurement Performance Criteria (MPC)	2.2.6	Data/Project Quality Objectives and MPC
13	Secondary Data Uses and Limitations	Chapter 3	QAPP Elements For Evaluating Existing Data

Optimized UFP-QAPP Worksheets		USEPA 2106-G-05 QAPP Guidance Section	
14 & 16	Project Tasks & Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection / Quantitation Limits	2.2.6	Data/Project Quality Objectives and MPC
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure , Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC	2.3.5	QC Requirements
21	Field SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical QC and Corrective Action	2.3.5	QC Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32 & 33	Assessments and Corrective Action	2.4	Assessments And Data Review (Check)
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

Qualified Project Personnel

Project Personnel	Title	Responsibilities	Signatures
Sarah Skrobialowski, BSEn	Project Manager (PM)	Project Management	
Phil Werner, HDR	Deputy PM	Project Management	
Todd Wickert, HDR	Quality Assurance Officer (QAO)	Project and Reporting Control	
Lynn Lutz, HDR	Project Chemist/ Data Validator	Data Validation	
Sengphet Julia Liu, BSEn	Project Engineer	Project QC, Reporting, Data Interpretation	

This page intentionally left blank.

TABLE OF CONTENTS

QAPP Worksheet #1 & 2: Title and Approval Page.....	C-1
QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution.....	C-2
QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet.....	C-6
QAPP Worksheet #6: Communication Pathways	C-8
QAPP Worksheet #9: Project Planning Session Summary	C-9
QAPP Worksheet #10: Conceptual Site Model	C-10
QAPP Worksheet #11: Project/Data Quality Objectives	C-11
QAPP Worksheet #13: Secondary Data Uses and Limitations.....	C-16
QAPP Worksheet #14 & 16: Project Tasks & Schedule.....	C-17
QAPP Worksheet #15-1: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits	C-21
QAPP Worksheet #15-2: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits	C-23
QAPP Worksheet #15-3: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits	C-24
QAPP Worksheet #15-4: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits	C-25
QAPP Worksheet #15-5: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits	C-26
QAPP Worksheet #17: Sampling Design and Rationale	C-27
QAPP Worksheet #18: Sampling Locations and Methods	C-29
QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times.....	C-30
QAPP Worksheet #20: Field QC Summary.....	C-31
QAPP Worksheet #21: Field SOPs	C-32
QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection.....	C-33
QAPP Worksheet #23: Analytical SOPs.....	C-34
QAPP Worksheet #24: Analytical Instrument Calibration	C-35
QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection.....	C-45
QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal	C-46
QAPP Worksheet #28-1: Analytical Quality Control and Corrective Action	C-47
QAPP Worksheet #28-2: Analytical Quality Control and Corrective Action	C-48

QAPP Worksheet #28-3: Analytical Quality Control and Corrective Action	C-49
QAPP Worksheet #28-4: Analytical Quality Control and Corrective Action	C-50
QAPP Worksheet #28-5: Analytical Quality Control and Corrective Action	C-51
QAPP Worksheet #29: Project Documents and Records.....	C-52
QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action	C-53
QAPP Worksheet #34: Data Verification and Validation Inputs	C-55
QAPP Worksheet #35: Data Verification Procedures.....	C-56
QAPP Worksheet #36: Data Validation Procedures	C-57
QAPP Worksheet #37: Data Usability Assessment	C-60

Tables

Table 1. Crosswalk: UFP-QAPP Workbook to 2106-G-05 QAPP	C-i

Figures

Figure C-1 Planned Transect Coverage of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.....	C-63
Figure C-2 Sampling Locations, Former Gun and Mortar Range (RFAAP-002-R-01) MRSC.....	C-64

Attachments

Attachment C1. Corrective and Preventive Action Request	
Attachment C2. SOPs	
Attachment C3. Field Sampling Audit Checklist	
Attachment C4. Data Usability Assessment Form	

ACRONYMS AND ABBREVIATIONS

APP	Accident Prevention Plan
AVS	Assisted Visual Survey
bgs	below ground surface
BSEn	Bering Sea Environmental Inc.
CA	Corrective Action
CAR	Corrective Action Report
CAS	Chemistry Abstracts Service
CCC	Calibration Check Compounds
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration Factor
cm	centimeter
COC	Chain-of-Custody
CSM	Conceptual Site Model
CTL	CT Laboratories, LLC
CVAA	Cold Vapor Atomic Absorption
DDT	Dichlorodiphenyltrichloroethane
DL	Detection Limit
DNT	Dinitrotoluene
DoD	Department of Defense
DQO	Data Quality Objective
DMM	Discarded Military Munitions
DU	Decision Unit
EcoSSL	Ecological Soil Screening Level
EICP	Extracted Ion Current Profile
ELAP	Environmental Laboratory Accreditation Program
EOD	Explosive Ordnance Disposal
FD	Field Duplicate
GC/MS	Gas Chromatograph Mass Spectrometer
GIS	Geographic Information System
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDR	HDR Environmental, Operations and Construction, Inc.
HMX	Cyclotetramethylene Tetranitramine
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
hr	hour
HRR	Historical Records Review
HTRW	Hazardous, Toxic, and Radioactive Waste
IAW	In Accordance With
ICAL	Initial Calibration

ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
ID	Identification
IRP	Installation Restoration Program
IS	Internal Standard
ISM	Incremental Sampling Methodology
LCS	Laboratory Control Sample
LD	Laboratory Duplicate
LOD	Limit of Detection
LODV	Limit of Detection Verification
LOQ	Limit of Quantitation
MC	Munitions Constituents
MD	Munitions Debris
MDL	Method Detection Limit
MEC	Munitions and Explosives of Concern
mg/kg	milligrams per kilogram
Microbac	Microbac Laboratories, Inc.
mm	millimeter
MMRP	Military Munitions Response Program
MPC	Measurement Performance Criteria
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MWP	Master Work Plan
NG	Nitroglycerine
oz	ounce
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability and Sensitivity
PCV	Project Comparison Value
PETN	Pentaerythritol tetranitrate
PO	Purchase Order
POC	Point of Contact
PM	Project Manager
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
QSM	Quality System Manual
RCRA	Resource Conservation and Recovery Act

RF	Response Factor
RFAAP	Radford Army Ammunition Plant
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
RRT	Reliability Run Test
RSD	Relative Standard Deviation
RSL	Regional Screening Level
SI	Site Investigation
SPCC	System Performance Check Compound
SOO	Statement of Objective
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SVOC	Semi-volatile Organic Compound
TBD	To Be Determined
THI	Target Hazard Index
TPP	Technical Project Planning
TR	Target Risk
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USEPA	U.S. Environmental Protection Agency
UXO	Unexploded Ordnance
VDEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compounds
%R	Percent Recovery
°C	degrees Celsius



This page intentionally left blank

QAPP Worksheet #1 & 2: Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(USEPA 2106-G-05 Section 2.2.1)

1. Project Identifying Information
 - a. Site (Munitions Response Site [MRS])) name/project name: Radford Army Ammunition Plant (RFAAP) / Former Gun and Mortar Range
 - b. Site (MRS) location/number: Virginia / RFAAP-002-R-01
 - c. Contract/Work assignment number: W912QR-13-D-0001, Task Order 0001

2. Lead Organization
 - a. Lead Organization Project Manager (PM) (name/title/signature/date):
Kimberly Gross, United States Army Corps of Engineers (USACE), Baltimore District

 - b. Lead Organization Quality Manager (name/title/signature/date):
To Be Determined

3. Federal Regulatory Agency (name/title/signature/date):
U.S. Environmental Protection Agency (USEPA) Region III
Erich Weissbart, Federal Regulator

4. State Regulatory Agency (name/title/signature/date):
Virginia Department of Environmental Quality (VDEQ)
James Cutler, State Regulator

5. Other Stakeholders (as needed):
USACE Baltimore District (project management)
VDEQ
USEPA Region 3
RFAAP
Bering Sea Environmental, Inc. (BSEn)
HDR Environmental, Operations and Construction, Inc. (HDR)

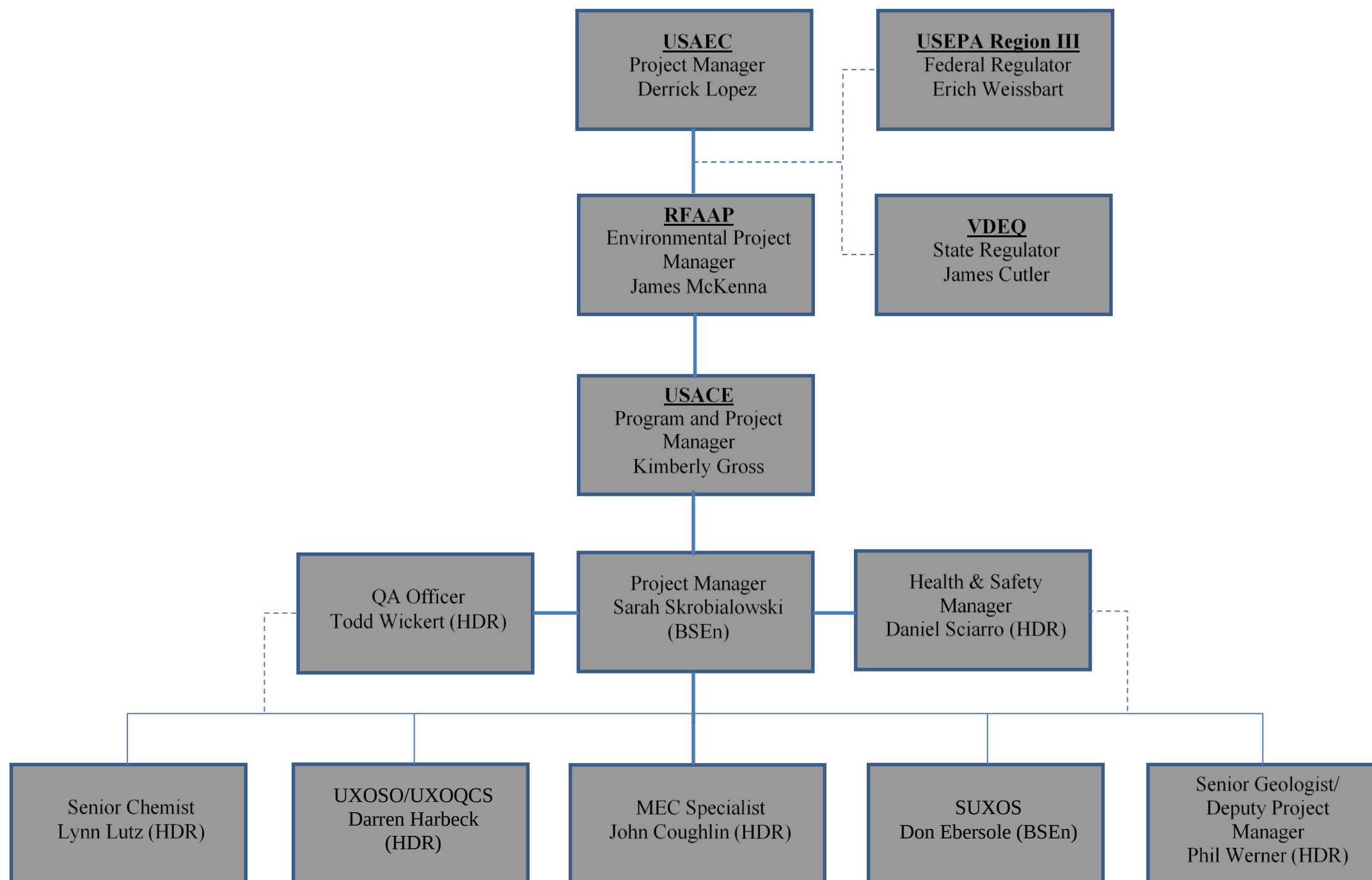
6. List plans and reports from previous investigations relevant to this project:
Not Applicable.

QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution
(UFP-QAPP Manual Section 2.3 and 2.4)
(USEPA 2106-G-05 Section 2.2.3 and 2.2.4)

QAPP Distribution List

QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address
Kimberly Gross	Program and PM	USACE- Baltimore	410-962-3457	N/A	Kimberly.U.Gross@usace.army.mil
Derrick Lopez	PM	U.S. Army Environmental Command (USAEC) - San Antonio	210-466-1872	N/A	derrick.r.lopez2.civ@mail.mil
James McKenna	Env PM	U.S Army RFAAP	540-731-5782	N/A	james.j.mckenna16.civ@mail.mil
Erich Weissbart	Federal Regulator	USEPA Region III	410-305-2779	N/A	Weissbart.Erich@epa.gov
James Cutler	State Regulator	VDEQ	804-698-4498	N/A	James.Cutler@deq.virginia.gov
Sarah Skrobialowski	PM	BSEn	757-604-1173	N/A	sskrobialowski@bsenv.com
Phil Werner	Project Geologist/ Deputy PM	HDR	301-831-0344	N/A	Philip.Werner@hdrinc.com
John Coughlin	Munitions and Explosives of Concern (MEC) Specialist	HDR	571-327-5850	N/A	John.Coughlin@hdrinc.com
Todd Wickert	Project Quality Assurance Officer (QAO)	HDR	303-754-4200	303-721-9202	Todd.Wickert@hdrinc.com
Lynn K. Lutz	Project Chemist	HDR	303-754-4200	303-721-9202	lynn.Lutz@hdrinc.com
Danny Sciarro	Health & Safety Manager	HDR	303-643-6724	N/A	daniel.Sciarro@hdrinc.com
Celeste Marsh	Project Human Health Risk Assessor	HDR	970-270-6129	N/A	cmarsh@mail.coloradomtn.edu
Patrick Letterer	Laboratory PM	CT Laboratories, LLC (CTL)	608-356-2760	608-356-2766	pletterer@ctlaboratories.com
Christelle Newsome	Laboratory QAO	CTL	608-356-2760	608-356-2766	cnewsome@ctlaboratories.com





This page intentionally left blank.

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(USEPA 2106-G-05 Section 2.2.1 and 2.2.7)

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Kimberly Gross	USACE PM	N/A	N/A	
Sarah Skrobialowski	PM, BSEn	B.A. History, M.A. Public History, 2 years exp. Installation Restoration Program (IRP) and Military Munitions Response Program (MMRP) PM.	40-hour (Hr) Hazardous Waste Operations and Emergency Response (HAZWOPER)	
Phil Werner	Project Geologist/Deputy PM, HDR	B.S. Geology, 26 yrs. exp. conducting and managing Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) MMRP/Hazardous, Toxic, and Radioactive Waste (HTRW) site remediation.	40-Hr HAZWOPER	
John Coughlin	MEC Specialist, HDR	B.S. Geology, M.S. Hydrogeology, 20 yrs. exp. MMRP PM	US Navy Explosive Ordnance Disposal (EOD) Technician Training, 40-Hr HAZWOPER	
Lynn K. Lutz	Project Chemist, HDR	B.A. Chemistry 30 yrs. exp. Environmental Consulting, project chemist on over 25 MMRP projects	USEPA Region 8 validation training, USEPA guidelines and online programs for laboratory data verification and validation	
Todd Wickert	Project QAO, HDR	B.S. Biology, M.S. Environmental Policy & Management, 22 yrs. exp. Quality Assurance (QA)/Quality Control (QC), QC Manager for over 30 MMRP projects	OSHA 10-Hour Construction Safety; Certified Asbestos Inspector, California and Colorado; Certified AHERA Asbestos Project Designer, Colorado; Lead Inspector/Risk Assessor, Colorado; 40-Hr HAZWOPER; Certified Asbestos Management Planner, Colorado	
To Be Determined (TBD)	Field Team Leader, HDR	TBD	TBD	
Daren Harbeck	Unexploded Ordnance (UXO) Specialist	More than 21 years of experience in UXO and EOD operations.	EOD Technician Training U.S. Army, 1995, 40-Hr HAZWOPER	
TBD	H/S Officer / Field Team Lead	TBD	TBD	

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (Continued)

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Peter Hille	Geographic Information System (GIS) Manager	B.A. Geography and Environmental Studies. 8 yrs. exp.	N/A	
ORGANIZATION: CT Laboratories				
Patrick Letterer	Laboratory PM, CTL	B.S. Biology, 25 yrs. exp. in environmental labs	N/A	
Christelle Newsome	Laboratory QAO, CTL	B.S. Biology and Chemistry, M.S. Toxicology, 25 yrs. exp. in QA	N/A	

*Signatures indicate personnel have read and agree to implement this Quality Assurance Project Plan (QAPP) as written.

QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(USEPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (timing, pathway, documentation, etc.)
Manage all Project Phases	USACE PM	Kimberly Gross	410-962-3457	Responsible for the RFAAP project.
Manage all Project Phases	Contractor PM	Sarah Skrobialowski	757-604-1173	Responsible for all aspects of the project and will communicate with USACE PM.
Manage all Project Phases	Contractor Deputy PM	Phil Werner	301-831-0344	Responsible for all aspects of the project and will communicate with BSEn PM.
QAPP changes in the field	Contractor QAO/ Project Chemist	Todd Wickert and Lynn K. Lutz	303-754-4200	Will manage any QAPP field changes and notify Phil Werner
Daily Field Progress Reports	Sampling Team Leader	TBD	TBD	Will provide Daily Field Progress Reports to Phil Werner and will notify him of any work stoppages.
Reporting Lab Data Quality Issues	Laboratory QAO	Christelle Newsome	608-356-2760	Will notify Project Chemist regarding laboratory data quality issues including corrective actions and data usability.
Field and Analytical Corrective Actions	Contractor QAO	Todd Wickert	303-754-4200	Will ensure that corrective actions have been incorporated into all fieldwork.
Release of Analytical Data	Contractor Data Validator	Lynn K. Lutz	303-754-4200	Will provide data validation report and release the data to Contractor PM.

QAPP Worksheet #9: Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
(USEPA 2106-G-05 Section 2.2.5)

Date of planning session: November 6, 2014 and July 10, 2015

Location: RFAAP (November 2014) and Conference Call (July 2015)

Purpose: Introduce and discuss Site Investigation (SI) Work Plan

Participants:

Name	Organization	Title/Role	Email/Phone
Kimberly Gross	USACE PM	USACE-Baltimore	Kimberly.U.Gross@usace.army.mil 410-962-3457
Thomas Meyer (2014 & 2015)	PM	USACE-Baltimore	tom.meyer@usace.army.mil 410-962-0032
Jim McKenna (2014)	Environmental Chief	U.S. Army, RFAAP	james.j.mckenna16.civ@mail.mil 540-731-5782
Matthew Alberts (2014)	Environmental Lead	BAE Systems Inc., RFAAP	matt.alberts@baesystems.com 540-639-8722
Deborah McKinley (2015)	Project Engineer	USACE-Baltimore	deborah.k.mckinley@usace.army.mil 410-962-6730
Bonnie Morris (2014 & 2015)	Program Manager	BSEn	bmorris@bsenv.com 907-762-8510
Sarah Skrobialowski (2014 & 2015)	PM	BSEn	sskrobialowski@bsenv.com 757-604-1173
John Coughlin (2014 & 2015)	MEC Specialist, HDR	HDR	John.coughlin@hdrinc.com 571-327-5850

Notes/Comments: Discussed SI Work Plan. Others in attendance included RFAAP safety and security personnel as noted in the Technical Project Planning (TPP) 1 Memo.

Consensus decisions made: N/A

Action Items: 2014 TPP1 meeting resulted in the decision to conduct Assisted Visual Survey (AVS) of the MRS at 10 meter distances and composite surface soil sampling of any breached or low ordered munitions located during the AVS.

The 2015 conference call resulted in the addition of Incremental Sampling Methodology (ISM) Decision Units (DUs) and discrete sampling at drainage features on the south border of the MRS. In addition, the composite sampling at breached or low ordered munitions was changed to discrete sampling.

QAPP Worksheet #10: Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(USEPA 2106-G-05 Section 2.2.5)

The conceptual site model (CSM) is presented in detail in Section 4.0 of the Work Plan.

**QAPP Worksheet #11: Project/Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(USEPA 2106-G-05 Section 2.2.6)**

The presence of MEC at the MRS was established during the reconnaissance site walk performed in December 2014, when a 60mm mortar was discovered lying on the ground surface. As such, further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping). Therefore, this SI will include a MEC assisted visual survey (AVS) that will be conducted with the objective of gathering sufficient information to identify potential types of MEC, MEC disposal areas (areas with DMM lying on the ground surface), impact areas, and to identify potential sample locations biased toward drainage features to determine the potential of MC migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River. The AVS will include the ridgeline adjacent to the New River and unsurveyable slope to identify additional drainages. Further, the AVS will include areas around buildings in the current manufacturing area to identify surface MEC that could pose a hazard to workers. The information gathered during this SI will be used to support the planning of future investigations (e.g., RFI Work Plan).

The objective of the incremental sampling is to determine the presence or absence of diffuse MC contamination related to historical activities conducted at the MRS. Biased discrete samples will be collected from drainages to evaluate the potential migration of MC from the MRS, while discrete samples will be collected from locations where compromised surface MEC are discovered. The intent of the discrete samples is to determine if a release of MC has occurred at the location of the compromised MEC item.

DQOs for the SI were developed IAW the procedures outlined in the USEPA DQOs Process for Hazardous Waste SIs (EPA, 2000).

QAPP Worksheet #11: Project/Data Quality Objectives (Continued)

Worksheet #11 DQO Process

Step	Description	DQO for RFAAP
Step 1. State the Problem	Define the problem that necessitates the study; identify the planning team, examine budget, schedule.	The Former Gun and Mortar Range (RFAAP-002-R-01) MRS at RFAAP requires an SI due to the discovery of mortars at the MRS in the past. The preliminary CSM indicates that there is potential for exposure of MEC, MPPEH and MC to human receptors, and MC to ecological receptors. The planning team for this SI includes the USACE Baltimore District (Project Management) and the executing contractors. Stakeholders include the VDEQ, the USEPA Region 3, and RFAAP.
Step 2. Identify the Goal of the Study	State how environmental data will be used in meeting objectives and solving the problem, identify study questions, define alternative outcomes.	Environmental data collected during this investigation will be utilized to determine answers to the following study questions: 1) what types of MEC are present on the ground surface and can be inferred for the subsurface; 2) can MEC disposal or impact areas be identified; 3) has MC been released to drainages on the MRS and, if so, is there potential for MC to migrate off site; and 4) is diffuse MC contamination present as a result of the presence of MEC and/or MPPEH, and are levels of MC (if present) of a sufficient concentration to warrant further investigations for MC at the MRS? Dependent on the findings of the soil investigation, several outcomes may be possible, including eliminating from consideration surface diffuse MC contamination from future investigations and focusing of future MC subsurface investigations. An RFI for MPPEH and/or MEC is already merited based on the site walk and historical record review.

Worksheet #11 DQO Process

Step	Description	DQO for RFAAP
Step 3. Identify Information Inputs	Identify data & information needed to answer study questions.	This is a new data collection effort. An HRR and interviews have been conducted for the MRS. Visual surveys will be performed by a team consisting of a UXO Technician III (who will act as team leader and Site Safety and Health Officer [SSHO]) and either an Environmental Professional or second UXO Technician. The UXO personnel will be equipped with metal detectors (a process referred to as AVS) to determine the presence or absence of MPPEH, MEC, and/or Munitions Debris (MD) lying on the ground surface in areas with dense vegetation being sampled for MC and around buildings within the active facility to identify potential sample locations biased toward drainage features to see if MC is potentially migrating off the MRS towards the unsurveyable area adjacent to the New River. The AVS will also include the ridgeline adjacent to the New River and unsurveyable slope to identify additional drainages. Soil sampling will be conducted to evaluate the presence or absence of diffuse MC (ISM samples), MC migration (discrete), and point source MC (discrete) where compromised MEC is discovered. USEPA Method SW846 8330B will be used for explosives. USEPA Method SW846 6010C/7471A will be used for target analyte list metals. USEPA Method SW846 8270D will be used for a short list of SVOCs, and USEPA Method SW846-6850 will be used for perchlorate analysis. The ISM analytical results will be compared to USEPA Regional Screening Levels (RSLs) and Ecological Soil Screening Levels (EcoSSLs), while discrete sample results will be compared to RSLs, EcoSSLs, and RFAAP-specific metal background levels to assess potential risks to human health and the environment.

Worksheet #11 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 4. Define the Boundaries of the Study	Specify the target population & characteristics of interest, define spatial & temporal limits, scale of influence.	The target population for MEC and MPPEH are those items present on the ground surface and in the subsurface contained within the MRS boundaries. The characteristics of interest include the hazards associated with contact with MEC or MPPEH. AVSs for MEC/MPPEH/MD will be performed only within the areas being sampled for MC, around buildings within the active facility to identify potential sample locations biased toward drainage features to see if MC is potentially migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River, and the ridgeline adjacent to the New River to identify additional drainages. The boundary of the MEC/MPPEH study area is the MRS, excluding the very steep unsurveyable slopes. AVSs will not be conducted on the steep slopes. The target populations for MC include the concentration of diffuse MC in surface soil across the MRS, concentration of MC where compromised MEC or MPPEH is discovered, and the concentration of MC in sediment within potential surface water and sediment migration routes. Table 3-1 includes the list of MC. All field work will occur during favorable climatic conditions void of snow cover or frozen surface soils that could impede AVS and surface soil sampling activities. The boundary of the MC study area includes the entire MRS (~ 107 acres).

Worksheet #11 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 5. Develop the Analytic Approach	Define the parameter of interest, specify the type of inference, and develop the logic for drawing conclusions from findings.	The focus of this SI is to identify the types of MEC, locations of potential MEC disposal areas (areas with DMM lying on the ground surface), impact areas, and to determine the potential of MC migrating off the accessible areas of the MRS towards the unsurveyable area adjacent to the New River. Characteristics of disposal areas (areas with DMM) will be noted to determine if they are indicative of a firing point to support and concentrate future investigations. Since the presence of MEC has already been established, future investigations will be required. The presence of MC concentrations in incremental samples that exceed RSLs, or Project Comparison Values (PCVs), is of primary interest. The presence of ISM and discrete MC concentrations in surface soils exceeding RSLs will require the subsequent determination of the extent of MC in surface soils and potentially subsurface soils, and whether the presence of MC in surface and/or subsurface soil presents an unacceptable risk to human health and the environment. Incremental surface soil sample MC results that are below RSLs will be interpreted to indicate that diffuse soil contamination is not present. The presence of MC concentrations in surface sediment exceeding RSLs will require the subsequent determination of the extent of MC in surface water/sediment migration routes, whether the MC is migrating off the MRS, and whether the presence of MC in sediment presents an unacceptable risk to human health and the environment. Sediment sample MC results that are below RSLs will be interpreted to indicate that MC are not migrating off the MRS. The presence of MC concentrations in soil samples collected adjacent to compromised surface MEC exceeding RSLs will require the subsequent determination of the extent of MC in the soils surrounding the compromised MEC and whether the presence of MC in these soils present an unacceptable risk to human health and the environment. MC soil sample results from compromised surface MEC that are below RSLs will be interpreted to indicate that MC soil contamination is not present. The PCVs are presented in Table 6-2 and Table 6-3.
Step 6. Specify Performance or Acceptance Criteria	Specify probability limits for false rejection and false acceptance decision errors. Develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use.	AVS activities will be performed IAW the procedures set forth in Section 5.1.1 and quality assurance/quality control (QA/QC) standards presented in Appendix C. Sampling and analysis will be performed IAW the procedures set forth in Section 5.1.2 and Section 6.0 and the QA/QC standards presented in Appendix C. Data need to be capable of accurately characterizing the presence of contaminants less than the comparison values. All data are anticipated to be definitive. Samples will be analyzed by an analytical laboratory following USEPA SW-846 methodologies specified in the QAPP worksheets. Sample results sent off-site for analysis will undergo data verification and validation IAW the National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2014) and Inorganic Superfund Data Review (USEPA, 2014) to assure its usability for making decisions regarding the site. Data qualified as rejected (R) will not be used. Data usability will be determined by evaluating sample collection and analysis results to the precision, accuracy, representativeness, completeness, comparability and sensitivity (PARCCS) parameters as discussed in Worksheet #37 of the QAPP.

Worksheet #11 DQO Process (Continued)

Step	Description	DQO for RFAAP
Step 7. Develop the Plan for Obtaining Data	Select the resource-effective sampling and analysis plan that meets the performance criteria.	The field sampling activities are presented in Section 6.0 of the Work Plan. QA/QC procedures for data collection are presented in this QAPP.

QAPP Worksheet #13: Secondary Data Uses and Limitations
(UFP-QAPP Manual Section 2.7)
(USEPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

Data type	Source	Data uses relative to current project	Factors affecting the reliability of data and limitations on data use
N/A	N/A	N/A	N/A

QAPP Worksheet #14 & 16: Project Tasks & Schedule
(UFP-QAPP Manual Section 2.8.2)
(USEPA 2106-G-05 Section 2.2.4)

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
SI Field Work	HDR	End of September 2016	Start of October 2016	Yes	N/A
Draft SI Report	HDR	January 2017	January 2017	Yes	August 2016
Final SI Report	HDR	March 2017	March 2017	Yes	November 2016
Final TPP Session	HDR	March 2016	March 2017	No	September 2016

A schedule will be developed and provided to the installation detailing day-to-day activities for the field work so that notification can be provided to appropriate offices and individuals throughout the installation. It should be noted that this schedule may change depending on field conditions, and the RFAAP Point of Contact (POC) will be provided daily updates on the field activities.

Summary of Project Tasks:

Project tasks are described in detail in the Work Plan, Section 6.0, *Field Sampling Plan*.

The presence of MEC at the MRS was established during the reconnaissance site walk performed December 2014 when a 60mm mortar was discovered lying on the ground surface. As such, further action beyond this SI will be required to characterize the nature and extent of MEC at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS through more robust survey methods (e.g., digital geophysical mapping). The primary objective of the SI is to gather sufficient information to identify potential types of MPPEH/MEC/MC to recommend and shape further characterizations, such as a RFI. The only possible recommendation for No Further Action resulting from this SI could be for MC in surface soils. It is not the intent of the SI to confirm all types of MEC present, nor to define the nature and extent of contamination.

QAPP Worksheet #14 & 16: Project Tasks & Schedule (Continued)**Sampling Tasks:**

Sampling tasks are described in detail in the Work Plan, Section 6.3, *Soil Sampling Plan*.

A digital photo will be taken at each sample location, which will include any MEC/MPPEH observed. Each sample location will be recorded with the hand held Global Positioning System (GPS) unit. Discrete soil samples for off-site shipment will be collected from 0-6 inches below ground surface (bgs), mixed, packaged and shipped with chain-of-custody (COC) documentation. If breached MEC/MPPEH is observed, then surface soil samples will be collected at these locations. ISM increments will be collected from 0-2.5 centimeters (cm) bgs, in triplicate, using a systematic random sampling pattern.

Analysis Tasks:

CTL in Baraboo, Wisconsin will process, prepare and analyze samples submitted for metals, explosives, and SVOCs following SW-846 methodologies and laboratory Standard Operating Procedures (SOPs). CTL may need to subcontract to Microbac Laboratories, Inc. (Microbac) in Marietta, Ohio for the analysis of Perchlorate.

Lab contacts are noted below.

CT Laboratories, LLC (CTL) 1230 Lange Court Baraboo, Wisconsin 53913-3109 Project Manager: Patrick Letterer pletterer@ctlaboratories.com 608-356-2760	Microbac Laboratories, Inc. (Microbac) 158 Starlite Drive Marietta, Ohio 45750 Project Manager: Stephanie Mossburg Stephanie.mossburg@microbac.com 800-373-4071

QC Tasks:

QC requirements for soil sampling and sample packaging and shipping are presented in the SOPs (**Attachment C2**).

QAPP Worksheet #14 & 16: Project Tasks & Schedule (Continued)**Data Management Tasks:**

Field data management tasks are described in detail in the Work Plan, Section 6.2.3, *General Field Work Procedures*.

The position of munitions-related features (e.g., MEC, MPPEH, suspected firing points, suspected target areas, range-related debris) will be captured as GPS waypoints and recorded in a field log. If GPS coordinates cannot be acquired, the team will record the location of the find along with a bearing to, and approximate distance from, an identifiable landmark (e.g., a unique terrain feature or a specific building). Digital photographs will be taken of any munitions-related feature identified in the field.

If any MPPEH or MEC items are observed in the field, the item will be left undisturbed. The UXO Technician III will collect as much information (e.g., type, model, condition, etc.) as possible without handling or disturbing the item prior to contacting the RFAAP POC, USACE PM, and BSEn PM to report the find. The reporting procedures are detailed in Section 11.8 of the Accident Prevention Plan (APP) (**Appendix D** of the Work Plan).

A Schonstedt magnetometer will be tested against a metallic source at the beginning of each work day, mid-day, and at the end of the work day to ensure the device is working properly. This check consists of a basic operations test in which a ferrous metallic object (such as a small section of steel pipe) is placed on the ground and the Schonstedt is waved over and around the object. The operator (the UXO Technician III) listens to the tone produced to ensure that the Schonstedt is detecting the metallic object.

GPS data will be downloaded and archived each evening at the conclusion of the daily survey and sampling activities. A field map showing the locations of all MEC/MPPEH/MD and related points of interest will be compiled from the GPS data as the investigative field work progresses. Digital photographs will also be downloaded, correlated with the field map, and archived daily. The team members will review and compare their field logs with the digital photographs taken in the field and the flagged data points to resolve any discrepancies of field data so that each item listed in the field log corresponds to a GPS point and digital photograph. As the SI field investigation proceeds, the SI field team will compile a field log documenting any MEC/MPPEH/MD and points of interest identified, and note any issues encountered while conducting the AVS. The log will also contain any sketches, images, or survey maps indicating portions of the MRS covered and any inaccessible portions of the MRS. These maps and images will be included as part of the survey record.

Sample collection tasks are described in detail in the Work Plan, Section 6.3.2.3, *Sample Collection*.

QAPP Worksheet #14 & 16: Project Tasks & Schedule (Continued)

Procedures for collection of the surface soil samples are described in SOP 300 included in **Attachment C2**. ISM samples will be collected in triplicate to calculate a 95% upper confidence limit for the DU and limit the effects of natural heterogeneity. Any deviation from the DU and/or increment locations (i.e., due to anomaly avoidance or impervious/inaccessible soil) will be recorded with an explanation. Replicate samples will be collected using a systematic-random pattern that complies with SOP 300 included in **Attachment C2**.

Analytical data will be summarized and presented in the SI Report. In addition, an electronic copy of the analytical data will be provided after validation.

Documentation and Records:

Field documentation is described in detail in the Work Plan, Section 6.7, *Deliverables*.

All samples collected will have locations, sample identifications (IDs), field observations, soil descriptions and a file reference to the corresponding digital photo recorded utilizing GPS units, sample analysis forms, and logbooks. Samples collected for off-site analysis will be maintained under strict custody procedures with three-carbon COC forms and overnight courier service air-bills signed by the field team and the laboratory, upon receipt. Original COC forms and air bills are included in the hardcopy analytical data package prepared by the laboratory.

Assessment/Audit Tasks:

Performance and system audits will be conducted to verify implementation of the QA program, assess the effectiveness of the SI Work Plan, identify any non-conformances, and to verify corrective action of identified deficiencies. The audit tasks are described in **Worksheet 31**, and an example field sampling audit checklist is included as **Attachment C3** to this QAPP.

Data Review Tasks:

Data review tasks are summarized in **Worksheets 34, 35, 36** and **37** of this QAPP.

All data will be reviewed and verified for completeness. A minimum of 10% of all data will be validated IAW the USEPA National Functional Guidelines for Organic Data Review (USEPA, 2014), or Inorganic Data Review (USEPA, 2014).

QAPP Worksheet #15-1: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(USEPA 2106-G-05 Section 2.2.6)

Matrix: Soil

Analytical Method: Metals - SW-846 Method 6010C

Concentration Level: Any

Analyte	Abbrev.	Chemistry Abstracts Service (CAS) Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁵	Achievable Laboratory Limits ⁴ SW-846 6010C		
							Detection Limit (DL) (mg/kg)	Limit of Detection (LOD) (mg/kg)	Limit of Quantitation (LOQ) (mg/kg)
Antimony	Sb	7440-36-0	N/A	N/A	470	Soil Invertebrates: 78 Mammalian Wildlife: 0.27	0.13	0.4	0.8
Beryllium	Be	7440-41-7	1.02	6,900	2,300	Soil Invertebrates: 40 Mammalian Wildlife: 21	0.004	0.012	0.04
Cadmium	Cd	7440-43-9	N/A	9,300	980	Soil Invertebrates: 140 Mammalian Wildlife: 0.36 Avian Wildlife: 0.77 Plants: 32	0.006	0.02	0.04
Chromium	Cr	7440-47-3	65.3	N/A	N/A	As Cr(III): Mammalian Wildlife: 34 Avian Wildlife: 26	0.023	0.07	0.14
Cobalt	Co	7440-48-4	72.3	1,900	350	Mammalian Wildlife: 230 Avian Wildlife: 120 Plants: 13	0.04	0.12	0.24
Copper	Cu	7440-50-8	53.5	N/A	47,000	Soil Invertebrates: 80 Mammalian Wildlife: 49 Avian Wildlife: 28 Plants: 70	0.07	0.2	0.4
Lead	Pb	7439-92-1	26.8	N/A	800	Soil Invertebrates: 1,700 Mammalian Wildlife: 56 Avian Wildlife: 11 Plants: 120	0.04	0.125	0.25
Lithium	Li	7439-93-2	N/A	N/A	2,300	N/A	0.06	0.18	0.36

QAPP Worksheet #15-1: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits (Continued)

Analyte	Abbrev.	Chemistry Abstracts Service (CAS) Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁵	Achievable Laboratory Limits ⁴ SW-846 6010C		
							Detection Limit (DL) (mg/kg)	Limit of Detection (LOD) (mg/kg)	Limit of Quantitation (LOQ) (mg/kg)
Manganese	Mn	7439-96-5	2,543	N/A	26,000	Soil Invertebrates: 450 Mammalian Wildlife: 4,000 Avian Wildlife: 4,300 Plants: 220	0.025	0.075	0.15
Molybdenum	Mo	7439-98-7	N/A	N/A	5,800	N/A	0.04	0.12	0.24
Nickel	Ni	7440-02-0	62.8	64,000	22,000	Soil Invertebrates: 280 Mammalian Wildlife: 130 Avian Wildlife: 210 Plants: 38	0.021	0.06	0.12
Selenium	Se	7782-49-2	N/A	N/A	5,800	Invertebrates: 4.1 Mammalian wildlife: 0.63 Avian Wildlife: 1.2 Plants: 0.52	0.06	0.2	0.4
Silver	Ag	7440-22-4	N/A	N/A	5,800	Mammalian Wildlife: 14 Avian Wildlife: 4.2 Plants: 560	0.017	0.05	0.1
Strontium	Sr	7440-24-6	N/A	N/A	700,000	N/A	0.013	0.040	0.080
Thallium	Tl	7440-28-0	2.11	N/A	12	N/A	0.08	0.24	0.48
Tin	Sn	7440-31-5	N/A	N/A	700,000	N/A	0.09	0.25	0.50
Vanadium	V	7440-62-2	108	N/A	5,800	Mammalian Wildlife: 280 Avian Wildlife: 7.8	0.012	0.04	0.08
Zinc	Zn	7440-66-6	202	N/A	350,000	Soil Invertebrates: 120 Mammalian Wildlife: 79 Avian Wildlife: 46 Plants: 160	0.05	0.15	0.3

¹ Background level from Facility-Wide Background Study Report (IT Corporation, 2001)

² From the RSL Composite Worker Soil Table (Target Risk [TR]=1E-6, Hazard Quotient [HQ]=1) June 2015, Carcinogenic Screening Level

³ From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, Target Hazard Index (THI)=1

⁴ Achievable method detection limits (MDLs) and quantitation limits (QLs) are limits that an individual laboratory can achieve when performing a specific analytical method

⁵ From Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

QAPP Worksheet #15-2: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(USEPA 2106-G-05 Section 2.2.6)

Matrix: Soil

Analytical Method: Mercury - SW-846 Method 7471A

Concentration Level: Any

Analyte	Abbrev.	CAS Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁵	Achievable Laboratory Limits ⁴ SW-846 7471A		
							DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Mercury	Hg	7439-97-6	0.13	N/A	46	N/A	0.0021	0.0042	0.007

¹ Background level from *Facility-Wide Background Study Report* (IT Corporation, 2001)

² From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Carcinogenic Screening Level*

³ From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, THI=1*

⁴ Achievable MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method

⁵ From *Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005*

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

QAPP Worksheet #15-3: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(USEPA 2106-G-05 Section 2.2.6)

Matrix: Soil

Analytical Method: Organics (Explosives by High Performance Liquid Chromatography [HPLC]) – SW-846 Method 8330B

Concentration Level: Any

Analyte	Abbrev.	CAS Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL ⁵ (mg/kg)	Achievable Laboratory Limits ⁴ SW-846 8330B		
							DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
1,3,5-trinitrobenzene	1,3,5-TNB	99-35-4	N/A	N/A	32,000	N/A	0.13	0.3	0.5
1,3-dinitrobenzene	1,3-DNB	99-65-0	N/A	N/A	82	N/A	0.08	0.2	0.3
2,4,6-trinitrotoluene	2,4,6-TNT	118-96-7	N/A	96	510	N/A	0.09	0.2	0.5
2,4-dinitrotoluene	2,4-DNT	121-14-2	N/A	7.4	1,600	N/A	0.08	0.2	0.3
2,6-dinitrotoluene	2,6-DNT	606-20-2	N/A	1.5	250	N/A	0.07	0.2	0.3
2-amino-4,6-dinitrotoluene	2-Am-DNT	35572-78-2	N/A	N/A	2,300	N/A	0.08	0.2	0.3
2-nitrotoluene	2-NT	88-72-2	N/A	15	1,100	N/A	0.08	0.2	0.3
3,5-dinitroaniline	3,5-DNA	618-87-1	N/A	N/A	N/A	N/A	0.08	0.2	0.3
3-nitrotoluene	3-NT	99-08-1	N/A	N/A	82	N/A	0.11	0.3	0.5
4-amino-2,6-dinitrotoluene	4-Am-DNT	19406-51-0	N/A	N/A	2,300	N/A	0.08	0.2	0.3
4-nitrotoluene	4-NT	99-99-0	N/A	140	3,300	N/A	0.1	0.2	0.5
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4	N/A	28	3,300	N/A	0.14	0.3	0.5
Nitrobenzene	NB	98-95-3	N/A	22	1,300	N/A	0.1	0.2	0.5
Nitroglycerin	NG	55-63-0	N/A	140	82	N/A	0.5	1.2	2.0
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0	N/A	N/A	57,000	N/A	0.12	0.3	0.5
Pentaerythritol tetranitrate	PETN	78-11-5	N/A	570	1,600	N/A	0.6	1.2	2.0
Trinitrophenylmethyl-nitramine	Tetryl	479-45-8	N/A	N/A	2,300	N/A	0.09	0.2	0.5

¹ Background level from Facility-Wide Background Study Report (IT Corporation, 2001)

² From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Carcinogenic Screening Level

³ From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, THI=1

⁴ Achievable MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method

⁵ From Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

QAPP Worksheet #15-4: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(USEPA 2106-G-05 Section 2.2.6)

Matrix: Soil

Analytical Method: Organics (SVOCs by Gas Chromatograph [GC]/Mass Spectrometer [MS]) – SW-846 Method 8270D

Concentration Level: Any

Analyte	CAS Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL ⁶ (mg/kg)	Achievable Laboratory Limits ⁴ SW-846 8270D		
						DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Di-n-butylphthalate	84-74-2	N/A	N/A	82,000	N/A	0.079	0.120	0.400
Diphenylamine ⁵	122-39-4	N/A	N/A	21,000	N/A	0.050	0.120	0.240
N-Nitrosodiphenylamine ⁵	86-30-6	N/A	470	N/A	N/A	0.050	0.120	0.240
2-Chloronaphthalene	91-58-7	N/A	N/A	60,000	N/A	0.023	0.060	0.120

¹ Background level from Facility-Wide Background Study Report (IT Corporation, 2001)

² From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Carcinogenic Screening Level

³ From the RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, THI=1

⁴ Achievable MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method

⁵ Analytes coelute and will be reported as a total.

⁶ From Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

**QAPP Worksheet #15-5: Project Comparison Values and Laboratory-Specific Detection/Quantitation Limits
(UFP-QAPP Manual Section 2.6.2.3 and Figure 15)
(USEPA 2106-G-05 Section 2.2.6)**

Matrix: Soil

Analytical Method: Inorganics (Perchlorate) – SW-846 Method 6850

Concentration Level: Medium - High

Analyte	CAS Number	Background Level ¹ (mg/kg)	RSL Carcinogenic SL ² (mg/kg)	RSL Non-Carcinogenic SL ³ (mg/kg)	Ecological SSL (mg/kg) ⁵	Achievable Laboratory Limits ⁴ SW-846 6850		
						DL (mg/kg)	LOD (mg/kg)	LOQ (mg/kg)
Perchlorate	14797-73-0	N/A	N/A	820	N/A	0.001	0.002	0.004

¹ Background level from *Facility-Wide Background Study Report* (IT Corporation, 2001)

² From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Carcinogenic Screening Level*

³ From the *RSL Composite Worker Soil Table (TR=1E-6, HQ=1) June 2015, Non-Carcinogenic Screening Level, THI=1*

⁴ Achievable MDLs and QLs are limits that an individual laboratory can achieve when performing a specific analytical method

⁵ From *Ecological Soil Screening Levels, Interim Final, OSWER Directive 9285.7, 2005*

N/A indicates that the a value is not available (i.e., no RSL, EcoSSL or background value has been established)

QAPP Worksheet #17: Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(USEPA 2106-G-05 Section 2.3.1)

Rationale and Design

Sampling rationale and design considerations are discussed in Section 5.0, *Data Quality Objectives*, and Section 6.0, *Field Sampling Plan*, of the Work Plan.

The DQOs were developed based on the findings of the HRR and CSM. Personnel interviews and records indicate the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was used as a testing range for mortar rounds and artillery fired to test and evaluate the quality of propellant charges. The limited number of historical records, photographs, and figures discovered during the HRR process substantiate these reports. The AVS and MC sampling methods described in the following sections will provide sufficient data to make a determination regarding the presence or absence of MPPEH, MEC, and MC.

Analog Instrument-Assisted Visual Survey

An AVS will be conducted to evaluate the presence or absence of MEC, MPPEH, and MD lying on the ground surface at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Mortars have routinely been discovered during facility operations, construction activities, or exposed by heavy rains. Personnel interviews and records indicate the Former Gun and Mortar Range (RFAAP-002-R-01) MRS was used as a testing range for mortar rounds and artillery fired to evaluate propellant charges. Visual surveys and metallic anomaly detection using analog metal detectors will be conducted as part of the AVS to identify the type of MEC/MPPEH/MD within select areas of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. Any identifiable range features (e.g., firing point or impact areas) will be recorded, in addition to any MEC/MPPEH/MD observed. AVSs will be conducted along 10-foot wide transects in the areas shown on **Figure C1**. The 10 foot wide transect is based on the approximate distance between two UXO technicians using analog metal detectors.

QAPP Worksheet #17: Sampling Design and Rationale (Continued)

Equipment anticipated to be used during the AVS includes:

1. Schonstedt GA-52Cx analog metal detector – This is the industry standard technology for anomaly avoidance. Target discrimination is not required, so the analog metal detector will provide sufficient information to evaluate the potential for subsurface MPPEH or MEC. A device with similar or greater detection capabilities may be substituted if necessary.
2. Trimble GeoXT or GeoXH handheld GPS – Both GPS units are capable of sub-meter accuracy (post-processed). These will be used to record points, lines, and areas in order to depict an accurate spatial characterization of the MRS.

Munitions Constituents Surface Soil Sampling

Surface soil samples will be collected using ISM, as presented by the Interstate Technology Regulatory Council (ITRC, 2012), from two areas of the MRS. Discrete soil samples will be collected from drainage features along the MRS boundary closest to the New River to assess whether contamination is moving off the MRS to the unsurveyable slope, located on the MRS, adjacent to the New River. Following the AVS, discrete, biased surface soil samples will be collected at locations where MPPEH or MEC has been positively identified during the AVS and MC is expected to have been released (UXO with exposed filler, low order detonation, etc.). Intact MEC or MPPEH would not indicate a release and MC will not be sampled at those locations. Surface soil samples will be collected IAW Section 5.2.9 of the Master Work Plan (MWP) and Section 6.3 of the Work Plan, within the depth interval of 0-6 inches bgs (URS, 2003). ISM increments will be collected from a depth of 0-2.5 cm bgs IAW Section 6.3 of the Work Plan. The vegetation and root mat will be removed prior to collecting discrete surface soil samples IAW the MWP [(URS, 2003), (USEPA, 2012)]. The vegetation and root mat will not be removed during the collection of ISM increments IAW SOP HDR MMRP-300 and ISM (ITRC, 2012).

QAPP Worksheet #18: Sampling Locations and Methods
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.1 and 2.3.2)

Sample ID	Matrix	Depth (ft bgs)	Type	Analyte/ Analytical Group	Sampling SOP	Comments
TBD	Discrete Soil	Surface (0-6 inches)	Disposable scoop	Inorganics and Organics	HDR MMRP-300	See Worksheet #17 for sampling rationale details.
ISM DU	ISM Soils	Surface (0-2.5 cm)	Disposable scoop	Inorganics and Organics	<i>Incremental Sampling Methodology</i> (ITRC, 2012)	See Worksheet #17 for sampling rationale details

QAPP Worksheet #19 & 30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(USEPA 2106-G-05 Section 2.3.2)

Laboratory (Name, sample receipt address, POC, e-mail, and phone numbers): CT Laboratories, LLC, 1230 Lange Court, Baraboo, WI 53913-3109. Pat Letterer 608-356-2760

List any required accreditations/certifications: Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) Certification

Back-up Laboratory: Microbac Laboratories, Inc., 158 Starlite Drive, Marietta, OH 45750. Stephanie Mossburg 800-373-4071

Sample Delivery Method: Federal Express Overnight/Saturday delivery as needed.

Analyte/Analyte Group	Matrix	Method/ SOP	Accreditation Expiration Date	Container(s) (number, size & type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround
Inorganic (Metals)	Soil	SW-846 6010C (CTL SOP MT009) (Microbac SOP ME600E)	4/30/2016	1x8-ounce (oz.) glass jar Teflon-lined lid	None	180 days to digestion	180 days	21 Days
Inorganic (Mercury)	Soil	SW-846 7471A (CTL SOP MT012)	4/30/2016	1x8-oz. glass jar Teflon-lined lid	Chill ≤ 4 degrees Celsius ($^{\circ}\text{C}$), $\pm 2^{\circ}\text{C}$	28 days to digestion	28 days	21 Days
Organic (Explosives)	Soil	SW-846 8330B Mod. (CTL SOP SV010)	4/30/2016	1x8-oz. glass jar Teflon-lined lid	Chill $\leq 4^{\circ}\text{C}$, $\pm 2^{\circ}\text{C}$	14 Days to extraction	40 Days to analysis	21 Days
Organic (SVOCs)	Soil	SW-846 8270D (CTL SOP SV009)	4/30/2016	1x8-oz. glass jar Teflon-lined lid	Chill $\leq 4^{\circ}\text{C}$, $\pm 2^{\circ}\text{C}$	14 Days to extraction	40 Days to analysis	21 Days
Inorganic (Perchlorate)	Soil	SW-846 6850 (Microbac SOP HPLC06)	4/30/2016	1x4-oz. amber glass jar Teflon-lined lid	Chill $\leq 4^{\circ}\text{C}$, $\pm 2^{\circ}\text{C}$	28 Days to extraction	28 Days	21 Days

QAPP Worksheet #20: Field QC Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(USEPA 2106-G-05 Section 2.3.5)

Matrix	Analyte/Analytical Group	Field Samples	Field Duplicates/Replicates	Matrix Spikes	Matrix Spike Duplicates	Field Blanks	Equipment Blanks	Trip Blanks	Other	Total # analyses
Soil	Inorganics (Metals)	12 (10 discrete) (2 ISM DU)	1 field duplicate (FD) for discrete samples and 2 replicates of ISM increments collected from each DU	2 (1 discrete) (1 ISM DU)	2 (1 discrete) (1 ISM DU)	0	0	0	N/A	18
Soil	Mercury	12 (10 discrete) (2 ISM DU)	1 FD for discrete samples and 2 replicates of ISM increments collected from each DU	2 (1 discrete) (1 ISM DU)	2 (1 discrete) (1 ISM DU)	0	0	0	N/A	18
Soil	Organics (Explosives)	12 (10 discrete) (2 ISM DU)	1 FD for discrete samples and 2 replicates of ISM increments collected from each DU	2 (1 discrete) (1 ISM DU)	2 (1 discrete) (1 ISM DU)	0	0	0	N/A	18
Soil	Organics (SVOCs)	12 (10 discrete) (2 ISM DU)	1 FD for discrete samples and 2 replicates of ISM increments collected from each DU	2 (1 discrete) (1 ISM DU)	2 (1 discrete) (1 ISM DU)	0	0	0	N/A	18
Soil	Inorganics (Perchlorate)	12 (10 discrete) (2 ISM DU)	1 FD for discrete samples and 2 replicates of ISM increments collected from each DU	2 (1 discrete) (1 ISM DU)	2 (1 discrete) (1 ISM DU)	0	0	0	N/A	18

QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(USEPA 2106-G-05 Section 2.3.2)

SOP # or reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
HDR MMRP-200	Visual Surveys Rev. 3.4 – 4/17/2013	HDR	Trimble GEO-XT	N	Hard copies of the SOPs will be kept on the project site for field team reference.
HDR MMRP-300	Soil Sampling Rev. 2.4 – 4/16/2013	HDR	Trowels, hand auger, disposable scoops	N	
HDR MMRP-400	Sample ID, Handling, Documentation, Shipping, and Tracking Rev. 2.4 – 7/31/2013	HDR	N/A	N	
HDR MMRP-500	Sampling Equipment and Personnel Decontamination Rev. 2.4 – 4/16/2013	HDR	Trowels/bowls bucket auger	N	
HDR MMRP-700	Site Permits, Notifications, and Utility Clearance Rev. 1.4 – 4/17/2013	HDR	Bucket, auger	N	
HDR MMRP-UXO-02	Anomaly Avoidance Rev. 1.5 – 4/17/2013	HDR	N/A	N	
HDR MMRP-UXO-03	General UXO Safety: MEC Rev. 1.6 – 4/17/2013	HDR	N/A	N	
HDR MMRP-UXO-07	UXO Anomaly Avoidance During Sampling Rev. 1.6 – 4/17/2013	HDR	N/A	N	

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.1.2.4)
(USEPA 2106-G-05 Section 2.3.6)

Field Equipment	Activity	SOP Reference	Title or position of responsible person	Frequency	Acceptance Criteria	Corrective Action
Ricoh GPS Camera	Firmware/software checks	HDR MMRP-200	Field Team Lead	Annually	--	Update as necessary
Ricoh GPS Camera	Battery Checks	HDR MMRP-200	Field Team Lead	Prior to mobilization, then after arrival on-site, then daily	Inspect for physical deficiencies. All physical parts function, and indicators represent normal	Take out of service and recharge or send to manufacturer for repair
Ricoh GPS Camera	GPS point compared to known geodetic control point/ second independent GPS receiver	HDR MMRP-200	Field Team Lead	--	Spatial positions meet manufacturer's specifications	Re-try. If still out - take out of service - send to manufacturer for repair
Trimble Geo-XT GPS Unit	Firmware/software checks	HDR MMRP-200	Field Team Lead	Annually	--	Update as necessary
Trimble Geo-XT GPS Unit	Battery Checks	HDR MMRP-200	Field Team Lead	Prior to mobilization, then after arrival on-site, then daily	Inspect for physical deficiencies. All physical parts function, and indicators represent normal	Take out of service and recharge or send to manufacturer for repair
Trimble Geo-XT GPS Unit	GPS point compared to known geodetic control point/ second independent GPS receiver	HDR MMRP-200	Field Team Lead	--	Spatial positions meet manufacturer's specifications	Re-try. If still out - take out of service - send to manufacturer for repair
Leica or Trimble Total Station	Optical plummets and level vials	HDR MMRP-200	Field Team Lead	--	Spatial positions meet or exceed manufacturer's specifications	Calibration by a qualified repair facility.
Leica or Trimble Total Station	Firmware/software checks	HDR MMRP-200	Field Team Lead	Annually	--	Update as necessary
Leica or Trimble Total Station	Distance checks between survey monuments	HDR MMRP-200	Field Team Lead	Daily	Meets manufacturer's accuracy specs.	Re-try. If still out take out of service and send to manufacturer for repair.
Leica or Trimble Total Station	Inspect for physical deficiencies	HDR MMRP-200	Field Team Lead	--	Prior to mobilization, then after arrival on-site, then daily	All physical parts function, and indicators represent normal

QAPP Worksheet #23: Analytical SOPs
(UFP-QAPP Manual Section 3.2.1)
(USEPA 2106-G-05 Section 2.3.4)

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? Y/N
CTL MT009	Inductively Coupled Plasma Emission—ICP-OES 6000 Series (SOP Number MT009 6105B-6000, Revision 2, 3/12/2014)	Definitive	Soil / Inorganics (Metals) – SW-846 Method 6010C	ICP 6500, Cetac autosampler, computer, & network printer	N
CTL MT012	Mercury Cold Vapor Atomic Absorption (CVAA) (SOP Number MT012, Revision 8, 3/12/2014)	Definitive	Inorganics (Mercury) – SW-846 Method 7471A	Cetac M-6000A Mercury Analyzer with ASX-500 autosampler	N
CTL SV010	Explosives by Modified Method 8330B (SOP SV 010, Revision 5, 3/12/2014)	Definitive	Organics (Explosives) – SW-846 Method 8330B	Shimadzu HPLC analytical system	N
CTL SV006	SVOCs by 8270D (SOP SV 006, Revision 0, 4/6/2015)	Definitive	Organics (SVOCs) – SW-846 Method 8270D	GC-MS system - Hewlett Packard 6890 GC/7683 autosampler/5973 MSD	N
Microbac HPLC06	(SOP HPLC06, Revision 4, 4/15/2012)	Definitive	Inorganics (Perchlorate) – SW-846 Method 6850	-High performance liquid chromatograph: Shimadzu Prominence UFLC XR -Mass spectrometer system: Applied Biosystems API-4000 triple quadrupole mass spectrometer with TurboIonspray probe	N

QAPP Worksheet #24: Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(USEPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP (Metals by ICP)	Initial Calibration	Any	As required by criteria	Linear regression correlation coefficient ≥ 0.998 , or single point calibration	Re-run calibration	CTL QAO	CTL MT009
	Initial Calibration Verification (ICV)	Any	Daily, at start of run	Mid-level: %D within 10% of initial calibration Low level: %D within 30% of initial calibration	Verify instrument operating conditions and adjust as needed. Re-run ICV. If still out: perform new calibration.		
	Continuing Calibration Verification (CCV)	Any	Every 20 samples	%D within 10% of initial calibration	Re-run all samples bracketed by the failed CCV		
	Method Blank	Any	Every 20 samples	< LOD or < 0.5 Reporting Limit (RL)	Locate and reduce source of contamination, reanalyze samples		
	Laboratory Control Sample (LCS)	Any	One per prep batch	80-120%	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch		
	Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	Any	One per batch per matrix	75-125%	None		
	Dilution test	Any	Each new sample matrix	1:5 dilution must agree within 10% of the original determination	Perform post digestion spike addition		
	Post digestion spike addition	Any	When dilution test fails	Recovery within 25% of expected results	Correct problem then re-analyze post digestion spike addition		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
CVAA (Mercury)	Initial Calibration	Any	Daily, at start of run	Linear regression correlation coefficient ≥ 0.995	Re-run calibration	CTL QAO	CTL MT012
	ICV	Any	Daily, at start of run	%D within 10% of initial calibration	Verify instrument operating conditions and adjust as needed. Re-run ICV. If still out: perform new calibration.		
	CCV	Any	Every 10 samples	%D within 10% of initial calibration	Re-run all samples bracketed by the failed CCV.		
	Method Blank	Any	Every 20 samples	< 0.5 RL	Locate and reduce source of contamination, reanalyze samples		
	LCS	Any	One per prep batch	80-120%	Correct problem then re-prepare and analyze the LCS and all samples in the affected analytical batch		
	MS/MSD	Any	One per batch per matrix	80-120%	None		
HPLC Explosives	Initial Calibration	Any	Prior to sample analysis. Recalibration performed annually at a minimum.	Relative Standard Deviation (RSD) of Calibration Factor (CF) of each analyte $\leq 15\%$, or linear fit $r \geq 0.995$	Correct problem, then repeat initial calibration	CTL QAO	CTL SOP SV010
	ICV from a 2nd source	Any	Immediately following initial calibration	All analytes within 15% of expected value	Correct problem then repeat initial calibration		
	CCV	Any	Start of run, and once every 10 samples, and at end of run	All analytes within 20% of expected value	Correct problem then repeat initial CCV and re-analyze all samples since last successful CCV		
	Method Blank	Any	One per prep batch of 20 samples	No analytes detected $\geq \frac{1}{2}$ RL	Correct problem then re-prepare and analyze method blank and all samples processed with the contaminated blank		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	LCS	Any	One per prep batch of 20 samples	Lab Control Limits	One per prep batch of samples per batch)		
	Surrogate	Any	Every sample, spike, standard, and blank	Lab Control Limits	Check system, re-inject, re-extract		
	MS/MSD	Any	One per batch per matrix	Lab Control Limits	None		
	Soil Grinding Blanks	Any	Between each sample	Clean soil matrix, no target analytes > ½ the RL	All blank results must be reported and affected samples must be flagged accordingly if blank criteria is not met		
	Confirmation Analysis	Any	When target analytes are detected on the primary column using the UV detector at concentration exceeding the LOD	Calibration and QC criteria same as primary column. Results between primary and second column relative percent difference (RPD) ≤ 40%	Report both columns. If >40% RPD data must be J flagged accordingly.		
GC-MS (SVOCs)	Tuning and Mass Calibration	Any	Prior to ICAL and at the beginning of each 12-hour period	Refer to method for specific ion criteria.	Problem must be corrected. No samples may be accepted without a valid tune.	CTL QAO	CTL SOP SV006
	Dichlorodiphenyltrichloroethane (DDT) Breakdown Check	Any	At the beginning of each 12-hour period, prior to analysis of samples	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2	No samples shall be run until degradation ≤ 20%		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Initial Calibration	Any	Prior to sample analysis	1. <u>Average response factor (RF) for System Performance Check Compounds (SPCCs)</u>: volatile organic compounds (VOCs) ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. SVOCs ≥ 0.050. 2. <u>RSD for RFs for Calibration Check Compounds (CCCs)</u>: VOCs and SVOCs $\leq 30\%$ and one option below: <u>Option 1</u>: RSD for each analyte $\leq 15\%$; <u>Option 2</u>: linear least squares regression $r \geq 0.995$; <u>Option 3</u>: non-linear regression—coefficient of determination $r^2 \geq 0.99$ (6 points shall be used for second order, 7 points shall be used for third order).	Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin.		
	ICV from a 2nd source	Any	Once after each ICAL	All analytes within 20% of expected value	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	Any	Daily before sample analysis and every 12 hours of analysis time	1. Average RF for SPCCs : SVOCs ≥ 0.050 . 2. %Difference/Drift for all target compounds and surrogates: $\leq 20\%D$ (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.		
	Method Blank	Any	One per preparatory batch	No analytes detected $> \frac{1}{2}$ RL and $> 1/10$ the amount measured in any sample or $1/10$ the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.		
	LCS	Any	One per preparatory batch	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		
	Surrogate	Any	Every sample, spike, standard, and blank	QC acceptance criteria specified by DoD, if available. Otherwise, use in-house control limits.	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	MS/MSD	Any	One per preparatory batch per matrix	For matrix evaluation, use LCS acceptance criteria specified by DoD, if available. Otherwise, use in-house LCS control limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.		
	Internal Standards Verification	Any	Every field sample, standard, and QC sample	Retention time $\pm$ 30 seconds from retention time of the midpoint standard in the ICAL; extracted ion current profile (EICP) area within - 50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.		
HPLC (Perchlorate)	Initial Calibration	Any	Minimum of 5 calibration standards to establish linearity at method set-up and after major maintenance.	$r \geq 0.995$ or $RSD \leq 20\%$. The concentration corresponding to the absolute value of the calibration curve's Y-intercept must be $\leq$ LOD.	Correct problem, then repeat initial calibration	Microbac QAO	Microbac SOP HPLC06
	ICV from a 2nd source	Any	Once after each ICAL, analysis of a second source standard at the midpoint of the calibration	Within $\pm 15\%$ of true value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	Any	Analysis of mid-level standard after every 10 field samples	Within $\pm 15\%$ of true value	All samples must be bracketed by the analysis of a standard demonstrating that the system was capable of accurately detecting and quantifying perchlorate. Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.		
	Limit of Detection Verification (LODV) (per batch)	Any	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within $\pm 30\%$ of true value	LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported.		
	Isotope ratio $^{35}\text{Cl}/^{37}\text{Cl}$	Any	Every sample, batch QC sample, and standard	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~ 3.06 . Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.).		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Method Blank	Any	One per preparatory batch	No perchlorate detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.		
	LCS	Any	One per preparatory batch. LCS must be spiked at the RL	Recovery within method requirements, laboratory-generated limits, or 80-120% (whichever is more stringent) to verify calibration and to check method performance.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		
	MS/MSD	Any	One per preparatory batch per matrix (see Box D-7). The MS must be spiked at the RL.	Recovery within 80-120% or within laboratory generated limits, whichever is more stringent	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.		
	MSD or laboratory duplicate (LD)	Any	One per preparatory batch per matrix (see Box D-7). The MSD must be spiked at the RL.	MSD: Recovery within 80-120% or within laboratory generated limits, whichever is more stringent. MSD or LD: RPD < 15%	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.		
	Internal standard (IS)	Any	Addition of ¹⁸ O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank	Measured ¹⁸ O IS area within ± 50% of the value from the average of the IS area counts of the ICAL. Reliability Run Test (RRT) of the perchlorate ion must be 1.0 ± 2% (0.98 – 1.02).	Rerun the sample at increasing dilutions until the ± 50% acceptance criteria are met. If criteria cannot be met with dilution, the interference are suspected and the sample must be reprepared using additional pretreatment steps.		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Interference check sample (ICS)	Any	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold. At least one ICS must be analyzed daily.	Within $\pm 30\%$ of true value	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed.		
	Laboratory reagent blank	Any	Prior to calibration, after samples with overrange concentration of perchlorate, and at the end of the analytical sequence	No perchlorate detected $> \frac{1}{2}$ RL	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank		
	Tuning	Any	Prior to ICAL and after any mass calibration or maintenance is performed	Tuning standards must contain the analytes of interest and meet acceptance criteria outlined in the laboratory SOP	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone.		

QAPP Worksheet #24: Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Mass calibration	Any	Instrument must have a valid mass calibration prior to any sample analysis. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved).	Mass calibration range must bracket the ion masses of interest without greatly exceeding the range. The most recent mass calibration must be used for an analytical run, and the same mass calibration must be used for all data files in an analytical run. Mass calibration must be verified by acquiring a full scan continuum mass spectrum of a perchlorate stock standard. Perchlorate ions should be within $\pm 0.3 m/z$ of mass 99, 101, and 107 or their respective daughter ion masses (83, 85, and 89), depending on which ions are quantitated.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance.		
	Interference threshold study	Any	At initial setup and when major changes occur in the method's operating procedures (e.g., addition of cleanup procedures, column changes, mobile phase changes)	Measure the threshold of common suppressors (chloride, sulfate, carbonate, bicarbonate) that can be present in the system without affecting the quantitation of perchlorate. The threshold is the concentration of the common suppressors where perchlorate recovery falls outside an 85-115% window.	N/A		

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.2.3)
(USEPA 2106-G-05 Section 2.3.6)

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Title/position responsible for CA	Reference
ICP for Metals in Water or Soil	Clean torch assembly, nebulizer, and spray chamber as needed. Check argon gas, vacuum, waste container, and reagent water levels daily. Replace pump tubing as needed.	Torch, nebulizer chamber, pump and pump tubing, vacuum source, waste container	--	Daily prior to calibration	Acceptable ICAL or CCV	Correct problem and repeat ICAL or CCV	Analyst / Supervisor	CTL MT009
CVAA for Mercury	See Cetac operator's manual for further troubleshooting instructions				Acceptable ICAL or CCV	Correct problem and repeat ICAL or CCV	Analyst / Supervisor	CTL MT012
HPLC for Explosives in Water or Soil	See lab's Appendix 9 of the Quality Assurance Manual (QAM)							CTL SV010
GC/MS for SVOCs	See lab's Appendix 9 of the QAM							CTL SV006
HPLC for Perchlorate	The curtain plate and nebulizer tip must be monitored for buildup and cleaned when necessary. The oil in the vacuum pumps should be changed every six (6) months. The source is cleaned and mass calibration performed on an as-needed basis.							Microbac HPLC06

QAPP Worksheet #26 & 27: Sample Handling, Custody, and Disposal
(UFP-QAPP Manual Section 3.3)
(USEPA 2106-G-05 Section 2.3.3)

Sampling Organization: HDR Field Team

Laboratory: CT Laboratories

Method of sample delivery (shipper/carrier): Federal Express overnight/Saturday delivery as needed

Number of days from reporting until sample disposal: 90 days

Activity	Organization and title or position of person responsible for the activity	SOP reference
Sample labeling	BSEn (HDR) Field Team	HDR SOP HDR MMRP-400.
COC form completion		
Packaging		
Shipping coordination		
Sample receipt, inspection, & log-in	Sample Receipt, CTL	PM003-Chemistry and Microbiology Sample Receiving and Processing: Upon receipt of the samples, the laboratory will compare the sample containers to the identifiers listed on the COC forms and will contact the BSEn Project Scientist within 24 hours to resolve any issues or discrepancies, if found. Once logged in, samples will be maintained in the designated sample refrigerator with internal custody and tracking procedures. Samples removed from this storage area will be signed out by the designated laboratory personnel, until return. Once all analyses are complete, samples will be maintained in the sample archives (not refrigerated), for a minimum of 90 days, prior to disposal.
Sample custody and storage		
Sample disposal		

QAPP Worksheet #28-1: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix: Soil

Analytical Group: Inorganics (Metals)

Analytical Method/SOP: SW-846 Method 6010C/ SOP MT009

QC Sample	Number/Frequency	Method/SOP Acceptance Criteria	CA	Title/Position of Person Responsible for CA	Project-Specific Measurement Performance Criteria (MPC)
Method Blank	1 per analytical batch	No target analytes above QL	Re-extract and re-analyze if possible, qualify data as needed	Inorganics Manager	No target analytes above QL
Instrument Blank	After initial calibration and every 12 hours	No target analytes above QL	Re-analyze affected samples. Qualify as needed	Instrument Analyst	No target analytes above QL
FD of discrete sample	10%	± 50% for soil matrix	Qualify as needed	Field Team Lead	± 50% for soil matrix
Field replicates of ISM increments from one DU	One sample and two replicates from each of the two DUs	± 35% for soil matrix	Qualify as needed	Field Team Lead	± 35% for soil matrix
LD	1 per analytical batch	± 35% for soil matrix	Qualify Data as needed.	Instrument Analyst	± 35% for soil matrix
ICS	1 per analytical batch	80-120 percent Recovery (%R)	Perform Serial Dilution	Instrument Analyst	80-120 %R
Matrix Spike /Duplicate	1 per analytical batch	75-125 %R	Qualify data as needed.	Instrument Analyst	75-125 %R The lab will spike the sample at an appropriate level so as to obtain usable recoveries. If the parent sample concentration is greater than four times the spike, the lab, IAW the options in the analytical method, will either: -Re-spike and re-digest an MS/MSD spiked at a higher concentration, or -Re-spike and re-digest an MS and digest a lab replicate.

QAPP Worksheet #28-2: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix: Soil

Analytical Group: Inorganics (Mercury)

Analytical Method/SOP: SW-846 Method 7471A/ SOP MT012

QC Sample	Number/Frequency	Method/SOP Acceptance Criteria	CA	Title/Position of Person Responsible for CA	Project-Specific MPC
Method Blank	1 per analytical batch	Results < 0.5 RL	Re-prep and re-analyze if possible, qualify data as needed	Inorganics Manager	No target analytes above QL
Instrument Blank	After initial calibration and every 10 samples	Results < 0.5 RL	Re-prep affected samples. Qualify as needed	Instrument Analyst	No target analytes above QL
FD of discrete sample	10%	± 50% for soil matrix	Qualify as needed	Field Team Lead	± 50% for soil matrix
Field replicates of ISM increments from one DU	One sample and two replicates from each of the two DUs	± 35% for soil matrix	Qualify as needed	Field Team Lead	± 35% for soil matrix
LD	1 per analytical batch	± 35% for soil matrix	Qualify Data as needed.	Instrument Analyst	± 35% for soil matrix
Matrix Spike /Duplicate	1 per analytical batch	80-120% R	No action taken on MS/MSD alone. Qualify data as needed.	Instrument Analyst	80-120% The lab will spike the sample at an appropriate level so as to obtain usable recoveries. If the parent sample concentration is greater than four times the spike, the lab, IAW the options in the analytical method, will either: -Re-spike and re-digest an MS/MSD spiked at a higher concentration, or -Re-spike and re-digest an MS and digest a lab replicate.

QAPP Worksheet #28-3: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix: Soil

Analytical Group: Organics (Explosives)

Analytical Method/SOP: SW-846 Method 8330B/ SOP SV010

QC Sample	Number/Frequency	Method/SOP Acceptance Criteria	CA	Title/Position of Person Responsible for CA	Project-Specific MPC
Method Blank	1 per analytical batch	No target analytes above QL	Re-extract and re-analyze if possible, qualify data as needed	Organics Manager	No target analytes above QL
Instrument Blank	After initial calibration and every 12 hours	No target analytes above QL	Re-analyzed affected samples. Qualify as needed	Instrument Analyst	No target analytes above QL
FD of discrete sample	10%	± 50% for soil matrix	Qualify as needed	Field Team Lead	± 50% for soil matrix
Field replicates of ISM increments from one DU	One ISM DU and two replicates from each of the two DUs	± 35% for soil matrix	Qualify as needed	Field Team Lead	± 35% for soil matrix
LD	1 per analytical batch	± 35% for soil matrix	Qualify Data as needed.	Instrument Analyst	± 35% for soil matrix
Surrogate Spikes	1 per analytical batch	Lab control limits	Qualify Data as needed.	Instrument Analyst	Lab control limits
Matrix Spike /Duplicate	1 per analytical batch	Lab control limits	No action taken on MS/MSD alone Qualify data as needed.	Instrument Analyst	Lab control limits The lab will spike the sample at an appropriate level so as to obtain usable recoveries. If the parent sample concentration is greater than four times the spike, the lab will: -Re-spike and re-extract an MS/MSD spiked at a higher concentration.

QAPP Worksheet #28-4: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix: Soil

Analytical Group: Organics (SVOCs)

Analytical Method/SOP: SW-846 Method 8270D/ SOP SV006

QC Sample	Number/Frequency	Method/SOP Acceptance Criteria	CA	Title/Position of Person Responsible for CA	Project-Specific MPC
Method Blank	1 per preparatory batch	No target analytes above ½ RL	Re-extract and re-analyze if possible, qualify data as needed	Organics Manager	No target analytes above ½ RL
LCS	1 per preparatory batch	Quality System Manual (QSM) limits or Lab control limits	Correct problem, then reprep and reanalyze the LCS and all associated samples. Qualify data as needed.	Organics Manager	QSM limits or Lab control limits
FD of discrete sample	10%	± 50% for soil matrix	Qualify as needed	Field Team Lead	± 50% for soil matrix
Field replicates of ISM increments from one DU	One sample and two replicates from each of the two DUs	± 35% for soil matrix	Qualify as needed	Field Team Lead	± 35% for soil matrix
MS/MSD	5%	RPD ≤30%	Qualify Data as needed.	Instrument Analyst	RPD ≤30%
Surrogate Spikes	Every sample	QSM limits or Lab control limits	Qualify Data as needed.	Instrument Analyst	QSM limits or Lab control limits
MS	5%	QSM limits or Lab control limits	No action taken on MS/MSD alone Qualify data as needed.	Instrument Analyst	QSM limits or Lab control limits The lab will spike the sample at an appropriate level so as to obtain usable recoveries. If the parent sample concentration is greater than four times the spike, the lab will: -Re-spike and re-extract an MS/MSD spiked at a higher concentration.

QAPP Worksheet #28-5: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(USEPA 2106-G-05 Section 2.3.5)

Matrix: Soil

Analytical Group: Inorganics (Perchlorate)

Analytical Method/SOP: SW-846 Method 6850/SOP HPLC06

QC Sample	Number/Frequency	Method/SOP Acceptance Criteria	CA	Title/Position of Person Responsible for CA	Project-Specific MPC
Method Blank	1 per prep batch	No target analytes above ½ RL	Re-extract and re-analyze if possible, qualify data as needed	Inorganics Manager	No target analytes above ½ RL
Lab Reagent Blank	Prior to calibration, after samples with overrange concentration of perchlorate, and at the end of the analytical sequence.	No target analytes above ½ RL	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank. Qualify as needed.	Instrument Analyst	No target analytes above ½ RL
LCS	1 per prep batch	More stringent of 80-120% or Lab control limits	Re-extract and re-analyze if possible, qualify data as needed	Inorganics Manager	More stringent of 80-120% or Lab control limits
FD of discrete sample	10%	± 50% for soil matrix	Qualify as needed	Field Team Lead	± 50% for soil matrix
Field replicates of ISM increments from one DU	One sample and two replicates from each of the two DUs	± 35% for soil matrix	Qualify as needed	Field Team Lead	± 35% for soil matrix
MS/MSD	5%	RPD ≤ 15%	Qualify as needed	Instrument Analyst	RPD ≤ 15%
LD	1 per prep batch	RPD ≤ 15%	Qualify Data as needed.	Instrument Analyst	RPD ≤ 15%
MS	5%	More stringent of 80-120% or Lab control limits	No action taken on MS/MSD alone. Qualify data as needed.	Instrument Analyst	More stringent of 80-120% or Lab control limits

QAPP Worksheet #29: Project Documents and Records
(UFP-QAPP Manual Section 3.5.1)
(USEPA 2106-G-05 Section 2.2.8)

Record	Generation	Verification	Storage location/archival
Sample Collection and Field Records			
Field Notes, and Logbooks	Field Team Leader, HDR	PM, BSEn	Project File
Photo-documentation files	Field Team Leader, HDR	PM, BSEn	Project File
GEO-XT GIS files	Field Team Leader, HDR	PM, BSEn	Project File
COC Forms	Field Team Leader, HDR	PM, BSEn	Project File
Airbills	Field Team Leader, HDR	PM, BSEn	Project File
Equipment Calibration Forms	Field Team Leader, HDR	PM, BSEn	Project File
Logbooks	Field Team Leader, HDR	PM, BSEn	Project File
Instrument data files	Field Team Leader, HDR	PM, BSEn	Project File
Daily Quality Control Reports	Field Team Leader, HDR	PM, BSEn	Project File
Project Assessments			
Equipment Logs	Labs	CTL QAO	Labs
Sample Prep Logs	Labs	CTL QAO	Labs
Analytical Run Logs	Labs	CTL QAO	Labs
Corrective Action Forms	Labs	CTL QAO	Labs
Extraction Records	Labs	CTL QAO	Labs
Reported Sample Results	Labs	CTL QAO	Labs
Raw Data Printouts	Labs	CTL QAO	Labs
Laboratory Records			
Analytical Data Packages	Labs	HDR Project Chemist	Project File
Validation Checklists	HDR Project Chemist	HDR QAO	Project File
Data Validation Reports	HDR Project Chemist	HDR QAO	Project File
Corrective Action Reports (CARs)	HDR Project Chemist	HDR QAO	Project File

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(USEPA 2106-G-05 Section 2.4 and 2.5.5)

Definable Features of Work to Assess:

Item	Definable Feature of Work	Inspection	Acceptance Criteria	Initials	Date
1	Mobilization and Site Preparation	Were all planning documents reviewed by site personnel?	Signature page signed by all site personnel.		
2	Mobilization and Site Preparation	Subcontractors identified and under contract.	Signed subcontracts and purchase orders (POs) in place for sample analyses and other SI Activities.		
3	Mobilization and Site Preparation	Notice to Proceed.	Authorization to proceed received from USACE.		
4	AVS	Perform AVS to locate MEC/MPPEH.	Work performed in compliance with Section 6.3.2 of the Work Plan.		
5	Perform Discrete Surface Soil Sampling	Collection of surface soil samples	Work performed in compliance with Section 6.3.2 of the Work Plan and SOP 300.		
6	Perform ISM	Collection of ISM Surface Soil Increments	Work performed in compliance with Section 6.3.2 of the Work Plan and SOP 300.		
7	Demobilization	Statement of Objectives (SOO) completed and all work performed in full.	Signed letter from USACE approving the work performed and the condition of the property. Demobilization performed IAW the Work Plan.		
8	Generate The Former Gun and Mortar Range (RFAAP-002-R-01) MMRP SI Report	Write Draft and Final MMRP SI Report documenting site activities and findings.	Work performed in compliance with the SOO.		

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (Continued)

Assessments:

Assessment Type	Responsible Party & Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable due date
Field Sampling Systems Audit	Todd Wickert, QAO, HDR	Annually for Program up to 1 per Delivery Order	TBD	Audit checklist and report of things done correctly as well as deficiencies	One week after completion of audit
Laboratory Technical Systems Audit	Christelle Newsome, QAO, CTL DoD ELAP auditor	Annually at a minimum	TBD	DoD ELAP Certification	Per the ELAP program

Assessment Response and CAR:

Assessment Type	Responsibility for responding to assessment findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for monitoring Corrective Action implementation
Field Sampling Systems Audit	TBD, HDR Field Team Leader	CAR Form	24 hours after audit is conducted	TBD, HDR Field Team Leader	Sarah Skrobialowski, PM, BSEn
Laboratory Technical Systems Audit	Christelle Newsome, CTL	Written audit report	48 hours from receipt of Memorandum and before further analyses can be conducted.	On-site Analytical Manager	HDR Project Chemist, with future data packages

QA Management Reports Table:

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Daily Quality Control Reports	Daily	Following business day	TBD, Field Lead, HDR	Phil Werner, Deputy PM, HDR
Project Status Reports	Monthly	First of the month	Phil Werner, Deputy PM, HDR	Kimberly Gross, PM, USACE, Baltimore District

QAPP Worksheet #34: Data Verification and Validation Inputs
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(USEPA 2106-G-05 Section 2.5.1)

Item	Description	Verification (completeness)	Validation (conformance to specifications)	Who will Verify or Validate
Field Records				
1	Field logbooks	X	X	HDR Field Team Leader
2	Equipment calibration records	X	X	HDR Field Team Leader
3	COC Forms	X	X	HDR Field Team Leader, PM, Project Chemist
4	Sampling diagrams/surveys	X	X	HDR Field Team Leader, PM
5	Drilling logs	X	X	HDR Field Team Leader
6	Geophysics reports	X	X	HDR Field Team Leader
7	Relevant Correspondence	X	X	HDR PM
8	Change orders/deviations	X	X	HDR PM
9	Field audit reports	X	X	HDR Field Team Leader, PM
10	Field CARs	X	X	HDR Field Team Leader, PM
Analytical Data Package				
11	Cover sheet (laboratory identifying information)	X	X	HDR Project Chemist
12	Case narrative	X	X	HDR Project Chemist
13	Internal laboratory COC	X	X	HDR Project Chemist
14	Sample receipt records	X	X	HDR Project Chemist
15	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	X	X	HDR Project Chemist
16	Communication records	X	X	HDR Project Chemist
17	Project-specific PT sample results	X	X	HDR Project Chemist
18	LOD/LOQ establishment and verification	X	X	HDR Project Chemist
19	Instrument calibration records	X	X	HDR Project Chemist
20	Definition of laboratory qualifiers	X	X	HDR Project Chemist
21	Results reporting forms	X	X	HDR Project Chemist
22	QC sample results	X	X	HDR Project Chemist
23	CARs	X	X	HDR Project Chemist
24	Raw data	X	X	HDR Project Chemist
25	Electronic data deliverable	X	X	HDR Project Chemist
26	Apply final project qualifiers per QAPP	X	X	HDR Project Chemist

QAPP Worksheet #35: Data Verification Procedures
(UFP-QAPP Manual Section 5.2.2)
(USEPA 2106-G-05 Section 2.5.1)

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
COC Forms & Shipping Airbills	QAPP and Lab SOP PM003 (Lab Sample Receipt and Processing)	COC Forms and shipping documents will be reviewed and verified for completeness and accuracy against the actual contents of the coolers represented in the shipment. Three sheet carbon COC forms will be used with the original and second copy sent with the samples, and the third copy kept by the sampling team.	Field Team Leader, HDR Sample Receipt, CTL
Field Notes	QAPP and HDR Field SOPs (HDR MMRP-300 and HDR MMRP-400)	Field notes will be reviewed for completeness and accuracy prior to being placed in the project file and scanned into electronic files.	Field Team Leader, HDR
Laboratory Data	QAPP and Lab Analytical and Prep SOPs	All data packages will be verified internally by laboratory personnel for technical accuracy and completeness prior to delivery to HDR. Upon receipt, the HDR Project Scientist will verify all data IAW standard data validation procedures.	Patrick Letterer, CTL PM, Lynn K. Lutz, HDR
Audit Reports, CARs	QAPP	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	HDR QAO

QAPP Worksheet #36: Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(USEPA 2106-G-05 Section 2.5.1)

This worksheet documents procedures that will be used to validate project data. Data validation is an analyte and sample-specific process for evaluating compliance with contract requirements, methods/SOPs, and MPC.

All data will be validated at the S2bVM level. Approximately 10 percent of the data will be validated at the S4VM level. When data issues are discovered, a higher level of validation will be applied until the validator is satisfied that data have been reported correctly.

The example provided below makes use of terminology contained in *Guidance for Labeling Externally Validated Laboratory Data for Superfund Use*, EPA 540-R-08-005, which was developed to promote the use of consistent terminology by external data reviewer to describe the scope and content of data review activities.

Data qualifiers will be applied as specified in the Functional Guidelines except for blank qualification. Sample results affected by blank concentrations will not be changed to undetected per the Functional Guidelines, but will be qualified as estimated with a possible high bias (J+).

As the data validator is the Project Chemist and as such is a member of the project team, the Chemist will apply all final qualifiers to the data, including a qualifier of “R” for rejected data.

Data Validator: Project Chemist, HDR

Analytical Group/Method:	All Methods
Data deliverable requirements:	SEDD Stage 3 plus chromatograms (pdf)
Analytical specifications:	WS 28-1, SOP VOA-02 (modified)
MPC:	WS 12
Percent of data packages to be validated:	100%
Percent of raw data reviewed:	10%
Percent of results to be recalculated:	One or two sample results per method.
Validation procedure:	Functional Guidelines for Organic and Inorganic data (August 2014)
Validation code (*see attached table):	S2bVM (100%), S3VM (10%)
Electronic validation program/version:	Not Applicable

Functional Guidelines are:

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review

OSWER 9355.0-131 EPA 540-R-13-001 August 2014

USEPA Contract Laboratory Program National Functional Guidelines for Organic Superfund Data Review

OSWER 9355.0-132 EPA-540-R-14-002 August 2014

Validation Code and Label Identifier Table

Validation Code*	Validation Label	Description/Reference
S1VE	Stage 1 Validation Electronic	EPA 540-R-08-005
S1VM	Stage 1 Validation Manual	
S1VEM	Stage 1 Validation Electronic and Manual	
S2aVE	Stage 2a Validation Electronic	
S2aVM	Stage 2a Validation Manual	
S2aVEM	Stage 2a Validation Electronic and Manual	
S2bVE	Stage 2b Validation Electronic	
S2bVM	Stage 2b Validation Manual	
S2bVEM	Stage 2b Validation Electronic and Manual	
S3VE	Stage 3 Validation Electronic	
S3VM	Stage 3 Validation Manual	
S3VEM	Stage 3 Validation Electronic and Manual	
S4VE	Stage 4 Validation Electronic	
S4VM	Stage 4 Validation Manual	
S4VEM	Stage 4 Validation Electronic and Manual	
NV	Not Validated	

The following data qualifiers will be applied during data validation by the Project Chemist. Potential impacts on project-specific DQOs will be discussed in the data validation report.

U	The analyte was analyzed for, but was not detected at a level greater than or equal to the level of the adjusted RL for sample and method.
J	The analyte was positively identified and the associated numerical value is the approximate concentration of the analyte in the sample (due either to the quality of the data generated because certain QC criteria were not met, or the concentration of the analyte was below the RL).
J+	Same as J, and the reported concentration is potentially biased high.
J-	Same as J, and the reported concentration is potentially biased low.
UJ	The analyte was not detected at a level greater than or equal to the adjusted MDL. However, the reported adjusted MDL is approximate and may be inaccurate or imprecise.
R	The sample results are unusable due to the quality of the data generated because certain criteria were not met. The analyte may or may not be present in the sample.

QAPP Worksheet #37: Data Usability Assessment
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(USEPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

All data collected from the SI field activities will be evaluated against the following data quality PARCCS parameters:

Precision – Precision refers to the degree to which repeated measurements are similar to one another, when obtained under prescribed conditions.

Laboratory precision will be assessed by evaluating results of field and laboratory duplicates to determine RPD, LCSs, and MS/MSDs. The RPD for a FD pair in a soil matrix for discrete samples may not exceed 50%. The RSD for the field sample and its two replicates collected by ISM from a DU in a soil matrix may not exceed 35%. (Refer to **Worksheets # 28-1** through **28-5**.)

Accuracy –Accuracy is defined as the measure of the closeness of an individual measurement or the average of a number of measurements to the actual or ‘true’ value. Laboratory accuracy will be assessed by evaluating LCSs and MSs and calculating the %R. The requirements for %R are shown in **Worksheets # 28-1** through **28-5**.

Representativeness – Representativeness is defined as a measure of the degree to which data accurately and precisely represents the characteristics and conditions of the sample from where the measurement was taken. Laboratory representativeness is assessed by ensuring that all analytical methods and laboratory procedures were followed consistently. In addition, method and instrument blanks are evaluated against the sample data to determine if results could be due to an outside source, such as glassware cross-contamination or instrument carryover. Field representativeness is evaluated in the same manner, through equipment blanks and review of sampling/decontamination techniques. Target analytes should not be present in any blanks. Data may be qualified accordingly if any analytes are detected in blank samples.

Completeness – Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data that was expected or planned for. Qualified data will be considered unless it has been rejected (R), in which case it is unusable. The goal for completeness is 100%, however rejected (unusable) data will be evaluated to determine whether data gaps exist, or if the project objectives were met without it.

QAPP Worksheet #37: Data Usability Assessment (Continued)

Comparability – Comparability is a measure of the confidence with which data sets may be compared to each other. Comparability is evaluated by reviewing adherence to Work Plans, SOPs, method requirements, and consistency in task execution, both in the field, and at off-site laboratories. Results from the discrete soil samples collected are not expected to be directly comparable to the ISM soil results due to the different sampling methodologies employed. Comparison of site ISM data to background discrete data will only be done using simple graphical analysis (e.g., plots grouping ISM results by study area) as a semi-quantitative method for comparing background to site distributions (ITRC, 2012). ISM sample results are not statistically comparable to a discrete sample collected from soil representing.

Sensitivity – Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest. In order to meet the project-specific DQOs, definitive data will be compared to the project's action limits or quantitation goals as listed in **Worksheets #15-1 through 15-5**.

Identify personnel (organization and position/title) responsible for participating in the data usability assessment:

Project Manager
Project QAO
Geologist/Hydrogeologist
Project Chemist
Field Task Leader

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

A Data Validation Report will be included as an Appendix to the Final SI report and will document the results of the data review, verification and validation. This report will describe the conclusions made during the data assessment regarding the data usability. Any limitations on the usability of the data will be explained, including the reasons for data qualifiers, the definitions of the qualifiers and a summary of the specific acceptance criteria that was assessed and found to be outside of control limits.

QAPP Worksheet #37: Data Usability Assessment (Continued)

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

For samples analyzed by off-site laboratories, results will be subjected to data review, verification and validation IAW the USEPA's National Functional Guidelines for Organic Data Review (USEPA, 2014) or Inorganic Data Review (USEPA, 2014). Equations used to assess acceptance criteria include:

For accuracy:

Percent Recovery for MS $\%R = \left(\frac{\text{Spike conc.} - \text{Sample conc.}}{\text{Amount of spike added}} \right) \times 100$

Percent Recovery for LCS $\%R = \left(\frac{\text{Spike conc.}}{\text{Amount of spike added}} \right) \times 100$

For precision:

RPD for MSD, and field duplicates $\%RPD = \left[\frac{|\text{Amount in sample 1} - \text{Amount in Sample 2}|}{\text{Amount in Sample 1} + \text{Amount in sample 2}} \right] \times 100$

For completeness:

$$\%Completeness = \left(\frac{\text{Number of usable measurements}}{\text{Number of planned measurements}} \right) \times 100$$

Figure C-1 Planned Coverage of the Former Gun and Mortar Range (RFAAP-002-R-01) MRS

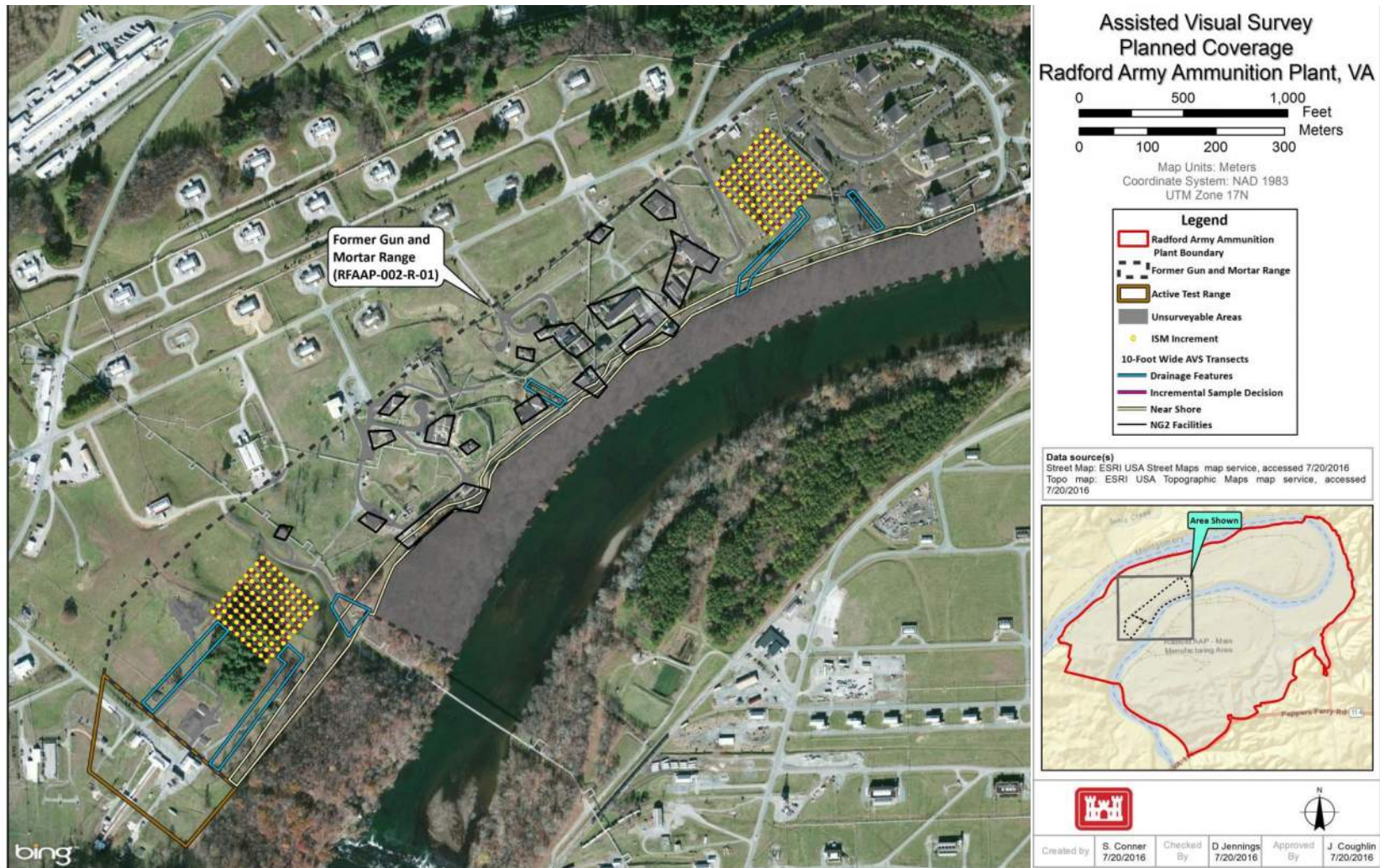
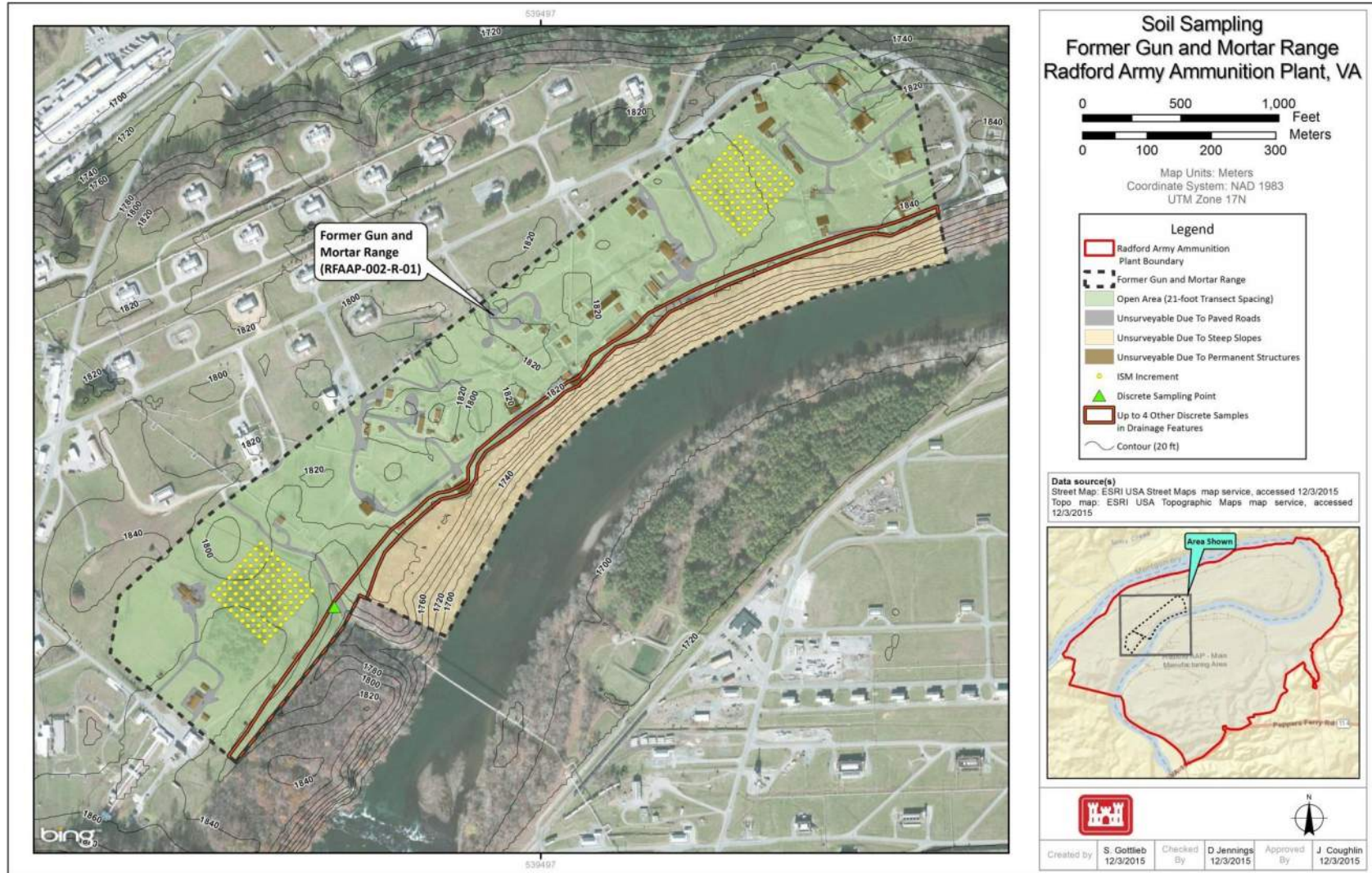


Figure C-2 Sampling Locations, Former Gun and Mortar Range (RFAAP-002-R-01) MRS



Attachment C1

Corrective and Preventive Action Request

This page intentionally left blank

HAZARD REPORTING - CORRECTIVE ACTION FORM	
EMPLOYEE REPORT OF HAZARD	
Is there an immediate threat of death or serious physical harm? Yes ☐ No ☐	
Provide information that will help locate the hazard, such as the office, project, or location and/or the supervisor's name.	
Briefly describe the hazard you believe exists and the approximate number of employees exposed to it.	
If this hazard has been called to anyone's attention, as far as you know, please provide the name of the person or committee notified and the approximate date.	
Submitted By (Optional):	Date:
MANAGEMENT EVALUATION OF REPORTED HAZARD	
Final action taken:	
All actions completed by (initials):	Date:
Tracking Number:	

CORRECTIVE ACTION HAZARD FOLLOW-UP DOCUMENTATION		
What was the hazard:		
What possible injury or illness could (or did) result from the hazard:		
Who/what was exposed to the hazard:	What was the frequency the hazard occurred:	
What was the duration of the hazard:		
What interim protection was provided:		
What corrective action was taken:	Corrective Action was taken by:	Completion Date:
Follow-up check made on: _____ Date: _____		
Was any additional action taken?:		
Signature of manager or supervisor: _____ Date: _____		
Is corrective action still in place: Yes ☐ No ☐		
Three month follow-up check made on _____ made by _____		
Tracking Number: _____		

Attachment C2

Standard Operating Procedures

This page intentionally left blank.



Anomaly Avoidance

Standard Operating Procedure

HDR-MMRP-UXO-02

Revision 1.7

Date of Issue: March 2011

Revised: May 28, 2015

Approved by:

A handwritten signature in black ink, appearing to read 'Daniel Sciarro', written over a horizontal line.

Daniel Sciarro, Health and Safety Manager

Date:

October 17, 2012

Approved by:

A handwritten signature in blue ink, appearing to read 'Rob Irons', written over a horizontal line.

Rob Irons, UXO Quality Control Specialist

Date:

October 17, 2012

Approved by:

A handwritten signature in blue ink, appearing to read 'John Coughlin', written over a horizontal line.

John Coughlin, MMRP Program Manager

Date:

May 28, 2015



This page intentionally left blank



Supervisor's Statement

I have read and understand this SOP. To the best of my knowledge, the investigation described in this SOP can be done in a safe, healthful, and environmentally sound manner. I have made sure that all persons assigned to this process are qualified, have read and understand the requirements of this SOP, and have signed the worker's statement for this purpose. I will ensure that the SOP contains current procedures. If a change to the SOP is necessary, I will ensure that the process is stopped until the SOP is revised and approved. Changes will require the submission of a Field Change Request (FCR) by the HDR project team. If unexpected safety, health, or environmental hazards are found, I will make sure that the process is stopped until the hazards have been eliminated.

Senior UXO Supervisor

Date

Worker's Statement

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
9781 S. Meridian Blvd., Ste 400
Englewood, CO 80112

Revisions:

Date	Revision Number	Author	Description
May 2010	1.0	Troy Pfertsh, Sky Research	First Release
12/9/2010	1.1	J. Gustafson	Updated for format, no content changes
3/2/2011	1.1a	Nicole Luke	Signatures obtained, minor grammatical changes.
03/17/2011	1.2	C. Petras	Grammatical edits, updated format EM 385-1-97 supersedes EP 385-1-95a
07/13/2011	1.3	C. Petras	New approval signatures added
4/16/2012	1.4	Wenona Wright	Formatting change, fix references, move content (without changing) to be in line with other SOPs
10/17/2012	1.5	DS, RI, JS	Signatures added
04/17/2013	1.6	Justin Bills	Changed Logo
5/28/2015	1.7	DJ	Logo, address, signature

Related Documents:

Document Name	Description	Document Reference

1.0 Purpose and Scope

1.1 Purpose

Anomaly avoidance procedures will be utilized during all field investigation activities that have the potential for encountering Munitions of Explosive Concern (MEC). These activities include, but are not limited to, surveying and mapping, surface and subsurface soil sampling, boring and drilling, and possibly groundwater sampling. The purpose of avoidance during field activities is to avoid contact or accidental explosion of any potential surface MEC and subsurface anomalies during survey or investigative activities. For anomaly avoidance, HDR Environmental, Operations and Construction, Inc. (HDR) will provide an Unexploded Ordnance (UXO) Technician II (or higher).

1.2 Scope

Personnel performing anomaly avoidance to MEC activities are responsible for safely executing these operations in accordance with the approved Safety Program including the Site Safety and Health Plan (SSHP), Accident Prevention Plan (APP), approved Work Plan (WP), and all applicable laws, regulations, policies and procedures. A detailed discussion of U.S. Army Corps of Engineers (USACE) organizational responsibilities for Military Munitions Response Program (MMRP) projects is presented in ER 1110-1-8153. Safety and health requirements, responsibilities, and procedures for MEC operations are defined in EM 385-1-97 and EM 385-1-1. HDR's Standard Operating Procedures (SOP) will comply with all applicable standards and regulations in accordance with all MEC activities.

2.0 Applicable Documents

2.1 Reference Documents

- USACE Engineer Regulations (ER) 1110-1-8153 Engineering and Design – Military Munitions Support Services
- USACE Engineer Manual (EM) 385-1-97 Explosives – Safety and Health Requirements Manual
- USACE EM 385-1-1 Safety – Safety and Health Requirements

3.1 Definitions

Anomaly – A feature distinguished in geophysical data which is different from the general surroundings.

Defense Sites - Locations that are or were owned by, leased to, or otherwise possessed or used by the Department of Defense. The term does not include any operational range, operating storage or manufacturing facility, or facility that is used for or was permitted for the treatment or disposal of military munitions. (10 U.S.C. 2710(e) (1)).



Discarded Military Munitions (DMM) - Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. 2710(e) (2)).

Military Munitions - Military munitions means all ammunition products and components produced for or used by the armed forces for national defense and security, including ammunition products or components under the control of the Department of Defense, the Coast Guard, the Department of Energy, and the National Guard. The term includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries, including bulk explosives and warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. The term does not include wholly inert items, improvised explosive devices, and nuclear weapons, nuclear devices, and nuclear components, other than non-nuclear components of nuclear devices that are managed under the nuclear weapons program of the Department of Energy after all required sanitization operations under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) have been completed. (10 U.S.C. 101(e) (4)).

Munitions Constituents - Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710(e) (4)).

Munitions and Explosives of Concern (MEC) - This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means:

- a) Unexploded Ordnance (UXO), as defined in 10 U.S.C. 2710(e) (9).
- b) Discarded Military Munitions (DMM), as defined in 10 U.S.C. 2710(e) (2).
- c) Munitions Constituents (MC) (e.g., TNT, RDX) present in high enough concentrations to pose an explosive hazard.

Munitions Response - Response actions, including investigation, removal and remedial actions to address the explosives safety, human health, or environmental risks presented by Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), or Munitions Constituents (MC).

Munitions Response Area (MRA) - Any area on a defense site that is known or suspected to contain UXO, DMM, or MC. Examples include former ranges and munitions burial areas. A munitions response area is comprised of one or more munitions response sites.

Munitions Response Site (MRS) - Is a discrete location within a MRA that is known to require a munitions response.

Unexploded Ordnance (UXO) - Military munitions that:

- a) Have been primed, fused, armed, or otherwise prepared for action.
- b) Have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material.
- c) Remain unexploded either by malfunction, design, or any other cause.
(10 U.S.C. 101(e) (5)).

UXO Qualified Individual - An Individual meeting the requirements for the positions of UXO Technician II, UXO Technician III, UXO Safety Officer, UXO Quality Control Specialist, or Senior UXO Supervisor. For qualification requirements, refer to EP 1110-1-18.

4.0 MEC Anomaly Avoidance

If MEC is encountered during any phase of work, the field team will immediately stop work. UXO Technicians will look for visual evidence of impact including craters, other MEC, Munition Constituents (MC), Munition Debris (MD), Discarded Military Munition (DMM), and Range Debris (RD). The UXO Technician(s) will then inform the representative outlined in the Site Specific Work Plan (WP) and Site Specific Site Safety and Health Plan (SSHP). Once the area has been marked in accordance with protocol, the UXO Technician will ensure that all field personnel are aware of the hazard and its location. A return to work, or, if warranted, an evacuation order will be given.

MEC will not be moved or handled in any way during a non-intrusive investigation or visual survey, nor will any suspect item be moved or disturbed in any way to obtain positive identification. In general, the following MEC safety protocols will be followed:

- The cardinal principle to be observed involving ordnance, explosives, ammunition, severe fire hazards, or toxic materials is to limit the exposure to a minimum number of authorized personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- When possible, any color coding that might be present and visible without handling the item will be noted. However, the color coding system cannot always be relied upon to be accurate.
- DO NOT be misled by markings on the MEC item stating “practice bomb,” “dummy,” or “inert.” Even practice bombs have explosive charges that are used to mark and/or spot the point of impact. The item could also be marked incorrectly.
- At no time will positive identification of MEC involve intrusive operations (i.e. digging, probing, or movement of any scrap, range debris, or vegetation).
- The age or condition of a MEC item does not decrease its effectiveness. MEC that has been exposed to the elements for an extended period of time becomes more sensitive to shock, movement, and friction because the stabilizing agents in the explosives may be degraded.
- Consider MEC that has been exposed to fire as extremely hazardous. Chemical and physical changes to the contents may have occurred that render it more sensitive than it was in its original state.

- DO NOT touch or move any ordnance items regardless of its markings or apparent condition.
- DO NOT visit a MEC site if an electrical storm is occurring or approaching within ten miles. If a storm approaches during a site visit or during site operations, safely leave the site immediately and seek shelter until electrical storm has subsided.
- No electronic devices shall be used within 50 feet of identified MEC items.
- DO NOT drive vehicles into a suspected MEC area until clearly marked lanes of travel have been established by the onsite UXO Safety Officer (UXOSO).
- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.
- Always assume MEC items contain a live charge until determined otherwise.

5.0 Training

MEC avoidance activities will be completed by HDR personnel and their approved subcontractors. Personnel will have UXO Technician training and experience, as well as appropriate documentation, in accordance with Department of Defense Explosives Safety Board (DDESB) Technical Paper 18 (DDESB 2008). The typical UXO team will consist of at least two personnel for anomaly avoidance, one of whom will be a qualified UXO Technician II or above. The UXO Technician must be on site during all activities where MEC is potentially present.

Additional personnel requirements, including certificates of training and medical monitoring guidelines, are listed in the Site Safety and Health Plan (SSHP) and Site Specific Work Plan.

6.0 Personnel and Responsibilities

The UXO team members have the following responsibilities for MEC avoidance procedures during field investigations in areas with potential or suspected MEC:

- Provide the ordnance expertise to identify and avoid all possible MEC-related hazards.
- Conduct an access survey and a subsurface survey for anomalies.
- Support and assist with visual surveying, geophysical surveying, and soil sampling and X-Ray Fluorescence (XRF) analysis.
- Establish and delineate surface MEC or subsurface anomaly-free ingress/egress lanes and work areas.
- Conduct MEC safety briefings for all site personnel and visitors before the start of work on a daily basis (Tail Gate Safety Brief).
- Report all potential surface and subsurface MEC encountered to the appropriate authority for proper response and disposition. The appropriate authority is designated in writing in the Work Plan.
- Work closely with the Site Safety, USACE personnel, and installation Remedial Project Manager (RPM) on all MEC-related matters.

7.0 Anomaly Avoidance Procedures for Surface and Subsurface Soil Sampling

7.1 Surface Soil Sampling

Surface soil samples are normally collected at depths from 0 to 6 inches below ground surface. The following paragraphs describe anomaly avoidance procedures for soil sampling between 0 and 6 inches below ground surface on a site with known or suspected MEC:

- The UXO team must conduct an access survey of the routes to and from the proposed investigation site as well as an area around the investigation site.
- The UXO team must visually survey the surface of each proposed surface soil sampling site for any indication of MEC or MC impact. In addition, the UXO team must conduct a survey of the proposed sampling locations using geophysical instruments capable of detecting the smallest known or anticipated military munition to a depth of 1 foot.
- If anomalies are detected at a proposed sampling location or too many anomalies are detected in a general area of interest, the sampling personnel will select an alternate location for collection of surface soil samples. Any anomalies detected will be prominently marked with survey flagging or pin flags for avoidance during sampling activities.

7.2 Subsurface Soil Sampling

Subsurface soil sampling is defined as the collection of samples below a nominal depth of approximately 6 inches. The following paragraphs describe anomaly avoidance procedures for subsurface soil sampling on a site with known or suspected MEC:

- The UXO team must conduct an access survey of the routes to and from the proposed investigation site as well as an area around the investigation site.
- The UXO team must visually survey the surface of each proposed soil sampling site for any indication of MEC or MC impact. In addition, the UXO team must conduct a survey of the proposed sampling locations using geophysical instruments capable of detecting the smallest known or anticipated military munition to the specified depth of sampling.
- Utilities will be cleared and dig permits will be obtained.
- If the sample depth is greater than the geophysical instruments detection capabilities, the UXO team must incrementally complete the geophysical survey every 12 inches until the required depth of sampling is reached. While the UXO team is completing their geophysical survey, remaining project personnel must withdraw out of the immediate area.
- If anomalies are detected at a proposed sampling location or too many anomalies are detected in the general area of interest, the sampling personnel will select an alternate location for the collection of samples.

- If an anomaly is detected during the incremental geophysical survey, the hole will be back filled in accordance with site specific procedures.
- Any anomalies will be prominently marked with survey flagging or pin flags for avoidance.

8.0 Anomaly Reporting

During field activities where MEC items or suspect MEC items are identified, the following procedures and reporting will be followed:

- Item will be marked with Orange or Red tape to aid in finding the item during the Explosive Ordnance Disposal (EOD) response. Global Positioning System (GPS) Coordinates will be collected and recorded.
- Once the item has been marked, the team will move upwind at least 200 feet and await further instruction by the HDR Field Lead and/or HDR UXO Technician.
- Once the field team is at a safe distance, the HDR Field Lead will notify the following personnel immediately: Installation Regional Project Manager (RPM), USACE PM and the HDR PM.
- Installation RPM will notify Installation EOD and others as required.
- USACE PM will notify MAJCOM and others as required.
- The HDR Field Lead and/or HDR UXO Technician may be utilized by Installation EOD to provide additional information as to the location of the item.
- HDR will return to work at the site after receiving the all clear from Installation EOD.

9.0 Quality Control (Equipment)

All equipment, regardless of source, will be inspected to ensure completeness and operational readiness. Any equipment found damaged or defective will be repaired or returned for replacement. All instruments and equipment that require routine maintenance and/or calibration will be inspected initially upon arrival, and then periodically as required in the manufacturer's equipment manual. Equipment required for daily use shall be calibrated twice daily (start and finish). This system of checks ensures that the equipment on-site is functioning properly. If an equipment check indicates that any piece of equipment is not operating correctly and field repair cannot immediately be accomplished, the equipment will be removed from service until it can be repaired. Alternately, the equipment may be replaced with a like model or an approved substitute. Replacement equipment will meet the same specifications for accuracy and precision as the equipment removed from service.



Visual Surveys

Standard Operating Procedure

HDR – Military Munitions Response
Program

Revision 4.2

May 27, 2015





This page intentionally left blank

Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
12850 E. Control Tower Road
Centennial, Colorado 80112

Approved By:

Date:

May 28, 2015

Emily Muñoz, Environmental Scientist I



John Coughlin, MMRP Program Manager

Date:

5/28/2015

Revisions:

Date	Revision Number	Author	Description
May 2010	1.0		First Release
3/2/2011	3.0	Nicole Luke	Formatting and template, signatures
10/17/2011	3.1	Wenona Wright	Formatting Changes only.
11/19/2012	3.2	ES, PD, JS	Add signatures, ES minor edits
4/2/2013	3.3	ES, NI, JS	Revised Signatures
4/16/2013	3.4	Justin Bills	Changed logs
4/18/2014	4.0	NI, WW	Content revisions and review
4/20/2014	4.1	D. Sciarro	Health and Safety Review
5/27/2015	4.2	D. Jennings	Revised Signatures, Formatted

Related Documents:

Document Name	Description	Document Reference
Anomaly Avoidance		HDR-MMRP-UXO-02

Table of Contents

1.0	Scope and Application	0
2.0	Reference Documents	0
3.0	Definitions	1
4.0	Equipment	2
5.0	Procedures	3
5.1	Planning	3
5.2	Equipment Configuration and Specifications.....	3
5.3	Data Collection	3
5.3.1	Start of Day Point.....	5
5.3.2	Munitions Item Point/Line/Area	5
5.3.3	Non-munitions Item Point/Line/Area.....	6
5.3.4	Site/Terrain Documentation Point/Line/Area	6
5.4	Field Team Composition.....	6
5.5	Data Management	7
6.0	Quality Assurance and Quality Control.....	7
7.0	Field Log Book/Forms	7
8.0	Safety.....	8
8.1	General Munitions Safety	9
8.2	On-Site Instructions – MEC Hazards	9

1.0 Scope and Application

The following procedure is intended to provide general guidance for the execution of visual surveys (VS) during site characterization activities. VS are conducted to accomplish the following project objectives:

- Confirm the presence/absence of surface munitions and evidence of past munitions use. These may include, but are not limited, to small arms (SA) debris, munitions debris (MD), material potentially presenting an explosive hazard (MPPEH) and munitions and explosives of concern (MEC).
- Identification of the size/extent of each Munitions Response Area (MRA) or Munitions Response Site (MRS) and identification of the approximate subsurface anomaly densities across each MRA/MRS.
- Document site characteristics to support recommendations for further munitions response actions or no further response actions.

The following sections provide descriptions of equipment, procedures and Quality Assurance/Quality Control (QA/QC) methods used during VS.

2.0 Reference Documents

- Code of Federal Regulations (CFR) Title 32 Part 179- Munitions Response Prioritization Protocol (MRSP) (DoD, 2009)
- Department of Defense, Definitions Related to Munitions Response Actions, (DoD, 2003)
- Department of Defense, Instruction. Material Potentially Presenting an Explosive Hazard. Number 4140.62, November 25, 2008. Incorporating change February 19th, 2014 (DoD, 2014).
- Department of Defense Title 10 – Armed Forces, Chapter 160 – Environmental Restoration, Section 2710. Inventory of unexploded ordnance, discarded military munitions, and munitions constituents at defense sites (other than operational ranges) (DoD, 2010)
- United States Environmental Protection Agency, Handbook on the Management of Munitions Response Actions Interim Final, Office of Solid Waste and Emergency Response, EPA 505-B-01-001, May 2005 (USEPA, 2005).
- Code of Federal Regulations (CFR) Title 40 Protection of the Environment, Subchapter I – Solid Wastes, Parts 260 -276 (USEPA, 2011)
- Trimble Navigation Limited, TerraSync Software Reference Manual, Version 3.00, Revision A, March 2007.
- Ricoh Company, Limited, Caplio 500SE Camera User Guide, November 2009.

3.0 Definitions

*Unless otherwise noted, the following definitions can be found in *Department of Defense, Definitions Related to Munitions Response Actions, (DoD, 2003)*.

Explosive Ordnance Disposal (EOD) - The detection, identification, field evaluation, rendering-safe recovery, and final disposal of unexploded ordnance or munitions.

Geographical Information System (GIS) - A system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data.

Geophysical Anomaly - Any identified subsurface mass that may be geologic in origin, Unexploded Ordnance (UXO), or some other man-made material. Such identification is made through geophysical investigation and reflects the response of the geophysical sensor used to conduct the investigation.

Global Navigation Satellite System (GNSS) - A standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage. A GNSS allows small electronic receivers to determine their location (longitude, latitude, and altitude) to within a few meters using time signals transmitted along a line of sight by radio from satellites.

Inert Ordnance – Munitions item with no known explosive or energetic materials present. Items may be stamped or stenciled with INERT on the side.

Material Potentially Presenting an Explosive Hazard (MPPEH) – An item, prior to determination of its explosives safety status, that may contain enough explosives or munitions to present an explosive hazard (DoD, 2014).

Military Munitions - All ammunition products and components produced for or used by the armed forces for national defense and security. The term includes confined gaseous, liquid and solid propellants, explosives, pyrotechnics, chemical and riot control agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof.

Munitions Constituents (MC) - Any materials originating from unexploded ordnance, discarded military munitions, or other military munitions; including explosive and non-explosive materials, emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. 2710 (e)(4)) (DoD, 2010).

Munitions and Explosives of Concern (MEC) - This term, distinguishes specific categories of military munitions that may pose unique explosives safety risks such as: (1) Unexploded Ordnance (UXO); (2) Discarded Military Munitions (DMM); or (3) Munitions Constituents (e.g. TNT, RDX) present in high enough concentrations to pose an explosive hazard. Formerly known as Ordnance and Explosives (OE).

Munitions Response - Actions taken, including investigation, removal actions, and remedial actions, to address the explosives safety, human health, or environmental risks presented by Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), or Munitions Constituents (MC). (32 CFR Part 179.3, Munitions Response Site Prioritization Protocol Final) (DoD, 2009).

Munitions Response Area (MRA) - An area on a defense site that is known or suspected to contain Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), or Munitions Constituents (MC). Examples include former ranges and munitions burial areas.

Munitions Response Site (MRS) - A discrete location within a MRA that is known to require a munitions response.

North American Datum of 1983 (NAD83) - NAD83 is the “legal” spatial reference system in the United States, Canada, Greenland and several Caribbean and Central American countries, excluding Mexico, which uses the International Terrestrial Reference System (ITRS) as the legal reference system.

Practice Ordnance - Ordnance manufactured to serve a training purpose. Practice ordnance generally does not carry a full payload. Practice ordnance may still contain explosive components such as spotting charges, bursters, and propulsion charges.

Projectile - An object projected by an applied force and continuing in motion by its own inertia, examples include: mortars, small arms, artillery projectiles, rockets, and guided missiles.

Range - Designated land and water areas set aside, managed, and used to research, develop, test and evaluate military munitions, explosives, other ordnance, or weapon systems; or to train military personnel in their use and handling. Ranges include firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, and buffer zones with restricted access and exclusionary areas (40 CFR 266.601) (USEPA, 2011).

Unexploded Ordnance (UXO) – Military munitions “that have been primed, fuzed, armed, or otherwise prepared for action, and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material and that remain unexploded either by malfunction, design, or any other cause.”

World Geodetic System of 1984 (WGS84) - The reference frame used by the U.S. Department of Defense (DoD) and is defined by the National Geospatial-Intelligence Agency (NGA) (formerly the National Imagery and Mapping Agency). WGS 84 is used by DoD for all its mapping, charting, surveying, and navigation needs, including its GPS “broadcast” and “precise” orbits.

4.0 Equipment

The following is a list of equipment and software that may be utilized during visual surveys;

- Trimble Geo-XT/Geo-XH sub-meter GNSS/GPS receiver and hand held computer or equivalent
- Field survey GIS data collection software such as Trimble’s Terrasync, ESRI’s ArcPad or equivalent
- Office software to create GIS data dictionary and QA/QC field data such as Trimble’s Pathfinder Office, ESRI’s ArcGIS or equivalent
- Digital camera, capable of an uncompressed pixel size of at least (1024 x 768)

- Site specific and hazard appropriate personal protective equipment (PPE)
- Hand-held magnetometer (if necessary)
- Hand-held transmitter/receiver radios (if necessary)

5.0 Procedures

5.1 Planning

Always refer to the field investigation section of the Site Specific Work Plan (SSWP) when creating a plan for VS operations in the field. Preparation is a significant step for proper execution.

Transect spacing and coverage will be determined from the results of a Comprehensive Site Evaluation Phase I, a Preliminary Assessment (PA), Site Inspection (SI) or a geophysical survey. Transects spacing and coverage will be computed by the GIS department. Transects will be provided as a standard GIS shape file and a coordinate waypoint file which will be uploaded to the hand-held GPS unit(s). A GPS data dictionary will be established prior to field operations and also uploaded to the GPS unit(s). The GPS data dictionary generates meta-data for the GPS positions logged at each item or feature of interest.

5.2 Equipment Configuration and Specifications

- The GPS/GNSS units will be capable of obtaining a positional accuracy of +/- 1.5 meters or better. The project mapping datum should be consistent throughout all field data collection activities. Datum consistency of the mapping data allows for a GIS datum transformation to be applied at a later time.
 - If the GPS/GNSS data is post-processed, care will be taken to assure positions are relative to the project survey datum.
- The GPS/GNSS receiver will be configured to “log positions between features,” which will provide an “as walked” transect versus the computed planned transects. The “as walked” transect is compared to the planned transect to verify that proper VS coverage has been obtained and the project Data Quality Objectives (DQO) have been met.
- The digital camera will be configured to take an uncompressed image with a resolution of at least (1024 x 768). The date and time stamp feature will be turned off, though time and date will be recorded digitally and may be used as an alternative to verify GPS location for data features collected.

5.3 Data Collection

The goal of VS is to cover 100% of the MRA to the extent practical depending on vegetation, land features, accessibility, etc. The field team will visual assess surface ground features and items while traversing the site. Flexibility is built into the scope of

the survey to grant the trained and experienced field personnel the authority to determine the best way to collect the most data possible in order to facilitate project objectives. The purpose of this flexibility is to avoid locking the field teams to specific areas of investigation and/or limit their ability to investigate the entire site, including areas outside the boundaries of those initially planned for VS.

VS data will not be collected in areas where the ground surface is obscured by vegetation or where foot travel is not safe or feasible. Any un-surveyable areas will be delineated and documented in the field investigation results section of the final report.

During the survey, the field team members will look for visual evidence of munitions related activity or debris. This includes SA debris, clay target debris, MD, MEC, DMM, and any supplementary evidence such as target frames, berms, structures, etc. Terrain is also documented by the field team to further characterize the site. Items and features will be documented with the GPS unit and photo documented with the GPS camera, including scale. VS data may be classified into the following feature categories;

- **Small Arms (SA) Debris**
 - o This includes any type of projectile or casing from a 0.50 caliber or smaller. This also includes shotgun pellets.
 - o Simunitions and simunition debris consist of simulated small arms ammunition used for training exercises including but not limited to polymer, plastic, paint and foam bullets.
- **Clay Target Debris**
 - o Remnants or debris from clay targets used during trap or skeet target shooting.
- **Munitions Debris (MD)**
 - o Debris from any munitions item larger than 0.50-caliber in size, with no remaining explosive hazard present.
- **Material Potentially Presenting an Explosive Hazard (MPPEH)**
 - o A munitions item that potentially contains explosives at a high enough concentration to present an explosive hazard. This feature class is utilized before a munitions item can be properly assessed, by a qualified person, and the explosive hazard accurately determined.
- **Munitions and Explosives of Concern (MEC)**
 - o A munitions item that poses an explosive threat. This includes practice munitions with intact fuzes and spotting charges.
- **Discarded Military Munitions (DMM)**
 - o A munitions item that was abandoned or not disposed of properly. This is commonly intact small arms from a storage magazine. This category does not include UXO.
- **Chemical Warfare Material (CWM)**

- o A munitions item that contains a chemical compound that is intended to kill, seriously injure, or incapacitate a person through its physiological effects. This category includes Chemical Agent Identification Set (CAIS) kits.
- **Evidence of Munitions Use**
 - o This category is used to document features that indicate MEC, MD, or SA usage such as firing in buttresses, berms, firing points, target frames, pits, etc.
- **Range Related Debris**
 - o This category is used to document debris observed at the site that may indicate past munitions use. This may include signage, crating or other non-munitions debris.
- **Other**
 - o For items of interest that do not fit the above descriptions.

Features may be collected as GPS points, lines, or areas to delineate an item or site feature to a sufficient degree. Any or all of the feature types may be used to help characterize the MRA/MRS. The documentation of features during VS may fall under the following categories with information listed;

5.3.1 Start of Day Point

- Date
- Time
- Field Crew
- Crew Comment
- EOD Technician
- EOD Technician Comment
- Geo-XT/XH Serial Number
- Camera Serial Number
- Supplemental GPS Units (i.e. Garmin)

5.3.2 Munitions Item Point/Line/Area

- Date
- Time
- Type
- Condition
- Number of items
- Comment
- Photo File Name

5.3.3 Non-munitions Item Point/Line/Area

- Date
- Time
- Type
- Condition
- Number of items
- Comment
- Photo File Name

5.3.4 Site/Terrain Documentation Point/Line/Area

- Date
- Time
- Type
- Comment

5.4 Field Team Composition

Each team shall be comprised of a minimum of two people: this includes two Field Technicians or a Field Technician and a UXO Technician II. Additional personnel may be assigned to each field team as deemed necessary based on site specific requirements.

*If conducting VS on a small arms range or any site not suspected to contain MD or MEC, then a UXO Technician escort is not required.

As required, the qualified personnel will need the following equipment;

- A Field Technician will carry a Trimble Geo-XT or Geo-XH GPS unit and a Ricoh GPS-enabled camera. Both instruments are described above, although equivalent GPS units and GPS-enabled cameras are acceptable. The Field Technician will also carry a retractable measuring tape, ruler or other scale used during photo documentation.
- A UXO Technician II will carry a Schonstedt magnetometer for anomaly avoidance. His/her expertise with regard to the identification of munitions related material will be critical to achieving the goals of the VS program on sites suspected to contain MEC and/or MD. The UXO Technician may carry a supplemental GPS to track their progress during the survey.

Prior to the start of each field day, VS transects will be uploaded to display on the Geo-XT/XH GPS unit. The GPS screen display will guide the team to each transect and help the field and UXO technicians stay on course. It will also record the path actually followed by the team for later compilation and illustration purposes. As the team traverses each area, they will collect digital photographs and GPS coordinates of

pertinent items encountered. Each item will be classified based on the recording scheme described above in **Section 5.3**.

If an area cannot be surveyed with GPS due to tree canopy, building infrastructure or any other interference source, water-based, biodegradable paint will be used to mark the ground to ensure complete coverage. If items of interest are found, items will be spatially positioned from known locations established using a GPS unit and measured offsets.

5.5 Data Management

The data collected from the field will be downloaded on a daily basis. The data will be reviewed and uploaded to the project GIS database. Extraneous data collection will be removed and field photos post processed, matching them to the appropriate GPS positions.

Daily coverage will be assessed and reported by way of softcopy maps, hardcopy maps, and/or internet mapping sites. Upon completion of a section of the data collection for a site or the completion of data collection for an entire site, data will be evaluated for completeness of coverage. Gaps in the survey coverage will be documented or recollected.

Once the survey is complete a comprehensive set of maps will be generated documenting the results; all survey data will be documented with FGDC compliant metadata and delivered to designated clients and stakeholders as stipulated in the work plan. All survey data will be stored on a secure network facility and backed up at regular intervals.

6.0 Quality Assurance and Quality Control

All VS data will undergo QA procedures and QC checks. Field review QA procedures will include supervision of the data collection teams and data verification by the field supervisor. The project GIS analyst will also review the VS data for completeness to ensure proper field procedures are being followed. QC procedures will include data deliverable review by the GIS and project manager.

In-field QC checks include:

- Control point check for GPS accuracy
 - o If no control point is accessible, verify GPS units are returning proper positional data by comparing the GPS coordinates from two or more GPS units
- Munitions items should be identified and verified by UXO Technician(s)

7.0 Field Log Book/Forms

Field notes associated with VS will be collected electronically with the GPS units. Field notes will be stored in a GIS compatible format and archived with the GIS data.

Supplemental hand notes will be recorded when features of interest cannot be adequately described by the GPS units. Supplemental notes may include graphical sketches, description of soil odor or discoloration, taped survey measurements or any other item that will describe features related to former military munitions activities. Field log books will have consecutively numbered pages and a permanent binding.

8.0 Safety

Site-specific safety concerns will be outlined in the Site Safety and Health Plan (SSHP). Terrain, weather, and wildlife are all common hazards encountered during VS, in addition to the hazards caused by the presence of munitions and UXO.

There are no direct safety concerns with respect to the equipment required to conduct a VS; however, the project specific SSHP found in the project work plan will be reviewed prior to commencing any field operations. Below are common safety requirements which should be reviewed.

8.1 Daily Field Safety

Designated field staff will provide safety briefings and maintain control over site access to and from the hazardous areas. Designated safety personnel will conduct site safety briefings at the beginning of each workday. All site personnel will attend each day's briefing and sign an attendance log. This attendance log can also serve as an emergency response head count roster to ensure there are no missing employees throughout the work shift. The safety briefings will be used as an opportunity to address any recognized site-specific safety issues that arise or that are outlined in the HASP or SSHP. Safety briefings are also used to refresh workers on specific policies and procedures applicable to HDR and the project, and to address any new hazards, operations, or hazard control methods to be used.

The Site Supervisor or designee will conduct a daily safety briefing that explains the following points outlined in the site specific HASP or SSHP:

- Scope of the days operations;
- Personnel assignments and PPE to be worn;
- Safety precautions expected for each assignment;
- Location of other teams in the area;
- Identification of survey safety equipment required;
- Review the project site specific HASP or SSHP;
- Changes in activities or daily operations.
- Changes in site conditions.
- Emergency evacuation routes.
- Emergency duties and procedures.
- Pertinent information that may affect safety within any work activities.

- Anticipated weather conditions.

8.2 General Munitions Safety

Old, damaged, and possibly deteriorated explosive-loaded ordnance requires extreme caution. Some explosives may react with metals, other explosives, air, or chemicals in the earth to produce extremely sensitive explosive compounds.

If munitions with unknown fillers or CWM are found the team will evacuate upwind, secure the item, and follow the notification protocol outlined in the project WP.

Consider ordnance that has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents, which render it more sensitive than it was in its original state.

8.3 On-Site Instructions – MEC Hazards

- DO NOT touch or move any ordnance items regardless of the marking or apparent condition.
- DO NOT visit an ordnance site if an electrical storm is occurring or approaching. If a storm approaches during a site visit leave the site immediately and seek shelter.
- DO NOT use radio or cellular phones in the vicinity of the suspected ordnance items.
- DO NOT walk across an area where the ground cannot be seen. If dead vegetation or dead animals are observed, leave the area immediately due to potential chemical agent contamination.
- DO NOT drive vehicles into suspected MEC areas where clearance has not been performed; if possible, always use clearly marked roads.
- Field vehicles will be oriented towards the exit of the working area when parked to allow for expedited departure from the area, if necessary.
- DO NOT carry matches, lighted cigarettes, lighters or other flame producing devices into a MEC site.
- DO NOT rely on color codes for positive identification of ordnance items or their contents.
- Always assume ordnance items contain a live charge until it can be determined otherwise.



Equipment and Personnel Decontamination

Standard Operating Procedure

HDR - MMRP 500

Revision 2.6

Date of Issue: March 2, 2011

Revised: May 28, 2015

Approved by:

A handwritten signature in black ink, appearing to read 'Emily Munoz'.

Emily Munoz, Environmental Scientist

Date:

5/28/2015

Approved by:

A handwritten signature in blue ink, appearing to read 'John Coughlin'.

John Coughlin, MMRP Program Manager

Date:

5/28/2015



This page intentionally left blank



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
9781 South Meridian Boulevard, Suite 400
Englewood, Colorado 80112

Revisions:

Date	Revision Number	Author	Description
12/22/2011	1.0		First Release
3/2/2011	2.0	Pamela Blanton	Edit to Section 4.2, Sampling Equipment Decontamination
4/11/2012	2.1	Wenona Wright	Formatting changes only.
10/17/2012	2.2	CW, PD, JS	Added Signature
4/2/2013	2.3	CW, NL, JS	Revised Signature Block
4/6/2013	2.4	Justin Bills	Changed Logo
5/28/2015	2.5	DJ	Signatures, logos.
5/28/2015	2.6	EM	Minor edits, signature

Related Documents:

Document Name	Description	Document Reference



This page intentionally left blank



1.0 Introduction and Types of Contamination

This document defines the SOP for decontamination of sampling equipment and personnel. This procedure is intended to be used together with the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) and the other SOPs. Applicable SOPs are in Section 2.

1.1 Site and/or Sample Cross Contamination

The overall objective of a multimedia sampling program is to obtain samples that accurately depict the chemical, physical, or biological conditions at the sampling site and to properly collect such samples in a safe manner that does not expose the field crew to any potential contaminants or introduce cross-contamination into the sample aliquot. Contaminants can be introduced to the sampling location or introduced into the medium of interest from one location to another during the sampling program (e.g. using sampling equipment that is not properly decontaminated). Trace quantities of contaminants can consequently be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of sampling equipment (e.g., all re-usable equipment that will come in direct contact with samples) and field support equipment (e.g., direct push rigs, vehicles) is required prior to and after each use to ensure that sample cross-contamination is prevented, and that on-site contaminants are not carried off-site.

2.0 Applicable Documents

2.1 Associated Documents

HDR – MMRP 100	Characterizing Metals in Soil Using XRF Spectrometry
HDR – MMRP 200	Visual Surveys
HDR – MMRP 300	Soil Sampling

3.0 Responsibilities

The Project Manager, or designee, will have the responsibility to ensure that all decontamination procedures are conducted in accordance with this SOP and other applicable project-specific documents such as Work Plans, Site Health and Safety Plans, and UFP-QAPP.

The field personnel designated for sampling activities will be responsible for understanding this SOP, and ensuring that all required equipment and materials are available to perform the required procedures.

4.0 Definitions

Contamination Reduction Zone (CRZ) - The area immediately adjacent to the EZ where personnel and equipment are decontaminated prior to entrance into the Support Zone.

Decontamination - The cleaning and removal of chemical constituents (organic and inorganic) from objects or personnel by means physical or chemical cleansing, brushing, removal etc.

Exclusion Zone (EZ) - Any area designated as containing potential contamination where work access is limited to trained, qualified, protected personnel.

Investigation Derived Waste (IDW) - Any manner of materials to be disposed that are accumulated during an investigation, including but not limited to ; used PPE, disposable sampling equipment, decon liquids, purge water, drill cuttings, and paper wastes.

Personal Protective Equipment (PPE) - Any type of protective clothing, gear, or respiratory device designed to be impervious to the specific contaminants of potential exposure, including but not limited to hard hats, gloves, steel-toe boots, coveralls, safety glasses, SCBA, etc.

Support Zone - The area outside of the EZ and the CRZ where PPE is not required.

5.0 Decontamination Procedures

5.1 Personnel Decontamination

A temporary personnel decontamination line or Contamination Reduction Zone (CRZ), will be set up outside each exclusion zone.

Most site work performed by HDR requires Modified Level D PPE. As such, typical personnel decontamination is a dry decontamination, consisting of the disposal of used PPE such as nitrile gloves and Tyvek boot covers (if used).

If real-time monitoring instruments indicate that contamination has been encountered, (i.e. action levels are exceeded requiring an upgrade from initial PPE levels) a complete personnel decontamination station will be established.

The temporary decontamination line should provide space to wash and rinse boots, gloves, and all sampling or measuring equipment prior to placing the equipment into a vehicle. A container should be available to dispose of used items such as gloves, tape, or Tyvek (if used).

The decontamination procedure for field personnel will include:

- Glove and boot wash in a Liquinox or Alconox solution;
- Glove and boot rinse in potable water;
- Duct tape removal (if used);
- Outer glove removal (if used);
- Coverall removal (if used);
- Respirator removal (if used);
- Inner glove removal.

5.2 Sampling Equipment Decontamination

Every effort will be made to minimize the generation of Investigation Derived Waste (IDW). Equipment rinse blanks will ensure that the decontamination procedure is adequate.

The following is a list of equipment that may be needed to perform decontamination:

- Brushes;
- Wash tubs;
- Buckets;
- Scrapers, flat bladed;
- Hot water – high-pressure sprayer;
- Sponges or paper towels;
- Liquinox detergent (or equivalent);
- Potable tap water;
- Laboratory-grade de-ionized water;
- Garden-type water sprayers;
- Appropriate Health and Safety equipment (i.e., nitrile gloves, safety glasses, etc.);
- Appropriate IDW containers.

Decontamination procedures on sampling equipment will be conducted in the field at the CRZ or at the sample locations, if possible.

Stainless steel sampling equipment that has been in contact with the soil sample will be scrubbed with a stiff, nylon-bristle brush to remove any residue. Potable water may be used to aid in the removal of residue.

The sampling equipment will be washed with a 1% detergent solution of potable water and Liquinox (or equivalent). The item will be scrubbed with stiff, nylon-bristle brush, as necessary. This procedure will be completed until all visible evidence of soil is removed from the item.

The equipment will be rinsed with potable water. A final rinse of de-ionized water will complete the decontamination procedure. Depending on the equipment being decontaminated, spray bottle rinses may be employed.

All decontamination materials and PPE will be ultimately disposed in a solid waste dumpster.

Field analytical equipment (e.g., XRF) will be decontaminated using specialized procedures provided by the manufacturer.

In addition, sampling equipment may be brushed clean and ground with silica sand when appropriate.

The following steps will be used to decontaminate sampling equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure as required by the Site Safety and Health Plan (SSHP);
- Gross contamination on equipment will be scraped off at the sampling or construction site;
- Equipment that cannot be damaged by water will be placed in a wash tub containing Liquinox or equivalent low-sudsing non-phosphate detergent along with potable water and scrubbed with a bristle brush or similar utensil. Equipment will be rinsed with tap water in a second wash tub followed by a de-ionized water rinse. Spray bottles also may be used to apply the potable water and de-ionized water rinses;
- Equipment that can be damaged by water will be carefully wiped clean using a sponge and detergent water and rinsed with de-ionized water. Care will be taken to prevent equipment damage.

Following decontamination, equipment will be placed in a clean area or on clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately after decontamination, the equipment will be covered or wrapped in plastic sheeting, foil, or heavy-duty trash bags to minimize potential contact with contaminants.

5.3 Direct Push Equipment

Direct push rigs and equipment will be decontaminated at a decontamination station located near the staging area. Mobile decontamination trailers may be used to decontaminate equipment at each site. The following steps will be used to decontaminate direct push equipment:

- Personnel will dress in suitable PPE to reduce personal exposure as required by the SSHP;
- Equipment showing gross contamination will be scraped with a flat-bladed scraper at the sampling site;
- Equipment that cannot be damaged by water will be washed with a hot water, high-pressure sprayer then rinsed with potable water.

Following decontamination, direct push equipment will be placed on the clean direct push rig and moved to a clean area. If the equipment is not used immediately, it should be stored in a designated clean area.

5.3.1 Equipment Leaving the Site

Vehicles used for activities in non-contaminated areas shall be cleaned on an as-needed basis, as determined by the Site Safety and Health Officer (SSHO), using soap and water on the outside and vacuuming the inside. On-site cleaning will be required for very dirty vehicles leaving the area. Construction equipment such as trucks, direct push rigs, backhoes, trailers, etc., will be pressure washed before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.



5.4 Decontamination Solutions

A decontamination solution should be capable of removing, or converting to a harmless substance, the contaminant of concern without harming the object being decontaminated. The preferred solution is a mixture of detergent and water, which is a relatively safe option compared to chemical decontaminants. A solution recommended for decontaminating consists of 1 to 1.5 tablespoons of Liquinox per gallon of warm water. Skin surfaces should be decontaminated by washing with hand soap and water. The decontamination solution must be changed when it no longer foams or when it becomes extremely dirty. Rinse water must be changed when it becomes discolored, begins to foam, or when the decontamination solution cannot be removed.

6.0 Responsible Authority

Decontamination operations at each hazardous waste site shall be supervised by the SSHO. The SSHO is responsible for ensuring that all personnel follow decontamination procedures and that all contaminated equipment is adequately decontaminated. The SSHO is also responsible for maintaining the decontamination zone and managing the wastes generated from the decontamination process.

Site activities should be conducted with the general goal of preventing the contamination of people and equipment. Using remote sampling techniques, bagging monitoring instruments, avoiding contact with obvious contamination, and employing dust suppression methods reduce the probability of becoming contaminated and, therefore, reduce the need and extent of decontamination. However, some type of decontamination will always be required on site. A sample personnel decontamination set-up guideline and a sample decontamination equipment and supplies list are included in the SSHP.

The Occupational Safety and Health Administration (OSHA) require that proper PPE must be worn when operating steam or pressure washing equipment. A rain suit, boots, hard hat, and a face shield are recommended to be worn. All personnel must be kept out of the path of steam or water spray.

6.1 Wastewater

Liquid wastewater from decontamination, well development, and purging will be containerized, labeled, and stored for later disposal. All containerized IDW identified for off-site disposal will be dispatched on an annual basis, at a minimum, either in the fall or prior to demobilization from the site, whichever is the shortest duration.

6.2 Emergency Decontamination

Hazardous waste facilities should also have in place emergency decontamination procedures, in order to prevent the loss of life or severe injury to site personnel. In the case of threat to life, decontamination should be delayed until the victim is stabilized; however, decontamination should always be performed first, when practical, if it can be done without interfering with essential lifesaving techniques or first aid, or if a worker has been contaminated with an extremely toxic or corrosive material that could cause severe injury or loss of life. During an emergency, provisions must also be made for protecting



medical personnel and disposing of contaminated clothing or equipment. HDR will immediately identify the site POC if any employee or subcontractor requires emergency decontamination.

6.3 Documentation

Sampling personnel will be responsible for documenting the decontamination of sampling and direct push equipment. The documentation will be recorded with waterproof ink in the sampler's field logbook with consecutively numbered pages. The information entered in the field logbook concerning decontamination should include the following:

- Decontamination personnel;
- Date and time;
- Decontamination observations;
- IDW handling.



General OE and UXO Safety: Munitions and Explosives of Concern (MEC)

Standard Operating Procedure

HDR-MMRP-UXO-03

Revision 1.7

Date of Issue: March 2011

Revised: May 28, 2015

Approved by:

A handwritten signature in black ink, appearing to read 'Daniel Sciarro'.

Date: October 17, 2012

Daniel Sciarro, Health and Safety Manager

Approved by:

A handwritten signature in blue ink, appearing to read 'Rob Irons'.

Date: October 17, 2012

Rob Irons, UXO Quality Control Specialist

Approved by:

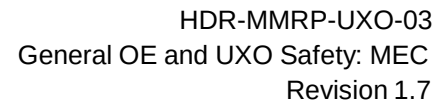
A handwritten signature in blue ink, appearing to read 'John Coughlin'.

Date: May 28, 2015

John Coughlin, MMRP Program Manager



This page intentionally left blank



Printed Name

Signature

Date

May 2015



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
9781 S. Meridian Blvd., Ste 400
Englewood, CO 80112

Revisions:

Date	Revision Number	Author	Description
4/2010	1.0	Mary Morrin, Troy Pfertsh, Sky Research	First Release
12/7/2010	1.1	Jan Gustafson,	Update style only. No text has been changed.
03/02/2011	1.1a	Jan Gustafson/Nicole Luke	Grammatical and format changes. Approval signatures added.
03/16/2011	1.2	Cathy Petras/Nicole Luke	Grammatical edits, updated format EM 385-1-97 supersedes EP 385-1-95a
10/18/2011	1.3	Wenona Wright	Formatting changes only.
02/07/2012	1.4	Rob Irons/C.Petras	Grammatical edits, update formatting
10/17/2012	1.5	DS, RI, JS	Added Signatures
04/17/2013	1.6	Justin Bills	Changed Logo
5/28/2015	1.7	DJ	Logo, signature, address

Related Documents:

Document Name	Description	Document Reference
Explosives - Safety and Health Requirements Manual	EM 385-1-97	US ACE Publication



1.0 Purpose and Scope

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to provide the minimum safety and health requirements and procedures for conducting operations on sites with Munitions of Explosive Concern (MEC) or Unexploded Ordnance (UXO) contamination. This SOP will be used in conjunction with the HDR Corporate Safety and Health Program (CSHP) Manual, and will be implemented on a project site as part of an approved Site Safety and Health Plan (SSHP) or Accident Prevention Plan (APP). Specifications and guidance relevant to the development of either a SSHP or an APP are outlined in the HDR CSHP.

1.2 Scope

This SOP applies to all HDR personnel, including contractor and subcontractor personnel conducting operations on a project site with known or suspected MEC hazards. This SOP is not a standalone document intended to contain all the requirements necessary to ensure complete regulatory compliance. Consult the documents listed in **Section 2.0** of this SOP and associated work plans for additional regulatory guidelines.

2.0 Applicable Documents

2.1 Reference Documents

- The U.S. Army Corps of Engineers (USACE), *Engineering Manual (EM) 385-1-97, Basic Safety Concepts and Considerations for Ordnance and Explosives Operations*.
- USACE, *Engineering Manual (EM) 385-1-1, Safety and Health Requirements Manual*.
- *DDESB TP 18 Minimum Qualification for Unexploded Ordnance Technicians and Personnel*. (DDESB, 2004).

3.0 Definitions

As related to this SOP and MEC/UXO operations, the definitions presented below shall apply:

MEC Procedures: Procedures which include, but are not limited to, the following actions performed by a UXO-qualified individual:



- Gaining access to (manual and mechanical excavation) and identifying subsurface anomalies and assessing the condition of buried MEC.
- Identifying and assessing the condition of surface MEC.
- Recovering and making final disposal of MEC.

MEC Related Procedures: Procedures which include, but are not limited to, the following actions which may be performed by a non-UXO-qualified individual:

- Locating and marking subsurface anomalies.
- Locating and marking suspected surface MEC.
- Utilizing Earth Moving Machinery (EMM) to excavate overburden from suspected MEC.

Ordnance and Explosives: Military munitions that consist of: (1) UXO, (2) military munitions that have been abandoned, expelled from demolition pits, or burning pads, lost, and discarded or buried, (3) soil presenting explosion hazards, and (4) buildings with explosives residues that present an explosive hazard.

Unexploded Ordnance: Military munitions that have been primed, fuzed, armed, or otherwise prepared for action and have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material and remain unexploded either by malfunction, design, or any other cause.

UXO-Qualified Personnel: Personnel meeting the requirements for the positions of UXO Technician I, UXO Technician II, UXO Technician III, UXO Safety Officer, UXO Quality Control Specialist, and Senior UXO Supervisor. Underwater MEC avoidance activities will be completed by HDR personnel or Subcontractors with specialized Underwater UXO Technician training and experience, as well as appropriate documentation, in accordance with Department of Defense Explosives Safety Board (DDESB) Technical Paper 18 (DDESB, 2004). All UXO personnel conducting Underwater Anomaly Avoidance procedures will be graduates of the U.S. Naval School Explosives Ordnance Disposal (NAVSCOLEOD), Indian Head Maryland, or NAVSCOLEOD Eglin Air Force Base, Florida.

4.0 Responsibilities

4.1 Project Manager

The Project Manager shall be responsible for ensuring the availability of HDR personnel and equipment resources needed to effectively implement this SOP. The PM will also ensure that this SOP is incorporated into site specific plans, procedures and training for sites on which MEC/UXO contamination may be encountered.

4.2 Site Supervisor

The Site Supervisor (SS) will ensure that this SOP is implemented for operations that involve personnel exposure to hazards associated with MEC/UXO. The SS will also ensure that relevant sections of this SOP are discussed in the daily safety briefings and



information related to its daily implementation is recorded in the appropriate site documentation.

4.3 Site Safety and Health Officer

The Site Safety and Health Officer (SSHO) will ensure that the safety and health hazards and control techniques associated with MEC/UXO are discussed during the initial site hazard training and the daily safety briefings. The SSHO will also be responsible for daily inspection of site operations and conditions to ensure their initial and continued compliance with this SOP and other regulatory guidelines.

5.0 Procedures

5.1 Safety Hazards and Operational Control Techniques

5.1.1 MEC/UXO Hazards

Due to the nature of their design and components, MEC/UXO presents unique hazards that may cause catastrophic effects involving personal injury or death as well as property damage. MEC/UXO hazards include: explosion, fire, burns, blast over pressure, excessive noise, and fragmentation.

5.1.2 General Precautions for MEC/UXO

If MEC/UXO is present or may be encountered during site activities, only UXO-qualified personnel shall be allowed to perform UXO operations. UXO-qualified personnel will follow the procedures and requirements of the EM 385-1-97 and other UXO safety procedures found in the Work Plan (WP) when investigating, inspecting, handling or demilitarizing MEC/UXO. UXO-qualified personnel shall also follow all other site-specific UXO and occupational safety and health SOPs presented in the site-specific WP/SSHP.

5.1.3 Requirements for Non-UXO Qualified Personnel

Due to the lack of required training non-UXO qualified personnel will be prohibited from conducting UXO operations as defined above. Non-UXO-qualified personnel who have been determined to be essential for the operations being performed may be utilized to perform MEC-related procedures when supervised by a UXO Tech III. Whenever a non-UXO qualified individual who is not essential to the operation enters the site exclusion zone as defined in the project WP, all UXO operations will be halted. Further, the safe work practices listed below shall be applicable to and followed by all non UXO qualified personnel on site:

- Non UXO qualified personnel shall receive site-specific UXO recognition training prior to participation in site activities.

- Non UXO qualified personnel shall be escorted in areas with known or potential UXO contamination at all times by an UXO-qualified Tech II or, until such time as the area is cleared of all UXO hazards.
- Once an area has been cleared, the boundaries of the cleared area will be identified through the use of flagging, and only then may non UXO qualified personnel perform duties in the area unescorted.
- At no time shall non-UXO qualified personnel leave the cleared area unescorted.
- Non UXO qualified personnel shall not touch or disturb any object that could potentially be MEC/UXO related, and shall immediately notify a UXO qualified person when discovered.

5.2 Safety and Personal Protective Equipment Requirements

The following safety measures and Personal Protective Equipment (PPE) shall be used for preventing or reducing exposure to the hazards associated with MEC/UXO operations. These requirements will be implemented unless superseded by site-specific requirements in the SSHP.

- Hard hats are required only when working around heavy equipment or when an overhead or head impact hazard exists. If a hard hat is required and personnel are involved with the hand excavation, investigation, handling, or demolition of explosives, the hard hat shall be secured to prevent it from falling and striking potential MEC.
- Composite/steel toe safety boots will be worn by any personnel working around heavy equipment (EMM) or when a toe/foot crushing hazard exists.
- Safety glasses will be required if an eye hazard exists. For example, when personnel are working around flying dirt/debris, using hand tools, etc. Safety glasses will provide protection from impact hazards, and, if necessary, Ultraviolet (UV) radiation (i.e., sunlight). Safety glasses shall be secured to prevent them from falling off if UXO personnel are involved in hand excavation of anomalies, inspection of possible MEC items, and handling of MEC or demolition operations.
- Leather work gloves will be worn during any handling of MEC/MD scrap or while performing any activity that may result in cuts, lacerations or splinters.

6.0 Audit Criteria

The following items related to operations on an MEC/UXO contaminated site will be audited to ensure compliance with this SOP:

- The Site Daily Operational and Safety Logs.
- The Documentation of Training Form for the initial site hazard training.
- Daily Safety Briefings.
- The Daily Safety Inspection Checklist.

Soil Sampling

Standard Operating Procedure

HDR – MMRP 300

Revision 2.7

Date of Issue: August 24, 2010

Revised: October 09, 2015



This page intentionally left blank

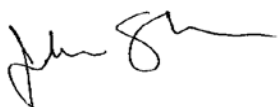


Approval Page

Approved by: 

Emily Munoz, Environmental Scientist

Date: 10/09/2015

Approved by: 

John Coughlin, MMRP Program Manager

Date: 10/09/2015

Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.

9781 S. Meridian Blvd, Suite 400

Englewood, CO 80112

Revisions

Date	Revision Number	Author	Description
08/24/2010	1.0		First Release
12/21/2010	1.1	Jan Gustafson	Format only, no content changes,
03/02/2011	1.3	Jan Gustafson/ Nicole Luke	Edited definition for TAT, update UFP-QAPP reference, obtain signatures
07/07/2011	2.0	Craig R. Walker	Minor edits / added Incremental Sampling and references.
10/17/2011	2.1	Wenona Wright	Formatting changes only.
10/17/2012	2.2	CW, PD, JS	Signed
04/02/2013	2.3	CW, NL, JS	Revised Signature block
04/16/2013	2.4	Justin Bills	Changed Logo
05/28/2015	2.5	DJ	Logo, signatures.
05/28/2015	2.6	EM	Minor edits, signature
10/09/2015	2.7	JFC	Addition of ISM protocols

Related Documents:

Document Name	Description	Document Reference

Contents

1	Purpose and Scope	1
1.1	Purpose	1
1.2	Scope	1
2	Applicable Documents	2
2.1	Associated Documents.....	2
2.2	Reference Documents.....	2
3	Definitions	3
4	Material, Equipment, and Calibration	4
5	Personnel and Responsibilities	5
5.1	Project Manager	5
5.2	Project Scientist.....	5
5.3	Field Lead.....	5
6	Field Procedures.....	6
6.1	Site Preparation.....	6
6.2	Soil Sample Types	6
6.2.1	Surface Soil Samples	6
6.2.2	Subsurface Soil Samples.....	7
6.2.3	Discrete Samples.....	7
6.2.4	Composite Samples.....	7
6.2.5	Incremental Samples	7
6.2.6	General ISM Process.....	10
6.3	Sample Collection	11
6.3.1	Sampling Surface Soils with a Trowel or Hand Scoop	11
6.3.2	Sampling Surface Soils with a Push Type Core Device	11
6.3.3	Sampling Surface Soils with a Hand Auger	12
6.3.4	Sampling Surface Soils from Power Augers etc	13
6.3.5	Sampling Subsurface Soils with a Drill Rig.....	13
6.4	Sample Preservation	15
6.5	Sample Packaging and Shipping	15
6.5.1	Sample Packaging	15
6.5.2	Sample Shipment.....	15
7	Documentation.....	16
7.1	Field Log Books and Forms	16
8	Chain-of-Custody Forms.....	17
9	Quality Assurance/Quality Control.....	18

Figures

Figure 1	Systematic-Random ISM Pattern	8

Attachment

Attachment 1	Chain-of-Custody Form

This page intentionally left blank

1 Purpose and Scope

1.1 Purpose

This Standard Operating Procedure (SOP) describes actions followed by HDR Environmental, Operations, and Construction, Inc. (HDR) for conducting soil sampling for fixed-laboratory chemical analysis. The purpose of the soil sampling is to obtain data for site-specific organic and inorganic soil concentrations generated by approved off-site analytical laboratories. Analysis of soil may determine whether concentrations of specific contaminants exceed established threshold action levels, or if the concentrations present a risk to public health, welfare, or the environment.

1.2 Scope

The soil sampling will be conducted by a trained, qualified field crew in accordance with this SOP and a site-specific Work Plan, and the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP). The SOP provides instructions for sample collection and preservation, field documentation, Chain-of-Custody (COC) preparation, and sample packaging and shipment. The methodologies discussed in this procedure are applicable to the sampling of (dry) soil. Typically this term “soil” refers to samples which are not covered with an aqueous layer for more than 30% of the time. The descriptions and procedures are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by the sampling area. However, if modifications occur, they should be documented in the site logbook or report summarizing field activities.

Soil samples may be recovered using a variety of methods and equipment, depending on the portion of the soil profile required (surface versus subsurface), and the type of sample required (disturbed versus undisturbed) and the soil type. Soil is collected directly, using a hand-held device such as hand scoop, auger or a post hole digger, or indirectly using a power activated device such as power augers, back hoes, or drill rigs.

Following collection, the soil can be mixed in a container constructed of inert material and transferred to the appropriate sample containers.

NOTE: This SOP does not provide sufficient detail to describe the essential details for collecting samples for volatile organic compounds; e.g., total petroleum hydrocarbons-gasoline, benzene, toluene, ethylbenzene, and xylenes (BTEX), etc. There are many nuances for sampling soil volatile organic compounds (VOCs), thus a separate SOP is being drafted to explain specific sampling, sub-sampling, preservation and analytical preparations.

2 Applicable Documents

2.1 Associated Documents

Attachment 1 Chain of Custody Form – Sample

2.2 Reference Documents

- United States Army Corps of Engineers (USACE) Data Item Description MR-005-10.
- USACE 2001 Engineering and Design – Requirements for the Preparation of Sampling and Analysis Plans.
- United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Update IVB (USEPA, 2008).
- USACE Interim Guidance 09-02 Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program (USACE, 2009).
- The Interstate Technology & Regulatory Council (ITRC), Incremental Sampling Methodology (ISM), (ITRC, 2012)

3 Definitions

Anomaly Avoidance - Field safety procedure in which personnel avoid potential surface Munitions of Explosive Concern (MEC) and any subsurface anomalies during field activities.

Chain-of-Custody (COC) – Documentation of sample possession from time of collection to delivery to the laboratory. The COC Form should remain with the samples at all times and a signature on the form indicates accountability for the samples. In addition to this function, the COC Form also contains information regarding the samples such as the sample identification, collection date and time, requested analyses, sample containers, etc.

Hold Time – Method specific time allowed between the collection of the sample and the start of the sample extraction or analysis.

Munitions Constituents (MC) - Any materials that originated from Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), or other military munitions. MC includes explosive and non-explosive materials and emission, degradation or breakdown products of such ordnance or munitions. (10 United States Code [U.S.C.] 2710(e)(4))

Preservation – The physical or chemical manipulation of the sample in order to stabilize for shipping and storage purposes. Physical preservation is primarily temperature adjustments, usually cooling to 4 degrees Celsius (°C). Chemical preservation consists primarily of pH adjustments which involves the addition of an acidic or basic solution to the sample. Soil samples typically are treated with physical preservation techniques only (cooling).

Sample – A sample is defined as a representative aliquot, or aliquots of a matrix (water, soil, sediment), collected at, or from a specific location at a specific time. One sample may have several aliquots and be placed in numerous sample containers, or be a subsample of a composite sample which is representative of multiple locations and/or times.

Turnaround Time (TAT) – Turnaround Time is the requested time from sample submission to the laboratory until data is reported. Unlike the Hold Time, which is method specific, the TAT is the time in which the analytical data is reported back to the client. The standard TAT for most analytical laboratories is 21 days but can be dependent on project need or specialized analyses.

4 Material, Equipment, and Calibration

Sampling materials and equipment that may be needed for soil sampling include:

- Personal Protective Equipment and safety equipment as required by the Sampling and Analysis Plan (SAP) and Site Safety and Health Plan (SSHP);
- Field Log Book or forms;
- Indelible ink pens or markers;
- Disposable trowels or scoops;
- Push core sampler (incremental sampling);
- Stainless steel trowels or spoons;
- Digital camera;
- Global Positioning System (GPS) unit;
- Shovel;
- Hand Auger;
- Polyethylene sheeting;
- Disposable nitrile gloves;
- Pin flags;
- Re-sealable plastic bags;
- Clear plastic tape;
- Paper towels;
- De-ionized water;
- Rinse bottles;
- Detergent such as Liquinox, or equivalent;
- Sample coolers;
- Sample containers;
- Sample labels;
- COC forms;
- Shipping papers (airbill);
- Packing materials such as bubble wrap;
- Strapping tape;
- Custody seals;
- Ice;
- Water (potable);
- Trash bags (heavy duty drum liners).

5 Personnel and Responsibilities

5.1 Project Manager

The Project Manager (PM) has the overall responsibility of the design, schedule implementation, and management of all activities required for the work effort. The PM monitors all personnel and provides direction to all field team members. In addition, the PM has overall responsibility for safety and all project deliverables.

5.2 Project Scientist

The Project Scientist assists the field team in mobilization efforts, COC preparation, and serves as a point of contact for the off-site laboratory. The Project Scientist supports the project team by ensuring that all sampling is conducted in accordance with this SOP, the site-specific Work Plan, and other technical standards associated with environmental sampling.

5.3 Field Lead

The Field Lead is responsible for the management and coordination of the field team during all on-site activities. With the support of the Project Scientist and the PM, the Field Lead will be responsible for adherence to this SOP, the project specific Work Plan, and the SSHP.

6 Field Procedures

6.1 Site Preparation

Prior to initiating site work, all site-specific access arrangements (e.g. Rights of Entry, base access badging, etc.) and required permits (e.g. dig permits) must be completed.

Prior to sampling activities, the field team will be briefed on all anticipated Health and Safety issues by the Site Safety and Health Officer. Workers on sites with a potential MEC hazard must be trained in anomaly avoidance procedures and briefed on anticipated MEC hazards by the escorting UXO Technician. The team will arrive on-site prepared with the items listed in **Section 4.0** of this SOP, as appropriate for the type of soil samples to be collected.

1. Determine the extent of the sampling effort, the sampling methods to be employed, and required equipment and supplies according to the sampling Quality Assurance (QA) plans for the site.
2. Obtain necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.
6. Use stakes, flags, or buoys to identify and mark all sampling locations. Specific site characteristics, including soil characteristics, depth of overlying aqueous layer, and extent and nature of contaminant should be considered when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

GPS coordinates for the sampling locations selected during the development of the Work Plan will be loaded onto the GPS unit(s) prior to sampling. Alternatively, hard copy instructions for selecting sampling locations (e.g. illustrations showing sample locations relative to visible site features, clearly written text descriptions) may be carried in the field.

The field team will be familiar with the site-specific Work Plan and details regarding sample requirements (number of samples, locations, required analyses bottle ware and preservation). A copy of the site-specific Work Plan will be available on-site during sampling.

6.2 Soil Sample Types

6.2.1 Surface Soil Samples

Surface samples are generally considered samples collected from 0 to 6 inches (in.) below ground surface (bgs). After surface vegetation has been removed, surface soils may be collected using a stainless steel trowel, spoon, or similar disposable device.

6.2.2 Subsurface Soil Samples

Samples collected at depths greater than 6 in. bgs are generally considered subsurface soil samples. Various sampling devices may be used to collect these samples: scoops or trowels, hand augers, split-spoon samplers, Direct-Push Technology (DPT), etc.

6.2.3 Discrete Samples

A grab sample is a discrete aliquot of the sample matrix (in this case, soil) from one specific location at one specific time. This type of sample is representative only of the specific location at that particular time. Discrete sampling is good for delineation and confirmation purposes.

6.2.4 Composite Samples

Composite are samples composed of more than one aliquot of the matrix, collected from different locations, depths, or times. Compositing is a technique that combines a number of discrete samples collected from a body of material into a single mixed sample for the purpose of analysis. The objective of composite soil sampling is to represent the average conditions in the sampled body of material. Subsample aliquots are mixed together prior to placement into the sample container. The concentrations of the contaminant in individual grab samples are diluted proportionally to the number of subsamples combined together. Composite samples are useful for providing an average concentration over a geographic location at a specific time.

6.2.5 Incremental Samples

Incremental Sampling Methods (ISM) produce estimates of the mean contaminant concentration in a defined volume (area and depth) of soil. The goal is to obtain a subsample that contains the contaminants of concern in the exact proportion of the area sampled. Detailed guidance and methodology for incremental sampling can be found in the ITRC, Incremental Sampling Methodology, February, 2012.

In brief, the method requires the development of a Decision Unit (DU) that is site specific and appropriate in size for the area that contamination is of concern. The depth and interval of each DU should be based on the project objectives and the Conceptual Site Model (CSM) and should never be decided in the field or without great forethought.

ISM sampling methods include random sampling within grids, simple random sampling within the entire DU, or Systematic Random Sampling. Systematic sampling patterns are generally easier to implement in the field and ensure relatively even spatial distribution. For that reason Systematic Random Sampling is the only method that is described in this SOP.

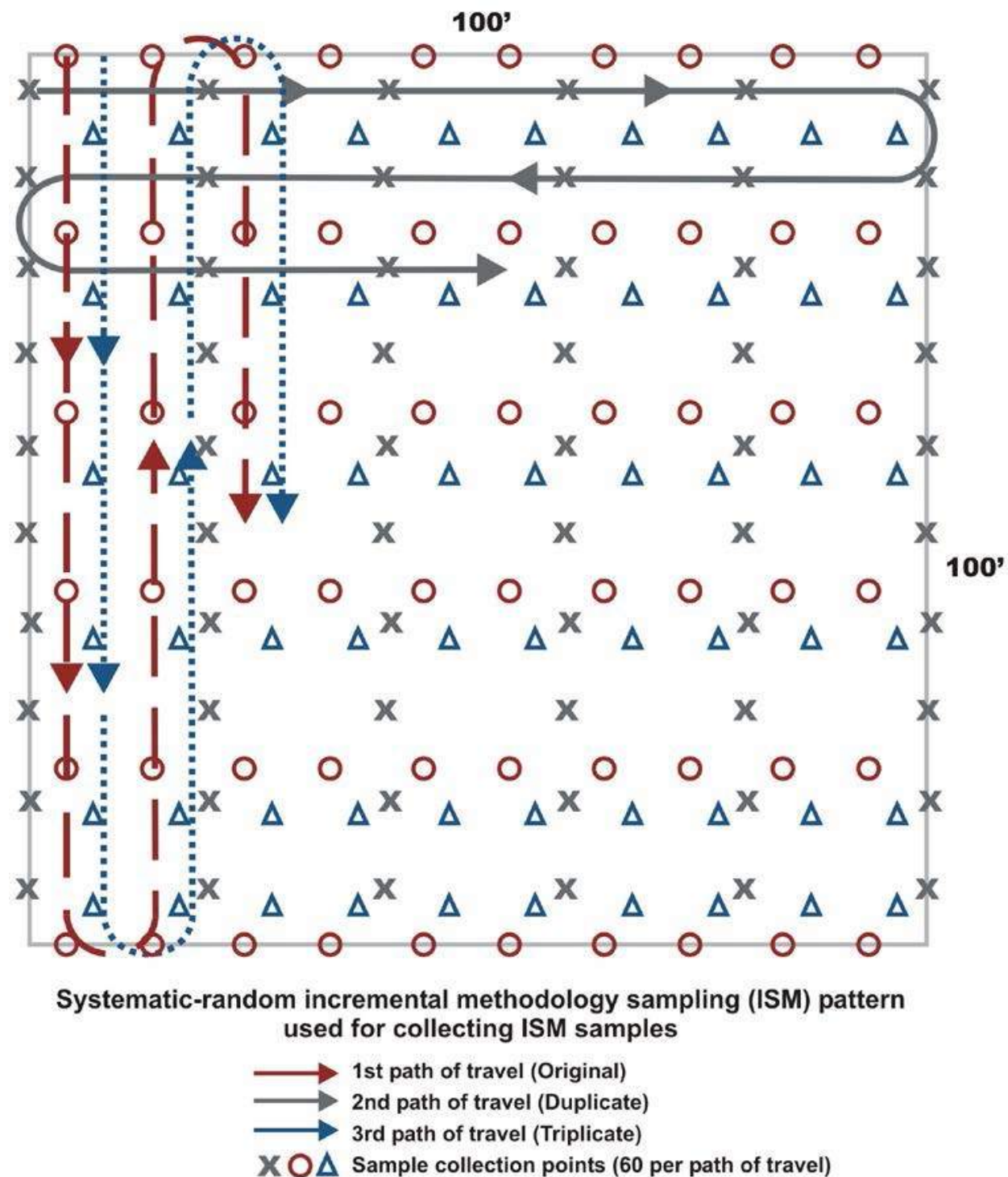
6.2.5.1 Systematic Random Sampling

Figure 1 depicts a systematic random sampling design on a square area with replicate sample locations shown. The DU is divided in a grid pattern, a random sampling location is identified within the first grid cell, and then increments are obtained from adjacent cells sequentially in a serpentine pattern using the same relative location within each cell. Replicate ISM samples are collected with the same sampling method but not the same exact locations.

The ISM sampler starts in one corner or end of the DU and collects an increment at the predetermined positions. For the systematic random sampling design, the location of the first

increment is determined randomly, and subsequent increments are collected in the same relative location within each grid, resulting in a serpentine collection pattern ending at the opposite corner or end of the DU from where sampling was started.

Figure 1 Systematic-Random ISM Pattern



The sample size and mass collected needs to be very consistent and the number of discrete increments is typically 30 to 100 samples. The samples are then mixed into one sample (1-2 kilograms [kg]) and sent to the analytical laboratory. VOC samples collected using ISMs are not mixed. The number of increments to be collected per DU, the sampling depth, and the targeted mass should all be specified in the SAP.

ISM sample processing techniques, such as milling and representative subsampling, are designed to ensure that the mass of sample analyzed by the laboratory is representative of the DU. In order to minimize potential field sampling errors, ISM sample processing will be performed in a controlled laboratory setting unless directed differently in the SAP.

6.2.5.2 ISM Tool Selection

The selection of the appropriate sampling tool for an ISM sample depends on the cohesiveness and composition of the soil. Coring tools are ideal because they increase precision of the surface area, depth, and increment volume of the DU. Coring tools limits potential bias introduced during collection of surface samples, causes minimal surface disturbance, and requires the least human effort. For non-cohesive soils scoops/trowels can be used; however, care should be taken to obtain a “core-shaped” increment over the entire depth of interest and a uniform volume (1/4 to 1/2 scoop) must be collected at each increment in the DU. Sampling devices can be used within a DU without decontamination but should be decontaminated or disposed of between DUs.

6.2.5.3 Collection of Replicate Samples

To statistically evaluate sampling precision for each DU, additional replicate ISM samples are collected. The increments are collected in the same method as the original sample (systematic random), within grid locations within the DU that are different from those used for the initial ISM sample. ISM field replicates are made of the same number of increments and collected using the same sampling pattern from within the same DU. The replicate samples are prepared and analyzed in the same manner as the initial sample. Three replicate samples (i.e., the initial ISM sample plus two additional samples) are the recommended minimum.

6.2.5.4 ISM Considerations for Subsurface Soils

If a coring device is used, samples should be collected from targeted depth intervals in a manner that ensures the best coverage of the interval. Collection of the complete core interval as an increment is the recommended subsurface ISM procedure. This method can result in large ISM samples (approximately 5-10 kg), making logistics, such as field storage, shipping, and laboratory constraints, problematic.

Usually individual cores will require subsampling to reduce the final mass of the ISM sample. The simplest approach is to split the core as single wedge of soil is taken from the entire length of the targeted depth interval. Individual wedges from 30 or more separate DU cores are then combined to form the complete subsurface ISM sample.

Replicate(s) can be collected from the same core, combined with other wedge increments, and submitted as separate ISM sample(s) to assess the precision of this subsampling strategy. Core wedge replicates evaluate only the variability in the subsampling process as opposed to collecting the entire core interval as the increment.

This approach is not appropriate when VOCs are of concern since they can be quickly lost from exposed subsurface soils.

6.2.5.5 Collection of VOC ISM samples

VOC ISM samples of exposed soils are collected and combined in similar fashion as non-VOC ISM samples with the exception that they are field-preserved in methanol as described in USEPA SW-846 Method 5035A Section 8.2.2. The ISM VOC approach involves the collection of numerous soil increments using VOC coring devices, such as Tera Core Samplers.

Subsurface soil cores may be subsampled by collecting numerous, small (e.g., 5 grams [g]) “plugs” at regularly spaced intervals along the targeted DU depth interval of the subsurface core. The plugs are collected using Tera Core like samplers. As with ISM VOC sampling of exposed soil, the plugs are immediately placed in a sampling bottle containing a predetermined volume of methanol. The spacing interval of the VOC plugs along the core interval should be determined during the systematic planning process and included in the SAP.

6.2.6 General ISM Process

The ISM process steps described in this section are general and reflect the systematic-random sampling method. The DU size and shape will depend on data quality objectives (DQOs) and the local terrain. The DU could be square, rectangular, or circular, or it may be defined by terrain features (either man-made or natural). The objective is to collect increments so that the entire area is sampled evenly and is represented in the sample. Sizes recommended for military training ranges typically range from 10 × 10 meters (m) (100 cubic meters [m³]) to 50 × 50 m (2500 m²). The total sample weight can vary from 20% below to 300% above the target weight (typically defined in the SAP).

1. Position boundary limit flags at each corner of the selected area. Along two opposite sides, place flags that define the lanes and grids.
2. Select the number and size of increments to be collected and the sampling depth. The recommended sampling depths are 2.5, 5, or 10 centimeters (cm), depending on the expected depth distribution of the analytes.
3. Set or mark the sampling tool for the appropriate depth. For greater depths and larger number of increments, use a smaller diameter sampling tool so as not to build samples that weigh much more than 1 kg.
 - a. For a depth of 2.5 cm, 2- and 3-cm-diameter coring tools (or scoop/trowel) would be appropriate for a 100- or 30-increment sample, respectively.
 - b. For a depth of 5 cm, 1.75- and 2-cm-diameter coring tools would be appropriate.
 - c. For a depth of 10 cm, 1.25- and 1.75-cm-diameter tools would be appropriate for 100- and 30-increment samples.
4. ISM sampling works best as a two-person activity: one person collects the increments and the other holds the sample container (clean polyethylene bag) and keeps track of the number of increments.
5. Using the flags to visualize the DU, start in a randomly selected corner and acquire an increment. Subsequent increments are collected in the same relative location within each grid while moving in a serpentine collection pattern ending at the opposite corner or end of the DU from where sampling was started (**Figure 1**).

6. The replicate samples should be collected starting a different randomly selected corner at a randomly selected location within the grid.
 - ISM field replicates are made of the same number of increments and collected using the same sampling pattern from within the same DU.
 - The replicate samples are prepared and analyzed in the same manner as the initial sample.
 - The same sampling tool is used for the original sample and replicates within the same DU. A pre-cleaned or new sampling tool is used to sample other DUs.

6.3 Sample Collection

Selection of a sampling device is most often contingent upon: (1) depth of soil at the sampling location, and (2) the physical characteristics of the medium to be sampled.

6.3.1 Sampling Surface Soils with a Trowel or Hand Scoop

Collection of surface soil can be accomplished with tools such as spades, shovels, and scoops. Surface soil can be removed to the required depth with a garden spade, then use a stainless steel or plastic scoop to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. A stainless steel or plastic scoop or lab spoon will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials. Plating is particularly common with garden trowels.

Follow these procedures to collect soil samples with a scoop or trowel:

1. Using a pre-cleaned stainless steel scoop or trowel remove vegetation and top layer of soil, then loosen the desired volume of soil from the sampling area.
2. Transfer the discrete grab sample into an appropriate samples container.
3. For composite sample, mix grab samples in a stainless steel or glass mixing container using the appropriate tool (stainless steel spoon, trowel, or pestle).
4. Secure the cap tightly.
5. Label and tag sample containers, and record appropriate data on soil sample data sheets (depth, location, color, and other observations).
6. Place glass sample containers in sealable plastic bags, if required, and place containers into an iced shipping container. Samples should be cooled to 4°C as soon as possible.

6.3.2 Sampling Surface Soils with a Push Type Core Device

Use the following procedure to collect soil samples with a push type core device:

1. Insert the core device into the material to be sampled slightly off of vertical. This orientation minimizes spillage of the sample from the sampler. Extraction of samples may require tilting of the sampler
2. Rotate the core device once or twice to cut a core of material.

3. Slowly withdraw the core device, making sure that the slot is facing upward.
4. Transfer the sample into an appropriate sample or mixing container

6.3.3 Sampling Surface Soils with a Hand Auger

This system uses an auger, a series of extension rods, a “T” handle, and a thin-wall tube sampler. The auger bores a hole to a desired sampling depth and then is withdrawn. The auger tip is then replaced with a tube core sampler, lowered down the borehole, and driven into the soil at the completion depth. The core is then withdrawn and the sample collected. Posthole augers have limited utility for sample collection, as they are designed more for their ability to cut through fibrous, rooted areas. Bucket augers are better for direct sample recovery, are fast, and provide a large volume of sample.

Use the following procedure to collect soil samples with a hand auger:

1. Insert the auger into the material to be sampled at a 0° to 45° angle from vertical. This orientation minimizes spillage of the sample from the sampler. Extraction of samples may require tilting of the sampler.
2. Rotate the auger once or twice to cut a core of material.
3. Slowly withdraw the auger, making sure that the slot is facing upward.
4. An acetate core may be inserted into the auger prior to sampling, if characteristics of the soils or body of water warrant. By using this technique, an intact core can be extracted.
5. Transfer the sample into an appropriate sample or mixing container

OR

Follow these procedures to collect soil samples with a hand auger:

1. Attach the auger bit to a drill extension rod, and then attach the “T” handle to the drill extension rod.
2. Clear the area to be sampled of any surface debris.
3. Begin augering, periodically removing any accumulated soil from the auger bucket.
4. After reaching the desired depth, slowly and carefully remove the auger from boring. (When sampling directly from the auger, collect sample after the auger is removed from boring and proceed to Step 10.)
5. Remove auger tip from drill rods and replace with a pre-cleaned thin-wall tube sampler. Install proper cutting tip.
6. Carefully lower tube sampler down borehole. Gradually force tube sampler into soil. Care should be taken to avoid scraping the borehole sides. Also avoid hammering of the drill rods to facilitate coring, since the vibrations may cause the boring walls to collapse.
7. Remove tube sampler and unscrew drill rods.
8. Remove cutting tip and remove core from device.
9. Discard top of core (approximately 1 in.), as this represents material collected by the tube sampler before penetration of the layer of concern.
10. Transfer sample into an appropriate sample or mixing container.

6.3.4 Sampling Surface Soils from Power Augers

Samples for volatile organic analysis must be collected by sub-sampling directly from the bucket before mixing the sample to minimize volatilization of contaminants.

6.3.5 Sampling Subsurface Soils with a Drill Rig

Follow these procedures when using a sample coring device to collect subsurface soils. It consists of a coring device, handle, and acetate core utilized in the following procedure:

1. Assemble the coring device by inserting the acetate core into the sampling tube. This sampling device works best in medium to fine-grained cohesive sediments.
2. For loose sandy materials place an “eggshell” check valve mechanism into the tip of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the coring point onto the tip of the sampling tube.
4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.
5. Place the sampler in a perpendicular position on the material to be sampled.
6. This sampler may be used with either a drive hammer for firm consolidated soils, or a “T” handle for soft soils. If the “T” handle is used, place downward pressure on the device until the desired depth is reached. Rotate the sample to shear off the core of the bottom, retrieve the device and proceed to Step 15.
7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.
8. With left hand holding the tube, drive the sampler into the material to the desired depth. Do not drive the tube further than the tip of the hammer’s guide.
9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.
10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.
11. Rotate the sampler at least two revolutions to shear off the sample at the bottom.
12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90 degrees.
13. Withdraw the sampler by pulling the handle (hammer) upwards and dislodging the hammer from the sampler.
14. Unscrew the coring point and remove the “eggshell” check valve.
15. Slide the acetate core out of the sampler tube. The acetate core may be capped at both ends. The sample may be used in this fashion, or the contents transferred to a stainless steel or plastic bucket and mixed thoroughly to obtain a sample representative of the entire sampling interval.
16. Samples for volatile organic analysis must be collected directly from the bucket before mixing the sample to minimize volatilization of contaminants.

Additional notes may include any pertinent visual observations, observed odors, weather conditions, and any field screening results.

Sample procedures will be followed as outlined in the site-specific Work Plan and UFP-QAPP. Sample aliquots for volatile organics analysis (if required) should be collected first, with minimal disturbance and without mixing. If direct fill techniques are used for the volatile organics fraction, the container should be filled leaving no headspace, and special care will be taken not to touch the soil directly with gloved hands. Specific requirements for these samples may vary depending on USEPA Region or state requirements.

Samples, except for volatile organic compounds, will be mixed in either a re-sealable bag or a clean, decontaminated stainless steel bowl in the following manner (unless otherwise specified in the site-specific Work Plan):

- Any vegetation (leaves, roots, stems, etc.), rocks, metal debris, or other foreign materials will be removed;
- If using a stainless steel bowl, the soil will be thoroughly mixed in the bowl with a spoon or trowel until a uniform appearance is achieved (soil is consistent throughout in color and particle size);
- If using a re-sealable bag, the bag will be closed and the soil shaken within bag. Using gentle pressure, the soil conglomerates will be broken up until a uniform appearance is achieved (soil is consistent throughout in color and particle size);
- Material removed from sample will be photo documented if relevant to the analysis (e.g., lead shot removed from a soil sample for metals analysis);
- Transfer soil to sample container;
- Affix sample label to container, completed with the following information:
 - o Sample ID;
 - o Date and time of collection;
 - o Sampler's initials;
 - o Preservation method;
 - o Analysis requested;
- Cover the label with wide, clear plastic tape;
- Samples shall immediately be placed in coolers with appropriate cooling agents (bagged ice, gel packs, etc.);
 - o Samples for metals analysis only may be held at ambient temperature;
- Document sample on field log and COC.

The QAPP will be followed regarding additional QA/Quality Control (QC) samples; such as field duplicates, split samples, matrix spike/matrix spike duplicate samples. Procedures for sample storage and preservation will be followed per the site-specific Work Plan.

6.4 Sample Preservation

Samples will be stabilized for transport by using proper sample containers and preservation techniques. Sample preservation procedures are outlined in current USEPA and USACE guidance and analytical method requirements. Soil samples are typically not chemically preserved but will be physically cooled to 4°C immediately after collection. Excessive exposure to direct sunlight will be avoided.

6.5 Sample Packaging and Shipping

6.5.1 Sample Packaging

Samples that will require shipment to off-site laboratories will be carefully packaged to ensure that the samples arrive at the laboratory intact and at the proper temperature. Samples suspected of being Hazardous Material will be evaluated by the environmental compliance manager and if so determined, will be shipped in accordance to the Department of Transportation (DOT) regulations.

Sample coolers will be inspected for damage prior to each use. To further ensure that no water leakage occurs during shipment, any drainage ports will be taped and a heavy duty plastic bag will be used to line the inside of the cooler. An absorbent liner and foam or bubble wrap shall be placed in the bottom of the cooler below the plastic bag. Samples collected in glass containers will be individually wrapped in bubble wrap. All samples will be placed within the plastic bag in the cooler.

Ice must be double bagged in re-sealable plastic bags to prevent any melt water from interacting with the samples or leaking out of the cooler. Ice will be placed within the cooler in sufficient quantities to maintain the samples at the required temperature of 4°C. Consider seasonal differences in outside temperatures between the site and the laboratory.

Coolers must include a laboratory supplied temperature blank, which should be measured by the laboratory upon receipt to ensure that the temperature requirements for shipping are met. If no temperature blank was provided by the laboratory, include a small High-Density Polyethylene (HDPE) container filled with tap water. Label this container as a temperature blank and include with shipment.

The completed COC form will be placed in a re-sealable bag and taped to the inside top lid of the cooler. See **Section 8.0** for details regarding the COC.

Once the cooler has been filled and the completed/signed paperwork included, the cooler will be closed and signed/dated custody seals placed on outer closures in the front and back of the cooler. Wrap strapping tape entirely around the cooler to secure the lid from opening during shipment.

6.5.2 Sample Shipment

Soil samples should be shipped via an overnight courier for next day delivery to the laboratory. The airbill tracking information from the courier should be documented on the COC. If the tracking information was not available at the time the cooler was sealed, the tracking information will be communicated to the appropriate parties (i.e. the laboratory contact, project scientist, and PM) and a copy of the tracking information will be retained on-file as part of the COC documentation. For shipments on Fridays, confirmation will be made with the laboratory that Saturday deliveries are acceptable, and "Saturday Delivery" will be indicated appropriately on the airbill.

7 Documentation

7.1 Field Log Books and Forms

A field log book and/or forms will be maintained each day that samples are collected. For soil sampling, the following information will be entered into the field log book or form:

- Project name;
- Brief description of sampling purpose (include analysis required);
- Equipment used;
- Location;
- Date and time of each sample collected;
- Sample identification;
- Sample depth(s);
- Field measurements;
- Field conditions that may cause a deviation from the site-specific Work Plan;
- Sample type/matrix;
- Personnel conducting the sampling;
- Shipping information including airbill number, laboratory, and number of coolers.

8 Chain-of-Custody Forms

The primary purpose of the COC form is to legally document possession and transfer of the samples from the time of collection to time of receipt by the laboratory. Airbills provided by the overnight courier can serve as part of the COC form for that portion of time when the courier is in possession of the samples as long as there is a place on the airbill to indicate (by signature) that the samples were relinquished to the courier. A COC form will accompany every sample shipment and ultimately is included in the analytical data package.

In addition, the COC form provides a record of the samples including information regarding:

- Collection dates/times;
- Identification numbers;
- Analyses requested;
- Types and numbers of sample containers;
- Sample matrix;
- Points of contact and phone numbers;
- Sampler's name or initials;
- TATs;
- Sample preservatives.

Any other information that is deemed important by the sampler will be added in a comment section on the COC form.

The COC form will be signed by the sampler (or person currently in possession of the samples) in the "Relinquished" section. A copy of the signed COC form will be made prior to placement in the shipping cooler, or one copy of a duplicate or triplicate COC form will be retained. The original will accompany the samples to the laboratory. Airbill information should be placed on the COC form if possible, for tracking purposes. The information on the COC and airbill will be used if any problems arise regarding sample delivery. An example of a COC form is included as **Attachment 1**.

9 Quality Assurance/Quality Control

Unless described in the QAPP, there are no specific quality assurance activities which apply to the implementation of these procedures. The following general QA/QC procedures do apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.

Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

1

Attachment 1. Chain-of-Custody Form

This page intentionally left blank

This page intentionally left blank

Intrusive Investigation: Munitions and Explosives of Concern (MEC)

Standard Operating Procedure

HDR – MMRP – UXO-01

Revision 0

May 2015



This page intentionally left blank



Supervisor's Statement

I have read and understand this Standard Operating Procedure (SOP). To the best of my knowledge, the investigation described in this SOP can be done in a safe, healthful, and environmentally sound manner. I have made sure that all persons assigned to this process are qualified, have read and understand the requirements of this SOP, and have signed the worker's statement for this purpose. I will ensure that the SOP contains current procedures. If a change to the SOP is necessary, I will ensure that the process is stopped until the SOP is revised and approved. Changes will require the submission of a Field Change Request (FCR) by the HDR project team. If unexpected safety, health, or environmental hazards are found, I will make sure that the process is stopped until the hazards have been eliminated.

Senior UXO Supervisor

Date

Worker's Statement

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.

9781 S. Meridian Blvd, Suite 400

Englewood, CO 80112

Revisions

Date	Revision Number	Author	Description
May 2015	0	Rob Irons, HDR	First Draft

Related Documents:

Document Name	Description	Document Reference
Department of Defense Explosive Safety Board Methodologies for Calculating primary Fragment Characteristics		Technical Paper (TP-16).
Department of Defense Explosive Safety Board Minimum Qualifications for Unexploded Ordnance (UXO Technicians and Personnel)		Technical Paper (TP-18)
Department of Defense Ammunition and Explosives Safety Standards		Directive 6055.09-M
Department of Defense Materiel Potentially Presenting an Explosive Hazard		DoD 4004b & DODI 4140.62
Explosives Safety and Health Requirements Manual		EM 385-1-97
USACE Ordnance and Explosives Response		EP-1110-1-18
Military Munitions Response Actions		EM 1110-1-4009



Contents

1	Purpose and Scope	1
2	Applicability.....	1
3	Responsibilities	1
3.1	Project Manager	1
3.2	Senior Unexploded Ordnance Supervisor.....	2
3.3	Unexploded Ordnance Safety Officer	2
3.4	Unexploded Ordnance Quality Control Specialist.....	2
3.5	Unexploded Ordnance Team Leader	2
3.6	Unexploded Technician II.....	2
3.7	Unexploded Ordnance Technician I	3
3.8	Unexploded Ordnance Sweep Personnel	3
3.9	Composition of UXO Teams	3
4	Minimum Requirements	3
4.1	Personnel Qualifications.....	3
4.2	Training Requirements	3
4.3	Training Curriculum	4
5	Exclusion Zone Establishment	4
5.1	Visitors.....	5
5.2	Daily Briefings	5
6	Equipment/Material Requirements.....	6
7	Field Procedures	6
7.1	Anomaly Reacquisition.....	7
7.2	Intrusive Investigation of Anomalies.....	8
7.3	General Requirements for Intrusive Investigation	8
7.4	Intrusive Investigation Procedures	9
7.5	Mag and Dig Operations	10
7.6	MPPEH Inspection Procedure	11
7.7	Anomaly Characterization	11
7.8	Munitions with Unknown Fillers.....	12
7.9	Anomalies Other Than MPPEH	12
7.10	Site Restoration.....	13
8	References	13

Attachments

Attachment 1 – Daily Site Report

Attachment 2 – Daily Quality Control Report

Attachment 3 – UXO Daily Report Form

Attachment 4 – Daily Safety Report

Attachment 5 – Nonconformance Report

Attachment 6 – Abbreviations and Acronyms

1 Purpose and Scope

The purpose and scope of this document is to define the standard operating procedures (SOP) for performing intrusive operations. These procedures give descriptions of briefings, equipment, field procedures, safety precautions, and Quality Control (QC) measures to be implemented for intrusive investigation and clearance of Munitions and Explosives of Concern (MEC) or suspected MEC items. Specific locations and frequency of operations are presented in the project-specific Work Plan for the site.

This SOP is applicable to situations involving MEC encountered at HDR Environmental, Operations and Construction, Inc. (HDR) project sites where the Project Management Team has determined that MEC may pose an immediate or substantial threat to public safety. In addition, this SOP shall be utilized when conducting Unexploded Ordnance (UXO) training for HDR and subcontractor personnel involved in intrusive operations during the preparatory, initial, and follow-up QC inspections. In all cases, when conducting intrusive investigations and/or training, this SOP will be used in conjunction with the approved site specific Work Plan (WP), Explosives Safety Submission (ESS) or Explosive Site Plan (ESP).

2 Applicability

This SOP is applicable to all employees and subcontractors who are involved in the intrusive investigation, clearance, and QC of anomalies on suspected or known MEC/UXO sites. All personnel involved in the intrusive investigation of anomalies will meet the minimum standards as described in "Department of Defense Explosive Safety Board (DDESB) Technical Paper (TP-18).

Personnel who are involved in the QC and or Geophysics process will be deemed as mission essential personnel and will have undergone thorough training in UXO recognition and avoidance. These essential personnel will be under the direct supervision of an Unexploded Ordnance Technician III (UXO Tech III) at all times. [Ref: EM 385-1-97].

3 Responsibilities

The following personnel have responsibilities in the intrusive investigation, clearance, and QC of anomalies on suspected or known MEC/UXO sites.

3.1 Project Manager

The Project Manager (PM) shall be responsible for ensuring the availability of HDR personnel and equipment resources needed to effectively implement this SOP. The PM will also ensure that this SOP is incorporated into site specific plans, procedures and training for sites on which MEC/UXO contamination may be encountered.

3.2 Senior Unexploded Ordnance Supervisor

The Senior UXO Supervisor (SUXOS) has overall responsibility for implementation, training, and supervision of personnel who will operate under this SOP and on sites where clearance operations include the removal of Munitions Debris (MD), Material Potentially Presenting an Explosive Hazard (MPPEH), Munitions Deemed as Safe (MDAS), Munitions Deemed as Hazardous (MDAH), MEC, Discarded Military Munitions (DMM) and Range Residue and Debris (RRD), or operations which are based in areas in which MEC\UXO may be suspected. The SUXOS will maintain all information related to the daily implementation of this SOP in the Site Operational Log.

3.3 Unexploded Ordnance Safety Officer

The UXO Safety Officer (UXOSO) is responsible for ensuring removal of MD, MDAS and RRD is done with due care and attention to the hazards involved in the operation. The hazards associated with UXO operations pertaining to intrusive operations and removal of MEC, MPPEH, MDAH, MD, and RRD to include the inspection process will be detailed within each project specific Site Safety and Health Plan (SSHP).

3.4 Unexploded Ordnance Quality Control Specialist

The UXO Quality Control Specialist (UXOQCS) is responsible for the field implementation of this SOP. In addition, it is the responsibility of the UXOQCS to make this SOP understood throughout the entire project site, and ensure a high level of workmanship is demonstrated in order to meet the goals and expectations that have been agreed upon by HDR and its customer as well as the various stakeholders as detailed in the approved Work Plan and/or Scope of Work (SOW). The UXOQCS will also ensure that relevant sections of this SOP are discussed in the tailgate safety briefings and that information related to its daily implementation is documented in the Site Operational Log. The UXOQCS is responsible for ensuring all data and deliverables are accurate prior to submission to intended recipients. UXOQCS will also evaluate, prepare, and recommend actions through Non Conformance Reports (NCR), After Action Reviews (AAR), and Daily Quality Control Reports (DQCR).

3.5 Unexploded Ordnance Team Leader

The UXO Team Leader (UXO Tech III) is responsible for implementing this SOP in the field at the team level and ensuring that all team personnel under their supervision comply with all written standards outlined within the project documents. Also, this team member will be responsible for the safety, efficiency, and performance of their assigned team, and reports directly to the SUXOS.

3.6 Unexploded Technician II

UXO Technician II personnel report directly to their assigned UXO Team leader and are responsible for the safe and efficient performance of specified field tasks. They are held responsible for the complete familiarity with the approved WP, SSHP, and this SOP.

3.7 Unexploded Ordnance Technician I

UXO Technician I personnel report directly to their assigned UXO Team leader and UXO Tech II and are responsible for the safe and efficient performance of specified field tasks. They are held responsible for the complete familiarity with the approved WP, SSHP, and this SOP.

3.8 Unexploded Ordnance Sweep Personnel

UXO Sweep personnel assist UXO Technicians in the performance of surface clearance operations. Sweep personnel do not have to be UXO technicians, However they shall be provided with site specific training which will include at least the following:

- Explosive Safety.
- Proper use of Personal Protective Equipment (PPE).
- MEC Recognition.

At no time will UXO sweep personnel be involved with explosive operations (Demo), nor shall they have intentional physical contact with MEC. Under the direction of UXO qualified personnel, sweep personnel may assist in the visual or detector aided MEC search activities. Sweep personnel can remove non-hazardous munitions debris and range debris only after such items have been inspected by qualified UXO technicians and determined safe for handling. During explosive operations UXO sweep personnel may provide site/area security functions.

3.9 Composition of UXO Teams

Each UXO Team will consist of one UXO Technician III and six or less team members in accordance with (IAW) EM 385-1-97.

Teams will have a minimum of two UXO qualified personnel, one of which will be the UXO Team Leader (Tech III). Teams performing as an intrusive or Investigation team shall be staffed entirely with UXO trained personnel (IAW DDESB TP-18).

4 Minimum Requirements

4.1 Personnel Qualifications

Project personnel will be able to perform their assigned jobs in accordance with DDESB TP -18.

4.2 Training Requirements

Project-specific training is required by all personnel involved in daily field work. Training topics covered will be recorded on attendance rosters and kept onsite within personnel folders. The site-specific training will include a step-by-step review of all SOPs to ensure that all field personnel clearly understand the procedures for operation of equipment, reacquisition of targets, intrusive investigation, and data recording.

4.3 Training Curriculum

Topics covered will include but are not limited to:

1. Project summary.
2. SSHP review.
3. Work plan review.
4. SOP review.
5. Documentation training.
 - a. Log books.
 - b. Field forms.
 - c. Photographs.
6. Equipment training.
 - a. Metal detector training.
 - b. Navigation/positioning equipment training (as needed).
 - c. Backhoe/excavator training (if required).
7. Safety.
 - a. Notification procedures.
 - b. Site-specific and general ordnance briefing.
 - c. Review of emergency response equipment.
 - d. Talk/walk-through of emergency procedures.
 - e. Emergency drill.
 - f. Daily health and safety briefing (including tail-gate briefings).
 - g. Weekly site-specific munitions training.

5 Exclusion Zone Establishment

An Exclusion Zone (EZ) is defined as the area where explosive hazards or contamination is either known or likely to be present, or where activity with the potential to cause harm to personnel is occurring.

EZs will be established and marked with clearly identifiable markers, such as traffic cones or delineators, easels, etc. The signs will be placed at the entrance to the work site or trail heads leading to the work site.

The size of the EZ (minimum separation distance [MSD]) will be based upon the Munition with the Greatest Fragmentation Distance (MGFD) identified for each work site and the hazardous fragment distance (HFD) for intentionally or unintentionally detonations.

During the course of an investigation, if a MEC item with a greater fragmentation distance is encountered, the MSD will be adjusted in accordance with DDESB TP 16, Methodologies for

Calculating Primary Fragment Characteristics (DDESB, 2010); operations will continue, and an amendment to the Explosive Site Plan or Explosive Safety Submission will be submitted for approval (a copy of this document will be available on site). Q-D arcs will be adjusted accordingly.

5.1 Visitors

Under certain conditions and on a case-by-case basis, authorized visitors may be granted access to the EZ when operations are being conducted – provided that the following requirements are fulfilled:

- Access is limited to essential personnel and authorized personnel.
- The UXOSO will complete an operational risk assessment at the beginning of the project, which will determine the maximum number of personnel (essential personnel and visitors) that can be in the EZ at one time.
- Persons requesting access to the EZ must demonstrate a legitimate need for access and obtain authorization from the PM, SUXOS and the UXOSO. Individuals requesting site access must submit this request and wait for approval prior to arriving at the site.
- Prior to entry, visitors must receive a site-specific briefing describing the specific hazards and safety procedures to follow. Individuals receiving the briefing will be required to sign a site-specific visitors log and safety briefing.
- Authorized visitors will be escorted by UXO-qualified personnel at all times while in the EZ.
- **Any authorized visitor who violates established safety procedures will be immediately escorted out of the EZ for the visitor's own protection and to protect essential personnel in the EZ.**

5.2 Daily Briefings

At the beginning of each workday, the SUXOS and UXOSO will hold a daily briefing IAW the requirements of the WP, ESS, and SSHP. At a minimum, this briefing will include the following:

- Work assignments.
- Review of emergency procedures.
- Review of ordnance safety.
- Review of communications procedures and equipment.
- Review of any site-specific hazards and the measures that will be used to mitigate those hazards.
- Procedures for coordination of other site personnel which are not part of the contract or project team.
- Prior to conducting intrusive operations, the SUXOS or the UXOSO will make necessary notifications (e.g. Medical, Fire, Police, and the Community).
- Other issues will be discussed during the briefing as necessary to support safe and efficient operations.

Daily Safety and Operations briefings will be documented on the Daily Safety Log along with all signatures of personnel present for that day's work. The daily logs will be maintained by the UXOSO

and kept in the field office until project completion. Upon completion, the log will be kept in the corporate office in Centennial, Colorado.

During the daily briefing, the SUXOS will also assign work sites to each of the UXO teams for intrusive operations. Each team will receive documentation containing necessary information for assigned work.

The UXO team leader will receive documentation from the geophysical department and ensure that all necessary information is filled out before leaving to the field. Team leaders will also fill out the Activities Checklist (**Attachment 1**). The top portion of this checklist verifies that the UXO Team Leader has received the necessary information to support the daily activities, including information pertinent to the present work area, daily briefing, and safety information. Also prior to leaving to the field, team leaders will conduct a communication check with the UXOSO.

After arriving at the worksite, UXO Team leaders will conduct a tailgate safety meeting at the work location. They will brief their team on potential hazards in the area where they will be working, and document the briefing on the Daily Activities Checklist. Work assignments, equipment inspections, and other routine daily activities may be documented on the Daily Activities Checklist as well.

6 Equipment/Material Requirements

The UXO Team Leaders, supported by the UXOQCS, will ensure that all team equipment/instruments used by UXO personnel are in proper working order and that the functionality of hand-held magnetometers and navigation/positioning equipment (if applicable) is verified and documented on a daily basis.

Functionality test will be accomplished by passing the instrument detection heads over selected metal items on the ground surface or buried in an instrument test area (approved Geophysical Prove-out (GPO)).

Positioning equipment will be function tested in accordance with procedures outlined with in HDR – MMRP 004 Global Positioning System (GPS) Surveys.

All detection equipment/instruments will be checked and properly functioning prior to their deployment to the field and use by field teams. Team Leaders will ensure that equipment is tested and in proper working order prior to departing to the work area. Team leaders will annotate the function test in the Team Leader log book and the daily equipment log.

Instruments which do not pass the equipment check, or the GPO will not be taken to field, instead these items will be turned into the UXOQCS along with an equipment fault record. This record will briefly state the malfunction of the equipment.

The Team Leaders will also ensure that team members complete the required site-specific equipment and vehicle inspections.

7 Field Procedures

Under these procedures the mobilization and set up for the geophysical reacquisition and mapping will follow the same steps as Section 7.

7.1 Anomaly Reacquisition

Reacquisition is the process whereby the location of each anomaly identified in the geophysical data is physically marked in the field, by a paint spot and a non-metallic pin flag carrying the unique anomaly identification number. That location is later investigated by a UXO dig team. It is understood that the dig team, assisted by an analog metal detector, will remove all the metallic items found within a 3-foot radius centered on the paint spot.

Initial anomaly reacquisition will be carried out by a team consisting of a HDR geophysical field technician and a UXO Tech II. The HDR technician will be equipped with a Trimble RTK GPS unit, pre-loaded with a list of anomalies while the UXO Tech II will carry an analog metal detector. Their procedure is as follows:

- The anomaly list for a given grid is loaded on the GPS rover unit. Each anomaly is assigned a unique identification number.
- The team, using the GPS, navigates to the exact anomaly coordinates and marks that point on the ground with biodegradable paint.
- The UXO technician, using his analog metal detector, ensures that a location approximately 1-foot north of the paint spot is clear of metal and places a pin flag, bearing the anomaly ID, in the ground. If that location is unsuitable (anomalous), the flag is planted at the closest “clean” location. If that pin flag location turns out to be several feet away from the original paint spot, a line is spray painted from the pin flag to the paint spot.
- If an anomaly is not satisfactorily resolved during the excavation process (such as a “No Hit”, “Flag Not Found”, “Hot Rock” or “Geology” report from the dig team), a more detailed reacquisition process is initiated:
- The instrument operator, using the GPS, navigates to the approximate anomaly coordinates.
- Using a man-portable EM61 the operator then investigates the area within 3 feet of the identified anomaly location, monitoring the EM61 response. The same channel is used during the reacquisition process as was used for anomaly selection. In order to minimize any instrument drift effects, the EM61 will be “nulled” several times throughout the day. It is always nulled following a battery change or anytime the instrument is turned off and on.
- If a response is located, the team marks the anomaly location using spray paint and a flag, as described above. If multiple hits are located within a 3’ radius circle around the anomaly coordinates, the anomaly is deemed to be located at those coordinates. The dig teams are under instruction to clear all of the anomalies located within a 3’ radius of that point.
- If, when using the EM61, the peak anomaly value is found to be greater than 3 feet away from the original anomaly coordinates, that location is recorded by the GPS and the paint spot/flag emplacement procedure described above is followed at the new coordinate location.
- If an anomalous EM61 response cannot be found in the vicinity of the specified anomaly coordinates, a “No Hit” (false positive) comment is recorded and a flag is not planted.

For reference on reacquisition procedures refer to HDR – MMRP 005 Anomaly Reacquisition.

7.2 Intrusive Investigation of Anomalies

Clearance operations will be performed within a 3-foot diameter of identified target anomalies from the surface to depth based on the SOW, or to a reasonable depth based on site constraints (bedrock, water in the excavation area, etc.). Intrusive work includes a number of tasks/activities listed below. The following sections describe procedures and requirements for intrusive investigation:

- Site mobilization.
- Daily safety/SUXOS briefing.
- Vehicle load out/equipment check.
- Communications check.
- Tailgate safety briefing.
- EZ establishment.
- Anomaly acquisition and excavation.
- MEC disposition.
- MPPEH handling, transportation, and storage.
- Non-munitions debris storage.
- Data collection and recording.
- Demobilization.

7.3 General Requirements for Intrusive Investigation

Each intrusive investigation team will be composed of at least one UXO Tech III who will serve as the UXO Team Leader, and up to a six person UXO team who will be comprised of UXO Tech II(s) and UXO Tech I(s), depending on contractual obligations.

A QC representative may also be included on the team, deemed as essential personnel. This person will serve as a Geophysical QC representative and will be included as part of a seven person UXO Team.

Intrusive investigation activities will not be conducted until the required training (both general and site-specific) and proper equipment/vehicle checks have been completed. Records of training will be annotated on training attendance forms and maintained in the field office.

Equipment checks will be recorded on the Daily Equipment Check List and turned in weekly to the UXOQCS/SUXOS or their representative.

MEC Daily Activities log and Team leader daily Grid/Operations sheet will be turned in to the SUXOS daily and maintained in the field office by the UXOQCS.

Vehicle checks will be recorded on a Vehicle/Heavy Equipment Inspection Checklist by vehicle operators and maintained in the field office by the UXOSO.

Intrusive investigation operations will not be initiated until an appropriate EZ is established based upon the MGFD in accordance with the approved ESS.

The UXO Team Leader is responsible for the safety of all persons assigned to his team. The team leader will also act as the safety observer during intrusive operations to observe the work conducted by their assigned dig teams.

The team will have a vehicle equipped with first-aid supplies and will maintain communications with the other dig teams, UXOSO, UXOQCS and SUXOS. All other personnel will remain outside the EZ, unless otherwise approved by the SUXOS or UXOSO.

The UXOQCS and/or SUXOS will be notified of all MEC finds.

The following sections discuss various elements of the intrusive process.

7.4 Intrusive Investigation Procedures

The UXO Team Leader will notify the UXOSO/SUXOS prior to commencing intrusive operations. A metal detector will be used to locate the boundaries of the anomaly. The anomaly will be hand dug to the side and checked with detectors to verify how close the item is. At no time will any person dig on top of an item or “blind dig” an item. If the target cannot be detected by hand-held instruments, the QC operator will be called to help re-locate the target with the EM-61.

If, at any time during the excavation, water begins pooling in the hole and obscures the bottom of the dig, an attempt to remove the water will be made using available methods (pumping, bailing, etc.), but if this effort fails, the excavation will cease for safety reasons. The hole will be backfilled, following QC verification, and the condition preventing investigation (e.g., water in the hole) will be noted and the comment section of the Surface/Subsurface Clearance Data Sheet and Munitions Accountability Log as an abandoned dig.

Specific intrusive investigation procedures are outlined below:

- If it is visually determined that an anomaly is not MEC, it may be removed from the excavation.
- If the anomaly is MEC but the UXOSO and SUXOS determines that it is safe to move, it will first be recorded with a GPS, and then may be removed from the excavation.
- If the anomaly is determined to be MEC, and cannot be safely removed from the excavation (fuzed/fired, etc.), the SUXOS and UXOQCS will be notified to perform final verification, the item will be flagged with two crossed red flags. The SUXOS and UXOQCS will then set a time for demolition of the item.
- If an anomaly is located that is not MEC and is too large to be removed, the SUXOS and UXOQCS will be contacted to determine if removal is necessary. If approval is granted to leave the item in place, attempts to excavate around the anomaly should be made in order to clear the soil beside the item. If no signal can be detected near the anomaly, or a 3-foot radius is reached, the excavation will be complete.
- However, if the excavation cannot be cleared using a metal detector, the hole will be backfilled following UXOQCS verification, and the target will be noted as an abandoned dig. An explanation of the situation and reason for not removing the anomaly will also be provided in the comment section. In the event that a 4-foot required clearance depth is achieved and an anomaly remains uncovered below the 4-foot depth, the Client or his designated representative will be notified and an entry of explanation will be made in the comment section.
- Once the anomaly is removed, the excavation will be inspected both visually and with the hand held magnetometers to ensure that target anomalies present within the dig depth have been

removed. The UXO Team Leader will record the results of the anomaly excavation and fill out the proper information. Upon completion of approximately 25% of the grid flags, an HDR QC representative will use an EM61 to verify that the anomalies have been removed, providing a real time QC effort to the intrusive operations.

- Upon completion of the excavation, target removal, and QC validation, the hole will be backfilled. The hole must be cleared or the reason it is not able to be cleared must be noted (e.g., numerous nails spread over a wide area, no find, munitions constituents or non-munitions related soil contamination).

Note: A photograph will be taken (and appropriately labeled) of each piece of MEC recovered to document the item and it will be included in the report. Photos will be taken of all significant removal activities.

After excavation, backfilling, and data entry is complete, the team will proceed to the next target location to be investigated. The completed forms will be submitted to the SUXOS at the end of each day.

At the time of the excavation, the UXO team will electronically record all data into a dig sheet or tablet for inclusion in the project GIS database via electronic download. All data sheets, digital photographs, and checklists will be turned over to the UXOQCS at the end of each working day without exception. It is critical that data not be compromised through loss or improper handling. The Data Manager will extract each team's daily digital record into the project GIS and produce the Daily Grid Tracking Log. The SUXOS and the UXOQCS will identify and resolve errors in the forms and turn the corrected forms over to the Data Manager for entry into the project database. Once all changes to the electronic database that were requested have been made and the SUXOS and UXOQCS are satisfied that the daily information is correct and correlates with entries in their respective logbooks, a final version of the Daily Grid Tracking Log will be reviewed. All teams may be subject to safety and QC inspection at any time during the work day.

7.5 Mag and Dig Operations

In the event that DGM data is not used, the UXO team will begin mag and dig operations within the area specified. All mag and dig operations will be conducted the same way regardless of the size/or density of area and are as follows:

- Grid corners will be surveyed in.
- If the area for mag and dig operations is within an existing DGM area (Data Gap, High Density Target Area), the UXO team will mark off the area and follow normal mag and dig procedures.
- Once the grids are in place the UXO team will lay out north and south grid lines which will be marked every 5 feet.
- Once the north and south lines are in place the UXO team will then lay lines every 5 feet.
- The UXO team will then use the hand held magnetometers by swinging the sensor head back and forth over the 5-foot lane. The team will use both a ferrous metals locator and an all metals locator, as approved for the specific project.
- When the UXO team member identifies a hit with the magnetometer, they will pass the magnetometer over the anomaly in a north-south, east-west fashion to determine the boundaries of the anomaly.

- The UXO team will follow the same procedures described in paragraph 7.4 of this SOP for the excavation and recovery of anomalies.
- Once the hole is considered clear (no other anomalies), the dig team will then continue the 100% coverage of the lane with both instruments.
- Once the lane has been completed the UXO team member will move to the next lane/area which needs to be cleared. At this point the UXO team leader will annotate completion of that lane on the UXO grid sheet.
- Documentation will be completed as stated in paragraph 7.4 of this SOP.

7.6 MPPEH Inspection Procedure

MPPEH inspection procedures will be conducted IAW EM 385-1-97, EM1110-1-4009 and DoDI 4140.62 to ensure that the items collected will be properly inspected and classified. The method includes three distinct inspections, which will be performed by persons of increasing levels of responsibility. The UXO technician II will perform the first inspection at the discovery location; the UXO Technician III/Team Leader will perform an additional inspection. The SUXOS will perform the final inspection.

Material Potentially Presenting an Explosive Hazard

Items determined to be MPPEH will be vented, blown in place, or consolidated with other MPPEH items for disposal. MPPEH items may only be consolidated if the SUXOS and UXOSO both concur that the item is safe to move. An additional inspection will be performed after the chosen disposal procedure to ensure no explosive residue remains.

Munitions and Explosives of Concern

Items determined to be MEC will either be blown in place (BIP) or consolidated with other MEC items for disposal. MEC items may only be consolidated if the SUXOS and UXOSO both concur that the item is safe to move. Any material resulting from MEC disposal will be re-inspected to ensure no explosive residue remains.

Munitions Debris

Items determined to be MD will be stored in a metal scrap storage container and secured with a lock by the SUXOS.

Material Documented as Safe

Upon project completion, all secured MD will re-inspected by SUXOS and UXOSO and the inspection process will be verified by the OESS if available. In the absence of an OESS, the UXO Quality Control Supervisor UXOQCS) may be utilized to verify the inspection. A DD Form 1348-1A will be completed and signed by the SUXOS and UXOSO certifying and verifying the debris as free of explosive hazards.

7.7 Anomaly Characterization

All recovered anomalies will be categorized to provide data to support MRA closure, to provide a complete record of the work, and to meet the regulatory requirements for solid waste management under the Resource Conservation and Recovery Act (RCRA) Military Munitions Rule.

If the item is determined by the UXOSO or SUXOS to be MEC and unsafe to move, it will be left in place and barricaded until it can be safely disposed of. MEC will be disposed of on a weekly basis,

either where found (blown in place) or at a consolidation point within each site if deemed safe to move. MEC items which are safe to move may be consolidated within each site on the day demolition operations are to take place. Only safe-to-move items are allowed to be consolidated. Notifications to proper authorities will be made prior to any demolition operation. All MEC items will be guarded until disposal can be accomplished. For detailed instruction on demolition operations refer to HDR – MMRP - UXO -06 Explosive Demolition Operations.

If MEC items are not intact upon discovery (i.e., exposed High Explosives [HE] or filler) this will be noted in the Trimble entry classification screen. Any HE or filler that is found on the soil will be marked with a GPS coordinate and logged in the UXO Team Leaders logbook/Grid Daily. If sampling is required based on field conditions encountered, the procedures outlined in HDR – MMRP 300 Soil Sampling (see munitions constituents (MC) Sampling Quality Assurance Project Plan [QAPP]). All breached munitions will be blown in place along with any identified HE released from it.

Any suspected hazardous material (not MPPEH related) located will be assessed on a case-by-case basis by the UXOSO and SUXOS in consultation with the United States Army Corps of Engineers (USACE). All material is suspected to be hazardous if it emits a chemical odor, has caused soil staining, or is contained in a drum or other container commonly used (or marked) for storage of hazardous materials. If in doubt, materials will be reported for investigation and instructions for future action will be provided.

7.8 Munitions with Unknown Fillers

Although munitions with chemical warfare materiel (CWM) fillers are unlikely to be present, the external design of some munitions (e.g., 4.2 inch mortar, Stokes Mortar) does not allow for the positive identification of their fillers. If a munitions is encountered that is suspected to contain CWM, or if the identification of the filler cannot be positively identified, the following steps will be taken:

- All work will immediately cease.
- Personnel on the site will withdraw upwind.
- A team consisting of a minimum of two personnel will secure the area to prevent unauthorized access as directed by the SUXOS. They will position themselves as far upwind as possible while still maintaining security of the site.
- The SUXOS and/or USACE OESS will notify the respective project managers, who will then request from the U.S. Army Technical Escort Unit (Contact: Tech Escort Unit Operations, Edgewood Arsenal, Aberdeen, Maryland, (410) 436-8534 or (410) 435-4384).
- The SUXOS will ensure that security on the site is maintained until the arrival of Explosive Ordnance Disposal (EOD)\TECH Escort and assist them as necessary.
- Only EOD\Tech Escort personnel can treat or dispose munitions with unknown fillers.

7.9 Anomalies Other Than MPPEH

It is possible that hazardous and non-hazardous material other than MPPEH may be located during the MEC intrusive investigation, including metal debris, underground utilities, chemicals, and other hazards.

- Non-Munitions Debris—Metal debris located during the clearance will be documented by the UXO team leader and will be removed to the central collection containers for the assigned site.

- Chemicals—Locating industrial-type chemicals is a possibility during intrusive activities. If any evidence of chemical contamination is detected, all intrusive activities will cease, and the UXOSO/SUXOS will notify the PM using the established notification procedures. The evacuated area will be evaluated by the SUXOS, UXOSO, and USACE OESS. Operations will continue only when it is safe to proceed.
- Other Hazards—if sealed drums, contaminated soils, or other suspect materials or conditions that would indicate a potential health or safety hazard are encountered during the intrusive investigation, work efforts will stop, and the notification procedures followed. Work will not continue until the SUXOS, UXOSO and USACE

OESS evaluate the situation and confer with the PM, USACE, and Corporate Certified Industrial Hygienist (CIH) and all agree it is safe to proceed.

7.10 Site Restoration

Following intrusive operations each day, pin flags, signs, and barricades will be removed as appropriate and the excavated area will be backfilled. If the excavation is to be left open for QC personnel to verify anomaly status, caution tape will be used to mark excavation. Backfill material will consist of native soil from the excavation. EZ signs can be left in place with approval of the SUXOS. EZ signs will be left in place if UXO remains in the work area. Following completion of all operations, the site will be returned to a condition as near as practically possible to its condition before removal activities were initiated.

8 References

- United States Department of Defense (DoD). *Methodologies for Calculating Primary Fragment Characteristics*. DDESB Technical Paper 16, Revision 1. December 1, 2004. (Website: <https://secureweb.hqda.pentagon.mil/ddesb/> [log on required]).
- DoD. *Defense Demilitarization Manual*. DOD 4160.21-M--1. February, 1995. (Website: <http://www.dtic.mil/whs/directives/corres/html/416021m1.htm>).
- DoD. *Defense Materiel Disposition Manual*. DOD 4160.21-M. August, 1997. (Website: <http://www.dtic.mil/whs/directives/corres/pdf/416021m.pdf>).
- DoD. *DoD Ammunition and Explosives Safety Standards*. Directive 6055.09-M. October 5, 2004. (Website: <http://www.ddesb.pentagon.mil/DoD6055.9-STD%205%20Oct%202004.pdf>).
- DoD. *DoD Ammunition and Explosives Safety Standards*. Directive 4140.62. October 5, 2004. Note. Most current Directive update: (Website: <http://www.dtic.mil/whs/directives/corres/pdf/414062p.pdf>).
- DoD. *Material Potentially Presenting an Explosive Hazard (MPPEH)*. DoDI 4140.62. November 25, 2008. <http://140.194.76.129/publications/eng-pamphlets/ep1110-1-18/toc.htm>.
- DDESB. *Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel*. DDESB Technical Paper 18. December 20, 2004. (Website: http://www.ddesb.pentagon.mil/TP18_122004.pdf).
- Explosive Ordnance Disposal Bulletin (EODB). *General Information on EOD Disposal Procedures*. TM 60A-1-1-31. January, 2002.

USACE. *Ordnance and Explosives Response*. USACE Engineering Pamphlet EP-1110-1-18. April 24, 2000. Errata Sheet Number 1, December 4, 2007. (Website: <http://140.194.76.129/publications/eng-pamphlets/ep1110-1-18/toc.htm>).

A large, solid red square that occupies the left side of the page, partially overlapping the white background.A large, solid grey square that occupies the top right corner of the page.A large, solid grey square that occupies the bottom left corner of the page.A large, solid black square that occupies the bottom right corner of the page.

1

Attachment 1. Daily Site Report

This page intentionally left blank

DAILY SITE REPORT



HDR EOC 9781 S. Meridian Blvd Ste 400 Englewood, CO 80112		Project Name: Project Location: Report No.: Day/Date: Click here to enter a date. Contract #	
UXO Personnel on Site/Area of Responsibility/Daily Site Operating Hours:			
See Attached Site Personnel List		Site Operating Hours:	
Activities Conducted: (Include location of work performed including equipment used):			
Munitions and Other Items Found Today: (Include location of the items found):			
Changed Conditions/Delays/Conflicts Encountered: (List any conflicts which have hindered visual surveys and other operations today):			
Other comments or additional information:			
Contractors' Verification: The above report is complete and correct. All material, equipment used, and work performed during this reporting period are in compliance with the plans and specifications except as noted above.			
Name:		Date: Click here to enter a date.	

DAILY SITE REPORT

[illegible]

DAILY SITE REPORT

[illegible]

This page intentionally left blank

The background features a large red rectangle on the left side, a grey rectangle at the top right, a grey rectangle at the bottom left, and a black rectangle at the bottom right.

2

Attachment 2. Daily Quality Control Report

This page intentionally left blank

DAILY QUALITY CONTROL REPORT



Date: HDR EOC 9781 S Meridian Blvd, Suite 400 Englewood, CO 80112	Project Name: Contract #: Report #
COE Safety Specialist:	Project Manager:
SUXOS:	UXOQCS:
UXOSO:	Project Geophysicist:
	Other:
LIST DEFINABLE FEATURES OF WORK AND INSPECTION COMMENTS	
Preparatory Phase Inspection:	
Initial Phase Inspection:	
Follow-Up Phase Inspection:	
Additional QC/QA Comments:	

Daily Quality Control Report

Additional QC/QA Comments (continued):

AGGR DGM Daily QC	DGM Activities Today (According to WP)					
Standardization Test	TA 1	TA 2	PC 1	PC 2	RCQ 1	RCQ 2
Equipment Warm Up	N/A	N/A	Yes	Yes		
Record Sensor Position	N/A	N/A				
Cable Shake Test	N/A	N/A	Yes	Yes		
Static/Spike	N/A	N/A	Yes	Yes		
Point Position/Control Point Check	N/A	N/A			N/A	N/A
IVS	N/A	N/A				

Comments for DGM Activities if any:

- No DGM field operations were conducted under this contract.

Non-Compliant Items Identified Today	Non-Compliant Items Corrected Today

On behalf of the contractor, I certify that this report is complete and correct and the equipment and material used and work performed during this reporting period is in compliance with the work plan specifications to the best of my knowledge unless otherwise noted in this report.

TA- Tow Array
RCQ – Reacquire

PC –EM 61 Push Cart
IVS – Instrument Verification Strip

The background features a large red rectangle on the left side, a grey rectangle at the top right, a grey rectangle at the bottom left, and a black rectangle at the bottom right.

3

Attachment 3. UXO Daily Report Form

This page intentionally left blank



UXO Daily Report Form

Date:	MRS:	Grid:		Total Anomalies	
Team Number:	Team Leader:	Number of Personnel:	Man Hours UXO:	Man Hours Scrap:	Man Hours Demo:
Lbs MD:	Lbs Non MD Scrap:	Date Grid Completed:		Equipment Hours:	
SUXOS		Quality Control			
Schonstedt Settings: 1 2 3 4 5		Shadow X5 All Meal Mode Sensitivity	Manual GB	Fixed Disc Mode Disc SW	Black Sand

Nomenclature	MDAS	MEC		Vent	Nomenclature	MDAS	MEC		Vent
		UXO	DMM				UXO	DMM	
BLU-43/b (Dragon Tooth)					Fuze Bomb VT M166				
Bomb 500lb GP					Fuze Bomb M108				
Bomb M38 100lb Practice					Fuze Mechanical Time T55E1				
Bomb M41 20lb Frag					Fuze Mortar M52				
Bomb M50 4lb Incendiary					Fuze Projectile 20mm				
Bomb M69 6lb Incendiary					Fuze Projectile M1907				
Bomb M69X 6lb Incendiary					Fuze Projectile M38				
Bomb M74 10lb Incendiary					Fuze Projectile M58				
Bomb M23 3lb Practice					Igniter M23 w/Fuze				
Bomb Photo Flash					Igniter Tube				
Bomblet BDU-28					Illuminating Cartridge				
Bomblet M139 Trainer					M44A1 Aircraft Flare				
Booster Cup					Mine Anti-Personnel				
Burster Tube					Mortar 60mm HE				
Cartridge					Mortar 60mm WP				
Cartridge Photo Flash					MD Scrap				
Cartridge Starter					Parachute Delay Mech M1A1				
Detonating Cord Conduit					Parachute Flare				
Frag of 37mm					Primer Detonator				
Frag of 75mm HE					Projectile 20mm				
Frag, (from High Explosives)					Projectile 37mm				
Fuze Bomb M1					Projectile 57mm Heat M307				
Fuze Bomb M100 Series					Projectile 75mm Shrapnel				
Fuze Bomb M126					Rocket 2.25				
Fuze Bomb M142					Rocket Motor (JATO)				
Fuze Bomb M145					Rocket Motor 2.75				
Fuze Bomb M146					Rocket Motor 3.5				
Fuze Bomb M150					Signal Illuminating Aircraft				
Fuze Bomb M152					Signal Illumination				
Fuze Bomb M158					Small Arms				
Fuze Bomb M159					Spotting Charge M38				
Fuze Bomb Nose					War Head Rocket 2.75 Practice				
Fuze Bomb Tail					War Head Rocket 2.75 HE				
Totals					Totals				

UXO Daily Report Form

Scrap			
I certify that to the best of my knowledge and belief that all recovered items removed on the dates indicated from the aforementioned location(s) is free of hazardous materials.			
UXOS Signature:		Specialist Signature:	
Ordnance Locator Daily Checks		AM:	PM:
Communications Checks		AM:	PM:
Disposal			
Number	Detonation or Vent	Quantity	Item
TL/Team Members Present (Specify hours if not a full day)			
TL:			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
Comments:			



4

Attachment 4. Daily Safety Form



This page intentionally left blank

DAILY SAFETY REPORT



Project Name: <u>Choose an item.</u>		Report No: _____
Project No: _____	Location: _____	Date: _____
I. Site Safety Brief Topics:		
II. Safety Inspections:		
III. Problems Encountered / Corrective Actions Taken:		
IV. Additional Health and Safety Comments:		
VII. Visitors		
VIII. Approval		
	Date: _____	

This page intentionally left blank



5

Attachment 5. Nonconformance Report



This page intentionally left blank



Non-Conformance Report

NCR Number: 001

Date: 1/31/2013

Project Name/Location

Project Number:

Contract Number:

Task Order Number:

I. Non-Conformance Description (including requirement violated, if applicable)

Identified by

Name

[Click here to enter a date.](#)

Date

II. Root Cause of Non-Conformance Action

III. Corrective action(s) to be taken:

V

To be performed by:

Name:

Date to be completed

[Click here to enter a date.](#)

IV. Actions to be taken to preclude reoccurrence:

To be performed by:

Name:

Date to be completed

[Click here to enter a date.](#)

Acceptance by:

Project Manager

Date:

[Click here to enter a date.](#)

Quality Assurance
Manager

Date:

[Click here to enter a date.](#)

Corrective action(s) completed by:

Name

Title

[Click here to enter a date.](#)

Date

Verification by:

Name

Title

[Click here to enter a date.](#)

Date

This page intentionally left blank

The background features a large red rectangle on the left side, a grey rectangle at the top right, a grey rectangle at the bottom left, and a black rectangle at the bottom right.

6

Attachment 6. Abbreviations and Acronyms

This page intentionally left blank

Abbreviations and Acronyms	
AAR	After Action Review
BIP	Blown in Place
CIH	Certified Industrial Hygienist
CWM	Chemical Warfare Materiel
DDESB	Department of Defense Explosives Safety Board
DMM	Discarded Military Munitions
DoD	Department of Defense
DQCR	Daily Quality Control Report
EOD	Explosive Ordnance Disposal
ESP	Explosive Site Plan
ESS	Explosives Safety Submission
EZ	Exclusion Zone
FCR	Field Change Request
GPO	Geophysical Prove-out
GPS	Global Positioning System
HDR	HDR Environmental, Operations and Construction, Inc.
HE	High Explosives
HFD	Hazardous Fragment Distance
IAW	In Accordance With
MC	Munitions Constituents
MD	Munitions Debris
MDAH	Munitions Deemed as Hazardous
MDAS	Munitions Deemed as Safe
MEC	Munitions of Concern
MGFD	Munitions with Greatest Fragmentation Distance
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MSD	Minimum Separation Distance
NCR	Non-Conformance Report
OESS	Ordnance and Explosives Safety Specialist
PM	Project Manager
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RRD	Range Residue and Debris

RTK	Real Time Kinematic
SOP	Standard Operating Procedure
SOW	Statement of Work
SSHP	Site Safety and Health Plan
SUXOS	Senior UXO Supervisor
TP	Technical Paper
USACE	US Army Corp of Engineers



Munitions Response Quality Management Plan

Standard Operating Procedure

HDR-MMRP-UXO-11

Revision 1.4

Date of Issue: November 2010

Revised: May 2015

Approved by:

A handwritten signature in black ink, appearing to read 'Daniel Sciarro', written over a horizontal line.

Date: October 17, 2012

Daniel Sciarro, Health and Safety Manager

Approved by:

A handwritten signature in blue ink, appearing to read 'Rob Irons', written over a horizontal line.

Date: October 17, 2012

Rob Irons, UXO Quality Control Specialist

Approved by:

A handwritten signature in blue ink, appearing to read 'John Coughlin', written over a horizontal line.

Date: May 28, 2015

John Coughlin, MMRP Program Manager



This page intentionally left blank



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
12850 E. Control Tower Road
Centennial, Colorado 80112

Revisions:

Date	Revision Number	Author	Description
	0.01	T. Pfertsh, Sky Research	First Draft
11/11/2010	0.02	T. Pfertsh, Sky Research	Second Draft
07/13/2011	1.0	C. Petras, Sky Research	New approval signatures, references
09/08/2011	1.1	C. Petras, Sky Research	Removed section 7.0, consolidated references, current references in document
04/11/2012	1.2	C. Petras, Sky Research	Updated formatting
10/17/2012	1.3	DS, RI, JS	Signatures added
04/17/2013	1.4	Justin Bills	Changed Logo
5/28/2015	1.5	DJ	Logo, signature

Related Documents:

Document Name	Description	Document Reference
International Organization for Standardization (ISO) Quality Management System Requirements	ISO 9001:2000 specifies requirements for a quality management system	ISO 9001:2000
Department Of Defense Test Method Standard DOD Preferred Methods For Acceptance Of Product	Process to submit efficient and effective process control (prevention) procedures to the US Government	MIL-STD-1916. April 1, 1997
	Quality Control Plan	DID OE-005-11
Quality Considerations for Munitions Response Projects UXO-5, Washington, D.C.		UXO-5. ITRC (Interstate Technology and Regulatory Council). 2008



This page intentionally left blank



Supervisor's Statement

I have read and understand this SOP. To the best of my knowledge, the investigation described in this SOP can be done in a safe, healthful, and environmentally sound manner. I have made sure that all persons assigned to this process are qualified, have read and understand the requirements of this SOP, and have signed the worker's statement for this purpose. I will ensure that the SOP contains current procedures. If a change to the SOP is necessary, I will ensure that the process is stopped until the SOP is revised and approved. Changes will require the submission of a Field Change Request (FCR) or by the HDR project team. If unexpected safety, health, or environmental hazards are found, I will make sure that the process is stopped until the hazards have been eliminated.

Senior UXO Supervisor

Date

Worker's Statement

I have read this SOP and I have received adequate training to perform the procedures addressed in the SOP. If I identify a hazard not addressed in the SOP, or encounter an operation I cannot safely perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date

Name

Date



This page intentionally left blank



Table of Contents

1.1	Purpose and Scope	1
1.2	Purpose	1
1.3	Scope	1
2.1	Applicable Documents	1
2.2	Associated Documents	1
2.3	Reference Documents	1
3.0	Quality Control Overview	1
4.1	Quality Control Plan for Typical MR Project	3
4.2	Introduction	3
4.3	Project Background	3
4.4	Project Scope of Work	3
4.5	QC Personnel Organization and Responsibilities	3
4.6	Documentation of Qualification and Training	4
4.7	Project Manager	4
4.8	Site Manager	5
4.9	UXO Quality Control Specialist	6
4.10	UXO QC Manager	6
4.11	Definable Features of Work (DFOWS) and the Three Phase Control Process	7
4.11.1	Definable Features of Work	7
4.11.2	Mobilization	8
4.11.3	Local Surveying and Mapping	8
4.11.4	Vegetation Removal	8
4.11.5	Appropriate DGM Activities	8
4.11.6	MEC Removal	8
4.11.7	MEC Demolition	8
4.11.8	Demobilization	8
4.11.9	Three Phase of Control	8
4.12	Inspection/Audit Procedures	11
5.1	Specialized MR Project Processes	12
5.2	Vegetation Clearance	12
5.2.1	QC Monitoring of Vegetation Clearance	13
5.2.2	Typical Quality Control Measures	13



5.3	Surface Removal	13
5.3.1	Objectives/Requirements	13
5.3.2	MR surface removal often involves the following activities and resources	14
5.3.3	QC Monitoring during Surface Removal	14
5.3.4	Common Quality Control Measures	15
5.4	Geophysical Prove-Out	15
5.4.1	Objectives and Requirements	15
5.4.2	Activities and Resources	16
5.4.3	QC Monitoring during GPO operations	16
5.4.4	Quality Control Measures for the GPO	17
5.5	Analog (Mag and Dig) Geophysics	18
5.5.1	Requirements/Objectives	18
5.5.2	Activities and Resources	19
5.5.3	QC Monitoring of “Mag and Dig” Operations	19
5.5.4	Quality Control Measures for Analog Geophysics	19
5.6	Anomaly Resolution	20
5.6.1	Objectives and Requirements	20
5.6.2	Activities and Resources	21
5.6.3	How and Where to Monitor	22
5.6.4	Quality Control Measures for the Anomaly Resolution Process	22
5.7	Verification Sampling	22
5.8	Objectives and Requirements	23
5.8.1	Activities and Resources	23
5.8.2	How and Where to Monitor	23
5.8.3	Common Quality Control Measures	24

1.0 Purpose and Scope

1.1 Purpose

The purpose of this document is to provide HDR with a formal document that describes its quality system in terms of the organizational structure, policy and procedures, functional responsibilities of management and staff, lines of authority, and needed interfaces for those planning, implementing, documenting, and assessing all activities conducted.

1.2 Scope

This SOP applies to any person affecting the quality of HDR's products, but is specifically developed for use by the Quality Control Manager in the performance of his/her duties.

2.1 Applicable Documents

2.1 Associated Documents

The following Occupational Safety and Health Administration (OSHA) standards directly apply to the conduct of operations associated with this document. In the event other hazards are associated with the conduct of this document, consultation of other SOPs and regulatory references may be needed. Additionally, this document has been designed to meet the U.S. Army Corps of Engineers (USACE) requirements outlined below.

2.2 Reference Documents

- ISO 9001:2000.
- MIL-STD-1916.
- DID OE-005-11.
- ITRC (Interstate Technology and Regulatory Council). 2008. Quality Considerations for Munitions Response Projects UXO-5, Washington, D.C.

3.1 Quality Control Overview

The following activities are the basic elements for quality control for an MR project:

- Establish and implement a QC program.
- Identify key processes and activities.
- Develop performance requirements.
- Identify inspection reports.
- Conduct performance monitoring (onsite).
- Identify non-conformance problems.
- Implement and document corrective actions.
- Document QC activities and results.



A munitions response (MR) project is a single large project that uses many inputs to generate many outputs. This single process is made-up of many smaller processes. Each of these processes uses inputs from other processes to generate outputs, which, in turn, are used, by still other processes. Some of the steps of these processes will occur concurrently while others will occur sequentially and each is imbedded with linked activities and tasks. A QAPP (Quality Assurance Project Plan) will be developed for each project that will identify the important processes and tasks for that project and the interrelationship between them.

Once the project process has been identified, key performance steps or inspection points must be determined. These inspection points will be at critical points in the process, where a failure could seriously compromise the entire project. Performance requirements will be established for the inspection points some of which will be qualitative and others, which will be quantitative.

Data Performance Criterion - Inadequate data performance criteria can compromise both the efficiency and the adequacy of the end product. Data Quality Objectives must be developed that define the type, quality, and quantity of data required to satisfy a specified use. Key elements of this process include:

- 1) Defining the problem.
- 2) Identifying the decision to be made.
- 3) Identifying the key inputs to the decision and boundaries of the study.
- 4) Developing the decision rule and tolerable limits on potential decision errors.
- 5) Selecting the most resource-efficient data collection design. This performance criterion should be determined during the project planning phase.

Once the process, key inspection, and performance requirements are identified, a monitoring system should be established. The monitoring system should specify inspection points, monitoring frequency, monitoring method, pass/fail criteria, responsible person, and the method of corrective action. This can be described in a Quality Control (QC) matrix that displays this information for the entire project. This QC Matrix can be incorporated into the QAPP and can serve as the basis for the inspection program for the field QC personnel. (See example **QC Matrix Table 1-1**).

Performance data from individual inspection points will usually contain variances. Some amount of variance is to be expected because of natural variation between instruments used and activities being performed. Variations in performance data that are not due to such common causes are assumed to be due to special causes. Special cause variations indicate that something has gone wrong or is going wrong in the activity when the variation exceeds the established performance criteria or is trending in that direction. These variations require the monitoring system to have a mechanism that initiates a root cause analysis. Once the root cause is identified, a corrective action can be determined, implemented, and documented.

4.1 Quality Control Plan for Typical MR Project

This Quality Control Plan (QCP) details the approach, methods, and operational procedures to be employed to perform quality control during a typical MEC removal action performed by HDR. This plan was developed in accordance with:

- NOSSAINST 8020.15, NAVSEA OP 5 VOL I (Revision 7).
- DDESB TP 18, ANSI/ASQC Q10011-1994, ANSI 14010-1996, and OE MCX DID OE-005-11.01.
- Mil-Std-1916 (and accompanying Mil-Hdbk-1916 will be implemented for performing QC as part of this TCRA for inspection of cleared grids and where applicable.
- USACE ER 1180-1-6: Construction Quality Management (1995).
- USACE ER 1110-1-12: Engineering and Design Quality Management (1993).
- USACE ER 415-1-10: Contractor Submittal Procedures (1997).
- Additionally, local and state laws and regulations, ATF P 5400.7, DoD 6055.09 M, and DOT regulations.

4.1 Introduction

The objectives of this QCP are to anticipate the specific operating requirements of the project, and to establish procedures to ensure that achieved quality meets technical design specifications and conforms to the requirements of the Task Order. Specifically, this plan:

- Identifies the project QC organization and defines each individual's respective authority, responsibilities, and qualifications.
- Defines project communication, documentation, and record keeping procedures.

Establish QC procedures, including the necessary supervision and tests, to ensure that work meets applicable specifications and drawings.

4.2 Project Background

The Project Background will be discussed in applicable project Work Plan.

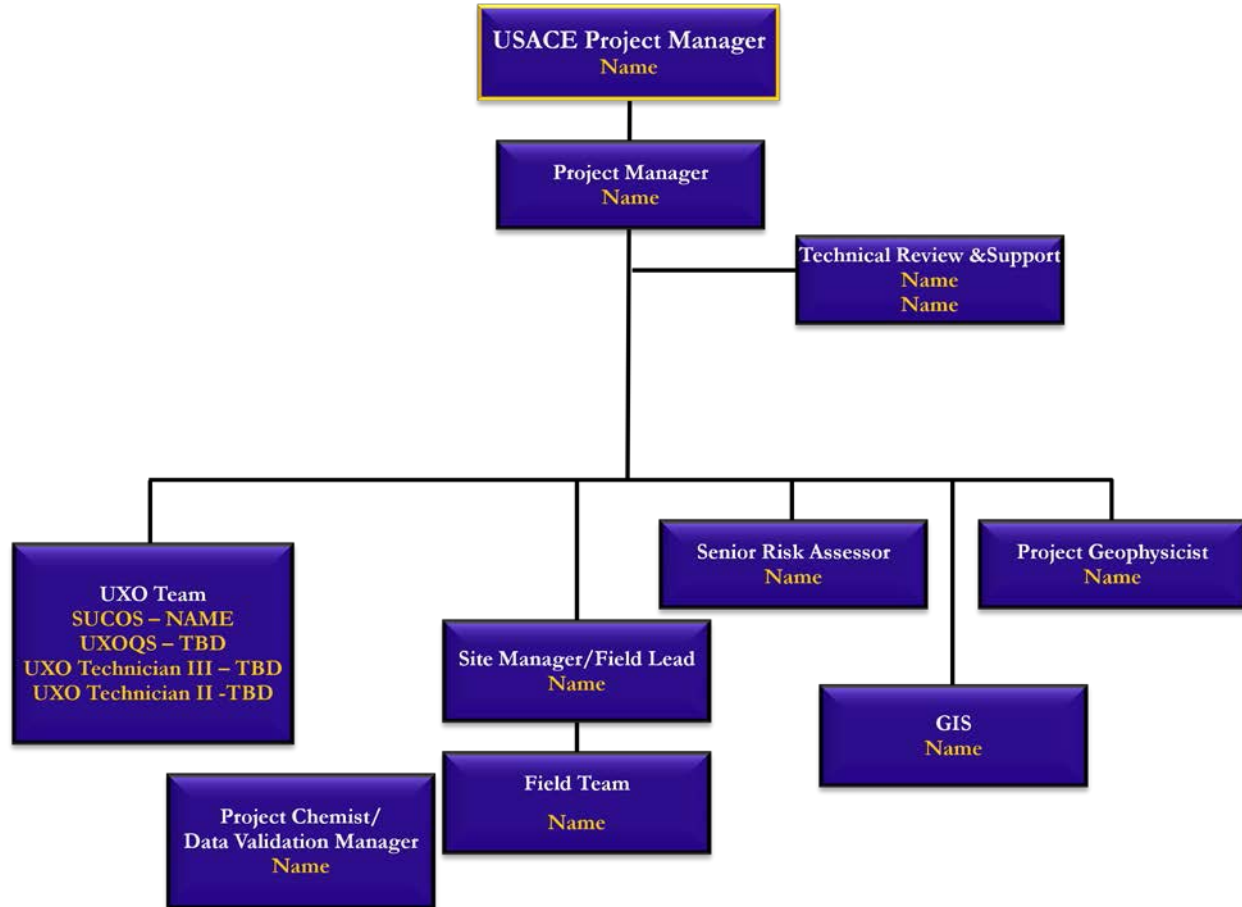
4.3 Project Scope of Work

Will be discussed in applicable project Work Plan

4.4 QC Personnel Organization and Responsibilities

The overall project organization and reporting structure is presented in this QCP and illustrated in the figure below. Quality Control personnel, organization, qualifications, and responsibilities are addressed in more detail in this section. A flow chart illustrating the project management structure for a typical project is presented in **Figure 4-1**.

Figure 4-1 Project Organizational Chart



Project staff members will be qualified to perform their assigned jobs in accordance with terms outlined by the scope of work. Site personnel handling hazardous materials must have the training as outlined in Site Specific Health and Safety Plan, which includes the OSHA 40 hour hazardous waste operators training and annual 8 hour refresher (29 CFR 1910.120).

4.5 Documentation of Qualification and Training

The UXOQCS will maintain records documenting the required qualifications and training for each site worker. The UXOQCS will monitor expiration dates to provide advance warning to the Project Manager of when employees will require refresher training or other requirements. The UXOQCS will maintain records of site specific and routine training for personnel and visitors, as required by the Work Plan. These records will be maintained onsite for audit purposes.

4.6 Project Manager

The primary responsibility of the Project Manager (PM) is the overall direction of the project and accountability for work activities undertaken as part of the project. As such, the PM will provide the managerial administrative skills to ensure that resource

allocation, planning, execution, and reporting meet contract requirements. The global quality related responsibilities of the PM may include, but are not limited to, the following:

- Organizing project staff and assigning responsibilities.
- Understanding the Contract and scope of work for the specific project.
- Communicating to the project staff regarding client requirements and QC practices.
- Identifying, providing documentation, and notifying the client and project team of changes in the scope of work, project documentation, and activities.
- Supervising the preparation and approval of project specific procedures, work plans, and QC project plans.
- Approving project documents.
- Approving project execution methodologies.
- Disseminating project related information from the client.
- Serving as liaison for communications with the client and subcontractors.
- Serving as liaison between the project staff and other internal groups.
- Deciding whether project documents require independent review.
- Investigating nonconformance and implementation of corrective actions.
- Evaluating the effect of nonconformance on the project and the appropriateness of reporting such items to the client.
- Providing appropriate documentation of nonconformance when reporting to the client.
- Serving as final reviewer prior to release of project information.
- Approving and signing outgoing correspondence.
- The PM may assign a portion of these responsibilities to the Site Manager and SUXOS, who will remain on site throughout the project field activities

4.7 Site Manager

The Site Manager is responsible for efficiently applying the resources of the project team to execute the field phase of the Contract. In addition, the Site Manager is responsible for local client interface regarding details of the project and the project team while assigned to the site. The Site Manager will assist the PM in maintaining sufficient resource allocations to meet the project schedule and budget and will provide daily feedback to the PM on project progress, issues requiring resolution, and other project-specific issues, as required. The quality-related responsibilities of the Site Manager include, but are not limited to, the following:

- Notifying the PM if problems arise with the schedule.
- Providing scheduling and integration of subcontractor services in support of the SUXOS.
- Serving as liaison for communications with project staff and subcontractors, as well as with the onsite client and regulatory agency representatives.
- Providing logistical support for field operations.
- Continuously monitoring work progress and adherence to authorized work scopes, budgets, and schedules.
- Aiding in the preparation of submittals.
- Leading weekly onsite status meetings.



- Reviewing the project work plans regularly.
- Interfacing daily with the subcontractors.

4.8 UXO Quality Control Specialist

The designated UXOQCS will be specified in the Removal Contractor's Site Specific Work Plan. The UXOQCS has authority to enforce the procedures defined in this QCP. In alignment with this authority, the UXOQCS has the authority to stop work in order to ensure that project activities comply with specifications of this QCP, the contract, and the Task Order. This authority applies equally to all project activities, whether performed by the Contractor or its subcontractors and suppliers. The UXOQCS is responsible for planning and executing QC oversight of project operations, and ensuring compliance with specified QC requirements. Specifically, the UXOQCS is responsible for:

- Developing, assessing the effectiveness of, and maintaining this QCP and related procedures.

€



- Notifying the appropriate officials 48 hours prior to beginning any required action of the preparatory and initial phases. At a minimum, the UXOQCS will use weekly QC Reports for the purposes of this notification.

The UXOQCS is to be physically onsite whenever project-related fieldwork is in progress. If the UXOQCS is to be absent from the site, with client approval, an alternative UXOQCS will be designated and will be given equivalent responsibilities and authority.

4.9 UXO QC Manager

The UXO QC Manager is responsible for developing, maintaining, and ensuring implementation of the quality program. This responsibility includes overseeing activities under the guidance of this QC plan, performing periodic reviews of the processes being implemented, evaluating any recommendations made by the project team over the course of the program regarding use of these processes, and implementing continuous improvement evaluations of the quality program. The QC Manager reports directly to the Corporate Quality Control Manager.

Specific responsibilities of the QC Manager include:

- Developing program-level QC program consistent with corporate guidance and requirements for MR projects.
- Approving project-level, QC plans.
- Performing reviews to ensure that sound professional engineering and other technical and regulatory capabilities are applied during planning and execution of MEC operations.
- Monitoring results of site audits.
- Conducting project audits.
- Ensuring that corrective actions are implemented promptly and fully.
- Developing lessons-learned for team distribution.
- Conducting quality training for UXOQCS.
- Evaluating the qualifications of the quality team.

4.10 Definable Features of Work (DFOWs) and the Three Phase Control Process

Quality control any project will be monitored through all of the Definable Features of Work (DFOWs) using a three-phase control process. The DFOWs and the three-phase control process are discussed in the following subsections.

4.10.1 Definable Features of Work

The definable features of work (DFOW) for this task order are divided into activities related to planning, field operations and final project reports and closeout:

Planning

- Pre-Mobilization Activities: System set-up for GIS, document management and control, data management and subcontracting.
- Technical Project Planning: Technical and operational approach.
- Removal Contractor Site Specific Work Plan and SOP's: Preparation and obtaining approval.
- Field Operations.
- Site Preparation: Mobilization, survey, vegetation removal, surface clearance, appropriate DGM activities.
- MEC investigation and removal.
- MPPEH/MD management (inspection/ demilitarization/ certification/ verification/ disposition).
- Appropriate DGM QC Operations and Verifications.
- Demilitarization of MEC and Demobilization.
- Final Project Reports and Closeout.
- Site-Specific Final Report:
 - o Preparation and obtaining approval.
- Data Archiving and Project Closeout.

4.10.2 Mobilization

This definable feature of work includes all required activities associated with mobilizing at the start of the project.

4.10.3 Local Surveying and Mapping

This definable feature of work includes all activities relating to grid layout activities.

4.10.4 Vegetation Removal

This definable feature of work includes all activities relating to the removal of vegetation. This feature may need to be subdivided as needed, especially if a more involved phased approach is used such as prescribed burning followed by manual/mechanical clearance.

4.10.5 Appropriate DGM Activities

Guidance will be obtained from project geophysicist.

4.10.6 MEC Removal

This definable feature of work includes all activities relating to UXO sweeps/intrusive activities to ensure that no MEC is present.

4.10.7 MEC Disposal

This definable feature of work includes all required activities associated with disposing of MEC or explosively venting items.

4.10.8 Demobilization

This definable feature of work includes all required activities associated with demobilizing at the completion of the project.

4.10.9 Three Phase of Control

The UXOQCS is to ensure that the three-phase control process, including the Preparatory Phase, Initial Phase, and Follow-Up Phase, is implemented for each DFOV listed in this QCP. Each control phase is important for obtaining a quality product and meeting the TO objectives, however the preparatory and initial audits are particularly valuable in preventing problems. Production work is not to be performed on a DFOV until a successful preparatory and initial phase has been completed.

4.10.9.1 Preparatory Phase

The preparatory phase culminates with the planning and design process leading up to actual field activities. Successful completion of the Preparatory Phase verifies that the TO delivery, QC, and safety plans have been completed and are ready to be implemented. The following actions will be performed as applicable for each DFOV:



1. Confirm that the appropriate technical procedures are incorporated into the project work plan and review procedures.
2. Confirm that adequate testing is called for to assure quality delivery.
3. Confirm definition of preliminary work required at the work site and examine the work area to confirm required preliminary work has been properly completed.
4. Confirm availability of required materials and equipment. Examine materials and equipment to confirm compliance with approved submittals and procedures. Ensure equipment testing procedures are in place, with control limits and frequency
5. Confirm qualifications of personnel and those theses roles/responsibilities are well defined and communicated.
6. Confirm with the UXOSO that the site health and safety plan and activity hazard analyses (AHA) adequately address the work operations and that applicable safety requirements have been incorporated into the plan.
7. Discuss methods to be employed during the field activities.
8. Confirm any required permits and other regulatory requirements are met.
9. Verify that lessons learned during previous similar work have been incorporated as appropriate into the project procedures to prevent recurrence of past problems.

Project staff must correct or resolve discrepancies between existing conditions and the approved plans/procedures identified by the UXOQCS and the team during the Preparatory Phase. The UXOQCS or designee must then verify that unsatisfactory and nonconforming conditions have been corrected prior to granting approval to begin work. Results of the activity are to be documented in the Preparatory Inspection Checklist specific for the DFOW and summarized in the Weekly QC Report.

4.10.9.2 Initial Phase

The initial phase occurs at the startup of field activities that are associated with a specific DFOW. The initial phase confirms that the Project QCP, other applicable work plan sections, and procedures are being effectively implemented and the desired results are being achieved.

During the initial phase, the initial segment of the DFOW is observed and inspected to ensure that the work complies with contract and work plan requirements. The initial phase should be repeated when acceptable levels of specified quality are not being met.

The following shall be performed for each DFOW:

1. Establish the quality of work required to properly deliver the TO in accordance with contract requirements. The UXOQCS ensures that supervision has made the work crews aware of expectations associated with the field methods established under the preparatory phase.
2. Resolve conflicts. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the Project Manager. Should the conflict not be resolved in a manner that satisfies the project requirements, the UXOQCS must elevate the conflict to the corporate level (QC Manager) and issue a non-conformance report. The UXOQCS may direct a cessation of work activity, with the concurrence of the QC Manager, should the issue jeopardize the results of the DFOW, or put the TO at risk of non-compliant performance.
3. Verify with the UXOSO that the site health and safety plan and activity hazard analyses were developed to ensure that the identified hazards adequately addressed field conditions. Confirm that applicable safety requirements are being implemented during field activities.

Upon completion of the initial phase activities, results are to be documented in the Initial Phase Inspection Checklist, the QC logbook and summarized in the Weekly QC Report. Should results be unsatisfactory, the initial phase will be rescheduled and performed again.

4.10.9.3 Follow-up Phase

Completion of the initial phase of QC activity then leads directly into the follow-up phase, which addresses the routine day-to-day activities on the field site. Specific concerns associated with the follow-up include:

1. Inspection of the work activity to ensure work it complies with the contract and work plans.
2. Evaluation and confirmation that the quality of work is being maintained at a level no less than that established during the initial phase.
3. Evaluation and confirmation that required testing is being performed in accordance with procedures established during the preparatory phase and confirmed during the initial phase.
4. Confirmation that non-conforming work is being corrected promptly and in accordance with the direction provided by the UXOQCS.

To conduct and document these inspections, the UXOQCS is to generate the Follow-up Phase Inspection Checklist. The follow-up phase inspections will be performed daily, or as otherwise identified in this QCP until the completion of each DFOV.

The UXOQCS is responsible for onsite monitoring of the practices and operations taking place and verifying continued compliance with the specifications and requirements of the contract, TO, and approved project plans and procedures. He/She is also responsible for verifying that a daily Health and Safety Inspection is performed and documented as prescribed in the project SSHP. Discrepancies between site practices and approved plans/procedures are to be resolved and corrective actions for unsatisfactory and nonconforming conditions or practices are to be verified by the UXOQCS or a designee prior to granting approval to continue work. Follow-up inspection results are to be documented in the QC logbook and summarized in the Weekly QC Report.

4.10.9.4 Additional Audits

Additional audits performed on the same definable feature of work may be required at the discretion of the QC Manager or the UXOQCS. Additional preparatory and initial audits are generally warranted under any of the following conditions: unsatisfactory work, changes in key personnel, resumption of work after a substantial period of inactivity (e.g., 2 weeks or more), or changes to the project scope of work/specifications.

4.10.9.5 Final Acceptance Audit

The Final Acceptance Inspection is performed, upon conclusion of the DFOV and prior to closeout, to verify that project requirements relevant to the work are satisfied. Outstanding and nonconforming items are to be identified and documented on the Final Inspection Checklist. As each item is resolved, it is to be noted on the checklist.

4.11 Inspection/Audit Procedures

The UXOQCS is responsible for verifying compliance with this QCP through audits and surveillance. The UXOQCS or a designee is to inspect/audit the quality of work being performed for the definable feature of work. The UXOQCS or a designee is to verify that procedures used conform to applicable specifications stated in this work plan or other applicable guidance. Identified deficiencies are to be communicated to the responsible individual and documented in the QC log and weekly QC report. Corrective actions are to be verified by the UXOQCS and recorded in the weekly QC report.

5.1 Specialized MR Project Processes

The specialized MR project processes that are common to many projects are discussed in the following sections:

- Vegetation Clearance
- Surface Removal
- GPO
- DGM (Digital Geophysical Mapping)
- “Mag and Dig” Operations
- Anomaly Resolution
- Verification Sampling

5.1 Vegetation Clearance

This process removes vegetation in order to facilitate follow-on activities. This can include mowing, limb-trimming, tree removal and mulching, “Hydro-Ax” deforestation and controlled burning. Follow-on activities can include such actions as surface removal and DGM work. Improper vegetation removal can make such follow-on actions more hazardous due to poor visibility of the ground surface. Methods and processes for the vegetation clearance can be impacted by many site-specific factors such as terrain, cultural features, environmental concerns, current or expected land use, and available equipment on hand.

Typical considerations:

- How much vegetation should be removed? Usually only enough to allow follow-on activities to be performed safely and efficiently.
- Are sensitive, threatened, or endangered plants or animals a concern?
- Is it most efficient to use hand labor, mechanical means, or a combination of two?
- Are any permits or notifications to land-use authorities required?

Key factors affecting decision-making:

- Site location and number of acres to be cleared
- What does the surface need to look like when complete? Must surface be completely visible or there an acceptable length/depth for vegetation or any mulch produced?
- Type of removal (grass cutting, brush clearance, controlled burn etc.?)
- How will remaining logs, stumps, mulch be removed/disposed of?
- Any weather patterns that can affect the process
- Qualifications of workers tasked with removal
- Type/depth of anticipated MEC items
- How fast will vegetation regenerate? Is there a time limit in within which follow-on procedures must be completed?



5.1.1 QC Monitoring of Vegetation Clearance

QC Monitoring of vegetation removal will likely focus on 3 phases of the work process.

1. Preparation:
 - a. Work site is correctly identified, surveyed, and marked.
 - b. Approved work plan has been prepared.
 - c. Trained personnel and proper equipment on hand.
 - d. Appropriate permits have been obtained and notifications made.
2. Observation:
 - a. Ensuring conformance of work performed to the procedures outlined in the work plan.
3. Inspection:
 - a. Ensuring that work done conforms to the requirements for follow-on MR processes.

5.1.2 Typical Quality Control Measures:

- Ensuring site personnel have documentation of the required training
- Checking vegetation removal equipment to ensure that it meets standards set forth in the work plan
- Reviewing equipment maintenance logs to ensure proper maintenance is being performed
- Observing the vegetation work in progress to ensure conformance with the work plan
- Inspecting the completed areas and measuring the results to ensure conformance with work plan specifications
- Documenting the QC activities performed to create conformance/nonconformance records that can be reviewed by QC personnel

5.2 Surface Removal

This process removes MEC and/or other surface metal or obstructions from the surface of the MR site.

5.2.1 Objectives/Requirements

Inspection of the surface of the MR site to locate MEC and/or inspection of the surface of the MR site to remove scrap and clutter that will interfere with follow-on MR processes.

Typical Considerations:

- What exactly needs to be removed?
- Is it necessary to only remove MEC or does metal scrap also needs to be removed?
- How “clean” does surface, need to be when finished?

- Will geophysical sensors/magnetometers be used to assist in the sweep/surface removal?
- What degree of certainty of MEC removal is needed?
- How will the removal be performed?
- What data needs to be recorded to document the results of the surface removal?

Key Factors in Decision Making:

- MEC is often very difficult to visually distinguish from surrounding soil and vegetation may prevent workers from being able to detect MEC without the use of a geophysical sensors. Hand-held magnetometers are generally adequate for this task.
- Surface removal work that prepares a site for follow-on DGM work may not have to adhere to the strict QC monitoring required for a surface removal that has the objective of full MEC removal.

5.2.2 MR surface removal often involves the following activities and resources:

- Division of work area into grids and grids into search lanes
- UXO Specialists, with or without geophysical sensors, walking the search lanes to visually inspect for MEC and/or metal scrap
- Removal of metal scrap, if required, and marking of MEC for later removal
- Documenting results such as MEC types, number of finds, locations, pounds of scrap etc.

5.2.3 QC Monitoring during Surface Removal:

QC Monitoring for Surface removal will often focus on the following four main phases of work:

1. Work Preparation
 - a. Making sure work site is correctly identified, surveyed, and marked
 - b. Ensuring there is an adequate, approved work plan
 - c. Ensuring correct equipment is chosen and obtained
 - d. Ensuring needed personnel are obtained and personnel are properly trained
 - e. Making sure all necessary permits are obtained and notifications made
2. Monitoring of the work in progress to ensure that the work complies with the work plan.
3. Inspection of the finished product to ensure conformance with finished-product requirements and/or requirements of the follow-on processes.
4. Inspection of surface removal documentation to ensure it complies with the work plan.

5.2.4 Common Quality Control Measures

- Making sure, UXO Specialists are supervised by a competent supervisor and that they are observed daily by onsite QC Specialist.
- Implementing a blind seeding program designed to provide confidence that required MEC and MEC related items are being recovered and to help identify areas where process needs improvement.
- Verification sampling- QC Specialist inspects random portion of each grid.
- Monitoring the recording of grid data required by the work plan for accuracy and completeness.

5.3 Geophysical Prove-Out

The GPO is the site-specific field validation of geophysical systems used during MR actions. As the project technical team begins the GPO process, they should have a good idea of what the basic needs are for a particular geophysical system when it is used to detect the types of targets that are known or suspected to be on-site. This knowledge, along with clear direction in the work plan regarding the goals and objectives of the project, should be applied when designing and implementing a site-specific GPO.

5.3.1 Objectives and Requirements:

Project-specific objectives for the GPO will address one or more specific statements of the data requirements established for the geophysical program. Example data requirements could be:

- What is the depth at which specific MEC is consistently detected and what is the maximum depth of detection?
- What are the terrain, vegetation, and cultural conditions at the project site?
- What percentage of seeded items are required to be detected above noise threshold and selected above target threshold?

Common GPO Objectives can be, but are not limited to, the following. The GPO should:

- Test and evaluate geophysical technologies used under site-specific conditions at an MR site.
- Evaluate contractor competence in using their geophysical systems under site-specific conditions (terrain, vegetation, cultural items, geology).
- Demonstrate the capability to detect MEC of interest at the required depth.
- Establish QC criteria that are specific to the geophysical systems and how they are used to ensure that MEC of interest is detected.
- Test how the contractor implements their QC plan.

Typical Decisions

Depending on the objectives and needs of the GPO, one or more of the following decisions and outcomes from a GPO is typical:

- Is the contractor competent and thus approved to proceed with fieldwork?

- Are the pass/fail criteria for various QC tests properly defined? (Maximum line spacing, maximum allowable survey speed, thresholds for geophysical system noise, maximum allowable search radius for target acquisition etc.)
- Are initial anomaly selection criteria defined?
- Are depths defined at which specific MEC should always be detected?
- Are system-specific operating parameters defined, such as probability of detection?
- Is the system or operator certified?

5.3.2 Activities and Resources

Trained geophysicists should be used as a prime resource when setting up a GPO. Experienced technical specialists are invaluable when developing and implementing a GPO. In addition, it is important that the team developing the GPO is the same team that will be performing the proposed geophysical work later in the project. This includes not only the geophysical equipment and team members collecting the data, but also the personnel performing the data analysis and interpretation.

5.3.3 QC Monitoring during GPO operations

There are four distinct phases common to most GPOs that should be monitored by QC personnel:

5.3.3.1 Design Phase

During the design phase of the GPO, the primary measure of its quality will be whether the final GPO design addresses the stated project objectives. It is also critical to determine how depth will be measured (either to the most shallow burial point or to the center mass of the item) and defining the properties of items that will be buried to simulate MEC if inert MEC items are not available.

5.3.3.2 Construction Phase

Quality monitoring during the construction phase consists of ensuring that the GPO is constructed according to the agreed upon design. During construction, monitoring can include written records and photos of items buried which may include their depth, orientation, and number in accordance with the GPO design specifications.

5.3.3.3 Implementation Phase

The last phase of quality monitoring will assess the quality of the GPO report. The GPO report should address all aspects of the GPO design and data collected. The report should describe how the data was analyzed and interpreted. If the analysis and interpretation procedures deviated from those planned, the report should detail how the new approaches benefit the GPO objectives. The GPO report should clearly define quality standards that need to be assessed throughout the duration of full production work.

QC elements that may be defined or identified as required tests:

1. Basic instrument function tests to include:
 - a. background tests;
 - b. instrument response tests;
 - c. cable tests;
 - d. personnel interference tests;
 - e. repeatability tests
2. Common data collection practices such as:
 - a. monitoring navigation procedures;
 - b. minimizing instrument bounce and maintaining its horizontal orientation with the ground;
 - c. eliminating metal on the operator or instrument platform;
 - d. rigidly mounting positioning equipment and measuring offset between positioning device and geophysical sensor;
 - e. equipment synchronization
3. Minimum positioning accuracies and repeatability are defined and tested.
4. Effects of selected line spacing are evaluated, or multiple line spacing options are evaluated.
5. Sensor height above ground is evaluated.
6. Common corrections needed for the particular system have been applied, such as heading and diurnal corrections to magnetometer data, latency and offset corrections to positioning data, deleting data, and positioning spikes.

5.3.4 Quality Control Measures for the GPO

To evaluate the construction of the GPO, QC personnel can use a simple checklist that may include the following questions:

- Was a background survey required/performed?
- Were burial locations selected according to design specifications?
- Do the quantities of MEC or simulated MEC items meet design specifications?
- Does the GPO meet design specifications for:
 - o Geology?
 - o Cultural Interferences?
 - o Terrain Conditions?
 - o Vegetation conditions?
- For each planned MEC seed item, the following should be recorded:
 - o Nomenclature
 - o Inert or simulated
 - o Planned depth of item
 - o Planned orientation of item
 - o Do actual burial characteristics meet the GPO plan?

QC personnel should look for the following specifications when evaluating data collection aspects of the GPO:

- Are the instruments tested the same as those described in the GPO plan?
- Do the field procedures for the instrument use follow those described in the GPO plan?
- Are the evaluation parameters being tested for:
 - o Different line spacing?
 - o Different instrument heights?
 - o Different survey speeds?

5.4 Analog (Mag and Dig) Geophysics

“Mag and Dig” geophysics is a process by which analog geophysical instruments are used to detect subsurface anomalies. The terminology “Mag and Dig” can be misleading because either analog magnetometers or analog electromagnetic induction (EMI) equipment can be used to detect the subsurface anomalies. These anomalies are marked with a pin flag (typically) and all of these marked anomalies are then excavated to determine if they are MEC. In summary, an analog geophysical instrument will be used to locate the anomaly, anomaly location will be marked on the surface with a pin flag, and later, the anomaly will be excavated by trained UXO personnel to determine what is buried there.

“Mag and Dig” is different than DGM (Digital Geophysical Mapping) in that no digital data is recorded. Subsequently, every subsurface anomaly must be excavated to determine whether or not it is a MEC item. “Mag and Dig” operations can also be used in a heavily saturated area to achieve a “preliminary removal” of the majority of MEC and metal debris prior to digital geophysical mapping (DGM).

5.4.1 Requirements/Objectives

The objective of analog geophysics is to remove MEC from the MR site by locating and investigating all anomalies that are detectable with analog geophysical instruments. On heavily cluttered/contaminated MR sites, this is a very difficult task. Analog geophysics therefore is most effective on relatively “clean” MR sites with a small number of anomalies, or as a preliminary removal technique on a heavily saturated site.

Typical Decisions

- Is the site suitable for analog geophysics (little clutter) or is an analog surface removal necessary to facilitate DGM processes?
- What level of confidence that MEC is removed is required?
- Which type of magnetometer will be most effective on this site? Are EMI sensors required or are magnetometers adequate for this removal?

Key Factors in Decision-making

- Is the site small in size and lightly contaminated? (May be suitable for analog geophysics as a final removal action).
- Is the site heavily contaminated with MEC and debris? (Analog geophysics useful for preliminary removal only).

- Does the project require removal of non-ferrous metals? In this case, EMI sensors will be required possibly in addition to magnetometers.

5.4.2 Activities and Resources

Typically, analog geophysics is performed by dividing the work area into 5-foot wide search lanes, which are then surveyed by a UXO technician using the required analog geophysical sensor. The sensor is swung back and forth across this “lane” ensuring that the entire surface area is covered as the technician slowly advances down the lane. An analog signal (noise) indicates a metal anomaly, which the technician then investigates or marks for future investigation as appropriate.

5.4.3 QC Monitoring of “Mag and Dig” Operations

If the analog geophysics is being used for the final clearance of an MR site, QC monitoring is extremely imperative to establish a high degree of confidence in the MEC removal's effectiveness. Each technician involved in the operation has a different level of experience and hearing acuity and every hand-held geophysical instrument has slightly differing detection sensitivity. For these reasons, careful monitoring for compliance with the work plan is necessary to help control the numerous variables inherent to “mag and dig” operations. Subsequently, QC monitoring may need to be performed several times each day and may even be performed continuously by placing a QC observer with each team on a daily basis.

QC monitoring can be conducted during:

- The selection of personnel to ensure personnel are properly qualified
- Personnel training to ensure workers are properly trained
- Geophysical instrument check-out on at least a daily basis to ensure instruments used are performing at the level required to meet the project performance requirements
- Performances of work to ensure proper procedures are being followed.

Because of the many variables involved in analog geophysics, QC monitoring must often take place multiple times each work day and may even be performed continuously by placing a QC observer with each analog survey team on a full time basis.

5.4.4 Quality Control Measures for Analog Geophysics

- Personnel selection, training, and geophysical instrument checkout may be observed by QC personnel or, at a minimum, documented in writing with the documentation inspected by QC personnel. Observation of work activities must be documented in daily QC reports.
- A “blind seeding program” has proven to be an effective method to demonstrate that project objectives are being met and to increase confidence in the final product.

5.5 Anomaly Resolution

This stage can be broken into four major components:

- Anomaly reacquisition
- Anomaly excavation
- Post-Excavation procedures
- Resolution (resolving dig results with geophysical data)

5.5.1 Objectives and Requirements:

- Anomaly Reacquisition:
 - o Navigating to the anomaly location
 - o Confirm the anomaly's presence within the project-defined search radius
- Anomaly Excavation:
 - o Excavate the anomaly
 - o Document the findings
- Post-Excavation:
 - o Disposal of any MEC
 - o Handling of any MPPEH
 - o Site restoration (backfilling, etc)
- Resolution of dig results with geophysical data:
 - o Verify the excavated items adequately give explain the anomaly characteristics.
 - o Evaluate any inconsistencies (no-finds, no-contacts, "hot "rocks and or "geo").

Once the DGM process has produced a map of the site, or, in the case of analog geophysics, once the subsurface anomalies have been marked, anomaly resolution begins. UXO Technicians navigate to the anomaly location (DGM) or visit each marked item (mag and dig) to excavate the anomaly. The results of the excavation are recorded (item identification, depth, weight etc.). After segregating the item found for proper treatment and/or disposal, the excavation is normally backfilled and the site restored according to the WP specifications.

The Project Geophysicist will reconcile the dig results with the geophysical data to determine if what was found is consistent with what the data had predicted.

Typical Decisions

- Have the selected anomalies been reacquired?
- Are anomalies consistent with geophysical data?
- Are recovered items properly segregated?
- Are recovered items free of explosive hazard?
- Are MEC and MPPEH items handled/disposed of in accordance with WP?

Key Factors for Decision Making

- Do the actual items recovered meet the expectations of the geophysicists based on the geophysical data?
- Have all anomalies meeting selection criteria been investigated?
- Has all hazardous material been properly identified, segregated, inspected and properly handled or disposed of?

5.5.2 Activities and Resources

For DGM, a combination team of geophysicists and UXO technicians usually collaborate in the reacquisition of anomalies. The geophysicists will be responsible for locating the anomaly and the UXO technicians will provide UXO safety support. Reacquisition is a major point of potential error in DGM systems and should be closely monitored.

Once the anomaly is located and its exact position confirmed by the geophysicist, the UXO excavation team could excavate the anomaly.

Once excavated, the anomaly must be properly identified. All items are considered MPPEH until they are positively identified. MPPEH must be inspected by at least two highly experienced UXO technicians (Tech II and III) who MUST concur on the positive identification. If item is determined to be MEC, a decision will be made by the UXO technicians whether to move the MEC to another location for disposal or to destroy the item in place (BIP).

Other munitions debris (MD) and range-related debris is inspected and re-inspected to ensure that they are free of explosive hazards. MD and range-related debris are segregated, containerized, sealed under chain of custody procedures, and delivered to an approved scrap processor. Refer to EM 1110-1-4009 (USACE 2007) chapter 14 for a complete description of MEC and scrap handling procedures.

Anomaly hole should be re-inspected to ensure that no anomalies remain. It is possible to have more than one MEC item located at an anomaly site and a shallow item may mask a deeper item.

Following anomaly excavation, geophysical data will be compared to dig results by the project geophysicist. This “feedback process” verifies that the item recovered adequately explain the anomaly characteristics in the geophysical data. It is possible that navigation or other errors in the field will cause the excavation team to dig up the wrong anomaly. The geophysicist should be able to identify this while reconciling the data. If not, a root-cause analysis can be performed and trends noted if numerous anomalies do not match the items excavated. Possible causes of this error are:

- Navigation errors (team digging in wrong location).

- Excavation team digging the wrong anomaly due to searching too wide of a radius from the initial location in an attempt to locate a false positive anomaly (error in geophysical data).

5.5.3 How and Where to Monitor

Monitoring of MEC and MPPEH disposal is important because it is a critical interface between the project site and the scrap disposal operation, which is usually located off-site in the community. Unfortunately, improperly classified “scrap” containing explosives delivered to recycling facilities has resulted in injuries and death. This process must be tightly controlled, monitored, and documented to prevent future incidents. EM 1110-1-4009 (USACE, 2007) chapter 14 provides a complete description of procedures for MPPEH inspection, certification, and disposition including required QC/QA checks by contractor personnel.

As mentioned previously, data analysis provided by the project geophysicist can be an invaluable tool in quality monitoring of the process and of the final product.

5.5.4 Quality Control Measures for the Anomaly Resolution Process

- Excavated locations (at least a percentage) should be evaluated by QC personnel to ensure that they meet the project criteria using detection tools that have the same detection capabilities as the original geophysical system. Areas that still present a geophysical response shall be documented with an explanation.
- Any blind seed items emplaced in the searched area will have been discovered and identified. If this is not the case, the cause of the failure to retrieve them should be investigated and documented.
- Scrap and MPPEH from the MR site should be managed and documented in accordance with EM 1110-1-4009 (USACE 2007), DOD Instruction 4160.21.M-1, Defense Demilitarization Manual (DoD 1991), and DoD Instruction 4140.62 Management and Disposition of Material Potentially Presenting an Explosive Hazard (DoD) 2004). Scrap requires 100% inspection and a 100% re-inspection of all MPPEH prior to release to a scrap recycler and these procedures must be clearly and accurately documented by QC personnel.
- Inconsistencies between reported findings and anomaly characteristics should be resolved with the assistance of the project geophysicist. Anomalies, which have characteristics inconsistent with dig team findings, may need to be revisited at the discretion of the geophysicist and/or QC personnel.

5.6 Verification Sampling

Verification sampling is a statistical sampling method used for post-remediation verification that project objectives have been met. Verification sampling should be

performed by the contracting authority (or their representative) to determine acceptance or rejection of the finished product.

5.7 Objectives and Requirements

Sampling often involves performing an independent geophysical survey of a portion of the completed project. Presence of a “non-conforming condition” during this survey such as remaining MEC or other items that should have been removed may be possible cause for requiring a rework of all or part of the area.

Some clients feel that verification sampling is not absolutely required on all types of projects. A well-executed QC program that practices spot checks, surveillance and implements a blind seeding program may be sufficient verification for some clients. The decision to include a verification-sampling program should be made in the project planning process.

Typical Decisions

- Should verification sampling be used as criteria for accepting completed areas of the MR project?
- How will the areas to be sampled be selected?
- How much of each area should be sampled and why is that an appropriate amount?
- Will the inspection be DGM or Mag and Dig?
- What constitutes a “non-conforming condition”?
- How will “non-conforming conditions be addressed?
- How much confidence in the quality of the completed project is necessary for future land use?
- How much sampling will be needed to increase confidence in the completed project to an acceptable level?

5.7.1 Activities and Resources

Verification sampling is usually performed by an independent “QC geophysics team” or possibly an independent contractor. This prevents any conflict of interest between the production managers (who are concerned with time and budget issues) and the QC managers (whose main concern is a quality product that meets project requirements. Generally, the verification samples will be conducted using the same type of instrumentation used when the work was performed.

5.7.2 How and Where to Monitor

For DGM surveys, verification sampling is accomplished by performing an independent geophysical survey on an agreed-upon inspection area. A random number generator may be used to select an appropriate number of lanes to be resurveyed.

QC team will locate the selected lanes to be resurveyed, collect geophysical data, and process the data to determine any anomalies to be investigated. Once

the anomalies are excavated, it can be determined whether items found constitute a “non-conforming condition”. If such a condition exists, corrective actions such as “root cause analysis” or rework of the area may be necessary.

For “Mag and Dig” operations, verification sampling is usually performed by walking over the area to be inspected while searching for anomalies with the same type hand-held instrument used in the original survey. Specific search patterns may be used such as an X pattern wherein the QC team covers the perimeter of the inspection area and two diagonal sweeps across the center forming an X. It is often advisable to survey in the opposite direction that the initial survey was done, as some anomalies are easier to detect depending on how they are approached with the magnetometer.

5.7.3 Common Quality Control Measures

It is possible that the project team will decide to perform little or no verification sampling. In this case, it is expected that the process QC will be adequate to ensure that the project goals will be achieved to a level that adequately develops stakeholder confidence in the project results.

If verification sampling is performed:

- The method of verification is included in the QC plan along with pass/fail criteria and procedures in the event of a “non-conforming condition”.
- Verification sampling is performed as planned by an independent team or contractor.
- Identified anomalies, which may represent “non-conforming conditions”, are excavated. (These can include MEC or other objects that should have been identified and removed)
- If the verification sampling reveals no “non-conforming conditions”, the area inspected will be accepted as meeting project objectives.
- If the results of the verification sampling are positive for “non-conforming conditions” appropriate corrective action must be taken. This may include a rework of all or part of the inspection area.

In the best QC program and work plan, situations will arise in which requirements are not/cannot be met. The individual who discovers or causes a departure from requirements has the responsibility to report it to their supervisor who should submit a non-conformance report if he/she deems it appropriate in the situation. All employees must be aware of how important it is that any departure from standards be recorded, reviewed, and approved by the proper authority. **Every effort must be made to correct the non-conformance before initiating a modification to requirements request.** Whether the solution involves correcting the deficiency or getting approval to modify requirements from a proper authority, the QC mechanism should create a document (non-conformance report) that documents the non-conformance, root cause analysis, corrective actions, and/or approved departures.



Sample Identification, Handling, Documentation, Shipping, and Tracking

Standard Operating Procedure

HDR - MMRP 400

Revision 2.6

Date of Issue: August 24, 2010

Revised: May 28, 2015

Approved by:

A handwritten signature in black ink, appearing to read 'Emily J. Munoz'.

Emily Munoz, Environmental
Scientist

Date: 5/28/2015

Approved by:

A handwritten signature in blue ink, appearing to read 'John Coughlin'.

John Coughlin, MMRP Program
Manager

Date: 5/28/2015



This page intentionally left blank



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
9781 S Meridian Boulevard, Suite 400
Englewood, CO 80112

Revisions:

Date	Revision Number	Author	Description
8/24/2010	1.0	Meg Watson, Larry deVries	First Release
12/15/2010	1.1	J. Gustafson	Format only, no content changes
3/2/2011	2.0	Nicole Luke/Jan Gustafson	Signatures obtained, grammar changes, added URL of SOPs, updated title of UFP-QAPP
4/11/2012	2.1	Wenona Wright	Formatting changes only
10/17/2012	2.2	CW, PW, JS	Added signature
3/4/2012	2.3	NI, CW, CP	Added sample nomenclature
7/31/2013	2.4	CP	Revised Sample Nomenclature /format
5/28/2015	2.5	DJ	Signatures, logos
5/28/2015	2.6	EM	Revised sample naming convention, other minor edits, signature

Related Documents:

Document Name	Description	Document Reference



This page intentionally left blank



1.0 Purpose and Scope

This Standard Operating Procedure (SOP) defines the procedures for the identification, handling, documentation, shipping, and tracking of environmental samples collected at various sites. These procedures are intended to be used together with the field methods presented in the site-specific Work Plan, the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) and other SOPs. Applicable SOPs are listed below.

2.0 Applicable Documents

2.1 Associated Documents

HDR MMRP-100	Characterizing Metals in Soil Using XRF Spectrometry
HDR MMRP 200	Visual Surveys
HDR MMRP 300	Soil Sampling

3.0 Sample Identification

This section describes a standardized method to identify samples collected in the field. Topics discussed include sample nomenclature, Quality Control (QC) samples and sample labeling.

3.1 Sample Nomenclature

Samples collected during field activities will be assigned a unique alpha-numeric identification code. Alpha-numeric codes will identify the installation/project name, site location, media type and sample location number. Each of the fields in bold are separated by a dash and arranged according to the convention found in **Table 1**.

Table 1 Sample Nomenclature

Project Identifier (3-5 Characters)	Designates the project location and consists of an abbreviation of the installation or facility name (e.g., EXAFB for Example Air Force Base).
Site Location: (2-6 Characters)	Designates the sampling site; consists of an abbreviation of the site name (e.g., FSAR for Former Small Arms Range), a programmatically designated ID code (e.g. an MRS ID designated under the MMRP), or a project specific code designated for each site, e.g.: BG = Background 01 = Sampling Site #1 02 = Sampling Site #2, etc.
Media Type: (2-3 Characters)	Designates the sample media: GW = Ground Water Sample SW = Surface Water Sample SD = Sediment Sample EB = Equipment Blank SS = Surface Soil (0-6 inches) *SB1 = Subsurface Soil (6-12 inches) *SB2 = Subsurface Soil (12-18 inches)
Sample Number: (3-4 Characters)	Designates the sample location, may be sequentially numbered as the samples are collected or designated prior to sampling.
<i>Example:</i>	Sample ID: <i>EXAFB-FSAR-SS-001</i> Description: <i>The first surface soil sample collected from the Former Small Arms Range site at Example Air Force Base.</i>

Details regarding specific coding selected for particular sites will be presented in the site-specific Work Plan. Any sample nomenclature described in the site-specific Work Plan supersedes the nomenclature described in this SOP.

3.2 Quality Control (QC) Samples:

Field Duplicate – Remove the Sample Number and replace it with DUPX, where X represents a sequential number. The duplicate sample will be blinded by altering the sample time (e.g., add 15 minutes) or omitting the sample time. The duplicate pair will be identified in the field notes.

Duplicate sample ID (from example above): EXAFB-FSAR-SS-DUP1

Matrix Spike / Matrix Spike Duplicate - MS / MSD will be written on the sample label and documented on the Chain of Custody (COC). The MS / MSD notation is not considered a field within the alpha-numeric sample ID.

3.3 Sample Labeling

Sample labels should be either pre-printed or filled out as completely as possible prior to beginning field sampling activities each day. The date, time, and sampler's initials should not be completed until the time of sample collection. All sample labels shall be filled out using waterproof ink. At a minimum, each label shall contain the following information:

- Sampler's company affiliation;
- Project;
- Sample identification;
- Date and time of sample collection;
- Analyses required;
- Method of preservation (if any) used;
- Sample matrix (i.e., soil, groundwater, surface water);
- Sampler's signature or initials.

An example of a sample label is shown in **Figure 1**.

Figure 1 Example Sample Label



Sample ID: _____

Location: _____

Sample Date/Time: _____

Analysis Required: _____

Preservative: _____

Matrix _____

Project: _____

Sampler's
Name/Initials: _____

* Example only: Labels may be provided by the contracted laboratory.

4.0 Sample Handling

This section discusses proper sample containers, preservatives, and handling and documentation procedures. The site-specific UFP-QAPP will include the information contained in this section and also includes the sample holding times for each analyst.

4.1 Sample Containers

Certified, commercially clean sample containers shall be obtained from the contract analytical laboratory. The contract laboratory may label the bottles to indicate the type of sample to be collected. Chemical preservatives (if required) shall be prepared and placed in the bottles at the laboratory prior to shipment to the site. Appropriate sample containers, preservatives, and storage conditions for the specific analyses required will be listed in the Work Plan.

Note: Soil samples for explosives and/or lead only may be stored in plastic storage bags.

4.2 Sample Collection

When collecting environmental samples follow these general guidelines; details regarding sample collection are presented in the Work Plans and other SOPs:

- Collect sufficient sample volume;
- Allow proper headspace in all samples (except for those collected for volatile organics analysis) to allow for expansion and contraction due to temperature and pressure changes;
- Make sure all container lids are secure and tight;
- Affix completed label to sample container;
- Document sample on Chain of Custody (COC) and Field Sampling Form and/or logbook;
- Place a strip of clear packing tape over label to prevent damage or accidental removal;
- Wrap glass sample containers in bubble wrap to prevent breakage;
- Properly store sample immediately after collection (i.e. place the sample in a cooler on ice).

4.3 Sample Preservation

Sample preservation efforts shall commence at the time of sample collection and will continue until analyses are performed. Preservation includes chemical additives (acids or bases for pH adjustment) and physical adjustments (cooling or storage in darkness). Samples collected for off-site laboratory analysis will be stored on ice at 4 ± 2 degrees Celsius ($^{\circ}\text{C}$) in coolers immediately following collection. Additional sample preservation requirements will be given in the UFP-QAPP. Chemical preservatives, if necessary, shall

be added to the sample containers by the laboratory prior to shipment to the field, unless otherwise specified in the QAPP.

5.0 Sample Documentation

This section describes documentation required in the field notes and on the sample COC forms.

Documentation of observations and data acquired in the field will provide information on the acquisition of samples and also provide a permanent record of field activities. The observations and data will be recorded using pens with permanent waterproof ink in a permanently bound field logbook containing consecutively numbered pages or on field sampling data sheets.

The information in the field logbook, forms or data sheets will include the following as a minimum:

- Project name;
- Location of sample;
- Sampler's printed name and signature;
- Date and time of sample collection;
- Sample identification code;
- Description of samples (matrix sampled);
- Sample depth (if applicable);
- Number and volume of samples;
- Sampling methods or reference to the appropriate SOP;
- Sample handling, including filtration and preservation, as appropriate for separate sample aliquots;
- Analytes of interest;
- Field observations;
- Results of any field measurements, such as depth to water, pH, temperature, and conductivity;
- Personnel present;
- Photographs taken.

Changes or deletions in the field logbook should be lined out with a single strike mark, initialed and dated while remaining legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without relying on the sampler's memory. Anyone making entries in another person's field logbook or form will sign and date those entries.

During field sampling activities, traceability of the sample must be maintained from the time that the samples are collected until laboratory data is issued. Initial information concerning collection of the samples will be recorded in the field logbook or form as described above. Information on the custody, transfer, handling, and shipping of samples will be recorded on a COC form. The COC includes a section for required signatures which documents the possession and transfer of the samples from the time of collection to receipt by the laboratory.

The COC will contain the following information:

- Sampler's signature and affiliation;
- Project contact information;
- Project number;
- Date and time of collection;
- Sample identification number;
- Sample type/media;
- Number and type of containers;
- Analyses requested;
- Method of shipment;
- Shipping air bill number (if appropriate);
- Laboratory address;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times.

6.0 Sample Shipping

After collection, sample labels will be completed as described in **Section 3.3** and samples stored on ice at $4\pm 2^{\circ}\text{C}$ (if required) in an insulated cooler. Ice, if required, will be double bagged in plastic zipper-lock storage bags.

Follow the following guideline for packing samples:

- Inspect shipment cooler for damage and seal drains with duct tape;
- Line bottom of cooler with sorbent liner and packing material;
- Place a heavy-duty plastic bag in the cooler to contain the samples and ice;
- Place the prepared sample containers (wrapped in protective packing material such as bubble wrap) right side up in the cooler;
- Place a temperature blank in the bottom of the cooler with the samples, if temperature control is required;
- Add sufficient double-bagged ice to maintain a temperature of $4\pm 2^{\circ}\text{C}$, if temperature control is required;
- Seal the heavy-duty plastic bag by twisting and tying or twisting and taping;
- Place the COC form in a zipper-lock storage bag and tape to the underside of cooler lid;
- Close lid and seal with strapping tape. Wrap strapping tape all the way around the cooler;
- Place signed and dated custody seal vertically across the opening of the cooler;
- Affix shipping documents/label to top of cooler.

Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory whenever possible. All samples must be shipped for laboratory receipt and analyses within specific holding times. This may require daily overnight shipment of samples with short holding times. Samples for Saturday delivery will be arranged with the laboratory prior to shipment and will be appropriately labelled for "Saturday Delivery." A COC form will accompany each cooler shipment. The temperature of all coolers will be measured upon receipt at the laboratory, if temperature controlled samples are shipped. Temperature control of the

cooler will be assessed by measuring the temperature blank which will be placed in the cooler prior to shipment.

The sample holding time is defined as the maximum allowable time between sample collection and analysis or extraction based on the analytes of interest, stability factors, and preservatives (if any) used. The holding time is defined by the analytical method used for analysis. Allowable holding times for each requested analysis will be provided in the UFP-QAPP. Samples should be shipped to the laboratory as soon as possible after collection by overnight courier service to minimize the possibility of exceeding holding times.

7.0 Sample Tracking

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain a copy of the COC form, document the method of shipment, and send the original COC form with the samples.

It is recommended that only sample couriers with traceable air bills be used to ship samples. By using this type of courier the coolers may be tracked during shipment by using the air bill number and contacting the courier. Any problems or delays may be addressed quickly and the laboratory may be notified of any issues regarding delivery.

Upon receipt at the laboratory, the person receiving the samples will sign the COC form and return a copy to the Project Manager. Copies of the COC forms documenting custody changes and all custody documentation will be received and kept in the central files. The original COC Forms will remain with the samples until final disposition of the samples by the laboratory. The analytical laboratory will dispose of the samples in an appropriate manner, 60 to 90 days after data reporting. After sample disposal, a copy of the original COC will be sent to the Project Manager by the analytical laboratory to be incorporated into the central files.



This page intentionally left blank



Site Permits, Notifications, and Utility Clearance

Standard Operating Procedure

HDR - MMRP 700

Revision 1.5

Date of Issue: March 2, 2011

Revised: May 28, 2015

Approved by:


John Coughlin, MMRP Program Manager

Date:

5/28/2015

Approved by:



Rob Irons, UXO Quality Control Specialist

Date:

5/28/2015



This page intentionally left blank



Document Information

Document Owner:

HDR Environmental, Operations and Construction, Inc.

Prepared By:

HDR Environmental, Operations and Construction, Inc.
9781 South Meridian Boulevard, Suite 400
Englewood, CO 80112

Revisions:

Date	Revision Number	Author	Description
3/2/2011	1.0		First Release
4/12/2012	1.1	Wenona Wright	Formatting changes only.
10/17/2012	1.2	PD, RI, JS	Added Signatures
4/2/2013	1.3	NL, RI, JS	Revised Signature Block
4/16/2013	1.4	Justin Bills	Changed Logo
5/27/2015	1.5	D J	Updated SOP to expand applicability beyond AF

Related Documents:

Document Name	Description	Document Reference



This page intentionally left blank



1.0 Purpose and Scope

This document defines the Standard Operating Procedure (SOP) for obtaining permits and clearances. Permits and clearances are required for underground utilities (drilling, hand auguring, excavating, etc.), for property security, and for use of hot equipment such as welders and steam cleaners.

2.0 Definitions

Anomaly Avoidance - Field procedure which personnel avoid potential surface Munitions of Explosive Concern (MEC) and any subsurface anomalies during field activities.

Plan of the Day - Either a formal (paper form) or informal (discussion) of the daily activities planned for the field crew, including but not limited to; specific location, expected duration of work, personnel on-site, description of field activity, vehicles and equipment list, and anticipated departure from site.

3.0 Contractor Badges, Vehicle Passes and Camera Passes

3.1 Contractor Identification and Notifications

Prior to the initiation of each field investigation, HDR personnel and all subcontractors on-site (HDR Team) will be identified to the property owner Environmental Manager (EM) or an alternate contact, as identified by organization chart presented in the specific project work plan. The EM will make all arrangements to notify property personnel and/or security (if applicable) of the pending field investigation. In addition to notifying the EM, all personnel and subcontractors are required to attend a safety briefing provided by the EM, if applicable.

Procedures for daily arrival on-site may include notification by phone of entrance on-site, signing in at a designated visitor area, or presenting the EM with the plan of the day in person. The plan of the day should provide information regarding the location of field work, duration of field work, personnel on-site, etc.

Photo identification badges or temporary visitor passes may be issued by the site facility. Ensure that all HDR Team personnel have all the required personnel identification in their possession when they arrive on-site.

3.2 Vehicle Passes

All vehicles that enter the property may need to be registered under property-specific protocol and obtain and display a vehicle permit tag, if required, before entering the property. The vehicle registration applicant will need to furnish proof of insurance, rental agreement (if applicable), and a valid driver's license. Additional site access requirements are possible, and staff, rental vehicles, and subcontractors and their vehicles will adhere to access requirements presented by the property owner. Confirm



that all Rights of Entry requirements for vehicles, personnel, and activities are met prior to entering the property.

Some properties have restrictions regarding the possession and use of photographic equipment on-site, and/or in certain restricted areas. The HDR Team Field Lead will ensure that the appropriate clearance/approval is obtained by the property, and that all field crew are properly instructed on the use of cameras and limitations or restrictions thereof.

3.3 Utility Clearance

Generally, “subsurface” depths are considered to be greater than one foot. Utility locates or excavation permits may be required anytime subsurface sampling or excavations are conducted.

Dig permits, or a documented response that dig permits are not required, will be obtained for all subsurface activities prior to initiating the work. Dig permits will be obtained in accordance with procedures established by the property owner. When any intrusive work is being performed in the vicinity of utility and/or communication cables/lines, One Call utility clearances will be completed. No mechanical digging will be performed within 5 feet on either side of utilities and/or communication line(s) until they are physically exposed by hand digging. If a utility and/or communication line is damaged, the designated representative of the property owner will be notified immediately for further directions.



MICROBAC SOP #: HPLC06
PAGE: 1 of 30
REVISION: 4

**STANDARD OPERATING PROCEDURE
PERCHLORATE
METHOD 6850/331.0**

Issue/Implementation Date: 15 April 2012

Last Review Date: 15 September 2012

Microbac Laboratories, Inc.
Ohio Valley Division
158 Starlite Drive
Marietta, Ohio 45750

Approved by:



Michael D. Cochran, Semi-Volatile Supervisor

9/6/12

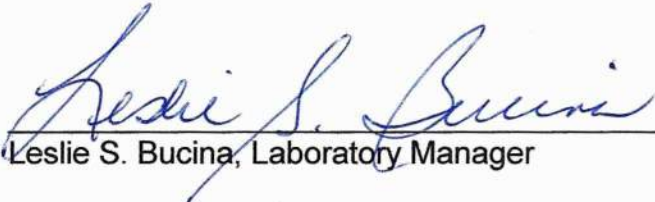
Date



Wade T. DeLong, Quality Assurance Officer

9-7-2012

Date



Leslie S. Bucina, Laboratory Manager

9/7/12

Date



TABLE OF CONTENTS

<u>SECTION</u>	<u>Page</u>
1.0 Scope and Application	3-4
2.0 Safety Precautions	4
3.0 Sample Preservation and Storage	4
4.0 Method Performance	4-5
5.0 Interferences and Corrective Action.....	5
6.0 Equipment and Supplies	5-6
7.0 Standards and Reagents	6-7
8.0 Sample Preparation	8-10
9.0 Calibration Procedures.....	10-11
10.0 Analytical Procedures	12
11.0 Details of Calculation.....	12-15
12.0 Quality Control Requirements.....	16-18
13.0 Data Review and Reporting Requirements	18
14.0 Preventive Maintenance.....	19
15.0 Waste Management and Pollution Control	19
16.0 References	20
Appendices.....	21-23
Tables.....	24-28
Figures.....	29-30



1.0 SCOPE AND APPLICATION

1.1 This method is utilized for the analysis of perchlorate (ClO_4^-) in water and soil samples using High Pressure Liquid Chromatography combined with Tandem Mass Spectrometry. The procedures in this method are based on EPA method 6850 and have been modified based on the Department of Defense Perchlorate Handbook. Modifications to this SOP for the analysis of Method 331 can be found in Appendix I.

1.2 After preparation, samples are injected onto the HPLC for separation, after which the perchlorate is introduced to the first mass spectrometer and fragmented for detection in the second mass spectrometer. Water samples are a direct aqueous injection after filtration. Soil samples are prepared by vortex and sonication prior to filtration and analysis.

1.3 Definitions and Acronyms

The following is a list of terms, definitions, and acronyms referenced in this SOP that are unique to the method.

CCV	Continuing Calibration Verification
DoD	Department of Defense
HPLC	High Pressure Liquid Chromatography
ICS	Interference Check Sample
ICV	Initial Calibration Verification
LCS	Laboratory Control Sample
LCSD	LCS Duplicate
LOD	Limit of Detection
LODV	Limit of Detection Verification
LOQ	Limit of Quantitation
MB	Method Blank
MCT	Method Conductivity Threshold
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheets
MS/MS	Tandem Mass Spectrometry
NCR	Non Conformance Report
QA	Quality Assurance
QC	Quality Control
RL	Reporting Limit
SOP	Standard Operating Procedure



For a more comprehensive list of common terms and definitions, consult Appendix A in Microbac SOP LQAP.

2.0 SAFETY PRECAUTIONS

- 2.1** Concentrated standards and acetonitrile are used in this method. Contact with these chemicals must be minimized. Working under a functioning vent hood and proper safety equipment such as gloves, lab coat, and safety glasses will normally provide adequate protection from contact. The MSDS should be consulted if questions about safe handling on a particular chemical requires additional personal protective clothing.

3.0 SAMPLE PRESERVATION AND STORAGE

- 3.1** Water samples are collected in 125 mL polyethylene bottles and should be stored with headspace to reduce anaerobic biodegradation. No preservation is required.
- 3.2** Soil samples are collected in 4 oz amber glass bottles.
- 3.3** Soil samples must be extracted within 28 days of collection and analyzed within 28 days of preparation. Water samples must be analyzed within 28 days of collection.
- 3.4** Samples are stored at $\leq 6^{\circ}\text{C}$.

4.0 METHOD PERFORMANCE

- 4.1** Table 1 summarizes the performance data for water analysis; Table 2 summarizes performance data for soil analysis. These tables include ranges for accuracy and precision, nominal laboratory RLs, and the current laboratory MDLs.
- 4.2** The laboratory performed an initial assessment of the MDL using the procedures outlined in 40 CFR Part 136. Results are filed electronically at H:\DATA\COMMON\MDL.
- 4.3** The LOD, or verified MDL, are presented in Tables 1 and 2 and were established using verification procedures outlined in Microbac SOP 45.



- 4.4 The LOQ are the nominal laboratory RLs and were established as per Microbac SOP 45.
- 4.5 Precision and accuracy data were derived from an initial demonstration of capability using spiked control samples. The laboratory uses results from LCS to assess precision/accuracy and to annually evaluate the associated control limits.

5.0 INTERFERENCES AND CORRECTIVE ACTION

- 5.1 All possible measures are taken to eliminate interferences from glassware and other equipment. Possible interferences from this source include artifact peaks and elevated baselines.
- 5.2 Only HPLC grade solvents are used.
- 5.3 All samples are filtered through 0.45 um filters to remove particulates that may damage the column and instrumentation.
- 5.4 If competing ions are present in samples at sufficient concentrations, they may take up active sites on the column and cause perchlorate to elute earlier than in the calibration standards; the internal standard peak will also shift and can be used to confirm the identification of the perchlorate peak.
- 5.5 If high concentrations of total dissolved solids are present in samples, ionization suppression may occur in the mass spectrometer, resulting in reduced peaks for perchlorate and the internal standard. A Matrix Conductivity Threshold study is performed to determine the concentration at which suppression occurs and samples are diluted accordingly.

6.0 EQUIPMENT AND SUPPLIES

- 6.1 Major Instrumentation
 - 6.1.1 High performance liquid chromatograph: Shimadzu Prominence UFLC XR
 - 6.1.2 Analytical column: K' (Prime) Technologies, Inc. reversed-phase HPLC column, 4 x 250mm (KP-RPPX250).
 - 6.1.3 Mass spectrometer system: Applied Biosystems API-4000 triple quadrupole mass spectrometer with Turbolonspray probe.



- 6.1.4 Data system: Applied Biosystems Analyst software running with a Microsoft Windows platform
- 6.1.5 Nitrogen generator: Parker NitroFlowLab
- 6.2 Apparatus or Equipment**
 - 6.2.1 Syringe pump: New Era Pump Systems NE-300 for use in mass calibration.
 - 6.2.2 Hamilton 1001TLL 1 mL syringe, for use with syringe pump
 - 6.2.3 Pipetter
 - 6.2.4 Conductivity meter
 - 6.2.5 Sonic bath: VWR Model 50T or equivalent
 - 6.2.6 Analytical balance
 - 6.2.7 Centrifuge
 - 6.2.8 Vortexer
 - 6.2.9 Centrifuge tubes – 15 mL and 50 mL
 - 6.2.10 10 mL disposable syringes
 - 6.2.11 PTFE syringe filters 25 mm x 0.45mm

7.0 STANDARDS AND REAGENTS

- 7.1 All purchased stock standards and reagents are logged into the LIMS system and assigned certificate of analysis (COA) numbers. All intermediate and working solutions are similarly logged into the LIMS and assigned STD or RGT numbers. Detailed information regarding solution concentrations, aliquot volumes and final volumes and concentrations are included under the STD or RGT number.
- 7.2 HPLC grade water (J.T. Baker 4218-03 or equivalent)
- 7.3 Deionized (DI) water (ASTM Type 2 or better)



- 7.4 HPLC grade acetonitrile (J.T. Baker 9017-03 or equivalent)
- 7.5 Perchlorate standard: A 1000 ug/L stock standard is prepared by diluting 100 uL of a 1000 ug/mL perchlorate standard (Ultra ICC-013-5) in 100 mL of DI water.
- 7.5.1 A 10 ug/L intermediate standard is prepared daily from the 1000 ug/L stock standard by diluting 100 uL in 10 mL of DI water.
- 7.5.2 A minimum of 5 calibration standards are required, with the lowest standard at a concentration at or below the LOQ. Working calibration standards are prepared from the stock standard using the following scheme:
- | | |
|----------|---|
| 10 ug/L | (intermediate standard) |
| 5.0 ug/L | (500 uL intermediate standard: 500 uL DI water) |
| 2.0 ug/L | (200 uL intermediate standard: 800 uL DI water) |
| 1.0 ug/L | (100 uL intermediate standard: 900 uL DI water) |
| 0.5 ug/L | (100 uL 5.0 ug/L standard: 900 uL DI water) |
| 0.2 ug/L | (100 uL 2.0 ug/L standard: 900 uL DI water) |
| 0.1 ug/L | (100 uL 1.0 ug/L standard: 900 uL DI water) |
- 7.6 Second source standard: A 1000 ug/L stock standard is prepared by diluting 100 uL of a 1000 ug/mL perchlorate standard (Accustandard IC-PER-10X-1) in 100 mL of DI water.
- 7.6.1 The working alternate source standard at 1.0 ug/L is prepared by diluting the alternate source stock as in Sections 7.5.1 and 7.5.2 above.
- 7.7 Internal standard: O18 labeled perchlorate ($\text{Cl}^{18}\text{O}_4^-$) purchased from Dionex (062923) at 1000 ug/L. Every working calibration standard and sample is spiked with this solution in the ratio of 50 uL internal standard: 10 mL sample, yielding a final concentration of 5 ug/L.
- 7.8 ICS solution: Dissolve 4 g NaCl, 3.72 g Na_2SO_4 , 4.4 g Na_2CO_3 in 100 mL of DI water. Dilute 11 mL of this solution in 200 mL of DI water to yield a final conductivity of approximately 10,000 uS/cm. Verify the conductivity with a conductivity meter.
- 7.9 The internal standard solution is stored at $\leq 6^\circ \text{C}$. All other standards are stored at room temperature.



8.0 SAMPLE PREPARATION

8.1 Samples are prepared in batches of up to 20 (twenty) field samples using the following procedures:

8.2 Water samples

8.2.1 Pour approximately 30-50 mL of sample into a disposable cup and measure the matrix conductivity of the sample using a conductivity meter.

8.2.2 Filter 5-10 mL of sample using a plastic syringe and 0.45 um nylon filter into a 15 mL disposable centrifuge tube.

8.2.3 Transfer 1 mL of sample into an autosampler vial, add 5 uL of internal standard, cap and shake well. If the conductivity measurement is >10,000 uS/cm, prepare a dilution using reagent water to achieve an acceptable level of conductivity (see 10.6).

8.2.4 With each preparation batch, include a method blank, LCS and MCT/ICS. The method blank and LCS are prepared using 10 mL of reagent water. The MCT/ICS is prepared using 10 mL of MCT solution. The LCS and MCT/ICS are spiked with 0.2 mL of the 10 ug/L intermediate standard. The blank, LCS and MCT/ICS are filtered in the same manner as field samples.

8.2.5 If a MS/MSD is included in the sample batch, they are spiked in the same manner as the LCS. If no MS/MSD are included, prepare an LCSD sample.

8.3 Soil samples

8.3.1 Sample Homogenization

8.3.1.1 Remove the sample bottle contents and place in tray lined with aluminum foil.

8.3.1.2 Mix sample with an inert rod or scoop and break up lump. Remove all large stones, sticks, leaves, etc. Do not overmix the sample.

8.3.1.3 Obtain representative sample either by random removal of 3-10 portions of the sample from the pan or by using a "standard" scoop designed to retrieve a linear cross-section of the pan contents.

8.3.1.4 The analyst will not attempt to target an exact weight once a method specified minimum amount is weighed.



- 8.3.1.5 The remaining sample will be returned to the sample container.
- 8.3.2 Weigh 5.0 g of homogenized sample into a tared 50 mL centrifuge tube and record the weight. Add enough reagent water to the tube to bring the total volume to 50 mL and add 250 uL of internal standard 018LP.
- 8.3.3 Invert 2-3 times to mix, then place in an ultrasonic bath for 30 min, then invert again.
- 8.3.4 Centrifuge the sample for 10 min to separate solids from the extract solution.
- 8.3.5 Transfer the extract into a 15 mL glass screw-cap vial and label.
- 8.3.6 Filter 5-10 mL of sample using a plastic syringe and 0.45 um PTFE filter into a 15 mL disposable centrifuge tube. Measure the matrix conductivity of remaining extract. If the conductivity measurement is > 10,000 uS/cm, prepare a dilution solution by adding 250 uL of internal standard 018LP to 50 mL of reagent water in a 50 mL centrifuge tube. Use this dilution solution to prepare a dilution on the sample extract to achieve an acceptable level of conductivity.
- 8.3.7 Transfer 1 mL of sample into an autosampler vial, cap and shake well.
- 8.3.8 With each preparation batch, include a method blank and LCS using 5.0 g lab sand spiked with 250 uL of internal standard. The LCS is also spiked with 1 mL of the 10 ug/L intermediate standard. The blank and LCS are filtered in the same manner as field samples.
- 8.3.9 If a MS/MSD is included in the sample batch, they are spiked in the same manner as the LCS. If no MS/MSD are included, prepare an LCSD sample.
- 8.3.10 Soil extract cleanup
- 8.3.10.1 If soil extracts are not clear or are highly colored, there may be large quantities of organic contaminants present. These may be removed using a C₁₈ column and the following procedure.
- 8.3.10.2 Activate the C₁₈ column by pushing approximately 5 mL of methanol through the column, followed by 5 mL of reagent water at a flow rate of approximately 0.5 mL/min. Do not let the column become dry.
- 8.3.10.3 Gently push approximately 6 mL of the extract through the column. Discard the first 2 mL and collect the remainder for analysis.



- 8.4 ICS: With each preparation batch, spike a 5.0 g lab sand sample with 1 mL at the 10 ug/L intermediate standard and bring to a 50 mL final volume with the ICS solution.
- 8.5 If samples are not analyzed immediately after preparation, they should be stored at room temperature with headspace until analysis can proceed.

9.0 CALIBRATION PROCEDURES

- 9.1 Mass tuning: the MS/MS system is optimized for detection of m/z ratios 83 (ClO_3^-), 85 ($^{37}\text{ClO}_3^-$) and 89 ($\text{Cl}^{18}\text{O}_3^-$), using a syringe pump and the manufacturer's instructions.
- 9.2 A laboratory reagent blank, prepared by spiking 10 mL of DI water with 50 uL of internal standard, is analyzed to assess the cleanliness of the system under these circumstances:
- 9.2.1 Prior to initial calibration.
- 9.2.2 After every 10 field samples.
- 9.2.3 Following samples found to have perchlorate concentrations above the calibration range (unless the instrument is running unattended).

In all cases, the concentration of perchlorate in the reagent blank must be $<1/2$ of the RL. If not, the blank must be reanalyzed until this criteria is met. Field samples not bracketed by passing reagent blanks must be reanalyzed.

9.3 Initial calibration

9.3.1 Initial calibration recommended conditions:

9.3.1.1 HPLC system:

Mobile phase: 47% H_2O /0.1% acetic acid: 53% Acetonitrile/0.1% acetic acid
Injection volume: 10 uL
Flow rate: 0.5 mL/min

9.3.1.2 Mass spectrometer:

Interface: Turbospray ion source
Curtain gas: 105 psi



Exhaust gas: 105 psi
Gas 1/Gas 2: 50 psi
Polarity: Negative
Resolution: Unit
Dwell time: 200 msec

SIM parameters:

Compound	Q1 mass	Q2 mass
Perchlorate	98.8	83.2
O18LP	107.0	89.0
Perchlorate confirmation	100.8	85.2

The same conditions are used for sample analysis.

- 9.3.2 Inject each calibration standard into the HPLC. After analysis, establish an initial calibration curve using linear regression (see Section 11.1). The correlation coefficient (r) must be ≥ 0.995 (see Section 11.2). Because linear calibrations tend to favor numbers at the higher end of the calibration range, a weighting factor (see Section 11.3) can be used to reduce this tendency.
- 9.4 ICV: Following the initial calibration, inject the 1.0 ug/L secondary source standard and evaluate the % drift using the calculation in Section 11.8. The %D must be ≤ 15 before sample analysis can begin. If the ICV exceeds the control limit, corrective action must be taken and the instrument recalibrated.
- 9.5 CCV: The calibration must be verified daily prior to sample analysis and after every 10 field samples by the analysis of the 1.0 ug/L calibration standard. The %D must be ≤ 15 before sample analysis can begin, and samples must be bracketed by passing CCV standards. Samples not bracketed by passing CCVs must be reanalyzed.
- 9.5.1 If a CCV fails to meet acceptance criteria, it may be reanalyzed once. If it still fails, corrective action must be taken followed by two consecutive CCV analyses in order to demonstrate a return to control.
- 9.6 LODV: The 0.2 ug/L calibration standard is analyzed daily prior to sample analysis and after every 10 field samples. The %D must be ≤ 30 ; if not, samples bracketed by failing LODV standards must be reanalyzed unless perchlorate concentrations in the samples are above the RL.



10.0 ANALYTICAL PROCEDURES

- 10.1** The instrument is calibrated as in Section 9.0.
- 10.2** After calibration, batch QC and up to 10 field samples are analyzed, followed by a CCV, LODV and laboratory reagent blank (batch and instrument QC need not be included in the count of 10). If the second set of standards is acceptable, analysis may continue with another set of 10 samples, etc. All samples must be bracketed by passing QC checks.
- 10.3** After sample analysis, the computer produces a quantitation report listing all target analytes and concentrations found in the sample. Extracted Ion Chromatograms (XIC) are generated for each analyte found at or above the minimum detection limit and are evaluated for validity.
- 10.4** Qualitative analysis: Perchlorate is qualitatively identified by verifying the ratios of m/z 83 and 85. The ratio must be within 2.3 to 3.8 to verify the presence of perchlorate.
- 10.5** If the response for perchlorate is above the upper limit of the initial calibration, a laboratory reagent blank should be analyzed and evaluated as in Section 8.2 in order to verify that no carryover is present.
- 10.6** Sample over the calibration range must be diluted in order to yield results within the range. Water samples are diluted using the following scheme:

Dilution	Amount Sample (mL)	Amount water (mL)	Final dilution volume (mL)	Amount ISTD (uL)
2x	0.5	0.5	1	5
5x	0.2	0.8	1	5
10x	0.1	0.9	1	5

Soil Extracts are diluted using the dilution solution described in 8.3.6 instead of water. Do not add ISTD as indicated in the table above.

Higher dilutions are prepared by using serial dilutions, e.g. for a 100x dilution, a 10x dilution is again diluted by a factor of 10.

11.0 DETAILS OF CALCULATIONS

- 11.1** Linear calibration calculations:



11.1.1 The response ratio is plotted vs. the concentration ratio giving a linear equation:

$$y = mx + b$$

where:

$$y = \text{Response ratio} = \text{Response}(x)/\text{Response}(\text{istd}) = R_x/R_{\text{istd}}$$

$$x = \text{Concentration ratio} = \text{Conc}(x)/\text{Conc}(\text{istd}) = C_x/C_{\text{istd}}$$

And m and b are the slope and intercept from the regression equation

11.1.2 For a given response ratio we can solve for C_x/C_{istd} :

$$C_x/C_{\text{istd}} = [R_x/R_{\text{istd}} - b]/m$$

Use equations 12.4 or 12.5 to calculate the unknown concentration, C_x .

11.2 Coefficient of correlation

$$\frac{\sum XY - \sum X \sum Y / n}{\sqrt{\left(\sum X^2 - (\sum X)^2 / n \right) \left(\sum Y^2 - (\sum Y)^2 / n \right)}}$$

where:

X = individual values of the independent variable, i.e. concentration

Y = individual values of the dependent variable, i.e. response

n = number of pairs of data

11.3 Linear regression weighing factor:

$$W_1 = 1/y_1$$

where:

w_1 = weighing factor

y_1 = instrument response

11.4 Calculating concentration from a water sample:

$$C_x = (C)(D)$$

where:



C_x = final concentration of perchlorate (ug/L)

D = dilution factor

11.5 Calculating concentration from a soil sample:

$$C_x = \frac{(C)(V_f)(D)}{V_i}$$

where:

C_x = final concentration of perchlorate (ug/g)

V_f = final volume of extract (L)

D = dilution factor

V_i = initial sample weight (g)

11.6 The dry weight concentration of a target analyte is further calculated as follows:

$$C_d = \frac{(C_x)(100)}{(\%solids)}$$

where:

C_x = The uncorrected wet weight concentration

% solids = the percent solids content of the sample

11.7 Precision

Precision is expressed as relative standard deviation

$$RSD = \left(\frac{s}{x} \right) 100$$

11.8 Accuracy as % difference:

$$\%D = \left[\frac{(C_t - C_x)}{C_t} \right] 100$$

where:

C_t = True concentration of the analyte in the standard



C_x = Measured concentration of analyte in the standard

11.9 Precision of duplicate measurements

Precision of duplicate measurements is expressed as relative percent difference

$$RPD = \left[\frac{|C_1 - C_2|}{(C_1 + C_2) / 2} \right] 100$$

where:

C_1 = Concentration of the first sample

C_2 = Concentration of the second sample

11.10 The LCS recovery is calculated as follows:

$$\%R = \left(\frac{C_x}{C_T} \right) 100$$

where:

C_x = the concentration of the analyte in the LCS.

C_t = the theoretical spike concentration.

$\%R$ = percent recovery

11.11 Accuracy as Percent Recovery

$$\%R = \left[\frac{(C_{spk} - C_x)}{C_t} \right] 100$$

where:

C_{spk} = the concentration of the analyte in the spiked sample

C_x = the concentration of the analyte in the reference (parent) sample

C_t = the theoretical spike concentration.

$\%R$ = percent recovery

12.0 QUALITY CONTROL REQUIREMENTS



- 12.1** The quality control procedures discussed in this section are intended to monitor and control the entire analytical process. Batch quality samples are specified in Section 8.0 for MB, LCS, MS, MSD and ICS. Additional procedures were defined in Section 10.0 for initial calibration, ICV, CCV, LODV and laboratory reagent blanks and are included in the overall review process. The procedures, required frequency, acceptance criteria, and the required corrective action measures are outlined in Table 3.
- 12.2** The MB cannot contain a concentration of perchlorate above the one-half of the RL, or greater than 1/10 the amount measured in any sample, whichever is greater. If the blank fails to meet this criteria, the entire batch must be re-prepped and the analysis performed again. All blanks are evaluated down to the current MDL for the presents of target analytes. Any amount of target analytes found in the blank at a level greater than the current
- MDLs are reported in the LIMS and these values appear on the QC summary sheet for the batch.
- 12.3** The LCS is spiked at 0.2 ug/L. Upon completion of a batch of samples, LCS summary reports are generated by the analyst, which compare the actual recoveries to the applicable acceptance ranges for the samples in the batch. The standard laboratory limits specified in Tables 1 and 2 are used in the absence of a project QAPP, or program specified control limits. If the LCS is beyond the laboratory limits, the analyst must stop the analysis, prepare an NCR, and contact the department supervisor for the appropriate corrective action. Corrective action will consist of re-preparation and re-analysis of the affected samples, unless the client's representative and the Quality Assurance Officer (QAO) approve of another course of action. If an LCSD is included in the preparation batch, it must meet the sample criteria as the LCS.
- 12.4** The MS and MSD are spiked at 0.2 ug/L. The results are included in the QC Summary Report and the data is used to monitor matrix accuracy and precision.
- 12.5** Internal standard areas must be between $\pm 50\%$ of the average areas from the initial calibration and the relative retention times must be within 0.98-1.02. All samples failing to meet this criteria must be reanalyzed at increasing dilutions until the acceptance criteria are met.
- 12.6** Back Up: All raw data files are automatically saved to the Microbac server on a daily basis.
- 12.7** When new standards are made, they must be checked against the existing curve before they can be used. Compare with old standards.



12.8 Control of Nonconforming Data

The laboratory implements general procedures to be followed when departures from documented policies, procedures and quality control have occurred. The policies and procedures are found in Section 13.0 of Microbac SOP LQAP (Laboratory Quality Assurance Program), Microbac SOP GP-CAPA (Corrective Action/Preventive Action: Initiating, Tracking and Monitoring) and Microbac SOP GP-RCA (Root Cause Analysis).

12.8.1 Nonconformances Requiring Corrections

A nonconformance occurs when any aspect of the method QC in an analysis, as outlined in Table 3 does not meet acceptance criteria. When nonconforming data occurs the employee initiates an NCR and proceeds with indicated corrections as per Table 3.

All data shall be scrutinized by the analysts for method and project specific compliance. Checklists are utilized and accompany each data batch (Figure 1). A nonconformance shall be documented in the NCR followed by one or more of the following actions.

- Reanalysis of the sample(s) in question
- Discussion and qualification of data (report and narrative)
- Client notification with approval
- Data qualification (Q-flagging)
- Re-sampling and reanalysis (client decision)

12.8.2 Nonconformances Requiring Corrective Action

Corrective action is required when a nonconformance is recurring, if the correction is ineffective or if the departure is so significant that it negatively effects data quality, sample integrity or customer satisfaction. When an event requiring corrective action is identified, the employee shall initiate a Corrective Action/ Preventive Action form as per Microbac SOP GP-CAPA. The corrective action process includes a root cause analysis as per Microbac SOP GP-RCA, corrections, corrective action(s) and evidence of effectiveness.

12.8.3 Nonconformances Not Requiring Corrections

There are some standard contingencies to the traditional corrections that maybe invoked, provided they comply with the project QAPP requirements. In many situations it may not be necessary to perform sample reanalysis or re-extraction for the following quality control departures, provided they are not a



chronic problem or indicative of a trend, and the laboratory provides documentation in the report narrative and project files. In addition, the employee is required to initiate an NCR to record the event.

- An LCS or surrogate recovery exceeds the upper control limit, but the corresponding sample results are non-detect.
- A MB exceeds the upper limit, but the corresponding sample results are non-detect.
- A MB exceeds the upper limit, but the corresponding sample results are greater than ten (10) times the level in the blank.

13.0 DATA REVIEW AND REPORTING REQUIREMENTS

13.1 Data Review

Prior to data entry into the LIMS (either manual or automatic), all data must undergo two (2) levels of review in the department. The primary review is performed by the analyst and the secondary review is performed by either the department supervisor (or a designee) or another qualified analyst.

13.2 Data Reporting

The reporting requirements depend upon the need of the client. Microbac offers four (4) levels of data reporting which are described in some detail below.

- 13.2.1 Level 1 reporting provides the client with the results for all samples submitted for analysis. No other documents or raw data are provided with this level of report.
- 13.2.2 Level 2 reporting provides the client with all of the information contained in a Level 1 report plus a summary of all of the QC analysis associated with the samples submitted by the client.
- 13.2.3 Level 3 reporting is essentially a custom report provided to the client that contains any additional data from the analysis that the client might request.
- 13.2.4 Level 4 reporting is provided in those cases where the client wishes to perform full data validation. All raw data, lab generated logs, and other associated data are provided.

14.0 PREVENTIVE MAINTENANCE

- 14.1 The curtain plate and nebulizer tip must be monitored for buildup and cleaned when necessary.



- 14.2 The oil in the vacuum pumps should be changed every six (6) months.
- 14.3 The source is cleaned and mass calibration performed on an as-needed basis.

15.0 WASTE MANAGEMENT AND POLLUTION CONTROL

- 15.1 Microbac is dedicated to eliminating or minimizing any and all laboratory waste, which requires disposal or contributes to pollution of any type. To that extent Microbac has implemented new technology and converted to micro techniques when available to facilitate these goals.

Each laboratory generates specific waste streams which are segregated and collected in labeled satellite containers. The analysts in each department are responsible for proper disposal of the spent samples and chemical waste in the specified satellite waste collection vessel. The waste management technician checks the satellite containers either daily, or as needed. They are then combined into waste drums in our explosion-proof waste building located outside of the Microbac laboratory facility. These drums are labeled with start date and a manifest is created for each. They are picked up on a regular basis for disposal at a licensed disposal facility.

- 15.2 This method generates wastes in the form of sample extracts in vials, which are placed in the satellite waste container labeled for Waste Vials/Sample Extracts (D001, F002).
- 15.3 Laboratory policies and procedures for management of hazardous waste are found in Microbac SOP 33 Laboratory Waste Management and the waste management section of the analytical SOPs contain procedures specific to each method. All laboratory waste is accumulated, stored and disposed in accordance with all federal and state laws and regulations. Each employee receives training in the proper handling and disposal of hazardous waste that is specific to their job description. As a hazardous generator, we are subject to inspection from the Ohio EPA.

16.0 REFERENCES

- 16.1 USEPA Method 6850, Revision 0, January 2007



MICROBAC SOP #: HPLC06
PAGE: 20 of 30
REVISION: 4

- 16.2** USEPA Method 8000C, Revision 3, March 2003
- 16.3** DoD Perchlorate Handbook, Revision 1 Change 1, August 2007.
- 16.4** DoD Quality Systems Manual for Environmental Laboratories, Version 4.1, 5 June 2003
- 16.5** EPA Document #: 815-R-05-007, Method 331.0, Determination of Perchlorate in Drinking Water by Liquid Chromatography Electrospray Ionization Mass Spectrometry, Revision 1.0, January 2005
- 16.6** Microbac SOP LQAP "Laboratory Quality Assurance Plan"
- 16.7** Microbac SOP 33, "Laboratory Waste Management"
- 16.8** Microbac SOP 45, "Method Validation Procedures"
- 16.9** Microbac SOP GP-CAPA, "Corrective Action/Preventive Action: Initiating, Tracking and Monitoring"
- 16.10** Microbac SOP GP-RCA, "Root Cause Analysis"



Appendix I Method 331.0

For EPA Method 331.0 analysis, the following modifications are made to this SOP:

1.3 Additional definitions:

QCS	Quality Control Sample
LFSSM	Laboratory Fortified Synthetic Sample Matrix
LSSM	Laboratory Synthetic Sample Matrix
LSSMB	Laboratory Synthetic Sample Matrix Blank

3.1 Samples are collected in a polypropylene beaker and filtered into sterile 125 mL plastic bottles using a sterile 20 cc syringe and 0.2 um sterile syringe filter.

3.4 Sample must be received at < 10° C.

4.0 Method performance data for Method 331.0 are presented in Table 4.

6.2.10 20 cc sterile silicone free disposable syringe Fisher cat# 14-817-33

6.2.11 Sterile syringe filters Corning 26 mm surfactant free cellulose acetate 0.2 um, Fisher catalog number 09-754-13.

7.5.2

10 ug/L	(intermediate standard)
5.0 ug/L	(5000 uL intermediate standard: 5000 uL DI water)
1.0 ug/L	(1000 uL intermediate standard: 9000 uL DI water)
0.5 ug/L	(5000 uL 1.0 ug/L standard: 5000 uL DI water)
0.1 ug/L	(1000 uL 1.0 ug/L standard: 9000 uL DI water)
0.05 ug/L	(1000 uL 0.5 ug/L standard: 9000 uL DI water)
0.02 ug/L	(2000 uL 0.1 ug/L standard: 8000 uL DI water)
0.01 ug/L	(1000 uL 0.1 ug/L standard: 9000 uL DI water)

7.6.1 The working alternate source standard at 0.1 ug/L is prepared by diluting the alternate source stock as in Sections 7.4.1 and 7.4.2.

7.7 Internal Standard: O18 labeled perchlorate purchased from Dionex at 1000 ug/L is diluted 1:10 in DI water. Every working calibration standard and sample is spiked with this solution in the ratio of 50 uL internal standard: 10 mL sample, yielding a final concentration of 0.5 ug/L.

7.8 The ICS solution is not used.



7.9 LSSM: dissolve 1.40 g NaHCO_3 , 1.48 g Na_2SO_4 , 1.54 g NaCl , in 1 L of reagent water.

8.2.4 With each preparation batch, include a MB, LCS and MS/MSD. The MB and LCS are prepared using 10 mL of reagent water spiked with 50 μL of internal standard solution from Section 7.6 above. The LCS, MS/MSD are spiked at rotating levels low, medium and high with the 10 $\mu\text{g/L}$ intermediate standard.

A LSSMB and LFSSM are required to be analyzed quarterly and do not have to be included in each analytical batch. The LFSSM is spiked at 0.5 $\mu\text{g/L}$ using the 10 $\mu\text{g/L}$ intermediate standard. The LSSMB and LFSSM are prepared using 10 mL of LSSM solution from Section 7.8 above.

The method blank, LCS and LSSMB and LFSSM are filtered in the same manner as field samples.

9.2.3 In all cases, the concentration of perchlorate in the Reagent blank must be $<1/3$ of the method reporting limit (MRL).

9.3.1.1 Mobile phase: 60% H_2O /0.1% acetic acid: 40% Acetonitrile/0.1% acetic acid

Injection volume: 100 μL
Flow rate: 0.75 mL/min

9.3.2 The validation of the calibration is determined by calculating the concentration of the analyte from each of the analyses used to generate the calibration curve. Calibration points that are $\leq$ MRL should calculate to be 50-150% of their true value. All other calibration points should calculate to be 80-120% of their true value. If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. In this case, corrective action should be taken to reanalyze the calibration standards, restrict the range of calibration, or select an alternate method of calibration.

9.4 ICV: Analyze a QCS sample fortified near the midpoint of the calibration range. The QCS should be from a different source than the source of the calibration standards. The acceptance criterion for the QCS is that the calculated amount of perchlorate must be 80-120% of the true value. If the measured analyte concentration does not meet this criterion, check the entire analytical procedure to locate and correct the problem before analyzing any field samples.

9.5 CCV: The beginning CCV for each analysis batch must include a CCV at or below the MRL and a CCV fortified at a level near the midpoint of the curve. Subsequent CCVs should alternate between a low, medium, and high



concentration. CCVs fortified at or below the MRL must calculate to be 50-150% of the true value. CCVs fortified at all other levels must calculate to be 80-120 % of the true value.

- 10.2** See Table 7 for an example sequence for Method 331.0.
- 10.4** Perchlorate is qualitatively identified by verifying the ratio of m/z 83 and 85. The ratio must be within 25% of theoretical value of 3.08 (2.31-3.85). If this ion ratio requirement is not met in any QC sample, then all samples in the analysis batch are considered invalid and must be reanalyzed after reestablishing acceptable instrument performance.
- 12.1** Quality control criteria for Method 331.0 are presented in Tables 5 and 6.
- 12.5** The internal standard area of the first CCV should be $\geq 50\%$ of the average IS area counts of the initial calibration standards. The internal standard area of the analysis batch must be within 30% of the internal standard area of the first CCV. Relative retention times must be within 0.98-1.02 for a peak to be identified as perchlorate.
- 16.0** Reference: USEPA Method 331.0, Revision 1, January 2005



MICROBAC SOP #: HPLC06
PAGE: 24 of 30
REVISION: 4

TABLE 1
MICROBAC'S QA OBJECTIVES FOR
THE ANALYSIS OF METHOD 6850 WATER

PARAMETER	CAS #	ACCURACY (% RECOVERY)*	PRECISION (% RPD)*	LOD (ug/L)	LOQ (ug/L)
Perchlorate	14797-73-0	80-120	0-15	0.1	0.2

* Limits are currently multi-lab performance limits from the method, will be derived from LCS data, and may be revised.

TABLE 2
MICROBAC'S QA OBJECTIVES FOR
THE ANALYSIS OF METHOD 6850 SOIL

PARAMETER	CAS #	ACCURACY (% RECOVERY)*	PRECISION (% RPD)*	LOD (ug/Kg)	LOQ (ug/Kg)
Perchlorate	14797-73-0	80-120	0-15	1	2

* Limits are currently multi-lab performance limits from the method, will be derived from LCS data, and may be revised.



TABLE 3
QUALITY CONTROL CRITERIA
METHOD 6850

Control Item	Frequency	Acceptance Criteria	Corrective Action
Mass Calibration	At instrument setup and as-needed thereafter.	Ions should be within +/- 0.3 m/z of masses 83, 85 and 89.	Recalibrate, contact manufacturer if necessary.
Initial Calibration	When continuing calibration is out of control or after major maintenance	$r \geq 0.995$	Correct problem, repeat ICAL.
Initial Calibration Verification (ICV)	After initial calibration	$\leq 15\%$ drift	Reanalyze ICV; upon second failure, repeat initial calibration.
Continuing Calibration Verification (CCV)	At beginning of daily analytical sequence and after every 10 field samples.	$\leq 15\%$ drift	Reanalyze CCV; upon second failure perform maintenance. Two consecutive CCVs must pass following maintenance.
Limit of Detection Verification (LODV)	Daily prior to sample analysis and after every 10 field samples.	$\leq 30\%$ drift	Reanalyze samples not bracketed by passing LODV unless results >RL.
Internal Standard	Every standard, Sample and batch QC sample.	Areas within $\pm 50\%$ of average ISTD areas from ICAL. RRT 1.0 +/-2% from ICAL.	Reanalyze at dilutions until area is acceptable.
Method Blank	One per matrix/batch.	Perchlorate < 1/2 RL or > 1/10 amount detected in samples.	Reprep and reanalyze blank and all associated samples
Laboratory Control Sample/ Laboratory Control Sample Duplicate (LCS/LCSD)	One per matrix/batch.	Recovery within 80-120%	Reprep and reanalyze LCS and all associated samples
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One per matrix/batch if specified by client.	Recovery within 80-120%. RPD <15%.	Qualify data and/or address in the report narrative
Interference Check Sample (ICS)	Extracted with every batch of 20 samples.	$\leq 30\%$ drift	Correct problem, reprep and reanalyze samples.
Laboratory Reagent Blank	Prior to calibration, at the end of analytical sequence and after samples with perchlorate over calibration range.	Perchlorate < 1/2 RL.	Reanalyzed blank until carryover is eliminated, repeat sample analysis.



MICROBAC SOP #: HPLC06
 PAGE: 26 of 30
 REVISION: 4

TABLE 4
MICROBAC'S QA OBJECTIVES FOR
THE ANALYSIS OF METHOD 331.0 WATER

PARAMETER	CAS #	ACCURACY (% RECOVERY)*	PRECISION (% RPD)*	LOD (ug/L)	LOQ (ug/L)
Perchlorate	14797-73-0	See Table 6	See Table 6	0.005	0.02

* Limits are currently multi-lab performance limits from the method, will be derived from LCS data, and may be revised.

TABLE 5
INITIAL DEMONSTRATION OF CAPABILITY
QUALITY CONTROL REQUIREMENTS METHOD 331.0

Requirement	Specification and Frequency	Acceptance Criteria
Demonstration of Low System Background	Analyze a Reagent blank and LSSMB prior to any other IDC steps.	Demonstrate that the target analyte is <1/3 of the MRL and that possible interferences from sampling devices do not prevent the identification and quantitation of perchlorate.
Test for System Carryover	Analyze a reagent water blank after the high ICAL standard during the IDC calibration.	Demonstrate that the target analyte is <1/3 of the MRL and that carry-over from previous samples does not prevent the identification and quantitation of perchlorate.
Demonstration of Precision	Analyze seven (7) replicate LCSs and seven (7) replicate LFSSMs fortified near the midrange concentration.	%RSD must be $\leq 20\%$
Demonstration of Accuracy	Calculate average recovery for replicates used in Section 11.11.	Mean recovery 80-120% of the true value
Minimum Reporting Limit (MRL) Confirmation	Fortify and analyze seven (7) replicate LCSs at the proposed MRL concentration. Calculate the mean and the Half Range (HR). Confirm that the Upper PIR and Lower PIR (Section 9.2.4.2) meet the recovery criteria.	Upper PIR $\leq 150\%$ Lower PIR $\geq 50\%$



TABLE 6
ONGOING QUALITY CONTROL REQUIREMENTS (SUMMARY) METHOD 331.0

Requirement	Specification and Frequency	Acceptance Criteria
Sample Holding Time	28 days when processed and stored according to Sections 3.0 and Appendix I.	Sample results are valid only if samples are analyzed within the sample holding time.
Initial Calibration	Use the Internal standard calibration technique to generate a linear or quadratic calibration curve. Use at least five (5) standard concentrations.	When each calibration standard is calculated as an unknown using the calibration curve, the lowest level standard should be within 50-150% of the true value. All other points should be within 80-120% of the true value.
Blank	Daily, or with each analysis batch of up to twenty (20) field samples, whichever is more frequent.	Results must be $< 1/3$ the MRL. If the background exceeds $1/3$ the MRL, the results for Perchlorate in the analysis batch are invalid.
Continuing Calibration Check (CCC)	Verify initial calibration by analyzing a Low CCC and a Mid CCC at the beginning of each analysis batch. Subsequent CCCs are required after every ten (10) field samples, and after the last field sample in a batch.	The lowest level CCC must be within 50-150% of the true value. All other points must be within 80-120% of the true value. Results are field samples that are not bracketed by acceptable CCCs are invalid.
Laboratory Control Sample (LCS)	Daily, or with each analysis batch of up to twenty (20) field samples, whichever is more frequent.	For LCSs fortified at concentrations $\leq$ MRL, the result must be within 50-150% of the true value. All other LCSs must be within 80-120% of the true value.
Internal Standard (IS)	Compare IS area to the IS area of the first CCC in the analysis batch for all QC and field samples.	Peak area counts for the IS must be within $\pm 30\%$ of the IS area of the first CCC of the analysis batch. If the IS area does not meet this criterion, the corresponding perchlorate results are invalid.
Isotope Area Count Ratio	Monitor the isotope ratio for all QC and field samples in the analysis batch.	The calculated area count ratio (m/z 99/101 for SIM, or m/z 85/83 MRM) must be within $\pm 25\%$ (2.31-3.85) of the theoretical value of 3.086.
Relative Retention Time	Monitor the relative retention time for all QC and field samples in the analysis batch.	The relative retention time for perchlorate vs. the IS must be between 0.98-1.02.
Matrix Spike (MS)	Analyze one MS per analysis batch. Fortify the MS with perchlorate at a concentration close to but greater than the native concentration (if known). Calculate MS recoveries.	For MS fortified at concentrations $\leq$ MRL, the result must be within 50-150% of the true value. All other MSs must be within 80-120% of the true value.
Matrix Spike Duplicate (MSD) or Laboratory Duplicate	Analyze at least one MSD or LD daily, or with each analysis batch of up to twenty (20) field samples, whichever is more frequent.	For MSDs or LDs having perchlorate concentrations $\leq 2 \times$ MRL, the RPD must be within 50-150%. All other MSDs and LDs must have RPDs within 80-120%.
Quality Control Sample (QCS)	Analyzed with every new calibration curve.	Results must be 80-120% of the true value.



TABLE 7
EXAMPLE SEQUENCE FOR
A METHOD 331.0 ANALYTICAL BATCH

Sample	Sample Description	*Acceptance Criteria
1	CCC $\leq$ MRL	50-150% of true value
2	Mid level CCC	80-120% of true value
3	Reagent Blank	$< 1/3$ MRL
4	LCS	$\leq$ MRL 50-150% of true value > MRL 80-120% of true value
5	Field Sample 1	
6	Field Sample 2	
7	Field Sample 3	
8	Field Sample 4	
9	Field Sample 5	
10	Field Sample 6	
11	Field Sample 7	
12	Field Sample 8	
13	Field Sample 9	
14	Field Sample 10	
15	CCC (rotate level)	$\leq$ MRL 50-150% of true value > MRL 80-120% of true value
16	MS	$\leq$ MRL 50-150% of true value > MRL 80-120% of true value
17	MSD	$\leq 2 \times$ MRL 50-150% of true value > $2 \times$ MRL 80-120% of true value
18	Field Sample 11	
19	Field Sample 12	
20	Field Sample 13	
21	Field Sample 14	
22	Field Sample 15	
23	Field Sample 16	
24	Field Sample 17	
25	Field Sample 18	
26	Field Sample 19	
27	Field Sample 20	
28	CCC (rotate level)	$\leq$ MRL 50-150% of true value > MRL 80-120% of true value

* Additionally, all samples must meet the isotope area count ratio criteria and the relative retention time criteria.



MICROBAC SOP #: HPLC06
 PAGE: 29 of 30
 REVISION: 4

Figure 1 Checklist

Checklist ID: 40695

Microbac Laboratories Inc.
Data Checklist

Date: 06-AUG-2009
 Analyst: WTD
 Analyst: NA
 Method: 6850
 Instrument: LCMS1
 Curve Workgroup: NA
 Runlog ID: 29520
 Analytical Workgroups: 308952

ANALYTICAL	
System Performance Check	NA
DFTPP (MS)	NA
Endrin/DDT breakdown (8081/MS)	NA
Pentachlorophenol/benzidine tailing (MS)	NA
Eluent check (IC)/system pressure (HPLC)	NA
Window standard (FID)	NA
Initial Calibration	NA
Average RF	NA
Linear regression or higher order curve	NA
Alternate source standard (ICV) % Difference	NA
Continuing Calibration (CCV)	X
% D/% Drift	X
Minimum response factors (MS)	X
Continuing calibration blank (CCB) (IC)	NA
Special standards	NA
Blanks	X
TCL hits	X
Surrogate recoveries	NA
LCS/LCSD (Laboratory Control Sample)	X
Recoveries	X
Surrogate recoveries	NA
MS/MSD/Sample duplicates	NA
Recoveries	NA
%RPD	NA
Samples	X
TCL hits	X
Mass spectra (MS/HPLC)/2nd column confirmations (ECD/FID/HPLC)	NA
Surrogate recoveries	NA
Internal standard areas (MS)	X
Library searches (MS)	NA
Calculations & correct factors	X
Compounds above calibration range	NA
Reruns	X
Manual integrations	X
Project/client specific requirements	X
REPORTING	
Upload batch form	X
KOBRA workgroup data/forms/bench sheets	X
Case narratives	NA
Check for completeness	X
Primary Reviewer	WTD
SUPERVISORY/SECONDARY REVIEW	
Check for compliance with method and project specific requirements	X
Check the completeness/accuracy of reported information	X
Data qualifiers	X
Secondary Reviewer	MDC

Primary Reviewer:
07-AUG-2009

Secondary Reviewer:
11-AUG-2009

Wade D. To *Michael Colman*

CHECKLIST1 - Modified 03/05/2008
 Generated: AUG-11-2009 08:15:59





MICROBAC SOP #: HPLC06
 PAGE: 30 of 30
 REVISION: 4

Figure 2 Run Log

Run Log ID: 29520

Microbac Laboratories Inc. Instrument Run Log

Instrument: LCMS1 Dataset: 080609.TXT
 Analyst1: WTD Analyst2: NA
 Method: 6850 SOP: _____ Rev: _____

Maintenance Log ID: 29718

Workgroups: 308952 Column 1 ID: KP-RPPX250 Column 2 ID: NA
 Internal STD: COA14015 Surrogate STD: NA Calibration STD: STD34502
 Comments:

Seq.	File ID	Sample Information	Mat	Dil	Reference	Date/Time
1	1LM.LM00155	CCB	1	1		08/06/09 09:23
2	1LM.LM00156	0.1 STD	1	1	STD34502	08/06/09 09:37
3	1LM.LM00157	0.2 STD	1	1	STD34502	08/06/09 09:52
4	1LM.LM00158	0.5 STD	1	1	STD34502	08/06/09 10:06
5	1LM.LM00159	1.0 STD	1	1	STD34502	08/06/09 10:21
6	1LM.LM00160	2.0 STD	1	1	STD34502	08/06/09 10:35
7	1LM.LM00161	5.0 STD	1	1	STD34502	08/06/09 10:49
8	1LM.LM00162	10.0 STD	1	1	STD34502	08/06/09 11:04
9	1LM.LM00163	ICV 1.0	1	1	STD34503	08/06/09 11:18
10	1LM.LM00164	MCT 0.2	1	1	STD34500	08/06/09 11:32
11	1LM.LM00165	CCB	1	1		08/06/09 11:47
12	1LM.LM00166	CCV 1.0	1	1	STD34502	08/06/09 12:01
13	1LM.LM00167	QCMRL 0.2	1	1	STD34502	08/06/09 12:16
14	1LM.LM00174	CCB	1	1		08/06/09 15:19
15	1LM.LM00175	QCMRL 0.2	1	1	STD34502	08/06/09 15:34
16	1LM.LM00176	CCV 1.0	1	1	STD34502	08/06/09 15:48
17	1LM.LM00177	MET BLK	1	1		08/06/09 16:02
18	1LM.LM00178	LCS	1	1	STD34502	08/06/09 16:17
19	1LM.LM00179	LCSD	1	1	STD34502	08/06/09 16:31
20	1LM.LM00180	L09070297-01 A 2X	1	2		08/06/09 16:45
21	1LM.LM00181	L09080013-01 A 2X	1	2		08/06/09 17:00
22	1LM.LM00182	L09080013-02 A 2X	1	2		08/06/09 17:14
23	1LM.LM00183	CCV 1.0	1	1	STD34502	08/06/09 17:29
24	1LM.LM00184	QCMRL 0.2	1	1	STD34502	08/06/09 17:43

Comments

Seq.	Rerun	Dil.	Reason	Analytes

Page: 1

Approved: 11-AUG-09



STANDARD OPERATING PROCEDURE
MT 009 Inductively Coupled Plasma (ICP) Emission – ICP-OES 6000

Review Date: 03/29/2015



03/29/2015

Technical Review by:

Date



3/30/15

Approved by: Quality Assurance

Date

1.0 Identification of Test Method

- 1.1 This procedure is used for the analysis of trace elements (metals) following EPA SW 846 Methods 6010B and/or 6010C (Inductively Coupled Plasma –Atomic Emission Spectrometry) and Method 200.7 (SDWA).

2.0 Applicable Matrix or Matrixes

- 2.1 This method is applicable to the determination of various metals in drinking water, surface water, groundwater, sludge, soils, and industrial wastes.

3.0 Detection Limits

- 3.1 Method detection limits (MDLs) are determined annually and results vary from element to element. For DOD-QSM, ACOE-LCG work MDL's and LOQ's are verified initially and quarterly thereafter. MDL checks are analyzed up to 3x the calculated MDL (to verify sensitivity). If MDL checks are not detected at the spiked level for any given element than increase the level of the spike until the element is detected (minimum 2 successful analyses). The level at which an element was successfully detected becomes the reported MDL. LOQ checks are used for accuracy verification and shall meet project or client specific control limits. Failing LOQ checks may also need elevation of the spike levels for a given element. The concentration that successfully meets control criteria is used as the reported LOQ. Procedures for conducting MDL studies can be found in CT Laboratories Initial Method Performance and Reporting SOP (CL-2, rev. 5).

4.0 Scope and Application

- 4.1 Metals in solution can be readily analyzed by atomic emission using an Inductively Coupled Plasma (ICP) spectrometer. All matrices, excluding filtered groundwater samples and drinking waters with a turbidity less than 1 NTU, will require a digestion prior to analysis.

5.0 Method Summary

- 5.1 If necessary, prior to analysis, samples are digested using an approved method. See SOPs 6205B, 6225B, 6230B, M200.2, and M-soluble for further information on sample digestion.
- 5.2 This method describes multi-element determinations using an iCAP 6000 Series ICP-OES which use an Echelle optical design and a Charge Injection Device (CID) solid-state detector to provide elemental analysis. Most Samples are liquids that are pumped through a nebulizer to produce a fine spray. The large droplets are removed by a spray chamber and the small droplets then pass through to the plasma. The solvent is evaporated. The residual sample is decomposed to atoms and ions that become excited and emit characteristic light which is measured, giving measurement of the concentration of each element type in the original sample. Control of the spectrometer is provided by the PC based iTeva software (refer to the Thermo ICP-OES software manual). Samples are routinely analyzed using an internal standard

solution of 50 mg/L Yttrium to eliminate certain matrix interference problems. Line switching is also used to extend the dynamic range of an element.

- 5.3 The data is exported to the LIMS system and reviewed by the analyst. Following analyst review, the data is given to a qualified reviewer for complete data review. After the data has been reviewed and it is determined that it is valid data, the reviewer sends the data to the “validated” mode in the LIMS system.

6.0 Definitions

- 6.1 Reagent Blank- A solution of de-ionized water, (containing in correct proportion, all reagents required by the method), used with the calibration standards to standardize the instrument, as a calibration blank, and for sample dilution.
- 6.2 Calibration Standards - A series of known standard solutions, which shall include the reagent blank, used for calibration of the instrument within the measurable linear range. Calibration standards shall contain, in correct proportion, all reagents required by the method. Acceptance of the calibration requires a correlation coefficient (r) of 0.995 or better. No samples shall be analyzed without acceptable calibration. For DOD-QSM data the low calibration standard shall be equal to or less than the MRL.
- 6.3 Calibration Verification Standard-Initial (ICV) & Continuing (CCV) - A midpoint calibration standard which is analyzed at the beginning of the run (ICV), at a frequency of 1 per 10 samples during a run (CCV), and at the end of a run to verify calibration throughout the run. The ICV must be from a second source different than that of the calibration standards.

Note for method 200.7 that limits for ICV are tighter than those for the CCV (see section 16).

- 6.4 Low-Level Calibration Check Standard – If a single point calibration is used (for DOD-QSM data) then a low level standard shall be analyzed. The acceptance criterion is +/- 20% of the expected value.
- 6.5 CB (Calibration Blanks- Initial and Continuing) - A reagent blank solution, which is analyzed immediately following the ICV (Initial Calibration Blank-ICB), at a frequency of 1 per 10 samples during a run (Continuing Calibration Blank-CCB), and at the end of a run to check for drifts in calibration, or possible analyte carry-over. Warning criteria include that the value be less than or equal to the three times the IDL for a given analyte for SW-846 work, less than the MDL for DOD-QSM data, or less than ½ the MRL for ACOE work. Control criteria consist of the CB value being less than or equal to 2 times the MDL for a given analyte for SW-846 and is determined by the QAPP for DOD/ACOE work. If this range is exceeded, a new calibration will be necessary.
- 6.6 LCS (Laboratory Control Sample) - A mid-range standard, prepared from a source different from that used for calibration standards, which is carried through the entire preparation and analytical method. The LCS is used to verify the accuracy of the preparation method. A minimum of one LCS is prepared per batch and is analyzed at the beginning of an analytical batch.
- 6.7 MB (Method Blank) - A Reagent Blank (see 3.1) which is carried through the entire preparation and analytical method. The method blank is used to detect possible contamination that may occur prior to or during the sample preparation. A minimum

of one MB is prepared per batch and is analyzed at the beginning of an analytical batch. Blank recovery must be less than 2x the MDL for SW846, less than the MDL for SWDA samples, less than ½ the RL for DOD-QSM, and is determined by the QAPP for ACOE samples.

- 6.8 MS-MSD (Matrix Spike-Matrix Spike Duplicate): - Two separate sample aliquots to which a known concentration of analyte has been added which is carried through the entire preparation and analytical procedure. The purpose of a matrix spike is to reveal any matrix effect from the sample on the recovery of the analyte by the method being used. An MS-MSD pair is prepared for every 20 samples of a given matrix per day for 6010B and once for every 10 samples of a given matrix per day for 200.7. For ACOE work only an MS is prepared and a duplicate sample is prepared rather than an MSD. Failure to meet criteria may be due to poor recovery during the preparation method or due to matrix interference within the digestate. To be considered acceptable, MSD must meet both the same % recovery criteria as an MS, and the same % RPD as a duplicate sample.
- 6.9 Duplicate sample- A separate sample aliquot which is carried through the entire preparation and analytical procedure. A duplicate is prepared for every 20 samples for ACOE/LCG work and per batch for DOD-QSM (in replacement of an MSD).
- 6.10 Method Reporting Limit (MRL) or Contract Required Detection Limit (CRDL) Standard: Detection level standard at a level near the reporting limit, or at a level specified by client contract. When required, it is to be analyzed following the ICB, and prior to the last CCV standard in the run.
- 6.11 Interement Correction Factors (IEC) – These correction factors are determined by analyzing a concentration range of known interferences (Al, Ca, Co, Cr, Cu, Fe, Mg, Mn, Ni, V and Zn) and examining all other lines for a significant linear response. A line is considered to be significantly affected when the correlation coefficient for the interference is 0.99 or better and the correction factor multiplied by ten is greater than the MDL of the affected line. For interferences known to occur at high levels in environmental samples (Al, Ca, Cr, Cu, Fe, Mg and Zn) the interference will be considered to be significant when the correction factor multiplied by 100 is over the MDL of the affected line and the correlation coefficient in 0.99 or better. Interement correction is used where applicable.
- 6.12 Linear Dynamic Range (LDR) – The upper limit of the linear dynamic range is established for each wavelength utilized by determining the signal responses from a minimum of three different concentration standards across the range. One of these will be near the upper limit of the range. The ranges used for the analysis of samples are judged by the analyst from the resulting data. The data and calculations are kept on file. The upper range limit is an observed signal no more than 10% below the level extrapolated from the lower standards. Determined analyte concentrations above the upper range limit are diluted and reanalyzed. New dynamic ranges are determined whenever there is a significant change in instrument response. For analytes that routinely approach the upper limit of the range, the range will be checked biannually. For analytes that are known interferences and exceed the dynamic range, the analyst will check that IEC's have been correctly applied. DOD-QSM requires that a LDR (or high level check standard) study be performed at least every six months.

Note: for ACOE/LCG work, analyte concentrations above the upper calibration limit are diluted and reanalyzed.

- 6.13 ICS-A (Interelement Correction Standard-A): A standard containing the elements Al, Ca, Fe, and Mg at 500mg/L. This standard is analyzed when using method 200.7 or performing ACOE work following the ICV at the beginning of the run to determine that interelement correction factors are correctly compensating for interference from these elements on other analyte lines. The ICSA may be required to be run before the last CCV of the run for ACOE work. Check the QAPP to determine if this is necessary.

Note: For ACOE work, the ICSA should be within the absolute value of two times the MDL for all analytes except Al, Ca, Fe and Mg unless a different requirement is specified within the contract.

- 6.14 ICS-AB (Interelement Correction Standard-AB): A standard containing the elements Al, Ca, Mg, and Fe at 500mg/L and all other elements at 500ug/L. This standard is analyzed following the ICV at the beginning of each run. It is analyzed to determine that the IEC are correctly preventing interference by these elements on the measurement of other analytes. The ICSAB may be required to be run before the last CCV of the run for ACOE work. Check the QAPP to determine if this is necessary.
- 6.15 PDS (Post Digestion Spike): When a serial dilution or matrix spike falls outside of the acceptance limits a post digestion spike is used to determine if the sample digestion matrix is interfering with the analysis of the analyte. The sample is spiked at a level similar to that of the matrix spike.

Note: For ACOE/LCG work, a PDS will be conducted at a minimum rate of one per prep batch per unique matrix.

- 6.16 SD (Serial Dilution Analysis): A sample is diluted 5x with method blank solution and analyzed. The diluted result and the undiluted result should agree within a limit of precision defined by the program (SW846, CLP, 200.7) or client QAPP.

Note: For ACOE/LCG work, a SD will be conducted at a minimum rate of one per prep batch per unique matrix.

- 6.17 Batch- A batch consists of 20 samples of the same matrix analyzed on the same day or 20 samples of the same medium that have been prepared together.
- 6.18 IDL (Instrument Detection Limit); A series of blanks analyzed during initial setup or after significant changes, or as per DOD-QSM requirements. The limits established shall be < LOD for any given element.
- 6.19 Method detection limit (MDL): The minimum concentration of an analyte that can be identified measured and reported with 99% confidence that the analyte concentration is greater than zero.
- 6.20 LOQ Check: An internally prepared standard at a level near the Limit of Quantitation (LOQ) or at a level specified by a specific program or contract. An LOQ Check is required after MDL studies and quarterly thereafter for QSM work. Recovery limits are required for LOQ Checks and are usually program/contract specific.
- 6.21 Method Detection Limit (MDL) Check: An internally prepared standard prepared at approximately 1-2 times the calculated MDL for a given analyte (1-4 times for multi-component analyses). The MDL check sample is used as verification

of the calculated MDL's. Detection of the individual analytes in the MDL check is the only requirement. The MDL check is required after MDL studies and on an analytical run for LCG work when there are failures on the MRL spikes or quarterly for QSM.

7.0 Interferences

- 7.1 Background emission and stray light are corrected using background correction. See ICP 6000 Series operator's manual for further instructions on background correction application.
- 7.2 Spectral overlaps are corrected for using interelement correction factors (IEC). When IEC are used, the interfering elements must be analyzed along with the elements of interest. The accuracy of IEC shall be verified daily by analyzing the ICSAB. All IEC factors shall be updated every six months or when an instrumentation change occurs; such as, changing a torch, nebulizer, injector, or plasma conditions.
- 7.3 Physical interferences such as viscosity are minimized by using an internal standard. Post digestion spike and serial dilutions help to determine if physical interferences are present.
- 7.4 Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Chemical interferences are not normally seen during ICP analysis and are highly matrix dependent.
- 7.5 Memory interferences occur when a sample of high analyte concentration does not thoroughly rinse prior to the analysis of the next sample. This causes elevated readings for that analyte in the subsequent sample. Memory effects can be minimized by rinsing at least 60 seconds between samples.

8.0 Safety

- 8.1 Gloves and protective clothing should be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure should utilize appropriate laboratory safety systems.
- 8.2 Insure that waste collection vessels contain enough room to accommodate all wastes that will be produced during the operation of the instrument.

9.0 Equipment and Supplies

- 9.1 ICP 6500, Cetac autosampler, computer, & network printer.
- 9.2 Argon (Airgas-liquid high purity or gaseous pre-purified grade or equivalent).
- 9.3 Class A volumetric flasks and pipettes (Chemglass or equivalent).
- 9.4 Disposable 15-mL polystyrene culture tubes.
- 9.5 100 uL pipette (Eppendorf or equivalent).
- 9.6 10-mL pipette (Eppendorf or equivalent).

10.0 Reagents and Materials

- 10.1 Reagents

- 10.1.1 Mixed and single element stock metals standards. See Section 9 and Appendix A, B, C and D for instructions on making the working standards.
- 10.1.2 Nitric acid, conc. (Fisher, Trace Metals grade or equivalent)
- 10.1.3 Hydrochloric acid, (Fisher, Trace Metals grade or equivalent)
- 10.1.4 Deionized water (Milli Q, > 10 mega ohm).

11.0 Sample Preservation and Storage

- 11.1 Samples must be preserved and analyzed within holding times stated in chart. Liquid samples are stored on shelves in the Laboratory warehouse and soil samples are stored in a walk-in refrigerator unit.

	<u>Liquids</u>	<u>Solids</u>
Preservative:	pH <2 with HNO ₃	4°C (+/-2)
Hold Time:	180 days	180 days

12.0 Quality Control

- 12.1 This SOP is designed to follow a variety of different projects and programs requirements. Table 3. is designed to illustrate the control steps and provisions required to adequately producing acceptable data.
- 12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.
- 12.3 For the routine analysis of groundwater, wastewater, leachate, surface water, soil, sludge, TCLP/SPLP extracts following method 6010B:
Required QC following instrument calibration is as follows :
 - 12.3.1 ICV (initial calibration verification); The ICV is prepared from an alternate source standard whose concentrations are within the linear working range of the instrument. The results of the ICV should agree within 10% of the expected value for a given analyte. The relative standard deviation (RSD) between the replicate integrations should be <5%. If results are outside of this range, corrective action must be taken before samples can be analyzed.
 - 12.3.2 ICB (initial calibration blank); analyze the calibration blank. The results of the initial calibration blank must be < 3x IDL for a given analyte. If the average of the replicates is not < 3x IDL, terminate the analysis, correct the problem and recalibrate or appropriately qualify the data. If the blank is less than 1/10th the concentration of the action level of interest and no sample is within ten percent of the action limit, analyses need not be rerun and re-calibration is not necessary before continuing with the analysis.
 - 12.3.3 ICSAB (interference check solution); analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start troubleshooting .

- 12.3.4 LCS (laboratory control sample); analyze an alternate source reference sample. Control limits are $\pm 20\%$ of true value or in-house limits, whichever is more restrictive, or as specified in a client QAPP or the DOD-QSM manual.
- 12.3.5 MB (method blank); analyze a reagent blank. The method blank is a reagent blank that has been taken through the preparations steps alongside the samples being analyzed. Control limits are the MDL. If the average of the replicates is not $< \text{MDL}$ terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and twenty times the concentration of the analyte in the method blank.
- 12.3.6 CCV (continuing calibration verification); analyze a check standard after every ten samples and following the last sample in the run. This standard should be at a level approximately mid-scale. Control limits are $\pm 10\%$ of true value. If values fall outside this range, all samples back to the last acceptable ICV or CCV must be repeated.
- 12.3.7 CCB (continuing calibration blank); The results of the continuing calibration blank must be $< 3 \times \text{IDL}$ for a given analyte. If the result falls outside this, reanalyze all samples back to the last acceptable CCB or qualify all sample < 20 times the blank and greater than the MDL.
- 12.3.8 MS/MSD (matrix spike/matrix spike duplicate); for non-digested samples, prepare a bench spike in duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are $\pm 25\%$ of true value, and 20% RPD, or use calculated limits, whichever is tighter. See Sec. 18.0 for bench spike preparation. For digested samples, see "Predigestion Spike" chart in section 18.0. For digested samples, analyze the MS/MSD samples as they apply to each digestion set. Follow the above for control limits. For digested spikes with sample results greater than four times the digested spike level, prepare and analyze a PDS sample if the MS and/or MSD are outside the control limits. Prepare the PDS at a level approximately two times the sample level.
- 12.4 For SDWA analysis following method 200.7
Required QC following instrument calibration is as follows:
 - 12.4.1 ICV: Referred to in 200.7 as LPC (laboratory performance check); analyze the mid-cal standard. Control limits are $\pm 5\%$ of true value. If values fall outside this range, recalibrate for the affected analytes.
 - 12.4.2 ICB (initial calibration blank); analyze the calibration blank. The absolute value of the result should be below the MDL for the analyte(s) of interest. If the blank result falls outside this, evaluate the effect on the sample results and/or recalibrate for the affected analytes. Samples with results $> 10 \times$ the associated blank value need not be reanalyzed.
 - 12.4.3 ICSA (interference check solution: interference only) analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe. This sample must be analyzed at the beginning of the analytical run before the ICSAB. Recovery for interfering analytes is $\pm 20\%$ true value. All other analytes need to be $\pm 2 \times$ the MDL. If recovery/result is outside the acceptable range, corrective

- action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start trouble shooting.
- 12.4.4 ICSAB (interference check solution); analyze a solution containing 500 mg/L Al, Ca, Mg, Fe and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points and IECs as a place to start trouble shooting.
- 12.4.5 LCS (laboratory control sample); analyze an alternate source reference sample per batch of 20 samples of the same matrix. Control limits are +/- 10% of true value, or manufacturer's limits, whichever is tighter.
- 12.4.6 MB (method blank); analyze a reagent blank per 20 samples of the same matrix. The method blank is a reagent blank that has been taken through the preparations steps alongside the samples being analyzed. If the average of the two replicates is not < MDL terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and twenty times the concentration of the analyte in the method blank .
- 12.4.7 CCV: Referred to in 200.7 as LPC (laboratory performance check); analyze the mid-cal standard after every 10 samples. Control limits are +/- 10% of true value. If values fall outside this range, reanalyze all samples back to the last acceptable ICV or CCV.
- 12.4.8 CCB (continuing calibration blank); analyze the calibration blank immediately after each CCV. The value of the result should be below the MDL for the analyte(s) of interest. If the result falls outside this, evaluate the effect on the sample results. Sample results >10x the associated blank value need not be reanalyzed. Otherwise, reanalyze all samples back to the last acceptable CCB or qualify data that is >LOD and <10x the associated blank.
- 12.4.9 MS/MSD (matrix spike/matrix spike duplicate); for non-digested samples, prepare a bench spike in duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are +/- 25% of true value, and 20% RPD, or use calculated limits, whichever is tighter. See Sec. 18.0 for bench spike preparation. For digested samples, see "Predigestion Spike" chart in section 18.0. For digested samples, analyze the MS/MSD samples as they apply to each digestion set. Follow the above for control limits. For digested spikes with sample results greater than four times the digested spike level, prepare and analyze a PDS sample if the MS and/or MSD are outside the control limits. Prepare the PDS at a level approximately two times the sample level.
- 12.5 For the CLP-like level 4 analysis of groundwater, surface water, wastewater and soil
Note: A default of three replicate exposures per sample should be used for ACOE/LCG work unless specified differently in the QAPP.
Required QC following instrument calibration:

- 12.5.1 ICV (initial calibration verification): analyze the alternate source check standard immediately following calibration. Control limits +/- 10 % true value.
- 12.5.2 ICB (initial calibration blank): analyze the calibration blank. The absolute value of the result must be below the contract required detection limit (CRDL) or the limit stated within the QAPP for the project. The ICB results shall be less than the LOD/MDL for ACOE/ DOD-QSM data (or project specific). If a result falls outside this, reanalyze (recalibration may be necessary).
- 12.5.3 CRDL (contract required detection limit standard) or MRL (Method Required Limit): analyze a standard at a level two times the contract-required detection limits (CRDL) or at the level stated within the QAPP for the project. Follow limits stated within the QAPP as there are no EPA specified control limits for this standard. This sample must be analyzed at the beginning and the end of the run for ACOE samples.
- 12.5.4 ICSA (interference check solution: interference only) analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe. This sample must be analyzed at the beginning of the analytical run prior to the ICSAB. Refer to QAPP for acceptability criteria. For ACOE work, the default criteria is the absolute value of two times the MDL for all analytes except Al, Ca, Mg and Fe which must have a recovery between 80-120%. Refer to QAPP to determine if the ICSA must also be analyzed at the end of the run.
- 12.5.5 ICSAB (interference check solution: interference plus analytes); analyze a solution containing 500 mg/L Al, Ca, Mg, and Fe, and all other analytes of interest at 0.50 mg/L. Recovery for analytes of interest is +/- 20% true value. If recovery is outside this range, corrective action must be taken before samples can be analyzed. Check placement of background correction points as a place to start troubleshooting. This sample must be analyzed at the beginning of the run. Refer to the QAPP to determine if the ICSAB must be analyzed at the end of the run.
- 12.5.6 Digested Sample set to include MB (S or W), LCS (S or W), MS, and DUP.
- 12.5.7 Serial Dilution: Analyze a x5 dilution of a sample from the digestion set. For sample results > 50x the MDL, the %RSD between the serial dilution result and the sample result must be ≤ 10 .
- 12.5.8 Post digestion spike addition (bench spike): An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within +/- 25% of the known value or as specified by the client QAPP. The spike addition should produce a minimum level of 10 times the instrumental detection limit. If the spike recovery falls outside the limits, a matrix effect should be suspected.
- 12.5.9 CCV (continuing calibration verification): Analyze a mid-level standard after every ten samples. The CRDL/MRL, ICSA, ICSAB and batch QC all count as samples. Control limits are +/- 10% of true value. If any result falls outside this, all samples back to the last acceptable ICV/CCV must be reanalyzed.

- 12.5.10 MB (method blank); analyze a reagent blank per 20 samples of the same matrix. The method blank is a reagent blank that has been taken through the preparations steps alongside the samples being analyzed. If the average of the two replicates is not < MDL (< ½ the RL for ACOE/DOD-QSM, or < project specified limits), terminate the analysis, correct the problem and recalibrate or appropriately qualify the data that falls within the MDL and ten times the concentration of the analyte in the method blank.
 - 12.5.11 CCB (continuing calibration blank); Analyze the calibration blank after each CCV (or every ten samples). Refer to the QAPP for CCB acceptance limits. The CCB results shall be less than the LOD for DOD-QSM data and <1/2 the RL for ACOE data (or project specific). If any result falls outside these limits, all samples with results less 10 times the CCB must be reanalyzed back to the last acceptable CCB or appropriately qualified.
 - 12.5.12 MS/DUP (matrix spike/matrix duplicate); for non-digested samples, prepare a bench spike and a duplicate at a frequency of 5% or per analytical batch, whichever is more frequent. Control limits are specified in client QAPP. or see “Predigestion Spikes”(Table 1). For digested samples, analyze the MS/DUP samples as they apply to each digestion set and follow Table 3 control limits.
- 12.6 New or unusual matrices: It is recommended that whenever a new or unusual sample matrix is encountered, a serial dilution and post digestion (bench) spike be performed prior to reporting results. These tests will ensure that neither positive nor negative interferences are affecting sample results.
- Note: For ACOE work, a serial dilution and a post digestion spike will be performed at a rate of one per matrix with each prep batch.**
- 12.6.1 Serial Dilution: If the analyte concentration is sufficiently high (minimally a factor of ten above the instrumental detection limit after dilution), an analysis of a 1:5 dilution should agree within +/- 10% of the original determination. If not, a chemical or physical interference effect should be suspected.
 - 12.6.2 Post digestion/bench spike addition (Table 2): An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within +/- 25% of the known value. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike recovery falls outside these limits, a matrix effect should be suspected..

13.0 Calibration and Standardization

- 13.1 The default calibration for TAL plus list (excluding Na and K) of metals for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called ‘DOD calibration’ which uses 12 mixed standards and a calibration blank.
- 13.2 The default calibration for the metals Sodium and Potassium for ACOE/ LCG, DOD-QSM and routine work is a multi-point calibration method called ‘Sodium and Potassium’ which uses 8 mixed standards and a calibration blank.

- 13.3 The default calibration for the metal Boron for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called 'Boron' which uses 5 standards and a calibration blank
- 13.4 The default calibration for the metal Lithium for ACOE, LCG, DOD-QSM and routine work is a multi-point calibration method called 'Lithium' which uses 7 standards and a calibration blank. Refer to section 11.0 for further instructions on how to perform the calibration.
Note: See Appendix A for preparations of calibration standards and blank for the DOD calibration method calibration. See Appendix B for the preparation of the calibration standards and blank for the Sodium and Potassium method calibration. See Appendix C for the preparation of the calibration standards and blank for the Boron calibrations. See Appendix D for the preparation of the calibration standards and blank for the Lithium calibration. See Tables 4 (a, b, & c), 5, 6, and 7 for individual element calibration concentrations/ranges.
- 13.5 Calibration Blank: Into a 1 L. volumetric flask, add 750 mL of Milli-Q water and 10mL of conc. HNO₃ and 10mL HCl. Mix, dilute to volume with Milli-Q H₂O. Transfer to a clean 1 L. Nalgene bottle. Prepare every 6 months or as needed.
- 13.6 Yttrium Internal std (Used for all methods) : Into a 2000mL volumetric flask, add 500mL of Milli-Q H₂O, 10 ml 10,000 mg/L Yttrium standard dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean 2L Nalgene bottle. Prepare every 6 months or as needed. Concentration = 50 mg/L Yttrium solution.
- 13.7 Initial/Continuing Calibration Verification (ICV/CCV): Into a 1000mL volumetric flask, add 500mL of Milli-Q water, 10 mL of conc. HNO₃ and 10mL HCl. Add the following:
 10 mL SPEX Certiprep Spike Sample Standard 1 or Equivalent
 0.5mL Mo 1000mg/L
 0.05ml Ag 1000mg/L
 2 ml Interferents-A-SPEX Certiprep or equivalent
 Dilute to volume with Milli-Q water, mix and transfer to a clean 1 L Nalgene bottle. Make new every 6 months or as needed.
- | <u>Concentration</u> | <u>Analyte</u> |
|----------------------|-------------------------------|
| 50ug/L | Cd, Be |
| 100ug/L | Ag |
| 200ug/L | Cr |
| 250ug/L | Cu |
| 500ug/L | Co, Mn, Mo, Ni, Pb, Sb, V, Zn |
| 2000ug/L | Ba, As, Tl, Se |
| 5,000ug/L | Fe |
| 10,000ug/L | Ca, Mg |
| 12,000ug/L | Al |
- 13.8 Interference Check Solution (ICSA): Into a 500 mL volumetric flask, add 300 mL of Milli-Q H₂O, 5 mL of conc. HNO₃ and 5mL conc. HCl. Add the following stock solutions in the volumes listed:

50 mL Spex Certiprep Interferents A or equivalent

15 ml Fe 10,000mg/L or equivalent

Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean 500 mL Nalgene bottle. Prepare every 6 months or as needed.

Concentration

Analyte

500,000 ug/L

Al, Ca, Mg, Fe

- 13.9 Interference Check Solution (ICSAB): Into a 500 mL volumetric flask, add 300 mL of Milli-Q H₂O, 5 mL of conc. HNO₃ and 5 mL conc. HCl. Add the following stock solutions in the volumes listed:

50 mL Spex Certiprep Interferent A or equivalent

15 ml Spex Certiprep Fe 10,000 mg/L or equivalent

2.5 ml Spex Certiprep QC-21 or equivalent

0.25 ml Ultra Scientific Ag 1000 mg/L or equivalent

0.25 ml Ultra Scientific Ba 1000 mg/L or equivalent

Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean 500 mL Nalgene bottle. Prepare every 6 months or as needed.

Concentration

Analyte

500,000 ug/L

Al, Ca, Mg, Fe

500 ug/L

Ag, As, Ba, Be Cd, Co, Cr, Cu, Mn,
Mo, Ni, Pb, Se, Sb, Tl, V, Zn

- 13.10 CRDL/MRL solution: Concentrations needed depend on the CRDL/MRL of a given contract.

14.0 Procedure

- 14.1 Instrument start-up procedure:

14.1.1 Open valve at argon tank, turn on chiller and instrument.. For best results, the instrument should be on and with an argon purge for at least 24 hours

14.1.2 Inspect pump tubing on instrument and on autosampler and change if necessary.

14.1.3 Fill DI rinse reservoir with DI water and preserve with HNO₃ to 1%.

14.1.4 Open up the ITeva software on the PC. Choose user, wait until instrument initializes.

14.1.5 Plasma startup and shutdown: Refer to the ICAP 6000 Series ICP-OES Spectrometer Operator manuals pages 11-1 thru 11-4. After plasma startup check the "Debug Wavelength Check" at the bottom of the ITeva control center. The absolute value of x and y #s should be less than 5, if not, stop and call Thermo service.

14.1.6 After a 30-minute warm-up period, check condition of nebulizer. Put pump tube into a 100mg/L solution Yttrium Std. With the lights off and after enough time has elapsed for the Yttrium standard to reach the plasma, a red cone should be noticeable in the center of the plasma. If the nebulizer is in good condition and the nebulizer gas flows are set properly, the red cone should project about 2mm beyond the coils. If not, check the settings, the pump tubes, and inspect the nebulizer under a microscope for any obstructions or breakage.

- 14.2 To create an autosampler sequence:
- 14.2.1 Refer to the ICAP 6000 Series ICP-OES Spectrometer Operator manuals pages 11-9 thru 11-11 to start an autosampler sequence.
 - 14.2.2 Add all samples, LCS, Blanks, MS-MSD, etc. in order of program, agency or client request.
 - 14.2.3 Print Autosampler Table: This will be used when preparing all samples and standards.
 - 14.2.4 Using the printed autosampler table sheet, prepare all standards, QC samples, and samples in their designated positions in the autosampler. Prepare any bench spikes and place them in autosampler. Calibration standards, CCV, ICV, CCB, ICB and ICSAB all go into 50 ml vials in the designated S-# positions of the autosampler. All others are poured into 15 ml plastic vials into the designated areas within the 60 position racks.
- 14.3 Calibration and Analysis.
- 14.3.1 Once all calibration standards have been placed in the autosampler make sure the autosampler is initialized by clicking on the autosampler icon and the sequence is saved and then press the yellow arrow icon to start the calibration and prepare the remaining samples as the calibration is being carried out.
- 14.4 Instrument shutdown
- 14.4.1 If run will not be finished during work hours, program the instrument to shut down at the end of the analytical run. When setting up on the sequence page click the “End Action (after all sequences) Box to “Shutdown Plasma”. This will shut down the plasma.
 - 14.4.2 For manual shutdown go to the flame icon in the bottom right corner and click, and then select the plasma off icon. After the plasma is shutdown loosen the pump tubes and shut off the chiller.

15.0 Calculations

15.1 Sample Calculations:

$$\text{Liquid Concentration (ug/L)} = A \times C$$

$$\text{Solid Concentrations (mg/kg)} = \frac{A \times B \times C}{D \times E},$$

$$D \times E$$

- Where:
- A = instrument reading for sample (ug/L)
 - B = total volume of digestion (L)
 - C = dilution factor, if necessary (ex. For a 1 to 10 dilution, C = 10)
 - D = amount of sample used in digestion (g)
 - E = percent solids/100, if necessary (fraction equivalent)

15.2 Spike Recovery Calculations:

$$\text{LCS Recovery (\%)} = \frac{(\text{Result obtained})}{(\text{LCS})} \times 100$$

(Spike amount)

$$MS/MSD \text{ Spike Recovery (\%)} = \frac{(\text{Spiked sample conc.} - \text{Sample conc.}) \times 100}{(\text{Spike amount})}$$

$$\%RPD = \frac{(MS - MSD) \times 100}{(MS + MSD)/2}$$

Where: MS = Matrix spike concentration obtained

MSD = Matrix spike duplicate concentration obtained

- 15.2 “Total Hardness” (by calculation) can also be determined by using the values for calcium and magnesium obtained by this procedure. The “Total Hardness” value is calculated in the LIMS system using the following equation:

Total Hardness (mg/L) or Hardness equivalent $\text{CaCO}_3/\text{L} =$

$$2.497[\text{Ca mg/L}] + 4.118[\text{Mg mg/L}]$$

16.0 Method Performance

- 16.1 Certified standard solutions, properly used instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies. Internal blind spikes are also utilized to check analyst performance.
- 16.2 Initial demonstration of capability (IDC) is another technique used to ensure acceptable method performance. An analyst must demonstrate initial precision and accuracy through the analysis of 4-5 laboratory control spikes for each matrix and sample type. After analysis, the analyst calculates the average recovery (AR) and the relative standard deviation (RSD) of the recoveries for each analyte. In the absence of specific criteria found in the EPA methods or project specific limits, the default criteria of 70-130% recovery and 20 % RSD are used until internal limits are generated.
- 16.3 Proper instrument maintenance is another means to ensure adequate method performance.
- 16.3.1 Pump tubing and rollers: Ensure that the pump rollers turn freely. Inspect pump tubing daily and replace when it starts failing to retain its shape.
- 16.3.2 Drain line: Spray chamber drain line must flow unimpeded directly into waste jug. Make sure line is draining properly.
- 16.3.3 Spray Chamber: If the spray chamber becomes dirty, the sample waste may not drain properly. Remove and wash with hot soapy water, then rinse with DI H_2O .
- 16.3.4 Torch and O-rings: The O-rings surrounding the torch may need to be replaced if the plasma becomes unstable or internal standard emission counts fall off. See ICP6000 manual for technique. Torch needs to be cleaned occasionally with aqua regia followed by sonication. See sections 5

and 6 in the “ICAP 6000 Series ICP-OES Spectrometer Operating Manuals” for further assistance if needed.

17.0 Pollution Prevention

- 17.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.
- 17.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18.0 Data Assessment and Acceptance Criteria for QC Measures

- 18.1 When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. The analyst will review the data to ensure QC is acceptable and that exceedances are addressed. Acceptable data is then captured into the LIMS system (See SOP ICP6000 Data Capture for instructions on data capture).
- 18.2 After data has been captured by LIMS, it is reviewed by the analyst for accuracy and completeness. See checklist (FMT9-01) for data review guidance.
- 18.3 Once analyst has reviewed and approved the data, it is given to a peer or supervisor for review.
- 18.4 After the second reviewer approves the data, the reviewer sends the data to “validated” status in LIMS.
- 18.5 A paper hard copy of the data is then filed or archived. The package includes the checklist, the sequence run log, and a copy of the bench sheet (if applicable), the LIMS run log, and verification of calibration data.

19.0 Corrective Measures for Out-of-Control Data

When data is out of control, a number of corrective actions may need implementing. If the nonconformities involve failing QC within the analytical sequence batch, then reanalysis of samples may eliminate any out of control data. If the out of control data is the result of instrument malfunctions, then maintenance or repair of the downed instrument followed by reanalysis of affected data may correct the problem. If sample matrix affect or contamination is the reason for poor data, the instrument may need cleaning and decontamination. In all cases, when out of control data presents itself, the appropriate corrective measures need to be enacted to eliminate unusable data. The Quality Control Requirements chart can be used as a guide as to which corrective actions should be taken for different QC-type failures or nonconformities (Table 3.).

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

- 20.1 Due to limited sample volume, expiration of hold times, downed instrumentation, and analyst error, the sample data may be out of control or unacceptable to report. Since these potential instances can arise, contingency plans need to be in place to prevent and/or minimize their effect on data.

- 20.1.1 The first thing addressed is prevention of producing unacceptable data. When limited sample volume is the issue, the analyst should determine if splitting the sample into lesser volumes or weights is an option. To avoid sample hold time issues, the analyst's first responsibility is to plan accordingly. The analyst is responsible for budgeting enough time for sample analysis, so if a problem arises, reanalysis is an option. Analyst error is prevented by a second analyst confirmation and validation. If the initial analyst makes an analysis error or inadvertently reports unacceptable data, the second analyst is responsible for finding and/or correcting those errors.
- 20.1.2 When out of control or unacceptable data is produced and it is too late for corrective measures, a number of actions can be taken. The first and foremost is alerting the client service personnel of the problem. Client services will inform the client and/or responsible parties. In some instances, more samples can be made available or re-sampling can occur, so it is important to alert the appropriate personnel as soon as possible.
- 20.1.2.1 If the out of control data affects only specific analytes, it is important to let the appropriate person(s) know in case his or her site assessment is based on a specific target analyte list.
- 20.1.2.2 In all instances, if results are reported from data that is out of control or unacceptable, that data should be qualified accordingly. Once the client has been notified and he or she instructs us to report the data, flag the data indicating what type of nonconformity has occurred.
- 20.1.2.3 Out of control data is still retained by the laboratory and filed and archived along with acceptable data. The file folder should be labeled as such, indicating that the data is out of control.
- 20.1.2.4 A non-conformance/corrective action report (CAR) form must be filled out whenever these types of events occur. The information on the report includes the problem encountered, planned corrective actions, and corrective action follow-up. The form is then discussed with and signed by the analyst, the client representative, the QA officer, and the laboratory manager. The purpose of the form is to document problems in order to eliminate the possibility of repeating nonconformance and to ensure that the proper corrective actions are employed.

21.0 Waste Management

Samples are routinely held for up to six weeks from analysis date before they enter the waste stream. Waste disposal of samples and standards follows the procedures documented in the Laboratory Waste Disposal SOP (Quality Assurance Section, SOP NO. FO-8, Rev. 4).

22.0 REFERENCES

- 22.1 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010B, rev. 2, December 1996.

- 22.2 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010B, rev. 3, February, 2000.
- 22.3 Test Methods for Evaluating Solid Waste, EPA, SW-846, Method 6010C, rev. 3, February, 2007.
- 22.4 Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, Method 200.7, rev. 4.4, 1991.
- 22.5 USEPA - Contract Laboratory Program, Statement of Work for Inorganic Analysis, ILM04.0.
- 22.6 ICAP 6000 Series ICP-OES Spectrometer Operator's Manual, Thermo Electron (registration number 441506).
- 22.7 Thermo Electron Corporation Training Manual iCAP 6000 Series.
- 22.8 Standard Methods For the Examination of Water and Wastewater, 21st Edition, 2340B-Hardness by Calculation, 2005.
- 22.9 CT Laboratories Quality Manual, current revision.
- 22.10 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.
- 22.11 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.
- 22.12 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.
- 22.13 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.

23.0 Appendices

**Table1: Spike, LCS, & LFB Analysis- ICP
Pre-digestion Spikes**

Element	Spike Amt. mL of	Spike Stock A, B, C	Stock Conc. mg/L	Final Vol. mL	Expected Conc. ug/L
Aluminum	1	A	200	50	4000
Antimony	1	A	50	50	1000
Arsenic	1	A	200	50	4000
Barium	1	A	200	50	4000
Beryllium	1	A	5	50	100
Cadmium	1	A	5	50	100
Calcium	0.5	C	20,000	50	200000
Chromium	1	A	20	50	400
Cobalt	1	A	50	50	1000
Copper	1	A	25	50	500
Iron	1	A	100	50	2000
Lead	1	A	50	50	1000
Manganese	1	A	50	50	1000
Magnesium	0.5	C	10,000	50	100000
Molybdenum*	0.1	B	1000	50	2000
Nickel	1	A	50	50	1000
Selenium	1	A	200	50	4000
Silver	1	A	5	50	100
Thallium	1	A	200	50	4000
Vanadium	1	A	50	50	1000
Zinc	1	A	50	50	1000
Spike Solutions ***					
Supplier	Lot #/ std	Stock			
SPEX Certiprep or equiv.	SPIKE 1- 500	A			
Molybdenum * or equiv.	1000 mg/L	B			
Custom Std***	SPEX	C			

- * Addition of Boron, Lithium, Silicon, Tin, Strontium, Titanium, and Tungsten at 0.1 ml each of a 1000 mg/L solution from SPEX Certiprep or equivalent.
- ** Addition of Potassium at 0.5 ml of a 10,000 mg/L solution from SPEX Certiprep or equivalent.
- *** Sodium is also included in this standard at 10,000 mg/L

**Table 2: Bench Spike Analysis-ICP
Post Digestion/ Bench Spikes**

Element	Spike Amt. ML of	Spike Soln.	Stock Conc. mg/L	Final Vol. mL	Expected Conc. ug/L
Aluminum	0.2	A	200	10	4000
Antimony	0.2	A	50	10	1000
Arsenic	0.2	A	200	10	4000
Barium	0.2	A	200	10	4000
Beryllium	0.2	A	5	10	100
Cadmium	0.2	A	5	10	100
Calcium	0.2	B	20,000	10	400000
Chromium	0.2	A	20	10	400
Cobalt	0.2	A	50	10	1000
Copper	0.2	A	25	10	500
Iron	0.2	A	100	10	2000
Lead	0.2	A	50	10	1000
Manganese	0.2	A	50	10	1000
Magnesium	0.2	B	10,000	10	200000
Molybdenum	0.02	C*	1000	10	2000
Nickel	0.2	A	50	10	1000
Selenium	0.2	A	200	10	4000
Silver	0.2	A	5	10	10
Thallium	0.2	A	200	10	4000
Vanadium	0.2	A	50	10	1000
Zinc	0.2	A	50	10	1000
Standard Source ***					
Supplier					
SPEX		A			
SPEX Custom Std		B			
Molybdenum-1,000 mg/L Std*		C*			

- * Addition of Boron, Lithium, Silicon, Tin, Strontium, Titanium, and Tungsten at 0.02 ml each of a 1000 mg/L solution from SPEX Certiprep or equivalent.
- ** Addition of Potassium and Sodium at 0.1 ml of a 10,000 mg/L solution from SPEX Certiprep or equivalent.

Table 3: Summary of Quality Control Requirements

QC Type	Frequency	Conc. Level	1. Acceptance Criteria	2. Corrective Action
Linear Dynamic Range(LDR) or high level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range	High point of calibration curve	Within $\pm 10\%$ of true value.	Data cannot be reported above the high calibration range without an established/passing high level check standard
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analyst	Table. 4a.	If more than one calibration standard used, $r^2 \geq 0.99$.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	1 per calibration	Mid. Calib. Range	SDWA:95-105% SW846:90-110% Or Project/Program Specific	Terminate run. Correct the problem before proceeding
Initial Calibration Blank (ICB)	Immediately after the ICV	<MDL	SW846: < 3x IDL SDWA: < MDL DOD-QSM < MDL LCG: <1/2 MRL or Project / Program Specific	Terminate analysis and correct the problem before proceeding.
Method Blank (MB)	1 per batch of 20 samples	<MDL	SDWA: < MDL SW846: < 2x MDL DOD-QSM / LCG: <1/2 MRL or Project / Program Specific	Access data and reanalyze/reprepare the MB and affected data or flag "B" analyte detected in Method Blank when insufficient sample remains
Laboratory Control Sample (LCS)	1 per batch of 20 samples	Mid. Calib. Range	In-house limits or, default 80-120% SDWA; 90-110% or Project / Program Specific	Terminate analysis: correct problem before proceeding.
Continuing Calibration Verification	1 after every 10 th sample	Mid. Calib. Range	SW846: 90-110% SDWA: 90-110% CLP:90-110%	Recalibrate and reanalyze all samples back to the last

(CCV)				acceptable CCV or ICV
Continuing Calibration Blank (CCB)	Immediately following each CCV	<MDL	SW846: < 3x IDL SDWA: < MDL DOD-QSM < MDL LCG: < 2x MDL or Project / Program Specific	Reanalyze all samples back to the last acceptable CCB or flag "B" analytes detected
Interference Check Solution A (ICSA)	Immediately After LCS (& before final CCV if required by program / project specific QAPP)	500mg/L Al, CA,FE, Mg	80-120% for Interference Elements ABS of analytes not included must be < 2X MRL or Project / Program Specific	Terminate analysis, correct problem & reanalyze all samples back to last good ICSA/ICSAB
Interference Check Solution AB (ICSAB)	Immediately After ICSA (& before final CCV if required by program / project specific QAPP)	500mg/L Al, CA, FE,MG Other elements 500ug/L	80-120% for All Elements	Terminate analysis, correct problem & reanalyze all samples back to last good ICSA/ICSAB
MS	One per batch per matrix	See Table 1 spike chart	1. In-house limits: default 70-130 % Rec. 2. DOD-QSM: Use specified LCS limits. 3. LCG: 75-125 % Rec. when [matrix] is <4x[spike]	1. Reanalyze an alternative sample or perform a PDS, if MS and PDS fail qualify data as to matrix effect. 2. DOD-QSM: Used for matrix evaluation only. Determine source of difference (i.e. serial dilution/PDS). Reanalyze or qualify data as per client/ project requirement. 3. LCG: If MS fails and sample results are < 5x the MRL run a PDS. If sample results are > 5x the

				MRL perform a serial dilution.
MSD or Matrix Dup. (MD)	1. In-house & QSM-DOD: one MSD or MD per batch or matrix. 2. LCG: one MD per batch or matrix.	See Table 1 spike chart	1. In-house limits: default 70-130 % Rec. RPD = 20% 2. DOD-QSM: Use specified LCS limits for MSD. RPD = 20 % for MS/MSD or MD. 3. LCG: RPD = 20%	1. Perform PDS, if MSD and PDS fail qualify data as to matrix effect. 2. DOD-QSM: Used for matrix evaluation only. Determine source of difference (i.e. serial dilution/PDS). Reanalyze or qualify data as per client/ project requirement. 3. LCG: Qualify positive detects for precision failures between the sample and the MD.
Serial Dilution Analysis (SD)	1. In-house: Analyzed on the sample with a PDS failure. 2. DOD-QSM: Analyzed with each batch of samples. 3. LCG: After an MS failure with sample results > 5x the MRL.	5 fold dilution of chosen sample	RPD within 10% of value of diluted and undiluted sample, but only if sample conc. 1. In-house: > 10x LOQ 2. DOD-QSM: > 50x the MDL 3. LCG: > 5x the MRL	1. In-house: Qualify data only if sample result is > 10x the LOQ. 2. Analyze a PDS if sample result is > 50x the MDL. 3. Analyze a PDS if sample result is > 5x the MDL.

Post Digestion Spike (PDS)	1. In-house: Upon failure of MS or MSD. 2. DOD-QSM: When the SD test fails or all sample results < 50x the MDL and there is an MS or MSD failure. 3. LCG: When the MS fails and the sample result is <5x the MRL or when the SD test fails.	Between 10 and 100 times the MDL	1. In-house: 80-120% Rec. 2. DOD-QSM & LCG: 75-125% Rec.	1. In-house: Qualify for matrix interference or if requested analyze by MSA. 2. DOD-QSM: Run samples by MSA or ISA or qualify data using program/project specified criteria. 3. LCG: Run samples by MSA or qualify data using program/project specified criteria.
Method of Standard Additions (MSA) or Internal Standard Calibration (ISA)	1. In-house: When requested. 2. DOD-QSM & LCG: After the failure of a PDS.	Minimum of 3 standard levels and the unspiked sample	N/A	Document the use of an MSA or ISA

Table 4a. TAL list Concentrations/Ranges for ICP ug/L

Element, Wavelength and Order	Blank		CalibStd=0.25		CalibStd=0.5		CalibStd=1		CalibStd=5		CalibStd=10		C
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	
Ag 328.068 (103)	☒	0	☐		☐		☐		☒	5	☒	10	☒
Ag 338.289 (100)	☒	0	☐		☐		☐		☐		☐		☒
Al 167.079 (502)	☒	0	☐		☐		☐		☐		☒	10	☒
Al 309.271 (109)	☒	0	☐		☐		☐		☐		☐		☒
Al 396.152 (85)	☒	0	☐		☐		☐		☐		☐		☒
As 189.042 (479)	☒	0	☐		☐		☐		☐		☒	10	☒
As 193.759 (474)	☒	0	☐		☐		☐		☐		☐		☒
Ba 455.403 (74)	☒	0	☐		☐		☒	1	☒	5	☒	10	☒
Ba 493.409 (68)	☒	0	☐		☐		☐		☐		☐		☒
Be 234.861 (144)	☒	0	☐	0.25	☐	0.5	☒	1	☒	5	☒	10	☒
Be 313.042 (108)	☒	0	☒		☒		☒		☒		☒		☒
Ca 317.933 (106)	☒	0	☐		☐		☐		☐		☒	10	☒
Ca 393.366 (86)	☒	0	☐		☐		☐		☐		☐		☒
Ca 396.847 (85)	☒	0	☐		☐		☐		☐		☐		☒
Cd 226.502 (449)	☒	0	☒	0.25	☒	0.5	☒	1	☒	5	☐		☒
Cd 228.802 (447)	☒	0	☐		☐		☐		☐		☐		☒
Co 228.616 (447)	☒	0	☐		☐		☒	1	☒	5	☒	10	☒
Co 238.892 (141)	☒	0	☐		☐		☐		☐		☐		☒
Cr 205.552 (464)	☒	0	☐		☐		☒	1	☐	5	☒	10	☒
Cr 267.716 (126)	☒	0	☐		☐		☒		☒		☐		☒
Cu 224.700 (450)	☒	0	☐		☐		☐		☒	5	☐		☒
Cu 327.396 (103)	☒	0	☐		☐		☐		☒		☐		☒
Fe 234.349 (144)	☒	0	☐		☐		☐		☐		☒	10	☒
Fe 239.562 (141)	☒	0	☐		☐		☐		☐		☐		☒
Fe 259.940 (130)	☒	0	☐		☐		☐		☐		☐		☒
Mg 279.079 (121)	☒	0	☐		☐		☐		☐		☒	10	☒
Mg 279.553 (121)	☒	0	☐		☐		☐		☐		☐		☒
Mg 280.270 (120)	☒	0	☐		☐		☐		☐		☐		☒
Mn 257.610 (131)	☒	0	☐		☐		☐		☒	5	☒	10	☒
Mn 259.373 (130)	☒	0	☐		☐		☐		☐		☐		☒
Mo 202.030 (467)	☒	0	☐		☐		☒	1	☐		☒	10	☒
Mo 204.598 (465)	☒	0	☐		☐		☐		☐		☐		☒
Ni 221.647 (452)	☒	0	☐		☐		☒	1	☐		☒	10	☒
Ni 231.604 (445)	☒	0	☐		☐		☒		☐		☐		☒
Pb 216.999 (455)	☒	0	☐		☐		☒	1	☐		☒	10	☒
Pb 220.353 (453)	☒	0	☐		☐		☒		☐		☐		☒
Sb 206.833 (463)	☒	0	☐		☐		☐		☒	5	☒	10	☒
Sb 217.581 (455)	☒	0	☐		☐		☐		☒		☐		☒
Se 196.090 (472)	☒	0	☐		☐		☒	1	☐		☒	10	☒
Se 206.279 (463)	☒	0	☐		☐		☐		☐		☐		☒
Tl 190.856 (477)	☒	0	☐		☐		☐		☒	5	☒	10	☒
Tl 351.924 (96)	☒	0	☐		☐		☐		☐		☐		☒
V 290.882 (116)	☒	0	☐		☐		☒	1	☒	5	☒	10	☒
V 292.402 (115)	☒	0	☐		☐		☒		☒		☐		☒
Y 360.073 (94)*	☒	0	☐		☐		☐		☐		☐		☒
Zn 206.200 (463)	☒	0	☐		☐		☒	1	☒	5	☒	10	☒
Zn 213.856 (458)	☒	0	☐		☐		☒		☒		☐		☒

Element, Wavelength and Order	Calibration Standards												
	CalibStd=20	CalibStd=50		CalibStd=100		CalibStd=500		CalibStd=1000		CalibStd=5000		CalibStd=10000	
	Cone	?	Cone	?	Cone	?	Cone	?	Cone	?	Cone	?	Cone
Ag 328.068 (103)	20	☒	50	☒	100	☒	500	☒	1000	☒		☒	
Ag 338.289 (100)		☒		☒		☒		☒		☒		☒	
Al 167.079 (502)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Al 309.271 (109)		☒		☒		☒		☒		☒		☒	
Al 396.152 (85)		☒		☒		☒		☒		☒		☒	
As 189.042 (479)		☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
As 193.759 (474)		☒		☒		☒		☒		☒		☒	
Ba 455.403 (74)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Ba 493.409 (68)		☒		☒		☒		☒		☒		☒	
Be 234.861 (144)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Be 313.042 (108)		☒		☒		☒		☒		☒		☒	
Ca 317.933 (106)	20	☒		☒	100	☒	500	☒	1000	☒	5000	☒	10000
Ca 393.366 (86)		☒		☒		☒		☒		☒		☒	
Ca 396.847 (85)		☒		☒		☒		☒		☒		☒	
Cd 226.502 (449)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Cd 228.802 (447)		☒		☒		☒		☒		☒		☒	
Co 228.616 (447)		☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Co 238.892 (141)		☒		☒		☒		☒		☒		☒	
Cr 205.552 (464)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Cr 267.716 (126)		☒		☒		☒		☒		☒		☒	
Cu 224.700 (450)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	
Cu 327.396 (103)		☒		☒		☒		☒		☒		☒	
Fe 234.349 (144)		☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Fe 239.562 (141)		☒		☒		☒		☒		☒		☒	
Fe 259.940 (130)		☒		☒		☒		☒		☒		☒	
Mg 279.079 (121)		☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Mg 279.553 (121)		☒		☒		☒		☒		☒		☒	
Mg 280.270 (120)		☒		☒		☒		☒		☒		☒	
Mn 257.610 (131)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Mn 259.373 (130)		☒		☒		☒		☒		☒		☒	
Mo 202.030 (467)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Mo 204.598 (465)		☒		☒		☒		☒		☒		☒	
Ni 221.647 (452)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Ni 231.604 (445)		☒		☒		☒		☒		☒		☒	
Pb 216.999 (455)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Pb 220.353 (453)		☒		☒		☒		☒		☒		☒	
Sb 206.833 (463)	20	☒		☒	100	☒	500	☒	1000	☒	5000	☒	10000
Sb 217.581 (455)		☒		☒		☒		☒		☒		☒	
Se 196.090 (472)		☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Se 206.279 (463)		☒		☒		☒		☒		☒		☒	
Tl 190.856 (477)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Tl 351.924 (96)		☒		☒		☒		☒		☒		☒	
V 290.882 (116)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
V 292.402 (115)		☒		☒		☒		☒		☒		☒	
Y 360.073 (94)*		☒		☒		☒		☒		☒		☒	
Zn 206.200 (463)	20	☒	50	☒	100	☒	500	☒	1000	☒	5000	☒	10000
Zn 213.856 (458)		☒		☒		☒		☒		☒		☒	

Table 4b. TAL list Concentrations/Ranges for ICP ug/L cont.

Table 4c. TAL list Concentrations/Ranges for ICP ug/L cont.

Element, Wavelength and Order	CalibStd-100k		CalibStd-100000		CalibStd-500000		CalibStd-1000k	
	?	Conc	?	Conc	?	Conc	?	Conc
Ag 328.068 {103}	☐		☐		☐		☐	
Ag 338.289 {100}	☐		☐		☐		☐	
Al 167.079 {502}	☐		☐	100000	☐	500000	☐	1e+006
Al 309.271 {109}	☐		☒		☐		☒	
Al 396.152 { 85}	☐		☒		☒		☒	
As 189.042 {479}	☐		☐		☐		☐	
As 193.759 {474}	☐		☐		☐		☐	
Ba 455.403 { 74}	☐		☐		☐		☐	
Ba 493.409 { 68}	☐		☐		☐		☐	
Be 234.861 {144}	☐		☐		☐		☐	
Be 313.042 {108}	☐		☐		☐		☐	
Ca 317.933 {106}	☐		☒	100000	☒	500000	☒	1e+006
Ca 393.366 { 86}	☐		☒		☐		☐	
Ca 396.847 { 85}	☐		☒		☐		☐	
Cd 226.502 {449}	☐		☐		☐		☐	
Cd 228.802 {447}	☐		☐		☐		☐	
Co 228.616 {447}	☐		☐		☐		☐	
Co 238.892 {141}	☐		☐		☐		☐	
Cr 205.552 {464}	☒	100000	☐		☐		☐	
Cr 267.716 {126}	☒	100000	☐		☐		☐	
Cu 224.700 {450}	☒	100000	☐		☐		☐	
Cu 327.396 {103}	☐		☐		☐		☐	
Fe 234.349 {144}	☐		☒	100000	☒	500000	☒	1e+006
Fe 239.562 {141}	☐		☐		☐		☐	
Fe 259.940 {130}	☐		☐		☐		☐	
Mg 279.079 {121}	☐		☒	100000	☒	500000	☒	1e+006
Mg 279.553 {121}	☐		☐		☐		☐	
Mg 280.270 {120}	☐		☐		☐		☐	
Mn 257.610 {131}	☐	100000	☐		☐		☐	
Mn 259.373 {130}	☒		☐		☐		☐	
Mo 202.030 {467}	☐		☐		☐		☐	
Mo 204.598 {465}	☐		☐		☐		☐	
Ni 221.647 {452}	☐		☐		☐		☐	
Ni 231.604 {445}	☐		☐		☐		☐	
Pb 216.999 {455}	☒	100000	☐		☐		☐	
Pb 220.353 {453}	☐		☐		☐		☐	
Sb 206.833 {463}	☐		☐		☐		☐	
Sb 217.581 {455}	☐		☐		☐		☐	
Se 196.090 {472}	☐		☐		☐		☐	
Se 206.279 {463}	☐		☐		☐		☐	
Tl 190.856 {477}	☐		☐		☐		☐	
Tl 351.924 { 96}	☐		☐		☐		☐	
V 290.882 {116}	☐		☐		☐		☐	
V 292.402 {115}	☐		☐		☐		☐	
Y 360.073 { 94}	☐		☐		☐		☐	
Zn 206.200 {463}	☒	100000	☐		☐		☐	
Zn 213.856 {458}	☐		☐		☐		☐	

Note: These metals are calibrated using a blank and minimum of three standards. It is not allowable to remove any mid-levels to obtain an acceptable calibration; all points must be used. Multi-level calibrations must be sequential.

Appendix A.

Element specific standard prep for multipoint calibration of ICP.

- A1 Calibration Standard 0.25 (Be, & Cd): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 0.25 uL of SPEX Quality Control Standard 7 and 0.25 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.25 ug/L.
- A2 Calibration Standard 0.50 (Be & Cd): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 50uL of SPEX Quality Control Standard 7 and 50uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.50 ug/L.
- A3 Calibration Standard 1.0 (Ba, Be, Cd, Co, Cr, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1 ml of conc. HNO₃ and 1mL conc. HCl. Add 1.0 uL of SPEX Quality Control Standard 7 and 1.0 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 ug/L
- A4 Calibration Standard 5.0 (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 5 uL of SPEX Quality Control Standard 7 and 5 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5 ug/L
- A5 Calibration Standard 10.0 (Ag, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 10 uL of SPEX Quality Control Standard 7 and 10 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 ug/L
- A6 Calibration Standard 20 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe Mn, Mo, Ni, Pb, Sb, Tl, & V): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 20uL of SPEX Quality Control Standard 7 and 20uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several

- times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 20 ug/L
- A7 Calibration Standard 50 (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 50uL of SPEX Quality Control Standard 7 and 50uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 ug/L
- A8 Calibration Standard 100 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sb, Tl, V, & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 100 uL of SPEX Quality Control Standard 7 and 100 uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 ug/L
- A9 Calibration Standard 500 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 500uL of SPEX Quality Control Standard 7 and 500uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L
- A10 Calibration Standard 1000 (Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 1000uL of SPEX Quality Control Standard 7 and 1000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L
- A11 Calibration Standard 5000 (Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 5000uL of SPEX Quality Control Standard 7 and 5000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5000 ug/L
- A12 Calibration Standard 10000 (Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Se, Tl, V & Zn): Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 10000uL of SPEX Quality Control Standard 7 and 10000uL of SPEX Quality Control Standard 21. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10000 ug/L

- A13 Calibration Standard 100000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 5mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL of HCl. Add 1mL of 10,000 mg/L Al, 1mL of 10,000 mg/L Ca, 1mL of 10,000 mg/L Fe and 1mL of 10,000 mg/L Mg. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100,000 ug/L Al, Ca, Fe, Mn, and Mg.
- A14 Calibration Standard 100K (Cr, Cu, Co, Ni, Mn, & Pb): Into a 100mL volumetric flask, add 5mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL of HCl and add 10 mls of Cr 1000 mg/L, 10 mls Cu 1000 mg/L, 10 mls Pb 1000 mg/L, 10 mls Co 1000 mg/L, 10 mls Ni 1000 mg/L and 10 ml of Mn 1000 mg/L and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100,000 ug/L Co, Cr, Cu, Ni, Mn, and Pb.
- A15 Calibration Standard 500000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL of HCl. Add 5mL of 10,000 mg/L Al, 5mL of 10,000 mg/L Ca, 5mL of 10,000 mg/L Fe and 5mL of 10,000 mg/L Mg. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500,000 ug/L Al, Ca, Fe and Mg
- A16 Calibration Standard 1000000 (Al, Ca, Fe, & Mg): Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL of HCl. Add 10mL of 10,000 mg/L Al, 10mL of 10,000 mg/L Ca, 10mL of 10,000 mg/L Fe and 10mL of 10,000 mg/L Mg. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1,000,000ug/L Al, Ca, Fe and Mg
- A17 Calibration Blank: Into a 1 L. volumetric flask, add 750 mL of Milli-Q water and 10 mL of conc. HNO₃ and 10mL HCl. Mix, dilute to volume with Milli-Q H₂O. Transfer to a clean 1 L. Nalgene bottle. Prepare every 6 months or as needed.
- A18 ICV/CCV: Into a 1000mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO₃ and 10mL of conc. HCl. Add 10.0mL Spex Certiprep Spike Sample Standard 1 or equivalent and 2.0mL Interference A or equivalent, 0.5 mls of 1000 ug/L Mo and 0.05 mls 1000 ug/L Ag. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L
- A19 ICSAB: Into a 100mL volumetric flask, add 500mL Milli-Q water, 5mL of conc. HNO₃ and 5mL of conc. HCl. Add 50 ml of SPEX Interferents A or equivalent, 15.0mLs of 10,000 mg/L Fe, 2.5mL Spex Certiprep QC 7 and 2.5 ml Spex Certiprep-QC 21 or equivalent. Dilute to volume with Milli-Q water and mix by inverting several times.

Table 5. Sodium and Potassium Concentrations/Ranges for ICP (mg/L)

Note: These metals are calibrated using a blank and minimum of three standards. It is not allowable to remove any mid-levels to obtain an acceptable calibration; all points must be used. Multi-level calibrations must be sequential.

Appendix B

Standard Prep for Sodium and Potassium analysis.

B1 Calibration Standard 0.5: Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 2mL of conc. HNO₃ and 2mL conc. HCl. Add 0.05mL Sodium 1000mg/L and 0.05mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 0.5 mg/L Na, K.

B2 Calibration Standard 1.0: Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 0.1mL Sodium 1000mg/L and 0.1mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 mg/L Na, K.

B3. Calibration Standard 5.0: Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of

Element, Wavelength and Order	Calibration Standards									
	Blank	CalibStd-0.5	CalibStd-1.0	CalibStd-5.0	CalibStd-10.0	CalibStd-50.0	CalibStd-100	CalibStd-200	CalibStd-500000	
	?	?	?	?	?	?	?	?	?	
	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc	Conc
K 766.490 (44)	0	0.5	1	5	10	50	100	200		
Na 330.237 (102)	0	0.5	1	5	10	50	100	200		
Na 589.592 (57)	0									
Al 309.271 (109)	0									500
Ca 317.933 (108)	0									500
Fe 258.940 (130)	0									500
Mg 279.079 (121)	0									500
Y 360.073 (94)*	0									500

conc. HNO₃ and 1mL conc. HCl. Add 0.5mL Sodium 1000mg/L and 0.5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5 mg/L Na, K.

B4. Calibration Standard 10: Into a 100mL volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 1mL Sodium 1000mg/L and 5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 mg/L Na, K.

B5. Calibration Standard 50: Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 5mL Sodium 1000mg/L and 5mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times.

Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 mg/L Na, K.

- B6. Calibration Standard 100: Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 10mL Sodium 1000mg/L and 10mL Potassium 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L Na, K.
- B7. Calibration Standard 200: Into a 100mL volumetric flask, add H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 50mL Sodium 1000mg/L and 50mL Potassium 1000mg/L. Mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Na, K.
- B8. Calibration Standard 500 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL, Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.
- B9. ICV/CCV: Into a 100mL volumetric flask, add 50mL Milli-Q water, 1mL of conc. HNO₃ and 1mL of conc. HCl. Add 1.0mL 10,000mg/L Na and 1.0mL 10,000 K. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 mg/L Na and K.
- B8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO₃ and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 1.0mL 10,000mg/L Na and 1.0mL 10,000 K. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100mg/L Na and K, 500,000ug/L Al, Ca, Fe and Mg.

Table 6. Boron and Silicon Concentrations/Ranges for ICP (ug/L)

Element, Wavelength and Order	Calibration Standards													
	Blank		CalibStd-50		CalibStd-50 & 10		CalibStd-500 & 1		CalibStd-1000 & 2		CalibStd-5000 & 1		CalibStd-50000	
	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc	?	Conc
B 249.773 (135)	☒	0	☒	50	☒	100	☒	1000	☒	2000	☒	10000	☐	
Si 251.611 (134)	☒	0	☐		☒	50	☒	500	☒	1000	☒	5000	☐	
Al 308.215 (109)	☒	0	☐		☐		☐		☐		☐		☒	500000
Ca 317.933 (106)	☒	0	☐		☐		☐		☐		☐		☒	500000
Fe 234.349 (144)	☒	0	☐		☐		☐		☐		☐		☒	500000
Mg 279.079 (121)	☒	0	☐		☐		☐		☐		☐		☒	500000
Y 360.073 (94)*	☒	0	☐		☐		☐		☐		☐		☐	

Note: Boron and Silicon are calibrated using a blank and a minimum three standards. It is not allowable to remove any mid-levels to obtain an acceptable calibration; all points must be used. Multi-level calibrations must be sequential.

3. Appendix C

Standard Prep for Boron and Silicon Analysis

- C1. Calibration Standard 50 ug/L B: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 0.05 ml Spex Certiprep QC std. 7 or equivalent. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 ug/L B
- C2. Calibration Standard 50 ug/L Si & 100 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 0.1 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 50 ug/L Si & 100 ug/L B
- C3. Calibration Standard 500 ug/L Si & 1000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Si & 1000 ug/L B.
- C4. Calibration Standard 1000 ug/L Si & 2000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L Si & 2000 ug/L B.
- C5. Calibration Standard 5000 ug/L Si & 10000 B ug/L: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 7. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 5000 ug/L Si & 10000 ug/L B.
- C6. Calibration Standard 500 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 1mL of conc. HNO₃ and 1mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL, Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.

- C7. ICV/CCV: Into a 100mL **plastic** volumetric flask, add 50mL of Milli-Q water, 1 mL of conc. HNO₃ and 1mL conc. HCl. Add 0.1mL of 1000mg/L Boron and 0.1mL of 1000mg/L Silicon (alternate sources from calibration source). Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L Boron and Silicon.
- C8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO₃ and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 0.05 ml 1000 mg/L B and 0.5 ml 1000 mg /L Si. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L B and Si, 500,000ug/L Al, Ca, Fe and Mg.

**Table 7. Lithium, Tin, Strontium, Titanium, and Tungsten
Concentrations/Ranges for ICP ug/L**

Appendix D

Standard prep for Lithium, Tin, Titanium, Strontium, and Tungsten

- D1. Calibration Standard 1: Into a 1000mL volumetric flask, add 50mL of Milli-Q H₂O, 10mL of

Element, Wavelength and Order	Calibration Standards													
	?	Blank Conc	?	1 Conc	?	10 Conc	?	100 Conc	?	1000 Conc	?	10000 Conc	?	500000 Conc
Li 670.784 (50)	☒	0	☒	1	☒	10	☒	200	☒	1000	☒	10000	☒	
Sn 189.989 (477)	☒	0	☒		☒	10	☒	100	☒	1000	☒	10000	☒	
Sn 189.989 (478)	☒	0	☒		☒	10	☒		☒		☒		☒	
Sr 407.771 (83)	☒	0	☒	1	☒	10	☒	100	☒	1000	☒	10000	☒	
Sr 421.552 (80)	☒	0	☒		☒		☒		☒		☒		☒	
Ti 334.941 (101)	☒	0	☒	1	☒	10	☒	100	☒	1000	☒	10000	☒	
Ti 337.280 (100)	☒	0	☒		☒		☒		☒		☒		☒	
W 224.875 (450)	☒	0	☒		☒	10	☒	100	☒	1000	☒	10000	☒	
W 239.709 (141)	☒	0	☒		☒		☒		☒		☒		☒	
Al 309.271 (109)	☒	0	☒		☒		☒		☒		☒		☒	500000
Ca 317.933 (106)	☒	0	☒		☒		☒		☒		☒		☒	500000
Fe 259.940 (130)	☒	0	☒		☒		☒		☒		☒		☒	500000
Mg 279.553 (121)	☒	0	☒		☒		☒		☒		☒		☒	500000
Y 360.073 (94)*	☒	0	☒		☒		☒		☒		☒		☒	

conc. HNO₃ and 10mL conc. HCl. Add 0.01 ml Spex Certiprep QC std. 21 or equivalent and .001 1000mg/L Sn and W . Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1 ug/L

- D2. Calibration Standard 10: Into a 1000mL volumetric flask, add 50mL of Milli-Q H₂O, 10mL of conc. HNO₃ and 10mL conc. HCl. Add 0.1 ml Spex Certiprep QC std. 21 or equivalent and .01 1000mg/L Sn and W . Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10 ug/L Li, Sr, Sn, Ti, and W.
- D3. Calibration Standard 100: Into a 1000mL volumetric flask, add 50mL of Milli-Q H₂O, 10mL of conc. HNO₃ and 10mL conc. HCl. Add 1.0 ml Spex Certiprep QC std. 21 or equivalent and 0.1 1000mg/L Sn and W . Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 100 ug/L Li, Sr, Sn, Ti, and W.

- D4. Calibration Standard 1000: Into a 1000mL volumetric flask, add 50mL of Milli-Q H₂O, 10mL of conc. HNO₃ and 10mL conc. HCl. Add 10.0 ml Spex Certiprep QC std. 21 or equivalent and 1.0 1000mg/L Sn and W. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 1000 ug/L Li, Sr, Sn, Ti, and W.
- D5. Calibration Standard 10000: Into a 1000mL volumetric flask, add 50mL of Milli-Q H₂O, 10mL of conc. HNO₃ and 10mL conc. HCl. Add 100.0 ml Spex Certiprep QC std. 21 or equivalent and 10.0 1000mg/L Sn and W. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 10000 ug/L Li, Sr, Sn, Ti, and W.
- D6. Calibration Standard 500000 high std: Into a 100mL volumetric flask, add 10mL of Milli-Q H₂O, 10mL of conc. HNO₃ and 10mL conc. HCl. Add 5mL Aluminum 10,000mg/L, 5mL, Calcium 10,000mg/L, 5mL, Magnesium 10,000mg/L and 5mL Iron 1000mg/L. Dilute to volume with Milli-Q H₂O and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 mg/L Al, Ca, Mg, and Fe.
- D7. ICV/CCV: Into a 1000mL volumetric flask, add 50mL of Milli-Q water, 10 ml of conc. HNO₃ and 10mL conc. HCl. Add 0.5mL of 1000mg/L Li, 0.5mL of 1000ug/L Sn, 0.5mL of 1000ug/L Sr, 0.5 ml of 1000mg/L Silicon, 0.5 ml 1000mg/L Tungsten and 0.5 ml of 1000mg/L Titanium. (all alternate sources from calibration source). Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Li, Sr, Sn, Ti, and W.
- D8. ICSAB: Into a 100mL volumetric flask, add 10mL Milli-Q water, 1mL of conc. HNO₃ and 1mL of conc. HCl. Add 10 ml of SPEX Interferents A or equivalent, 3.0mLs of 10,000 mg/L Fe, 0.05 ml of 1000 mg/L Sr, 0.05 ml 1000 mg /L of Li, 0.05 ml 1000 mg /L of Sn, 0.05 ml 1000 mg /L of Ti, 0.05 ml 1000 mg /L of W. Dilute to volume with Milli-Q water and mix by inverting several times. Transfer to a clean Nalgene bottle. Prepare every 6 months or as needed. Concentration: 500 ug/L Li, Sr, Sn, Ti, and W and 500,000ug/L Al, Ca, Fe and Mg.

Note: For DOD-QSM data the lowest level (Calib. Level # 1) on a multi-point curve is prepared at concentrations equal to or less than the MRL for any given project and these levels are subject to change.

FMT9-01 iCAP 6000/6500 Data Review Checklist

iCAP 6000 / 6500 Data Review Checklist		Analysis Date:		Data File:		Date of review:	
Cal Std ID:	LIMS #:	Analyst:		Reviewer:		Approved? Yes / No	
Is Audit Trail turned on or Manual Manipulations addressed? Yes / No (If no, any manual manipulations must be initialed, dated, and reason(s) stated for change)							
QC Parameters : 6010 / 200.7 / QSM / Other	YES	NO	YES	NO	Comments:		
1) Calibration linearity: $r > 0.995$ / $r > 0.998$							
2) ICV: 90-110% / 95-105%							
3) ICB: $< 3X$ IDL / $< LOD$ / $< LOQ$							
4) ICSA: $< ABS$ LOD							
5) ICSAB: 80-120%							
6) MRL: 70-130% / 80-120%							
7) MDL Check: $> LOD$							
8) CCV1/CCB1 (CCV: 90-110%)							
9) CCV2/CCB2 (CCB: $< 3X$ IDL / $< LOD$ / $< LOQ$)							
10) CCV3/CCB3							
11) CCV4/CCB4							
12) CCV5/CCB5							
13) CCV6/CCB6							
Preparation Batch Parameters	YES	NO	YES	NO			
Prep Batch ID#:					Dig. Meth.		
LCS - generated limits or project specific limits							
MB - $< LOD$ or $\leq \frac{1}{2} RL$							
Spiked samples in batch:							
a) matrix =							
b) matrix =							
c) matrix =							
PDS: $\pm 15\%$ / 20% / 25% Sample#:							
Prep Batch ID#:					Dig. Meth.		
LCS - generated limits or project specific limits							
MB - $< LOD$ or $\leq \frac{1}{2} RL$							
Spiked samples in batch:							
a) matrix =							
b) matrix =							
c) matrix =							
PDS: $\pm 15\%$ / 20% / 25% Sample#:							
Prep Batch ID#:					Dig. Meth.		
LCS - generated limits or project specific limits							
MB - $< LOD$ or $\leq \frac{1}{2} RL$							
Spiked samples in batch:							
a) matrix =							
b) matrix =							
c) matrix =							

Revision Number	Description of Changes	Date
02	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/12/2014
	Added 4.2 QSM reference	3-9-2015
	Added LDR and ICAL QC requirements to table 3	3-9-2015

STANDARD OPERATING PROCEDURE
MT 012 Mercury Cold Vapor Atomic Absorption (CV)

Review Date: 03/12/2014



03/12/2014

Technical Review by:

Date



03/14/2014

Approved by: QA Manager

Date

1.0 SCOPE AND APPLICATION

This method is appropriate for measuring mercury concentrations in groundwater, wastewater, drinking water, TCLP extracts, soils, sediments, and sludge-type materials.

2.0 METHOD SUMMARY

- 2.1 Prior to analysis, the samples must be prepared according to the procedures discussed in this SOP.
- 2.2 This is a cold-vapor atomic absorption technique, based on the absorption of radiation at 254-nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

3.0 DEFINITIONS

- 3.1 Reagent Blank - A solution of deionized water, (containing in correct proportion, all reagents required by the method), used with the calibration standards to standardize the instrument, as a calibration blank, and for sample dilution.
- 3.2 Calibration Standards - A series of known standard solutions used for calibration of the instrument within the measurable linear range. Calibration standards shall contain, in correct proportion, all reagents required by the method. A total of 5 calibration points are used for Mercury calibration. Acceptance of the calibration requires a correlation coefficient of 0.995 or better. No samples shall be analyzed without acceptable calibration.
- 3.3 Calibration Verification Standards-Initial (ICV) & Continuing (CCV) - A midpoint calibration standard which is analyzed at the beginning of the run (ICV), at a frequency of 1 per 10 samples during a run (CCV), and at the end of a run to verify calibration throughout the run. The ICV must be from a second source different than that of the calibration standards, while the CCV may be from the same source as the calibration standards. Note that limits for ICV are tighter than those for CCV (see section 16).
- 3.4 CB (Calibration Blanks- Initial and Continuing) - A reagent blank solution, which is analyzed immediately following the calibration standards (Initial Calibration Blank-ICB), at a frequency of 1 per 10 samples during a run (Continuing Calibration Blank-CCB), and at the end of a run to check for drifts in calibration or possible analyte carry-over. Control criteria consist of the highest of the following: the absolute value being less than or equal to the MDL for a given analyte for routine work, <2x the

MDL for DOD-QSM, or $< \frac{1}{2}$ the MRL for ACOE work. . If these ranges are exceeded, correct the problem and reanalyze affected data. A new calibration may be necessary to correct the problem.

- 3.5 LCS (Laboratory Control Sample)- A mid-range standard prepared from a source different from that used for calibration standards. The LCS is used to verify the accuracy of the digestion and is analyzed at the beginning of the analytical batch.
- 3.6 MB (Method Blank) - A Reagent Blank which is carried through the entire preparation and analytical method. The method blank is used to detect possible contamination that may occur prior to or during the sample preparation. A minimum of one MB is prepared per batch, and is analyzed at the beginning of an analytical batch. Method blank value should be lower than the highest of the following: the absolute value being less than or equal to the MDL for a given analyte, five percent of the regulatory limit of five percent of the measure concentration in the sample. The MB results shall also be $< \frac{1}{2}$ the MRL for DOD-QSM/ACOE data.
- 3.7 MS-MSD (Matrix Spike-Matrix Spike Duplicate): - Two separate sample aliquots to which a known concentration of analyte has been added which is carried through the entire preparation and analytical procedure. The purpose of a matrix spike is to reveal any matrix effect from the sample on the recovery of the analyte by the method being used. An MS-MSD pair is prepared for every 20 samples per matrix of routine samples or for ACOE a DUP/MS pair is prepared for every 20 samples of a given matrix per day. Failure to meet criteria may be due to poor recovery during the preparation method or due to matrix interference within the digestate. To be considered acceptable, MSD must meet both the same % recovery criteria as an MS, and the same % RPD as a duplicate sample. MS/MSD %RPD and may be used as acceptance criteria for duplicate analysis.
- 3.8 Method Reporting Limit (MRL) or Contract Required Detection Limit (CRDL) Standard: Detection level standard at a level near but below the reporting limit, or at a level specified by client contract. When required, it is to be analyzed following the ICB, and prior to the last CCV standard in the run.
- 3.9 Duplicate (DUP)- A separate aliquot of sample which has been carried through the entire preparation and analytical procedure the same as the original sample. One duplicate per batch is prepared for ACOE work.
- 3.10 SD (Serial Dilution Analysis): A sample is diluted 1:5 with method blank solution and analyzed. The diluted result and the undiluted result should agree within a limit of precision defined by the program (SW846, CLP, 200.7) or client QAPP. **For ACOE/QSM work, a SD will be conducted at a minimum rate of one per prep batch per unique matrix.**

4.0 HEALTH AND SAFETY

- 4.1** Gloves and protective clothing shall be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure shall utilize appropriate laboratory safety systems.

5.0 CAUTIONS

- 5.1** Mercury is a toxic substance and care should be taken to avoid contact with it. This includes wearing gloves and using ventilation devices when working with Mercury.
- 5.2** This method allows for detection of small quantities of Mercury. All potential sources of Mercury contamination should be avoided. This would include sources of Mercury present in other lab areas.

6.0 INTERFERENCES

- 6.1** Potassium permanganate is added to eliminate possible interference from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of added inorganic mercury from reagent water.
- 6.2** Copper has also been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on recovery of mercury from spiked samples.
- 6.3** Seawaters, brines, and industrial effluents high in chlorides require additional permanganate (as much as 25 mL) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs radiation of 254 nm. Care must therefore be taken to ensure that free chlorine is absent before the mercury is reduced and swept into the cell. This may be accomplished by using an excess of hydroxylamine sulfate reagent (25 mL).
- 6.4** Certain volatile organic materials that absorb at this wavelength may also cause interference. A preliminary run without reagents should determine if this type of interference is present.

7.0 PERSONNEL QUALIFICATIONS

- 7.1** Personnel operating the CVAA shall have background knowledge of the scientific principles used during this application. All operators shall perform an initial demonstration of capability (IDC) prior to analyzing any samples. It is preferable for the operator to have at least two semesters of college chemistry.

8.0 APPARATUS AND MATERIALS

8.1 APPARATUS & MATERIALS

- 8.1.1** Cetac M-6000A Mercury Analyzer with ASX-500 autosampler.
- 8.1.2** Argon gas, HP grade.
- 8.1.3** 50 mL disposable centrifuge tubes and caps. (Fisher p/n 05-539-9 or equivalent)
- 8.1.4** 25 mL Class A volumetric pipettes
- 8.1.5** 100 mL volumetric flasks
- 8.1.6** 25 mL glass Class A, TD, graduated cylinders
- 8.1.7** 1, 2, 3, 4, 5 mL Class A volumetric pipettes.
- 8.1.8** Eppendorf pipette, 0.100 to 1.000 mL range.
- 8.1.9** Environmental Express Hot Blocks set at 90-95 °C.

8.2 REAGENTS

- 8.2.1** Sulfuric acid, H₂SO₄, concentrated: Trace metal grade (Fisher p/n A300C-212)
- 8.2.2** Nitric acid, HNO₃, concentrated: Trace metal grade. (Fisher p/n A509-212 or equivalent)
- 8.2.3** Hydrochloric acid, HCl, concentrated: Trace metal grade. (Fisher p/n A508SK212 or equivalent)
- 8.2.4** Potassium permanganate solution, 5% w/v: Prepared by dissolving 50g Potassium Permanganate (Fisher p/n P279-212 or equivalent) in 1000 ml of deionized water. Prepare as needed. Expires 6 months from date of preparation. Store at room temperature in metals lab.
- 8.2.5** Potassium persulfate solution, 5% w/v: Prepared by dissolving 50 g Potassium Persulfate (Fisher p/n P282-500 or equivalent) in 1000 ml of DI water. Prepare as needed. Expires 6 months from date of preparation. Store at room temperature in metals lab.

- 8.2.6** Sodium chloride-hydroxylamine sulfate solution, 12% w/v: Prepared by dissolving 60 g Sodium Chloride (Fisher p/n) and 60 g of Hydroxylamine Sulfate in 500 ml of DI water. Prepare as needed. Expires 6 months from date of preparation. Store at room temperature in metals lab.
- 8.2.7** Stannous chloride (10% SnCl_2 w/v in 7% HCl v/v): to a 1000mL volumetric flask dissolve 100 gm Stannous Chloride(VWR part number MK817604) in 70mL conc. HCl. Stir until SnCl_2 is completely dissolved. Additional heat may be necessary to get complete dissolution. Once dissolved, dilute to line and cool. Prepare as needed. Expires 6 months from date of preparation. Store at room temperature in metals lab.
- 8.2.8** Aqua regia: In a fume hood, carefully add three volumes of concentrated HCl to one volume of concentrated HNO_3 . Prepare fresh daily.

8.3 Stock Standards

- 8.3.1** Mercury stock standards, 1000 mg/L certified solutions, two sources. One is to be used for the calibration standards and the other for the LCS. (Ultra Scientific ICP-080 and JT Baker 6934-04 or equivalents). Store at room temperature in the metals lab. Expiration dates are given by the manufacturer.

8.4 Calibration Standards:

- 8.4.1** Intermediate Stock #1 (10,000 ug/L): To a 100 ml volumetric flask add 50 ml DI water and 0.2 ml conc. HNO_3 and 0.2 mL HCl. Transfer 1.0mL of 1000 mg/L Hg stock standard. Dilute to 100 ml with DI water and mix. Prepare fresh daily.
- 8.4.2** Intermediate Stock #2 (100 ug/L): To a 100 ml volumetric flask add 50 ml DI water and 0.2 ml conc. HNO_3 and 0.2 mL HCl. Transfer 1.0mL of 10,000 ug/L intermediate stock #1. Dilute to 100 ml and mix. Prepare fresh daily.
- 8.4.3** Use 100mL volumetric flasks. To each, add 50 mL DI water and 0.2mL conc. HNO_3 and 0.2 mL conc. HCl. Add the following volumes of 100ug/L intermediate, dilute to volume with DI water, and mix well.

Std Conc. ug/L	Vol. 100ug/L Intermediate #2 Std	Final Volume
0.5	0.5 mL	100 mL
1.0	1.0 mL	100 mL
2.0	2.0 mL	100 mL
4.0	4.0 mL	100 mL
5.0	5.0 mL	100 mL

Using a 25 mL volumetric pipette, transfer 25 mL of each to 50 mL centrifuge tubes. Add 25 mL reagent water to another centrifuge tube for the calibration blank.

8.5 ICV/LCS and CCV: (ICV/LCS from second source, CCV from same source as standards)

8.5.1 Intermediate Stock #1 (10,000 ug/L): To a 100 ml volumetric flask add 50 ml DI water and 0.2 ml conc. HNO₃ and 0.2 mL HCl. Transfer 1.0mL of 1000 mg/L Hg stock standard. Dilute to 100 ml and mix. Prepare fresh daily.

8.5.2 Intermediate Stock #2 (100 ug/L): To a 100 ml volumetric flask add 50 ml DI water and 0.2 ml conc. HNO₃ and 0.2 mL HCl. Transfer 1.0mL of 10,000 ug/L intermediate stock #1. Dilute to 100 ml and mix. Prepare fresh daily.

8.5.3 Check Standard/LCS: To a 100 mL volumetric flask add 50 mL DI and 0.2 ml conc. HNO₃ and 0.2 mL HCl . Add 3.0 mL of the 100 ug/L intermediate stock from the second source standard, dilute to the line and mix.

8.5.4 Using a 25 mL volumetric pipette, transfer 25 mL of each to 50 mL centrifuge tubes.

8.5.4.1 Note: Due to different digestion matrices for aqueous and solid samples, two sets of standards must be prepped to match the matrix for each digestion.

9.0 INSTRUMENT CALIBRATION

In the upper window menu bar select Instrument then calibrate. Enter the calibration information which consists of the standard number and standard concentration in ug/L and press continue. The calibration data will now be available for sample analysis. See section 11.0 for further calibration instructions.

10.0 SAMPLE COLLECTION, HANDLING AND PRESERVATION

	<u>Water</u>	<u>Soil</u>
Preservative:	pH < 2 with HNO ₃	4 °C
Hold Time:	28 days	28 days

11.0 SAMPLE PREPARATION AND ANALYSIS

11.1 Turn on the Hot Block and allow it to heat to 95⁰ C while the samples are being prepared.

11.2 Sample Preparation-Aqueous:

11.2.1 Waters: Using a 25 mL graduated cylinder, transfer 25 mL of sample to a 50 mL polyethylene centrifuge tube. For drinking water analysis, a 25 mL Class A pipette must be used.

11.2.1.1 MS-MSD Prep: Add 0.50 mL of the 100 ug/L intermediate to a 25 mL final volume for a spike concentration of 2.0 ug/L.

11.2.1.2 To each of the samples, MS-MSD, LCS, standards, and blanks add the following (under a hood): 1.25 mL conc. H_2SO_4 . 0.625 mL conc. HNO_3

11.2.1.3 To all samples, standards, and blanks add 3.75 mL Potassium permanganate (KMnO_4) solution.

11.2.1.4 Tightly cap the samples and mix by inverting several times.

11.2.1.5 The purple permanganate color should remain for at least 15 minutes. If it does not, add additional permanganate in 1 mL aliquots until the purple color remains for at least 15 minutes. Record any extra permanganate added in the logbook. The same amount of extra permanganate will have to be added to all other samples and standards.

11.2.1.6 To all samples, standards, and blanks add 2.0 mL Potassium persulfate solution.

11.2.1.7 Place the samples and standards in the Hot Block. Heat at 90-95°C for 2 hours. Record initial and final Hot Block temperatures in the logbook.

11.2.1.8 Following digestion, remove the samples and place under a hood to cool. Alternately, the racks may be placed in a sink of cold water to hasten the cooling.

11.2.1.9 When the samples are cool, add 1.5 mL Sodium chloride-hydroxylamine sulfate solution to all samples, standards, and blanks. Tightly cap and mix by inverting until samples are clear. Samples are now ready for analysis.

11.3 Sample Preparation-Solids

11.3.1 Weigh triplicate 0.2 gram (approximate) portions from separate areas of the sample container of the untreated sample into a 50 mL polyethylene centrifuge tube with a plastic spatula. Do not use metal spatulas. Record the

weight in the mercury prep book. See the subsampling SOP FO-10 for further instructions on how to obtain a subsample for analysis.

11.3.2 Method Blank and LCS Prep: Weigh 0.50 g of sand blank into each of two 50 mL polyethylene centrifuge tubes. For the LCS, add 0.5 mL of the 100 ug/L second source intermediate stock solution #2.

11.3.3 MS-MSD Prep: Add 0.50 mL of the 100 ug/L intermediate to a 25 mL final volume for a spike concentration of 2.0 ug/L.

11.3.4 To all tubes, add 1.25 mL aqua regia reagent, and heat for 2 minutes in Hot Block at 95 °C.

11.3.5 Cool, and then add 25 mL of DI water and 3.75 mL of Potassium Permanganate solution to each vial.

11.3.6 Tightly cap all vials and mix by inverting several times.

11.3.7 The purple permanganate color should remain for at least 15 minutes. If it does not, add additional permanganate in 1 mL aliquots until the purple color remains for at least 15 minutes. Record any extra permanganate added in the logbook. The same amount of extra permanganate must be added to all other samples and standards.

11.3.8 Place the samples and standards in the Hot Block. Heat at 90-95 °C for 30 minutes. Record initial and final Hot Block temperatures in the logbook.

11.3.9 Cool, and then add 1.5 mL of Sodium Chloride-hydroxylamine sulfate to each sample and mix by inverting. The samples should turn clear.

11.4 Instrument Set-up

11.4.1 Power up the M-6000A and autosampler and allow to warm up for one hour.

11.4.2 Turn on lamp and gas supply and allow to warm up for 15 minutes.

11.4.3 Place autosampler tubing into rinse water (1%hydrochloric acid/1%nitric acid solution)

11.4.4 Verify that the sample capillary (inlet insert) is 0.5mm above the gas/liquid separator center post.

11.4.5 Open vents on waste container

- 11.4.6 Inspect peristaltic pump tubing for wear and flat spots and replace if necessary.
- 11.4.7 Place the peristaltic pump tubing in their appropriate holes and holder clips. Do not lock shoe clamps at this time.
- 11.4.8 Initiate M-6000A program by clicking on the M6000 icon, then controls then autosampler page.
- 11.4.9 Start the autosampler rinse pump by clicking the pump on and the probe down.
- 11.4.10 Place reagent capillary in a beaker of DI water and start the peristaltic pump in a clockwise rotation.
- 11.4.11 Lock down the peristaltic shoe clamps.
- 11.4.12 Inspect liquid flows. The GLS drain should be flowing smoothly with no build up or pulsing of liquid. The waste line from the peristaltic pump to the waste container should be liquid/gas with no vibration. If this is not the case upon inspection, stop
- 11.4.13 Immediately and change the GLS drain line and/or waste line.
- 11.4.14 Wet the GLS center post. Pinch the drain line prior to the tee of the peristaltic pump drain tubing. Let two or three liquid bubbles go to the top of the GLS center post and release the drain line. If the liquid does not bubble, then fill the GLS to the top of the center post and release the drain line.
- 11.4.15 Attach GLS exhaust tube to the GLS
- 11.4.16 Place reagent capillary in the reagent bottle
- 11.4.17 Open the appropriate worksheet and verify that the gas flow of the worksheet matches what is listed in the controls, if the flow is not the same make the necessary change and click set gas.
- 11.4.18 Zero the M-6000A using the autozero. This is under Instrument and then Zero Instrument.
- 11.4.19 Peak profile the high standard and verify baseline and sample integration times. Do this by clicking on Analysis and then read then standard and then choose the highest standard. If there are any adjustments needed to the peak, refer to the M6000A software manual 5.6.12.

11.5 Analysis

- 11.5.1** Insert sample labels by clicking on labels and then entering the sample ID numbers.
- 11.5.2** Right click to enter the QC standards after all the samples are entered. Choose “QC standard” for the CCV and “QC blank for the CCB.
- 11.5.3** Click on Analysis and then Click on start.
- 11.5.4** Choose the appropriate box and then click OK.
- 11.5.5** After analysis, click on file and choose return to main index.
- 11.5.6** Choose reports
- 11.5.7** Click on the data tab and choose the data that you want to report
- 11.5.8** Click on the Reports tab
- 11.5.9** Click on Write test to file and then enter the LIMS run number and make sure it is saved in the Cetac folder on the I drive.

11.6 Shutdown

- 11.6.1** Place the reagent capillary in a beaker of 10% nitric acid and cap the reagent bottle. Rinse the system for a minimum of ten minutes.
- 11.6.2** Place the reagent capillary in a beaker of DI water and rinse the system for one minute
- 11.6.3** Raise sample probe by clicking on controls then autosampler and click probe up and pump off.
- 11.6.4** Remove reagent capillary from DI water.
- 11.6.5** Allow the drain and waste lines to run completely dry
- 11.6.6** Turn off peristaltic pump
- 11.6.7** Release peristaltic shoe clamps and release the pump tubing from their holder clips.
- 11.6.8** Close vents on waste container.

11.6.9 Remove GLS exhaust line from GLS

11.6.10 Turn off gas and lamp

11.6.11 Exit software and run off the autosampler and instrument

12.0 TROUBLESHOOTING

12.1 See Cetac operator's manual for further troubleshooting instructions.

12.2 Preventative maintenance is recorded in the logbook located with the instrument. Follow the recommendations listed in the maintenance section of the Cetac M6000 Operators manual.

13.0 DATA ACQUISITION, CALCULATION AND DATA REDUCTION

Sample Calculations:

Liquid Concentration (ug/L) = A x C

Solid Concentrations (mg/kg) = A x B x C

D x E

where A = instrument reading for sample (ug/L)

B = total volume of digestion (L)

C = analyst dilution factor, if necessary (ex. For a 1 to 10 dilution, C = 10)

D = amount of sample used in digestion (g)

E = percent solids/100, if necessary

Spike Recovery (%) = $\frac{(\text{Spiked sample concentration} - \text{Sample concentration}) \times 100}{(\text{Spike amount})}$

%RSD = $\frac{(\text{MS} - \text{MSD}) \times 100}{(\text{MS} + \text{MSD})/2}$,

where MS = Matrix spike concentration

MSD = Matrix spike duplicate concentration

14.0 COMPUTER HARDWARE AND SOFTWARE

14.1 Computer

14.2 LIMS software

14.3 M6000A software

15.0 DATA MANAGEMENT AND RECORD MANAGEMENT

15.1 After data has been captured by LIMS, it is reviewed by the analyst for accuracy and completeness. See checklist for data review guidance.

15.2 Once analyst has reviewed and approved the data, it is given to a peer or supervisor for review.

15.3 After the second reviewer approves the data, the reviewer sends the data to “validated” status in LIMS.

15.4 The original data is filed by test in the file cabinet and periodically the contents of the file cabinet are archived.

16.0 QUALITY CONTROL AND QUALITY ASSURANCE

16.1 Non-CLP (Solid Waste and Wastewater-7470A &7471A):

16.1.1 For every analytical run, calibrate with the blank and 0.50, 1.00, 2.00, 4.00, and 5.00 ug/L standards.

16.1.2 ICV (initial calibration verification): Following instrument calibration, analyze the 3.0 ug/L ICV/CCV standard. Control limits are +/-10%. If the recovery exceeds this, terminate the run and correct the problem before proceeding.

16.1.3 CCV (Continuing Calibration Verification): Analyzed after every 10 samples and at end of run. A 3.0 ug/L standard. Control limits are +/- 20%.

16.1.4 ICB/CCB (initial and continuing calibration blank): After the ICV and any CCV, analyze a blank. The absolute value of the result for the blank must be below the highest of the following: the absolute value being less than or equal to the MDL for a given analyte, five percent of the regulatory limit or five percent of the measure concentration in the sample. If the result exceeds this, terminate the analysis and correct the problem before proceeding or appropriately qualify the data.

16.1.5 LCS (laboratory control sample): An alternate source standard from the same digestion set as the samples. It is prepared for every 20 samples per medium. Control limits are generated in-house control limits or as specified by client

QAPP. If the recovery exceeds this, terminate the run, reprep, and reanalyze all samples.

16.1.6 MB (method blank): From the same digestion set as the samples. Blank recovery should be less than the highest of the following: the absolute value being less than or equal to the MDL for a given analyte, five percent of the regulatory limit or five percent of the measure concentration in the sample. For Army Core of Engineers (ACOE) or Department of Defense Quality Systems Manual (QSM) data the criteria is $< \frac{1}{2}$ the reporting limit. If the result is exceeded, reanalyze. If still exceeded, isolate and correct problem, reprep and reanalyze the blank and samples associated with the blank, or appropriately qualify results.

16.1.7 MS/MSD (matrix spike/matrix spike duplicate): A MS/MSD is required every analytical run at a frequency of 5% per digestion batch for 7000 series or at a frequency of 10% per digestion batch for 200 series. To be considered acceptable, MSD must meet both the same % recovery criteria as an MS, and the same % RPD as a duplicate sample. For routine work, use in-house generated limits for the recovery and RPD limits.

16.2 CLP-Like Protocol (DOD-QSM/ACOE work):

16.2.1 For every analytical run, calibrate with the blank and 0.50, 1.00, 2.00, 4.00, and 5.00 ug/L standards..

16.2.2 ICV (initial calibration verification): Following instrument calibration, analyze the 3.0 ug/L ICV/CCV standard. Control limits are $\pm 10\%$. If the recovery exceeds this, terminate the run and correct the problem before proceeding.

16.2.3 ICB (initial calibration blank): Following the ICV, analyze a blank. The absolute value of the result for the ICB must be below $\frac{1}{2}$ the MRL ACOE data, and $< 2 \times$ the MDL for DOD-QSM data. If the result exceeds this, terminate the analysis and correct the problem before proceeding.

16.2.4 LCS (laboratory control sample): Following the calibration verification standard and the calibration verification blank, and every 20 samples thereafter, analyze the 3.0 ug/L alternate source standard. Control limits are specified within the client QAPP or use default limits of 80-120%. If the recovery exceeds this, terminate the run, reprep, and reanalyze all samples.

16.2.5 MRL/CRDL standard (Method Reporting limit/contract required detection limit standard): Analyze a standard at the MRL or the CRDL as specified by the client QAPP. Limits are listed within the client QAPP or use a default of 70-130%.

- 16.2.6** MB (method blank): From the digestion set. If the result exceeds the $\frac{1}{2}$ the MRL, re-digest all samples associated with the MB or appropriately qualify associated results.
- 16.2.7** CCV (continuing calibration verification): Analyze the 3.0 ug/L calibration standard following every ten samples, and at the end of the analysis. Control limits are +/-20% true value. If the recovery exceeds this, recalibrate and reanalyze all samples back to the last acceptable CCV.
- 16.2.8** CCB (continuing calibration blank): Analyze a blank following every CCV. The absolute value of the result for the CCB must be below $\frac{1}{2}$ the MRL ACOE data, and <2x the MDL for DOD-QSM data.. If the result exceeds this, reanalyze all samples back to the last acceptable CCB or appropriately qualify results.
- 16.2.9** Matrix Spike: A matrix spike is required every for every sample delivery group of 20 samples or less. The matrix spike shall be prepared at the time of digestion. Default control limits are +/- 25% true value or or as specified in the projects QAPP, or within limits established by the DOD-QSM . . If recovery is outside of limits, refer to project QAPP or DOD-QSM for further instruction.
- 16.2.10** Duplicate: A duplicate is required for every sample delivery group of 20 samples or less and is prepared at the time of digestion. For results exceeding five times the MRL, the default control limit is 20% RPD, or as specified in the projects QAPP, or within limits established by the DOD-QSM . For results that are less than five times the MRL, the default control limit is +/- MRL. If precision is outside of limits, refer to project QAPP or DOD-QSM for further instruction.
- 16.3** SDWA Protocol (245.1)
- 16.3.1** For every analytical run, calibrate with the blank and 0.50, 1.00, 2.00, 4.00, and 5.00 ug/L standards
- 16.3.2** ICV (initial calibration verification): Following instrument calibration, analyze the 3.0ug/L ICV/CCV standard. Control limits are +/-5%. If the recovery exceeds this, terminate the run and correct the problem before proceeding.
- 16.3.3** ICB (initial calibration blank): Following the ICV, analyze a blank. The absolute value of the result for the ICB must be below the MDL for the method. If the result exceeds this, terminate the analysis and correct the problem before proceeding or appropriately qualify the data.

- 16.3.4** LCS (laboratory control sample): Following the calibration verification standards, and every 20 samples thereafter, analyze the 3.0 ug/L alternate source standard. Control limits are generated control limits. If the recovery exceeds this, terminate the run, reprep, and reanalyze all samples associated with the LCS.
- 16.3.5** MB (method blank): From the same digestion set as the samples. Limits: the highest of the MDL, 5% of the measured concentration in the sample, or 5% of the regulatory limit for that analyte. If the results exceed this, terminate the run, reprep and reanalyze all samples associated with MB or appropriately qualify the data.
- 16.3.6** CCV (continuing calibration verification): Analyze the 3.0ug/L calibration standard following every ten samples, and at the end of the analysis. Control limits are +/-10% true value. If the recovery exceeds this, recalibrate and reanalyze all samples back to the last acceptable CCV.
- 16.3.7** CCB (continuing calibration blank): Analyze a blank following every CCV. The absolute value of the result for the CCB must be below the highest of the MDL, 5% of the measured concentration in the sample, or 5% of the regulatory limit for that analyte. If the result exceeds this, reanalyze all samples back to the last acceptable CCB or appropriately qualify results.
- 16.3.8** MS/MSD (matrix spike/matrix spike-duplicate): A MS/MSD is required every analytical run at a frequency of 10% per matrix type. For digested samples, appropriate samples are designated and spiked at the time of the digestion. Control limits are in-house limits.
- 16.4** Data Review Prior to Shutdown: Check results for the following criteria. It may be possible to correct some problems within the same analytical run.
- 16.4.1** ICV/CCV, LCS, MB, MRL acceptance. See above for corrective action.
- 16.4.2** Results over the calibration range of 5 ug/L. Dilute affected samples within calibration range with dilution blank.
- 16.4.3** MS-MSD recovery outside of acceptance range. If both are out of range, but all other CCV, CCB, and LCS associated with the MS/MSD are within specs, then the problem is matrix related-not instrument related. Sample data may be reported but flagged with the appropriate comment.
- 16.5** Analysis data review checklist- the checklist will be completed by the analyst and the data reviewer and attached to the analytical data package.

17.0 REFERENCES

- 17.1** Test Methods for Evaluating Solid Waste, EPA, SW-846, Methods 7470A, 7471A.

- 17.2 Methods for the Determination of Metals in Environmental Samples.
EPA/600/R94/111, Method 245.1
- 17.3 See CT Laboratories Quality System Manual, Section 8 for general references.
- 17.4 CT Laboratories Quality Manual, current revision.
- 17.5 Department of Defense, Quality Systems Manual for Environmental Laboratories,
Version 5.0, July 2013 or most recent revision.
- 17.6 National Environmental Laboratory Accreditation Conference (NELAC), 2003
NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent
version.
- 17.7 ISO. 2005. General requirements for the competence of testing and calibration
laboratories. ISO17025.

18.0 TABLES

18.1.1 Mercury Spike Prep

COLD VAPOR Element	Spike Amt. mL	Spike Solution Supplier	Stock Conc. ug/L	Final Vol. mL	Expected Conc. ug/L
Hg	0.50	Ultra 1000 mg/L	100.0	25.0	2.0

Standard Quality Control Requirements and Corrective Action

QC	Frequency	Conc. Level	1. Acceptance Criteria	2. Corrective Action
ICal	Each time the instrument is set up. The ICal consists of five standards and a blank.	0 + 0.5 – 5.0 ug/L	Correlation coefficient of .995 or greater	Terminate analysis, correct problem and recalibrate.
ICV	Immediately after the ICal	3 ug/L	Second source standard, SDWA: 95-105% SW846:90-110% ACOE- see client QAPP	Reanalyze once, if still unacceptable terminate analysis, correct problem and recalibrate
ICB	Immediately after the ICV	0	Routine work: < MDL, 5% of the Reg. Limit or 5% of the sample concentration. ACOE: ½ the MRL DOD-QSM: < 2x the MDL	Reanalyze once, if still unacceptable terminate analysis, correct problem and recalibrate.
LCS	1 per batch of ≤ 20 samples per matrix per day	mid cal. Range	SDWA; 90-110% SW846; 80-120% ACOE- see client QAPP	Reanalyze once, if still unacceptable terminate analysis, correct problem and reanalyze all associated samples. High bias is acceptable for associated samples that have results less than the MDL for routine work or the MRL for ACOE work.

CCV	After every 10 th sample and at the end of the analytical sequence	mid cal range	SDWA; 90-110% SW846; 80-120% ACOE- see client QAPP	Reanalyze once, if still unacceptable recalibrate and reanalyze all samples back to the last acceptable CCV or ICV. High bias is acceptable for associated samples that have results less than the MDL for routine work or the MRL for ACOE work.
CCB	Immediately following each CCV	0	Routine work: < MDL, 5% of the Reg. Limit or 5% of the sample concentration. ACOE: ½ the MRL DOD-QSM: < 2x the MDL	Reanalyze once, if still unacceptable reanalyze all samples back to the last acceptable CCB or appropriately qualify results.
MS-MSD (routine work) or MS-DUP (ACOE)	5% of samples per matrix per day	See attached spike chart	$\leq \pm 20\%$, Applicable when spike level is >25% of original analyte level in the sample and $RPD \leq \pm 20\%$ or as specified in DOD-QSM or ACOE QAPP	Perform PDS
Post Digestion Spike (PDS)	Upon failure of MS or per batch for ACOE work	Same level as MS	85-115%	Qualify data as matrix interference or perform MSA
Method Blank	1 per batch of 20 samples	0	Routine work: < MDL, 5% of the Reg. Limit or 5% of the sample concentration. DOD-QSM/ACOE: <1/2 the MRL	Investigate and isolate possible source and correct problem; then reanalyze all associated samples, if possible, or qualify data (B)

Revision Number	Description of Changes	Date
08	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/12/2014

GFAA / FLAA / CVAA Data Review checklist				Method: 200.9 7000 series AA 245.1	
Instrumentation:		PE SIMAA 6000		VARIAN SPECTRAA10	
Analysis Date:		Data File:		Date Review:	
Cal Std ID:		LIMS # :		Analyst:	
Reviewer:		Approved?		Yes	
Calibration Parameters -		YES	NO	YES	NO
1) Calibration linearity - $r > 0.995$					
2) ICV 90-110% 95-105%					
3) ICB ABS of LOD or RL					
6) CRA - (2X CRDL or LOD) 80-120%					
7) CCV1/CCB1- 90-110% / 80-120%					
8) CCV2/CCB2 ABS of LOD or RL					
9) CCV3/CCB3					
10) CCV4/CCB4					
11) CCV5/CCB5					
12) CCV6/CCB6					
Preparation Batch Parameters		YES	NO	YES	NO
Prep Batch ID#: _____ Dig. Meth. _____					
Prep. Blank - <LOD or RL					
LCS - generated limits;attached list					
Spiked samples in batch:					
a) _____ matrix = _____					
b) _____ matrix = _____					
c) _____ matrix = _____					
d) _____ matrix = _____					
e) _____ matrix = _____					
PDS 85-115% sample# _____					
MSA Performed? Yes No					
Prep Batch ID#: _____ Dig. Meth. _____					
Prep. Blank - <LOD or RL					
LCS - generated limits;attached list					
Spiked samples in batch:					
a) _____ matrix = _____					
b) _____ matrix = _____					
c) _____ matrix = _____					
d) _____ matrix = _____					
e) _____ matrix = _____					
PDS 85-115% sample# _____					
MSA Performed? Yes No					
Prep Batch ID#: _____ Dig. Meth. _____					
Prep. Blank - <LOD or RL					
LCS - generated limits;attached list					
Spiked samples in batch:					
a) _____ matrix = _____					
b) _____ matrix = _____					
c) _____ matrix = _____					
d) _____ matrix = _____					
e) _____ matrix = _____					
PDS 85-115% sample# _____					
MSA Performed? Yes No					
Prep Batch ID#: _____ Dig. Meth. _____					
Prep. Blank - <LOD or RL					
LCS - generated limits;attached list					
Spiked samples in batch:					

STANDARD OPERATING PROCEDURE

PM 003 Chemistry & Microbiology Sample Receiving and Processing

Review Date: 01/10/2014



01/10/2014

Technical Review by:

Date



01/10/2014

Approved by: QA Manager

Date

1.0 PURPOSE

- 1.1 To provide consistency when receiving and logging samples for the analytical laboratory. This document will provide guidance and serve as a resource for information when logging samples.
- 1.2 This procedure should only be used for the receiving and logging of samples analyzed in the Chemistry and Microbiology laboratory. This procedure should be used as a resource along with pertinent supplemental information to log samples into the LIMS system.

2.0 APPLICATION

Not applicable

3.0 SUMMARY OF PROCEDURE

- 3.1 Receive samples from field personnel
- 3.2 Document receipt information, including, time, date, pH, and temperature
- 3.3 Verify that all relevant information is labeled on sample containers and agrees with information on the Chain of Custody.
- 3.4 Log in to the LIMS system
- 3.5 Create a condition report for the project managers
- 3.6 Label containers
- 3.7 Store samples properly

4.0 DEFINITIONS

- 4.1 A sample is in your **custody** if:
 - 4.1.1 it is in your possession, or
 - 4.1.2 it is in your view after being in your possession, or
 - 4.1.3 it was in your possession and you returned it, or
 - 4.1.4 it is in a designated secure area.
- 4.2 LIMS – Laboratory Information Management System
- 4.3 Level III and Level IV- these are requirements dictated by contract and QAPP for clients that specify detailed data packages, documentation, tests and reporting limits. These are typically government regulated projects.
- 4.4 Restrictive- special storage and handling restrictions indicated in the QAPP on certain Level IV projects.

5.0 PERSONNEL QUALIFICATIONS

Sample Receiving Personnel will have general chemistry knowledge, including knowledge of the periodic table of elements, strong computer skills, extensive training in LIMS, and have knowledge of SOPs. Sample Receiving Personnel must also pay close attention to detail, have the ability to multi-task, and provide ample customer service.

6.0 PROCEDURE

6.1 Field Custody

- 6.1.1 The field sampler or designated field person is personally responsible for the proper care and custody of the field samples until they are properly transferred or dispatched to the laboratory.
- 6.1.2 Sample labels or tags must be completed for each sample and any sub-sample that make up a sample. At a minimum, the labels or tags should contain the sampling location, date, time and samplers name.
- 6.1.3 Sample containers or shipping containers may be secured with a custody seal. If used, the seal must be made in such a manner that visually shows a break, destruction or change in nature if the seal is tampered with.
- 6.1.4 All samples must be accompanied by proper documentation in the form of a *CHAIN OF CUSTODY* record. This document must clearly identify the samples and/or sub-samples, the designation of the desired testing to be performed on each sample, the sampler, the person relinquishing custody of the samples, and to whom the samples are relinquished to and the dates/time of these events.

6.2 Transfer of Custody and Transport/Shipment

- 6.2.1 Samples must be properly packaged for shipment. For samples requiring temperature preservation, sufficient ice should surround samples to assure ice is present when the samples reach the lab. Internal packaging should be in place to assure container integrity and comply with shipping requirements.
- 6.2.2 The original Chain of Custody will accompany the samples. Each shipment should be accompanied by a Chain of Custody form. A copy of the form should be retained by the field personnel.
 - 6.2.2.1 If the samples are to be considered restrictive and are shipped via common carriers (UPS, FedEx, Airborne, etc.) the mode of shipping should be noted in the "Remarks" section of the form. The person relinquishing the samples can sign, date and note the time in the first "Relinquished by" portion on the form. The shipping document (Air Bill, etc.) will serve as documentation of custody possession. The *Chain of Custody* should be placed in a waterproof container directly in the shipping container.
 - 6.2.2.2 Additionally restrictive samples shipped via a laboratory courier should have the person relinquishing the samples sign, date and note the time in the first "Relinquished by" portion on the form. The laboratory's courier should take possession of the samples and immediately sign the "Received by" portion of the corresponding line on the form.

6.3 Sample Arrival

- 6.3.1 Samples are received at the west side of the building marked “receiving.”
- 6.3.2 Samples will be accepted during our normal working hours of 8:00am-5:00pm, Monday through Friday. Exceptions can be made on a case by case basis.
- 6.3.3 Samples may arrive via UPS, Federal Express, US Mail, Dunham Express, Speedee, other privately contracted delivery services, and/or by the client.
- 6.3.4 Samples arriving will require a signature of the individual receiving the samples. Their signature will verify the number of packages delivered and accepted.
- 6.3.5 When samples are received (typically in a cooler or other packaging that is acceptable to project or sample specific requirements) personnel must first remove the paperwork or documentation from the contents. The paperwork may be in the form of a chain of custody (COC), and/or purchase order. If there is no paperwork accompanying the samples, the project manager will be contacted. Missing paperwork is to be documented and later added to the Sample Condition report. Exercise caution when opening coolers. Some may contain samples of unknown origin and may be hazardous to health. If unsure of the type of samples being delivered carefully open the cooler in a hood or well-ventilated area.
- 6.3.6 After paperwork is verified, record the preservation temperature of samples on the COC. The following steps should be taken to determine the temperature:
- If there is a temperature blank associated with the samples (one per cooler), take the temperature of the temperature blank by using a current calibrated temperature gun.
 - If there is no temperature blank, record the temperature from a sample bottle or from the ice/water inside the cooler preserving the sample. A calibrated temperature probe is to be used if temperature is not obtainable from a sample container.
 - Indicate if samples are received on ice (circle “yes” or “no”).
 - If the samples are submitted directly within 4 hours, note “direct” next to the temperature.
 - If the samples were previously on ice but it has completely melted, take the temperature of the melt water.

6.3.7 The COC must be checked to insure that it is properly filled out. Login personnel will verify that the COC:

- Is filled out in pen.
- Has the appropriate project # on COC (where it applies).
- Has the desired tests marked.
- Sample dates and times are within hold time.
- Has the signature(s) of sampler or anyone who took possession of the samples.
- Has Sample descriptions filled out.
- Documents any obvious damage or leaking shipping containers
- (If applicable) any special instructions, billing information, or turnaround requests are followed.
- If COC requires editing by CT Laboratories, a photocopy of the original chain will be made before any edits to the original COC occur.

Level III and Level IV Projects require additional documentation:

- Presence or absence of a custody seal on the shipping container.
- The condition of the seal (intact, damaged, open, etc).
- Shipping method and tracking number of shipping container removed from packaging and retained.

6.3.8 Remove samples from the cooler matching the sample with the chain of custody. Verify that all samples arrived undamaged and that all samples listed on chain of custody are present. Any damaged containers and/or discrepancies in the chain of custody and samples should be reported to the appropriate Project Manager.

6.3.9 Verify sample preservation by visually identifying that they are received in the proper bottles, and that the pH level is within acceptable limits. These limits are specified in the Quality Assurance Manual (QAM) Appendix 1. pH verification is conducted by the use of pH indicator paper and results of this test will be indicated in the LIMS system in log in.

6.3.10 Additional visual inspections of containers include the observation of adequate sample volume provided and presence/absence of air bubbles in zero headspace required VOA vials.

- 6.3.11 After the above steps are completed, any problems or inconsistencies are immediately reported to the Project Manager verbally and later recorded in the sample condition report as outlined in 6.5.2.

6.4 Log-in using LIMS

- 6.4.1 Double Click on the LIMS Icon on your Desktop
- The Login Screen appears
 - Enter your User Name and Password
 - Select OK
- 6.4.2 After the LIMS Main screen appears, select Login
- Select Login Standard, Sample Login Extended, or Login SEDD
 - Select ADD NEW in the client section of the window
 - Select Client from list of Clients available
 - Select project name or number from the List of Projects
- 6.4.3 Fill in the project name, project number, report and invoice contacts, name of sampler (In Iowa), PO number and make any necessary changes so LIMS and COC coincide.
- 6.4.4 Fill in sample date, sample time, matrix, and sample description. Change lab due date if applicable (ie. Rush).
- 6.4.5 Choose the “add tests” folder. Scroll through the tests to locate the requested test and double click to select. When all tests for a sample have been selected, and all samples have been logged in for their desired tests, commit the folder and record the folder and sample numbers on the chain of custody. COC will then be signed by personnel responsible for sample login.
- 6.4.6 Print container labels and affix each label to the appropriate container.

6.5 Handling Sample documentation and Log-In Problems

- 6.5.1 If log-in has encountered any problems during the log-in procedure, proper documentation and notification must be performed. Examples of problems include, but are not limited to:
- received outside proper temperature parameters of 4 degrees +/- 2
 - broken containers
 - incomplete chain of custodies
 - missing samples
 - samples received past hold time
 - samples without proper preservation
 - inadequate volume to perform test
 - For any situation that may warrant Project Management notification

- 6.5.6 Log-In personnel must fill in the “Sample Condition” form whenever there is any question or problem with samples within our custody. Once the proper information is gathered, the form goes immediately to the Project Manager for that older number. The Project Manager will then contact the client for direction on how to proceed. The Project Manager documents what action will be taken with the samples in question. The form is kept with the original chain of custody and mailed out with the final report to the client. Sample Condition forms are kept within the electronic file folder and are saved electronically for future reference.

Note: Some clients have an ongoing history of noncompliance with sample submission requirements. Regardless of noncompliance frequency, Log-in personnel must note discrepancies at all times, unless a specific client Protocol Variance Form” is on file (see 3.5.1 and SOP SS-7).

- 6.5.7 Level III and Level IV Projects require a SCR to be filled out for each folder.

The following documentation **must** apply to each project:

- 6.5.7.1 Condition of each sample, sub-sample or container will be recorded by the following codes:

- 1) Intact
- 2) Too Many Containers
- 3) Broken Container
- 5) Missing Bottles
- 7) Wrong Container
- 8) Past Hold Time
- 9) Incorrectly Preserved
- 10) Insufficient Volume
- 11) Labels Missing/Unreadable
- 12) Air bubbles in VOA vials

- 6.5.7.2 Compare documents to verify agreement between;

- Chain of Custody records
- Sample tags or labels
- Air Bills or Bills of Lading

UNCONTROLLED WHEN PRINTED

Folder #:	29071	Coolers:	12345	Date:	9/12/2002	Time:	
	09:23						
Client:	CT Laboratories	Received Date/Time:	9/12/2002	0930	Received By:	DJE	
Project Name:	2002 PT	Log-In Date/Time:	9/12/2002	0945	Logged By:		
	DJE						
Project #:	WP-92			PM:		PML	
Temperature:	2.0 C	On Ice:	Y	COC Present:	Y	Complete:	Y
Custody Seals Present:		Y	Intact:	Y	Numbers:	123456789	
Ship Method:	FedEx	Tracking Number:	123456789				
Adequate Packaging:	Y	Temp Blank Enclosed:	Y				

Sample ID/Description Filtered	Container Tests	#	Condition			
			Code			
148568 574	AMBER GL	1	1	Y	HG	
148569 580	HNO3	1	11	Y	ICP	
148570 582	AMBER HCL	1	9	N	O&G	
148572 586	HNO3	1	7	Y	ICP	
148573 830	VOA HCL	3	3	N	VOC	

- UNCONTROLLED WHEN PRINTED**

6.6 Sample Handling Outside of Quality System Guidelines

On occasion clients may request special handling, services and/or analysis of samples that fall outside of CT Laboratories' Quality System. These may include, but are not limited to: research or applied science projects with no quality control procedures or limits, analysis without regard to holding time or temperature, or filtering and/or preservation procedures of samples normally formed in the field. The protocol for these samples is detailed in **SOP Number SS-7, *Processing of Samples Outside of Quality System Guidelines***. For these samples, Log-in personnel will receive from the Project Manager either documented directions from the client and/or a "Protocol Variance Form," approved by the Laboratory Director and Quality Assurance Coordinator as stipulated in SOP SS-7 Sections 3.1.5- 3.4.2. The instructions contained in this documentation take precedence over the sample receiving and log-in procedures detailed in this SOP..

6.7 Post Log-in

6.7.1 In the event that a client notifies CT Laboratories staff, via email, phone call, or notation on the chain of custody that a submitted sample has already been determined to be hazardous, highly contaminated, or dangerous the samples will be dealt with on a case to case basis as directed by the project managers or the safety officer.

6.7.2 Samples may require special storage and/or handling for safety of employees and to prevent any cross contamination of other samples in storage.

6.7.3 Handling, and Storage Requirements including Restrictive Samples

6.7.3.1 Samples will be stored in appropriately designated areas and under conditions required for proper preservation.

6.7.3.2 Damaged samples will be disposed of and the disposal documented.

6.7.3.3 Whenever restrictive samples are removed returned from designated storage all sample movement will be documented on an *Internal Chain of Custody*. These records are controlled documents, originating from and maintained by the Quality Assurance Officer.

6.7.3.4 The location of stored restrictive sample extracts will be appropriately recorded.

6.7.3.5 Restrictive VOC samples will be stored separately from other samples, extracts, standards or any source of possible contamination.

6.7.3.6 Standards will be stored separately from samples and extracts.

6.7.3.7 After completion of restricted sample analysis, samples and extracts will be stored in compliance with the contract or until otherwise instructed by the appropriate authority.

6.8 Internal Chain of Custody Procedures

- 6.8.1 Restrictive VOC samples will be stored in a designated area within the VOC refrigerator. Restrictive non-VOC samples will be stored in a designated area within either Walk-in Refrigerator #1 or #2.
- 6.8.2 Restrictive samples will remain in the designated areas until removed for sample preparation or analysis.
- 6.8.3 All transfers of restrictive samples into and out of storage will be documented on an *Internal Chain of Custody*.
- 6.8.4 The restrictive sample will remain in the custody of that analyst until it is returned to the storage area.
- 6.8.5 If the volume submitted for restrictive sample is completely used in analysis, this will be documented on the *Internal Chain of Custody*.
- 6.8.6 If the contents of these sample containers are used for more than one analysis (multiple tests) this will also be documented on the *Internal Chain of Custody*.
- 6.8.7 If the contents of a restrictive sample container are prepared for analysis by one analyst, and the prepared sample extract is analyzed by a second analyst, the transfer from the first analyst to the second is documented.
- 6.8.8 All restrictive samples will be returned to storage at or before the end of the work day.
- 6.8.9 When restrictive sample analysis and reporting is completed by the laboratory, or after three months time, whichever is longer, the sample will be disposed of properly according to the Laboratory Waste Disposal SOP F08. All forms, data sheets and records will be retained as permanent documentation, or as directed by the contract or regulations.

6.9 Sample Security

- 6.9.1 The laboratory is a secure facility, with strict, limited access to laboratory personnel and approved contractors. Access to the laboratory is through locked doors.
- 6.9.2 Visitors to the laboratory must enter through a secure door, sign-in and out, and must be escorted at all times while in the laboratory. No visitor will be allowed access to sample or extract storage.
- 6.9.3 Restrictive samples will remain in specified sample storage until removed for analytical preparation or analysis. All transfers of these samples into and out of storage will be documented on an *Internal Chain of Custody* form.

Internal Sample Chain of Custody

CHECK IN DATE	SAMPLE ID NUMBER(S)	TEST	ANALYST	ANALYST CHECK OUT DATE	RETURNED # R / USED IN ANALYSIS = U BY / DATE	DISPOSED BY / DATE

CT Laboratories

Internal Chain of Custody Form SOP SS-4

- 6.10 When all samples are logged in for a given day, login confirmation sheets are printed from LIMS. Login confirmation sheets summarizes of all the information entered regarding each project including the tests assigned to each particular sample. Confirmations are subsequently used to check for log-in errors by comparing with the original chain of custody.
- 6.11 When sample analysis and reporting is completed by the laboratory, or after thirty days' time, whichever is longer, the sample will be disposed of properly according to the Laboratory Waste Disposal SOP FO-8 and QAM CL-3.

7.0 REFERENCES:

- 7.1 Policies and Procedures, May 1978 (Rev. March 1986)
- 7.2 EPA-330/9-78-001-R
- 7.3 EPA Central Regional Laboratory (communications)
- 7.4 US ACOE – EM 200-1-3
- 7.5 CT Laboratories Quality Manual, current revision.
- 7.6 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.
- 7.7 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.
- 7.8 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.

Revision Number	Description of Changes	Date
04	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	01/10/2014

STANDARD OPERATING PROCEDURE
QA 020 Data Reporting

Review Date: 03/20/2014



03/20/2014

Approved by: QA Manager

Date



03/20/2014

Approved by: Laboratory Director

Date

UNCONTROLLED WHEN PRINTED

Title: Data Reporting

1.0 Purpose:

CT Laboratories has three different methods for reporting data to our clients. They are analytical reports, data packages and Electronic Data Deliverables, EDD. All CT Laboratories analytical reports and data packages must contain specific information for which the testing was performed. The testing includes, but is not limited to, the National Environmental Laboratory Accreditation Program (NELAP), and the Department of Defense (DoD) programs and individual states which do not follow either of the above programs. Within these agencies are rules and regulations that direct what constitutes a report and what a report must contain. The following procedures specify, at a minimum, what must be included in every analytical report and data package. Electronic Data Deliverables, EDDs, are numerous and are either client and or program specified in requirements.

2.0 Application:

This reporting SOP is applicable to all analytical reports and data packages issued by CT Laboratories.

3.0 Summary of Procedure:

The goal of this SOP is to define what information needs to be presented in our analytical reports and data packages so that the results are reported accurately, clearly, unambiguously and objectively. Client and or program requests for alternative reports will supersede the established report requirements presented in the SOP as long as the requested format reports the analytical results in an accurate, clear, unambiguous and objective manner. All “required” information will be available to those clients upon request.

4.0 Definitions:

None

5.0 Personnel Qualifications:

Project Managers

6.0 Procedure:

6.1 Basic Report:

A basic report is comprised of an analytical report and copy of the chain of custody.

6.2 Analytical Report:

A NELAC/DOD analytical report is comprised of the following items: Cover page, analytical report, copy of the chain of custody, Sample Condition Report, case narrative when applicable, and correspondence when applicable. Each test report must include at least the following information.

- 6.2.1 A title of “*Analytical Report*” appears on the first page.
- 6.2.2 The name, address and phone number where the test was carried out is documented on the first page of the analytical report.
- 6.2.3 The CT Laboratories Folder number which is generated at sample login is used as the unique identification of the analytical report. The Folder number can be found on each page in order to ensure that the page is recognized as part of the analytical report. Each page of the analytical report is numbered as a number of the total reported pages.
- 6.2.4 The name and address of the client, and project name are present in the analytical report.
- 6.2.5 Each analyte will have the specified method identified with the analyte result.
- 6.2.6 A description of, the condition of, and unambiguous identification of the sample(s), including the client identification code is entered into the LIMS system. The information is populated in the report as a header for each sample and also in the Sample Condition Report which can be found in the analytical report.
- 6.2.7 The date of receipt of the sample(s), the date and time of sample collection, the date(s) and time(s) of sample preparation, if applicable, and analysis is all reported on the analytical report. If the time of sample collection is not provided, the laboratory must assume the most conservative time of day.
- 6.2.8 Samples are logged in using the analytical tests specified in an individual contract which has been set up to meet the project specifications.
- 6.2.9 Within the analytical results reporting section of the analytical report the units, where applicable, are documented for each analyte. A statement can also be found on each page of this section if the results have been calculated and reported on a dry weight basis. Any failures associated with the data are qualified either by test and or individual analyte, as applicable. A table with the qualifier definitions can be found at the end of this section. (Note: Data qualifiers for DOD-QSM work will follow the required DOD-QSM definitions.)

- 6.2.10** The name, function and signature, or electronic equivalent, of the person approving the report can be found on the last page of the results reporting section. The “Report Date” can be found on the first page of the results reporting section.
- 6.2.11** A statement can be found on the last page of the results reporting section that the results relate only to the sample(s) reported in the analytical report.
- 6.2.12** A statement can be found on the last page of the results reporting section that the report shall not be reproduced except in full without the written approval of the laboratory.
- 6.2.13** A statement can be found on the last page of the results reporting section that the test results are certified that they meet the requirements of NELAC and / or DoD-QSM. A “^” character denotes that the laboratory is NELAC accredited for this analyte by the indicated matrix and method. Any exceptions to NELAC requirements will be noted in the analytical report.
- 6.2.14** Any deviations, additions, or exclusions to the analytical method or environmental conditions that may have impacted the analytical results are documented by the analyst(s) as a note with in the analytical report.
- 6.2.15** A case narrative may also be used to document issues with the sample(s) analysis, sample receipt, or reporting. A narrative shall address the analyses for which manual integrations were necessary. The narrative must address each manual integration by sample and analyte.
- 6.2.16** A statement has been added to the analytical report that the level of uncertainty measurements can be provided upon request by the client.
- 6.2.17** Upon request by the client the laboratory can provide opinions and or interpretations of the data which would be documented in a case narrative and would be marked as an opinion and or interpretation.
- 6.2.18** The chain of custody is included in the analytical report which would include the documentation of the sample date and any field observations which had been documented on the chain of custody.
- 6.2.19** On occasion the laboratory has to subcontract certain test(s). The analytical results are received in either hard copy or electronic form. If the report is received in hard copy form it is scanned in its entirety and saved as a .pdf document. The entire subcontract report is attached to CT Laboratories analytical report and provided to the client.
- 6.2.20** Analytical reports are sent to clients in any of the following formats; hard copy, facsimile, e-mail or on electromagnetic media. When analytical reports are being sent via electronic transmission the cover pages and or e-mail signatures have

Confidentiality statements within them.

6.2.21 The analytical report(s) format is checked to make sure that different analyses will have all reported data presented clearly so that there is no misunderstanding or misuse of the data.

6.2.22 When analytical reports have to be revised/amended and resubmitted to the client(s) the cover page should be amended to “Revised Analytical Report”. Also, the basic report section of the analytical report has a “Report Date” which is the original report date and a “Reprint Date” which is populated with the date the report is reprinted.

6.3 Data Packages:

At times clients require more information regarding the sample analysis or need to have a third party data validation performed on the analysis. In those cases a data package is generated and supplied to the client. CT Laboratories offers two levels of a data package. Attachment 1 shows the two different levels, III & IV, and what is supplied in each package. Data packages are generated using proprietary software which takes different queued and validated sections and pulls them together in a specified order and paginates the document upon completion. Once the final data package has been generated the project manager will then review the package to ensure that the previous data reviews were documented properly and for completeness. Below is a summary of the different sections and who is responsible for the section.

6.3.1 Cover Page. The cover page is generated by the project managers and inserted once all of the other sections have been generated and validated.

6.3.2 Table of Contents. The data package software automatically populates and generates the table of contents sheet during the final generation of the data package.

6.3.3 Case Narrative. The project managers are responsible for generating the final case narrative. Each section of the laboratory that had testing in the submission is responsible for generating the narrative notes for the specific analyses. The project manager will then assimilate all of the different sections into the final narrative.

6.3.4 Analytical Results. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator.

6.3.5 Sample Management Records. The project managers are responsible for documenting and generating the Chain of Custody section of the data package. The chain of custody section should include chain of custody records, shipping

documents, Sample Condition Report(s), Login Confirmation Report(s), any correspondence with the client regarding the project and this set of samples, and any non-conformance/corrective actions that may have occurred during the analysis of the sample(s).

6.3.6 QA/QC Information. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator.

6.3.7 Information for Third-party Review. Each section of the laboratory is responsible for generating and validating the appropriate data which is queued into the data package generator. The level of documentation that is required will depend on which level of data package has been requested.

7.0 Quality Control and Quality Assurance:

None

8.0 References

1. Wisconsin Administrative Code, NR 149.15
2. CT Laboratories Quality Manual, current revision.
3. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.
4. National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.
5. ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.

Attachment 1

Data Package Deliverable Formats

Level III:

- ❖ Cover Page
- ❖ Table of Contents
- ❖ Case Narrative
- ❖ Data Qualifier Sheet
- ❖ Sample Delivery Group Summary
- ❖ QC Batch Cross Reference
- ❖ Analytical Results
- ❖ Surrogate Recoveries – where appropriate
- ❖ Method Blank
- ❖ Laboratory Control Sample (LCS) Summary
- ❖ Laboratory Control Sample Duplicate (LCSD) Summary – where appropriate
- ❖ Matrix Spike (MS) Summary
- ❖ Matrix Spike Duplicate (MSD) Summary – where appropriate
- ❖ Replicate/Duplicate – where appropriate
- ❖ GC/MS Tune – where appropriate
- ❖ Initial Calibration Summary & Raw Data
- ❖ Continuing Calibration Verification (CCV) Summary & Raw Data
- ❖ Raw Data – Including but not limited to instrument logs, standard prep logs, extraction logs, digestion logs, instrument sequences and data sheets.
- ❖ Chain of Custody
- ❖ Sample Condition Report
- ❖ Login Confirmation Report
- ❖ Project/Sample Related Correspondence

Level IV:

- ❖ Cover Page
- ❖ Table of Contents
- ❖ Case Narrative
- ❖ Data Qualifier Sheet
- ❖ Sample Delivery Group Summary
- ❖ QC Batch Cross Reference
- ❖ Analytical Results
- ❖ Surrogate Recoveries – where appropriate
- ❖ Method Blank
- ❖ Laboratory Control Sample (LCS) Summary
- ❖ Laboratory Control Sample Duplicate (LCSD) Summary – where appropriate
- ❖ Matrix Spike (MS) Summary
- ❖ Matrix Spike Duplicate (MSD) Summary – where appropriate
- ❖ Replicate/Duplicate – where appropriate
- ❖ GC/MS Tune – where appropriate
- ❖ Initial Calibration Summary & Raw Data
- ❖ Continuing Calibration Verification (CCV) Summary & Raw Data
- ❖ Raw Data – Including but not limited to instrument logs, standard prep logs, extraction logs, digestion logs, instrument sequences and data sheets. Chromatograms, spectra, raw data files for all samples and associated QC and calibrations.
- ❖ Chain of Custody
- ❖ Sample Condition Report
- ❖ Login Confirmation Report
- ❖ Project/Sample Related Correspondence

Revision Number	Description of Changes	Date
02	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/20/2014

STANDARD OPERATING PROCEDURE
SV 006 Semi-volatile Organic Compounds by 8270D

Review Date: 03/24/2015



3/24/2015

Technical Review by:

Date



4/6/15

Approved by: Quality Assurance

Date

Table of Contents

<u>Section Title</u>	<u>Page Number</u>
Table 1.0 8270D Compound List	4
Table 1.1 Additional Analytes	6
Table 1.2 Internal Standard for each Target Compound	7
Table 2.0 SIM+SCAN MS Parameters	12
Table 3.0 Intermediate Stock Standard	16
Table 3.1 Agents Intermediate Stock Standard	17
Table 3.2 8270 Initial Calibration	17
Table 3.3 8270 Agents Initial Calibration	17
Table 3.4 8270 SIM+SCAN Initial Calibration	18
Table 3.5 8270 ICV Working Standards	18
Table 3.6 8270 Agents ICV Working Standards	18
Table 3.7 8270 ICV SIM+SCAN Working Standards	19
Table 3.8 8270 CCV Working Standards	19
Table 3.9 8270 Agents CCV Working Standards	19
Table 3.10 8270 Surrogate Spiking Solution	20
Table 3.11 8270 Agents Surrogate Spiking Solution	20
Table 3.12 8270 SIM+SCAN Surrogate Spiking Solution	20
Table 3.13 8270 SIM+SCAN Internal Standard Solution	21
Table 3.14 8270 Agents Internal Standard Solution	21
Table 3.15 8270 Analyte Spiking Solution	21
Table 3.16 8270 Agents Analyte Spiking Solution	21
Table 3.17 DFTPP Standard Solution	22
Table 4.0 DFTPP Tuning Criteria	27
Table 4.1 System Performance Check Compounds and Minimum Response Factors	28
Table 5 Method 8270D Quality Control Requirements	42
Table 6 Analysis Data Review Checklist	46
Table 7 Semi-volatiles 8270 Extraction Bench Sheet	49

1.0 Identification of the Test Method

This method is designed to follow procedures and QC requirements found in EPA SW-846 methods 3510C, 3545A, 3546, 3580A, 8000 and 8270D in order to determine quantities of semivolatile organic compounds in a variety of different sample matrices.

2.0 Applicable Matrix or Matrices

Semivolatile organic compounds are quantitated from a variety of matrices. This method is applicable to nearly all types of samples; including ground water, surface water, wastewater, soils, sediments, and tissue as well as other matrices noted in SW-846 method 8270D.

3.0 Detection Limits

Method detection limits (MDLs) are determined annually and results vary from compound to compound. Water MDLs are typically between 0.10 and 10 ug/L. Soil MDLs are typically between 0.01 and 0.50 mg/kg. Water MDLs for PAH compounds analyzed in SIM mode are typically between 0.005 ug/L and 0.015 ug/L. Soil MDLs for PAH compounds analyzed in SIM mode are typically between 1.0 and 5.0 ug/kg. Procedures for conducting MDL studies can be found in CT Laboratories Initial Method Performance and Reporting SOP.

4.0 Scope and Application, including components to be analyzed

- 4.1 Method SW-846 8270D is used to quantify solvent-extractable semivolatile organic compounds in water and soil. Most base-neutral and acidic organic compounds which are soluble in methylene chloride and capable of being eluted in a gas chromatograph without derivatization can be quantitated. See Table 1.0 for a typical target analyte list (TAL).
- 4.2 Examples of other compounds which have been analyzed by this method are listed in Table 1.1. SW846 method 8270D notes a number of other compounds amenable to this test.
- 4.3 The following compounds require special treatment when being determined by this method.
 - 4.3.1 Benzidine is subject to oxidative losses during solvent concentration and exhibits poor chromatographic behavior.
 - 4.3.2 Hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reaction in acetone solution, and photochemical decomposition.
 - 4.3.3 Pentachlorophenol, 2,4-Dinitrophenol, 4-Nitrophenol, Benzoic Acid, N-Nitrosodimethylamine, 2-Naphthylamine, 4,6-Dinitro-2-Methylphenol, 4-Chloro-3-Methylphenol, 2-Nitroaniline, 3-Nitroaniline, 4-Chloroaniline, Pyridine, and Benzyl Alcohol are subject to erratic chromatographic behavior.
 - 4.3.4 The analytes listed above are flagged when there are limitations caused by sample preparation and/or chromatographic problems.

4.3.5 N-nitrosodiphenylamine decomposes in the gas chromatograph and cannot be separated or differentiated from Diphenylamine. Both analytes are reported as a pair.

4.3.6 Azobenzene & 1,2-Diphenylhydrazine, 3&4-Methylphenol and 3&4-Chlorophenol are reported as a pair.

Table 1.0
8270 Compound List

Codes (Tables 1):

S = Surrogates

I = Internal Standards

CT= Target Compounds

CPT= System Performance Check Compounds

Table 1.0						
PK#	Compound Name	Retention Time	Relative RT	Primary Ion	Secondary Ion(s)	Code
1	1,4-Dichlorobenzene d ₄	3.881	1.00	152	150,115	I
2	N-Nitrosodimethylamine	2.011	0.52	42	74,44	CT
3	Pyridine	2.023	0.52	79	52	CT
4	2-Fluorophenol	2.736	0.70	112	64,57	S
5	Aniline	3.546	0.91	93	65,66	CT
6	Bis(2-chloroethyl) ether	3.614	0.93	93	63,95	CPT
7	Phenol d ₅	3.517	0.91	99	42,71,100	S
8	Phenol	3.529	0.91	94	65,66	CPT
9	2-Chlorophenol	3.659	0.94	128	64,130	CPT
10	1,3-Dichlorobenzene	3.819	0.98	146	148,111	CT
11	1,4-Dichlorobenzene	3.901	1.01	146	148,111	CT
12	1,2-Dichlorobenzene	4.066	1.05	146	148,111	CT
13	Benzyl alcohol	4.054	1.04	108	79,77	CT
14	Bis(2-chloroisopropyl) ether	4.216	1.09	45	121,77	CPT
15	2-Methylphenol	4.194	1.08	107	108,77	CPT
16	N-Nitrosopyrrolidine	4.350	1.12	100	41,42	CT
17	Acetophenone	4.367	1.13	105	77,51	CPT
18	Hexachloroethane	4.466	1.15	117	201,199	CPT
19	N-Nitrosodi-n-propylamine	4.381	1.13	70	42,101	CPT
20	3 & 4-Methylphenol	4.398	1.13	107	108,77	CPT
21	Naphthalene d ₈	5.540	1.00	136	68,108	I
22	Nitrobenzene d ₅	4.546	0.82	82	128,54	S
23	Nitrobenzene	4.572	0.83	77	123,65	CPT
24	Isophorone	4.901	0.88	82	95,138	CPT
25	2-Nitrophenol	4.992	0.90	139	109,65	CPT
26	2,4-Dimethylphenol	5.106	0.92	122	107,121	CPT
27	Bis(2-chloroethoxy) methane	5.253	0.95	93	95,123	CPT
28	2,4-Dichlorophenol	5.370	0.97	162	164,98	CPT
29	1,2,4-Trichlorobenzene	5.475	0.99	180	182,145	CT

Table 1.0

PK#	Compound Name	Retention Time	Relative RT	Primary Ion	Secondary Ion(s)	Code
30	Benzoic Acid	5.336	0.96	122	105,77	CT
31	Naphthalene	5.569	1.01	128	129,127	CPT
32	4-Chloroaniline	5.680	1.03	127	129,65,92	CPT
33	2,6-Dichlorophenol	5.677	1.02	162	164,98	CT
34	Hexachloropropene	5.688	1.03	213	211,215	CPT
35	Hexachlorobutadiene	5.756	1.04	225	223,227	CPT
36	4-Chloro-3-methylphenol	6.262	1.13	107	144,142	CPT
37	2-Methylnaphthalene	6.353	1.15	142	141	CPT
38	1-Methylnaphthalene	6.441	1.16	141	142	CT
39	Acenaphthene d ₁₀	7.188	1.00	164	162,160	I
40	Hexachlorocyclopentadiene	6.504	0.90	237	235,272	CPT
41	1,2,4,5-Tetrachlorobenzene	6.509	0.91	216	214,179	CPT
42	2,4,6-Trichlorophenol	6.623	0.92	196	198,200	CPT
43	2,4,5-Trichlorophenol	6.651	0.93	196	198,97	CPT
44	2-Fluorobiphenyl	6.694	0.93	172	171,170	S
45	2-Chloronaphthalene	6.774	0.94	162	127,164	CPT
46	2-Nitroaniline	6.873	0.96	65	92,138	CPT
47	Acenaphthylene	7.086	0.99	152	151,153	CPT
48	Dimethylphthate	7.027	0.98	163	194,164	CPT
49	2,6-Dinitrotoluene	7.063	0.98	165	63,89	CPT
50	Acenaphthene	7.214	1.00	154	153,152	CPT
51	3-Nitroaniline	7.180	1.00	138	108,92	CPT
52	2,4-Dinitrophenol	7.254	1.01	184	63,154	CPT
53	Dibenzofuran	7.331	1.02	168	139	CPT
54	2,4-Dinitrotoluene	7.339	1.02	165	63,89	CPT
55	4-Nitrophenol	7.313	1.02	109	139,65	CPT
56	2,3,5,6-Tetrachlorophenol	7.390	1.03	232	194,234,230	CT
57	2,3,4,6-Tetrachlorophenol	7.419	1.03	232	131,230,234	CPT
58	Fluorene	7.558	1.05	166	165,167	CPT
59	4-Chlorophenyl phenyl ether	7.561	1.05	204	206,141	CPT
60	Diethyl phthalate	7.501	1.04	149	177,150	CPT
61	4-Nitroaniline	7.592	1.06	138	65,108,92	CPT
62	2,4,6-Tribromophenol	7.714	1.07	330	332,141	S
63	Phenanthrene d ₁₀	8.140	1.00	188	94,80	I
64	4,6-Dinitro-2-methylphenol	7.603	0.93	198	51,105	CPT
65	N-Nitrosodiphenylamine & Diphenylamine	7.643	0.94	169	168,167	CPT
66	Azobenzene & 1,2-Diphenylhydrazine	7.666	0.94	182	152,77	CT
67	4-Bromophenyl phenyl ether	7.868	0.97	248	250,141	CPT
68	Hexachlorobenzene	7.902	0.97	284	142,249	CPT
69	Pentachlorophenol	8.027	0.99	266	264,268	CPT
70	Phenanthrene	8.155	1.00	178	179,176	CPT
71	Anthracene	8.186	1.01	178	176,179	CPT
72	Carbazole	8.271	1.02	167	166,139	CPT

THIS DOCUMENT IS UNCONTROLLED WHEN PRINTED

Table 1.0						
PK#	Compound Name	Retention Time	Relative RT	Primary Ion	Secondary Ion(s)	Code
73	Di-n-butyl phthalate	8.430	1.04	149	150,104	CPT
74	Fluoranthene	8.748	1.07	202	101,203	CPT
75	Chrysene d ₁₂	9.567	1.00	240	120,236	I
76	Benzidine	8.814	0.92	184	92,185	CT
77	Pyrene	8.868	0.93	202	200,203	CPT
78	Terphenyl d ₁₄	8.944	0.93	244	122,212	S
79	Butyl benzyl phthalate	9.217	0.96	149	91,206	CPT
80	3,3-Dichlorobenzidine	9.541	1.00	252	254,126	CPT
81	Benzo (a) anthracene	9.558	1.00	228	229,226	CPT
82	Chrysene	9.581	1.00	228	226,229	CPT
83	Bis (2-ethylhexyl) phthalate	9.564	1.00	149	167,279	CPT
84	Di-n-octyl phthalate	9.973	1.04	149	167,43	CPT
85	Perylene d ₁₂	10.456	1.00	264	260,265	I
86	Benzo (b) fluoranthene	10.223	0.98	252	253,125	CPT
87	Benzo (k) fluoranthene	10.240	0.98	252	253,125	CPT
88	Benzo (a) pyrene	10.422	1.00	252	253,125	CPT
89	Indeno (1,2,3-cd) pyrene	11.164	1.07	276	138,277	CPT
90	Dibenz (a,h) anthracene	11.175	1.07	278	139,279	CPT
91	Benzo (g,h,i) perylene	11.368	1.09	276	138,277	CPT

Table 1.1
Additional Analytes

Table 1.1						
PK#	Compound	Retention Time	Relative RT	Primary Ion	Secondary Ion	Code
92	2-Ethoxyethanol	1.68	0.43	59	45,72	CT
93	N-Nitrosodiethylamine	3.468	0.76	102	42,57	CT
94	2-Chloro-5-Methylphenol	5.360	0.87	107	144,142	CT
95	2,5-Dichlorophenol	6.045	0.98	162	164,63,99	CT
96	2,3-Dichlorophenol	6.085	0.98	162	126,63,164,	CT
97	Quinoline	6.120	1.10	129	102,51	CT
98	3&4-Chlorophenol	6.176	1.11	128	130,65,100	CT
99	Alpha-terpineol	6.390	1.15	59	43,93	CT
100	N-Nitroso-di-n-butylamine	6.627	1.19	84	57,41	CT
101	2-Methyl-4-Chlorophenol	6.661	1.20	107	142,77	CT
102	3,4-Dichlorophenol	7.343	0.96	162	164,99,63	CT
103	2,5-Dinitrophenol	7.579	0.99	184	63,53,39	CT
104	Pentachlorobenzene	7.787	1.01	250	252,108	CT
105	Diallate	7.890	0.97	86	234,236	CT
106	2-Naphthylamine	7.895	1.03	143	115,116	CT
107	Benzaldehyde	4.287	0.90	106	105,77	CPT
108	Caprolactam	6.793	1.06	55	113,85	CPT
109	Biphenyl	7.430	0.95	154	153,152	CPT
110	Atrazine	8.518	0.98	200	215,58	CPT

Table 1.1						
PK#	Compound	Retention Time	Relative RT	Primary Ion	Secondary Ion	Code
111	Hexachlorophene	10.27	0.98	196	209,211	CT
112	Benzo(a)anthracene-d12	10.329	1.00	240		I
113	o-Terphenyl-d14	8.550	0.83	244		S
114	1,4-Oxithiane	4.320	0.830	104	61	CT
115	1,4-Dithiane	5.632	1.08	120	92	CT
116	2-bromophenylmethylsulfide	7.548	1.183	202	108	S

Note: Retention time shifts can occur when instrument maintenance is performed.
Shifts in the retention times are reflected in the analytical method.

Table 1.2
Internal Standard For Each Target Compound

Table 1.2					
1,4-Dichlorobenzene d₄	Naphthalene d₈	Acenaphthene d₁₀	Phenanthrene d₁₀	Chrysene d₁₂	Perylene d₁₂
N-Nitrosodimethylamine	Nitrobenzene d ₅	Hexachlorocyclopentadiene	4,6-Dinitro-2-methylphenol	Benzidine	Benzo (b) fluoranthene
Pyridine	Nitrobenzene	1,2,4,5-Tetrachlorobenzene	N-Nitrosodiphenylamine & Diphenylamine	Pyrene	Benzo (k) fluoranthene
2-Fluorophenol	Isophorone	2,4,6-Trichlorophenol	Azobenzene & 1,2-Diphenylhydrazine	Terphenyl d ₁₄	Benzo (a) pyrene
Aniline	2-Nitrophenol	2,4,5-Trichlorophenol	4-Bromophenyl phenyl ether	Butyl benzyl phthalate	Indeno (1,2,3-cd) pyrene
Bis(2-chloroethyl) ether	2,4-Dimethylphenol	2-Fluorobiphenyl	Hexachlorobenzene	3,3-Dichlorobenzidine	Dibenz (a,h) anthracene
Phenol d ₅	Bis(2-chloroethoxy) methane	2-Chloronaphthalene	Pentachlorophenol	Benzo (a) anthracene	Benzo (g,h,i) perylene
Phenol	2,4-Dichlorophenol	2-Nitroaniline	Phenanthrene	Chrysene	Hexachlorophene
2-Chlorophenol	1,2,4-Trichlorobenzene	Acenaphthylene	Anthracene	Bis (2-ethylhexyl) phthalate	
1,3-Dichlorobenzene	Benzoic Acid	Dimethylphthalate	Carbazole	Di-n-octyl phthalate	
1,4-Dichlorobenzene	Naphthalene	2,6-Dinitrotoluene	Di-n-butyl phthalate		
1,2-Dichlorobenzene	4-Chloroaniline	Acenaphthene	Fluoranthene		
Benzyl alcohol	2,6-Dichlorophenol	3-Nitroaniline	Atrazine		
Bis(2-chloroisopropyl) ether	Hexachloropropene	2,4-Dinitrophenol	Diallate		
2-Methylphenol	Hexachlorobutadiene	4-Nitrophenol			
N-Nitrosopyrrolidine	4-Chloro-3-methylphenol	2-Naphthylamine			
Acetophenone	2-Methylnaphthalene	Fluorene			
N-Nitrosodi-n-propylamine	1-Methylnaphthalene	4-Chlorophenyl phenyl ether			
3 & 4-Methylphenol	2-Chloro-5-methylphenol	Diethyl phthalate			
Hexachloroethane	2,5-Dichlorophenol	Dibenzofuran			
N-Nitrosodiethylamine	2,3-Dichlorophenol	2,4-Dinitrotoluene			
Benzaldehyde	3&4-Chlorophenol	4-Nitroaniline			
2-Ethoxyethanol	N-Nitroso-di-n-butylamine	2,4,6-Tribromophenol			

Table 1.2					
1,4-Dichlorobenzene d ₄	Naphthalene d ₈	Acenaphthene d ₁₀	Phenanthrene d ₁₀	Chrysene d ₁₂	Perylene d ₁₂
	2-Methyl-4-chlorophenol	2,3,5,6-Tetrachlorophenol			
	Caprolactam	2,3,4,6-Tetrachlorophenol			
	Quinoline	3,4-Dichlorophenol			
	Alpha-terpineol	2,5-Dinitrophenol			
		Pentachlorobenzene			
		Biphenyl			

5.0 Method Summary

- 5.1 This method describes procedures for isolating organic compounds through sample preparation from aqueous, soil and tissue matrices (reference methods SW846-3510C, 3580A, 3545A and 3546), concentration techniques that are suitable for preparing the extract, and the quantitative/qualitative analysis for the determination of target analytes by method SW846-8270D.
- 5.2 A sample of a known volume or weight is extracted with solvent or diluted with solvent. This method applies to aqueous samples extracted by liquid-liquid separatory funnel (SW846-3510C) and to soil/sediment and solid waste samples extracted by standard solvent extraction methods utilizing pressurized extraction techniques as heated pressurized fluid extraction (SW846-3545A) and using microwave energy to produce elevated temperature and pressure conditions in a closed vessel containing extraction solvent (SW846-3546). This method includes the extraction for waste dilution samples (SW846-3580A).
- 5.3 The resultant extract is chemically dried and concentrated in a Kuderna-Danish (K-D) apparatus in preparation for instrumental analysis.
- 5.4 Extracts for 8270D analysis may be subjected to cleanup measures, depending on the nature of the matrix interferences and target analytes. The suggested method of cleanup is Gel-Permeation Chromatography (GPC) cleanup (SW846 3640A). Refer to GPC SOP Rev 0. After cleanup, the extract is analyzed by injecting a known aliquot into a gas chromatograph equipped with a mass spectrometer detector.
- 5.5 Identification of target analytes is accomplished by comparing their mass spectra with the spectra of certified commercially-prepared stock standards. Quantitation is accomplished by comparing the response of a major quantitation ion relative to an internal standard using a five point (minimum) calibration curve.
- 5.6 The PAH compounds may be analyzed using SIM (selected ion monitoring) signals for quantitation in order to achieve lower detection limits. This is referred to in this SOP as SIM+SCAN.
- 5.7 The procedures contained within this method are restricted to use by or under the supervision of trained analysts. Each analyst must demonstrate the ability to generate acceptable results.

6.0 Definitions

- 6.1 DFTPP: Decafluorotriphenylphosphine. This compound is used to verify that the GC/MS is properly tuned and ready for calibration and sample analysis. To acquire the mass spectrum of DFTPP, three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction to eliminate column bleed or instrument background noise is accomplished using a single scan acquired no more than 20 scans prior to the elution of DFTPP. The DFTPP standard must also contain Pentachlorophenol, Benzidine, and DDT to assess GC column performance and injection port inertness. Benzidine and Pentachlorophenol must have tailing factors less than 2. Breakdown of DDT to DDD and DDE must be less than 20%.
- 6.2 System Performance Check Compounds (SPCC): SPCCs are system performance compounds that are a part of the Continuing Calibration Verification standard (CCV). The SPCCs must meet a minimum response factor of 0.050. The SPCC criteria also apply to the average response factor of the initial calibration curve.
- 6.3 Calibration Check Compounds (CCC): CCCs are calibration check compounds that are a part of the Continuing Calibration Verification standard (CCV). The CCC percent difference must be less than or equal to 20%.
- 6.4 For full definitions on all terms applicable to this method, see Section 25.6 in the Quality Assurance Manual (QAM).
- 6.5 For a list of common acronyms and abbreviations, see QAM front matter.

7.0 Interferences

- 7.1 Solvents, reagents, glassware, and other sample processing hardware can yield artifacts and /or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Refer to each method for specific guidance on quality control procedures.
- 7.2 Phthalate esters contaminate many types of products commonly found in the laboratory. Plastics, in particular, must be avoided because phthalates are commonly used as plasticizers and are easily extracted from plastic materials.
- 7.3 Soap residue (e.g. sodium dodecyl sulfate), which results in a basic pH on glassware surfaces, will cause degradation of certain analytes.
- 7.4 Interferences co-extracted from the samples will vary considerably from source to source. If analysis of an extracted sample is prevented due to interference, further cleanup of the sample extract or dilution of the sample extract will be necessary.
- 7.5 Mass spectrometer sensitivity, column degradation, and contamination can also contribute to background interferences. The presence of semivolatile hydrocarbons in the sample extracts may require an appropriate post analysis bake-out time to be incorporated in the method.

8.0 Safety

- 8.1 Safety glasses, gloves and protective clothing shall be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure must utilize appropriate laboratory safety systems.
- 8.2 The toxicity and carcinogenicity of chemicals used in this method are not precisely defined. Each chemical and sample shall be treated as a potential health hazard, and exposure to these chemicals shall be minimized.

9.0 Equipment and Supplies

- 9.1 GC-MS system - Hewlett Packard 6890 GC/7683 autosampler/5973 MSD - An analytical system complete with gas chromatograph suitable for split-splitless injection and all required accessories including syringes, analytical column, mass spectrometer detector, auto sampler, electronic pressure control, vacuum pumps, and HP Chemstation data acquisition system. The data acquisition system consists of an IBM compatible PC with an operating system of Windows XP Professional and Agilent Environmental Chemstation (MSD Chemstation Rev. D.03.00.611).

9.1.1 8270D GC Conditions

Carrier Gas: He at 1.6 mL/min, hold 5.0 min
Ramped to 1.2 ml/min (10 ml/min), hold 3.0 min
Ramped to 1.8 ml/min (10 ml/min), hold 4.96 min

Injector Temperature: 250° C

Mode: Pulsed Splitless

Inj. Volume: 0.5 uL

Pressure: 8.9 psi

Pulse Pressure: 30.0 psi

Pulse Time: 0.4 min

Purge Flow: 50.0 ml/min

Purge Time: 0.38 min

Total Flow: 53.5 ml/min

Gas Saver On: 20ml/min at 2 min

Oven: Initial – 20° (hold for 0.5 min)
Ramp – 45°/min
Final – 70° (hold for 0 min)
Ramp – 14°/min
Final – 120° (hold for 0 min)
Ramp – 45°/min
Final – 220° (hold for 0 min)
Ramp – 40°/min
Final – 280° (hold for 0 min)
Ramp – 30° /min
Final – 325° (hold for 1.6 min)

9.1.2 8270D MS Conditions

MS Interface: 300°
MS Source: 280°
Mass range: 35-500 amu
Scan time: 0.317 sec/scan

9.1.3 Chemical Warfare Agents (1,4-Oxathiane and 1,4-Dithiane) G.C. Conditions

Carrier Gas: He at 1.2 mL/min, hold 5.0 min

Injector Temperature: 250° C
Mode: Pulsed Splitless
Inj. Volume: 1.0 uL
Pressure: 8.9 psi
Pulse Pressure: 30.0 psi
Pulse Time: 0.4 min
Purge Flow: 50.0 ml/min
Purge Time: 0.38 min
Total Flow: 53.5 ml/min
Gas Saver On: 20ml/min at 2 min
Oven: Initial – 20° (hold for 0.5 min)
Ramp – 25°/min
Final – 300° (hold for 1.3 min)
Ramp – 45°/min
Final – 325° (hold for 1 min)

9.1.4 MS Conditions

MS Interface: 300°
MS Source: 280°
Mass range: 35-500 amu
Scan time: 0.317 sec/scan

9.1.4 SIM+SCAN GC Conditions

Carrier Gas: He at 1.6 mL/min
Ramped to 1.8 ml/min (10ml/min) at 14 min
Injector Temperature: 250° C
Mode: Pulsed Splitless
Inj. Volume: 0.5 uL
Pressure: 8.9 psi
Pulse Pressure: 30.0 psi
Pulse Time: 0.4 min
Purge Flow: 50.0 ml/min
Purge Time: 0.38 min
Total Flow: 53.5 ml/min

Gas Saver On: 20ml/min at 2 min
Oven: Initial – 20° (hold for 0.55 min)
Ramp – 45°/min
Final –70° (hold for 0 min)
Ramp – 14°/min
Final –120° (hold for 0 min)
Ramp – 35°/min
Final – 255° (hold for 0 min)
Ramp – 15°/min
Final – 290° (hold for 0 min)
Ramp – 4°/min
Final – 300° (hold for 0 min)
Ramp – 30°/min
Final – 325° (hold for 0.1 min)

9.1.5 SIM+SCAN MS Conditions

MS Interface: 300°
MS Source: 280°
See Table 2

Table 2
SIM+SCAN MS PARAMETERS

Table 1.3								
	START TIME	DWELL	LABEL	CYC LES/ SEC	ION 1	ION 2	ION 3	ION 4
1	0	1	Auto_1	47.6	128			
2	5.26	50	NP	8.3	127	128		
3	5.66	1	Auto_2	47.6	142			
4	6.12	50	2MN,1MN	8.3	141	142		
5	6.38	1	Auto_3	47.6	152			
6	6.90	40	ACY,ACNE	7.1	1515	152	153	
7	7.27	1	Auto_4	47.6	166			
8	7.50	50	FLE	8.3	165	166		
9	7.90	1	Auto_5	47.6	178			
10	8.24	50	PHE,AN	8.3	176	178		
11	8.52	100	O-TER	8.3	244			
12	8.64	1	Auto_7	47.6	202			
13	9.05	50	FLA,PYR	8.2	101	202		
14	9.60	1	Auto_8	47.6	228			
15	10.20	40	BA,CHRY	7.1	226	228	240	
16	10.80	1	Auto_9	47.6	252			
17	11.40	40	BB,BK	7.0	125	252	264	
18	12.40	1	Auto_10	47.6	276			
19	13.00	40	IN,DB,BG	5.4	138	139	276	278

Retention time shifts can occur when instrument maintenance is performed.
Shifts in the retention times are reflected in the analytical method.

Note: Instrument operating parameters are subject to change to improve chromatography. Changes are noted in the Instrument Maintenance Log

9.2 Analytical column: 30m x 0.25 mm ID, 0.25 um. (J&W DB-5.625 or equivalent).

9.3 CEM Microwave Accelerated Reaction System (MARS Xpress) extraction unit with Synergyprep software:

The CEM Mars extraction cycle:

Method 1
8-16 samples
Power: 100% at 800 watts
Ramp Time: 15 min
Pressure: 0
Temp: 110 C
Hold Time: 15 min

Method 2
17-48 samples
Power: 100% at 1600 watts
Ramp Time: 15 min
Pressure: 0
Temp: 110 C
Hold Time: 15 min

9.4 Organomation 12-position nitrogen concentrator. (N-Evap, Organomation #11250-RT)

9.5 Analytical balance capable of accurately weighing to the nearest 0.01 gram (Fischer Scientific XD 2200 or equivalent)

9.6 Oven, muffle and drying.

9.7 Separatory funnels - 2000 mL Nalgene 4301, Teflon FEF lined with Teflon TFE stopcocks and Tefzel ETFE screw closures (MG Scientific #F847-2L or equivalent).

9.8 Aluminum foil

9.10 2-Platform shakers (Eberbach Model 6010 150 V shaker, or equivalent) fitted with trays to hold 6 Nalgene separatory funnels each.

9.11 Water bath- heated and capable of accepting a Kuderna-Danish apparatus. (GlasCol 6 position heating mantle 100DRX30424 or equivalent)

9.12 Kuderna-Danish (K-D) apparatus:

9.12.1 Concentrator tube, 10.0 mL, graduated. (Fisher # K570051-1025).

- 9.12.2 Evaporation flask- 500 mL or 250 ml (Fisher # K570035-0250).
- 9.12.3 Snyder column- Three-ball macro (Fisher # K503000-0121).
- 9.12.4 Polyacetal 19/22 clamps (VWR #KT675300-019).
- 9.13 Graduated cylinder (Class A TC) - 1000 mL. (Fisher 08-559G).
- 9.14 Beakers - 250 mL (Pyrex, VWR #13912-207, or equivalent) and 600 mL (Pyrex, VWR #13912-240, or equivalent).
- 9.15 Vials - 2.0mL (National Scientific – C4000) 12mL (Kimble #60815-1965), and 60 mL screw cap vials with Teflon lined caps (C&G #LX64-A030-A01A) or equivalents.
- 9.16 Pasteur Pipettes; 5 ¾” and 9” (VWR #14672-200 and -300).
- 9.17 Funnels – glass. (VWR #154-08 or equivalent)
- 9.18 Volumetric flask – (Class A) 10 mL (VWR #29620-084, or equivalent), 25 mL (VWR #29620-109, or equivalent), 50 mL (VWR #29620-120, or equivalent), 100 mL (VWR #29620-142, or equivalent), and 200 mL (VWR #29620-164, or equivalent).
- 9.19 Syringes 10 uL (Hamilton #80300, or equivalent), 100 uL (Hamilton #80600, or equivalent), 500 uL (Hamilton #81243, or equivalent), 1 mL (Hamilton #81343, or equivalent), and 5 mL (Hamilton #81543, or equivalent).
- 9.20 Boiling chips, carborundum, approximately 10/40 mesh (methylene chloride rinsed) (Fisher # 09-191-12) equivalent. Stored in extractions lab.
- 9.21 Filter- Glass Microfiber 12.5 cm (Ahlstrom, MG # F136-1250).
- 9.22 CEM-MARS Microwave extraction tubes with plugs and caps, 75mL (CEM #574127)
- 9.23 Spatulas- stainless steel. (VWR #57952-253 or equivalent)
- 9.24 pH indicator paper- pH 0-14. (Whatman #2613991) or equivalent. Stored in general lab storage area.

10.0 Reagents and Materials

- 10.1 Deionized water (Milli-Q processed), analyte free or equivalent.
- 10.2 Sodium sulfate (granular, anhydrous 60/120 mesh, JT Baker # 3375-05) or equivalent. If sodium sulfate passes in house lot check, it can be used as is and stored in air tight glass jar. Otherwise condition sodium sulfate by heating to 400°C for 4 hours in a shallow glass tray loosely covered with foil and recheck for purity. Sodium sulfate is stored in airtight glass jars and used within five years of opening or before the manufacturer’s expiration date.

- 10.3 Silica sand- hydrocarbon free. Purify by heating to 400°C for 4 hours in a shallow glass tray, loosely covered with foil. Silica sand is stored in airtight glass jars and used within five years of purifying.
- 10.4 Methylene chloride, pesticide grade, analyte free. Used within one year of opening or before the manufacturer's expiration date. Or stored in large carboy tank provided by manufacturer and used by the manufacturer's expiration date.
- 10.5 Acetone, pesticide grade, analyte free. Used within one year of opening or before the manufacturer's expiration date.
- 10.6 Methanol, pesticide grade. Used within one year of opening or before the manufacturer's expiration date.
- 10.7 Sulfuric Acid (Certified ACS)/Deionized Water-1:1(v/v). ACS grade. Used within six months of mixing or before manufacturer's expiration date for any reagent used. Log number recorded in Semivolatiles log book.
- 10.8 Sodium Hydroxide- 10 N (Certified ACS). Used within six months of mixing or before manufacturer's expiration date for any reagent used. Log number recorded in Semivolatiles log book.
- 10.9 Diatomaceous earth (Celite 545 – EMD #CX0574) or equivalent. Used within five years of opening or before the manufacturers expiration date.
- 10.10 Nitrogen (99.995% purity or greater).
- 10.11 Helium (99.995% purity or greater).
- 10.12 Standards and spikes
 - 10.12.1 Preparation of standards is documented in the GC/MS standards logbook. Each standard is labeled by prep date to allow for tracking. Opened stock standards expire in one year or sooner if comparison with quality control check samples indicates a problem. Any subsequent dilutions made from the opened vial expire six months from the date of dilution (not to exceed one year from the initial opening of the vial). The cracking date of the stock standard vial will be recorded on the label along with the one year expiration date.
 - 10.12.2 Stock Standards – Stock Standards are purchased from vendors who provide certified solutions. Standards are stored at -10°C in a freezer reserved for standard solutions. Unopened standard shall have the manufacturer's suggested expiration date. Opened stock standards expire in one year or sooner if comparison with quality control check samples indicates a problem (Not to exceed the manufacturer's expiration date).The following list of stock standards (or equivalent) are commercially prepared standards which are certified by the manufacturer:

Benzidines:	SPEX Part # 605X at 2000 ug/ml
Balance Mix A:	SPEX Part # SV-X at 2000 ug/ml
Custom Mix:	SPEX Part # SVO-CTWI-6 at 2000 ug/ml
8270 Surrogate Mix BN:	Restek Part #31062 5000 ug/ml
8270 Surrogate Mix AE:	Restek Part #31063 10000 ug/ml
8270 Mega Mix:	Restek Part #31850 at 500/1000 ug/ml
8270 Benzidine Mix:	Restek Part #31834 at 2000 ug/ml
8270 Extra Analyte List:	SPEX Part # CT-SV-12 at 2000 ug/ml
TCLP B/N Mix:	Restek Part # 31028 at 2000 ug/ml
TCLP Acid Mix:	Restek Part # 31027 at 2000 ug/ml
8040 Phenol Mix #1:	Restek Part # 31088 at 2000 ug/ml
8040 Phenol Mix #2:	Restek Part # 31089 at 2000 ug/ml
PAH Mix:	Restek Part # 31622 at 2000 ug/ml
DFTPP:	Restek Part # 31615 at 1000 ug/ml
o-Terphenyl-d14:	Chem Service Part# FD1054-1,neat
Additions Mix	Restek Part # 31902 at 1000 ug/ml
Biphenyl	SPEX Part #S500 at 1000 ug/ml
1,4-Thioxane	Absolute standards part#71472 at 1000ug/ml
1,4-Dithiane	Absolute standards part# 71471 at 1000ug/ml
2-Bromophenylmethylsulfide	Absolute standards part# 72445 at 1000ug/ml

10.12.3 Intermediate Stock Standards: These standards are diluted stock standards so that the concentration levels are manageable for the preparation of working standards. The 8270D intermediate standard is prepared at an optimum level for the preparation of the working stock standard. Each 8270D target compound (or Surrogate) is at a concentration of 100.0 ug/ml in methylene chloride with the following exceptions: compounds that co-elute (listed in sec 4.3.6) are at a concentration of 200.0 ug/mL. For example, Azobenzene and 1,2-Diphenylhydrazine are each in the stock solution at 100.0 ug/mL. They are reported as a pair (Azobenzene&1,2-Diphenylhydrazine) with a concentration of 200.0 ug/mL. See Tables 3.0 and 3.1.

Table 3.0
Intermediate Stock Standard

Stock Standard	Stock Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8270 MegaMix	1000	1.000	10.0	100.0
Benzidines	2000	0.500	10.0	100.0
Customs Mix	2000	0.500	10.0	100.0
8270 Surr Mix BN	5000	0.200	10.0	100.0
8270 Surr Mix AE	10000	0.100	10.0	100.0

Table 3.1
Agents Intermediate Stock Standard

Stock Standard	Stock Standard Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
1,4-Thioxane	1000	100	5	20.0
1,4-Dithiane	1000	100	5	20.0
2-Bromophenylmethylsulfide	1000	100	5	20.0

10.12.4 Calibration standards: An initial calibration of the listed analytes in Table 1.0 is performed using a minimum of 5 points. The following concentrations correspond to the expected range of concentrations found in real samples and bracket the linear range of the detector. Standards are made by taking aliquots of the intermediate standard and diluting to volume in methylene chloride or by making dilutions directly from the stock standards (see Tables 3.2, 3.3 and 3.4). The following levels are repeated across all 8270D compounds. Note: due to low instrument response the following compounds are not calibrated from level 1: Benzoic acid, 2,4-Dinitrophenol, 4-Nitrophenol, 4,6-Dinitro-2-methylphenol and Pentachlorophenol.

Table 3.2
8270 Initial Calibration

Linearity Points	Spike Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
1	100.0	5	0.5	1.0
2	100.0	25	0.5	5.0
3	100.0	50	0.5	10
4	100.0	100	0.5	20
5	100.0	150	0.5	30
6	100.0	200	0.5	40
7	100.0	250	0.5	50

Table 3.3
8270 Agents Initial Calibration

Linearity Points	Spike Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
1	20	5	0.5	0.1
2	20	10	0.5	0.2
3	20	25	0.5	0.5
4	20	50	0.5	1.0
5	20	100	0.5	2.0
6	20	150	0.5	3.0
7	20	250	0.5	5.0

The PAH compounds may be analyzed using SIM (selected ion monitoring) signals for quantitation. In this case, two additional levels composed of PAH compounds only are acquired in the initial calibration at 0.02 ug/ml and 0.1 ug/mL. See Table 3.4.

Table 3.4
8270 SIM+SCAN Initial Calibration

Linearity Points	Spike Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
1*	20.0	0.010	10	0.020
2*	20.0	0.050	10	0.10
3	100.0	0.100	10	1.0
4	100.0	0.500	10	5.0
5	100.0	1.000	10	10
6	100.0	2.000	10	20
7	100.0	1.500	5	30
8	100.0	2.000	5	40
9	100.0	2.500	5	50

* SIM+SCAN linearity points 1 and 2 contain PAH compounds only. See Tables 2.0 and 2.1.

10.12.5 Initial Calibration Verification (ICV): The initial calibration verification standard shall verify the initial calibration curve (different manufacturer from the initial calibration standard, a second lot from the same manufacturer is acceptable if a second manufacturer cannot be found. The initial calibration verification standards involve the analysis of all target compounds at 20.0 ug/ml and 40.0 ug/mL (40.0 ug/mL and 80.0 ug/mL for Azobenzene & 1,2-Diphenylhydrazine and N-nitrosodiphenylamine & Diphenylamine) each time the initial calibration is performed. Standards are made by taking aliquots of the ICV intermediate standard or the purchased stock standards and diluting to volume in methylene chloride. The ICV stock standard is prepared in the same manner as the primary intermediate stock standard. See Tables 3.5, 3.6 and 3.7.

Table 3.5
8270 ICV Working Standards

Working ICV Standards	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
ICV 1	100.0	1.000	5.0	20.0
ICV 2	100.0	2.000	5.0	40.0

Table 3.6
8720 Agents ICV Working Standards

Working ICV Standards	Intermediate Standard Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
ICV 1	20	50	1	1.0
ICV 2	20	100	1	2.0

Table 3.7
8720 ICV SIM+SCAN Working Standards

Working ICV Standards	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
ICV 1*	20.0	0.250	10.0	0.50
ICV 2	100.0	0.500	5.0	10.0
ICV 3	100.0	1.500	5.0	30.0

* SIM+SCAN ICV 1 contains PAH compounds only. See Tables 3.0 and 3.1

10.12.6 Calibration Verification Standard (CCV): A working standard solution for 8270D at a concentration of 20.0 ug/ml and is used to check the validity of a calibration curve on a daily basis. Standard is made by taking an aliquot of the intermediate standard and diluting it to volume in methylene chloride. The CCV is prepared weekly and stored at -10°C. The CCV for SIM+SCAN is the same as for normal 8270D. See Tables 3.8 and 3.9.

Table 3.8
8270 CCV Working Standard

Working CCV Standard	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8270	100.0	1.00	5.0	20.0

Table 3.9
8720 Agents CCV Working Standards

Working ICV Standards	Intermediate Standard Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
CCV 1	20	50	1	1.0

10.12.7 Surrogate standard: Commercially prepared certified solutions of 2-Fluorophenol, Phenol d₅, and 2,4,6-Tribromophenol at 10000 ug/ml (AE Surrogates) and Nitrobenzene d₅, 2-Fluorobiphenyl, and p-Terphenyl d₁₄ (BN

Surrogates) are diluted in acetone to produce a working surrogate solution of 40/20 ug/ml (AE/BN). 1.0 mL is added to each sample.

For Agents 2-Bromophenylmethylsulfide at 1000ug/ml is diluted with Acetone to produce 1.0ug/ml working surrogate solution. 1.0ml is added to each sample. The surrogate concentration is normalized to 100% from the spiking solution in the initial calibration. This will provide percent recoveries that transfer directly to LIMS. For SIM+SCAN analyses o-Terphenyl d₁₄ is added at a final concentration of 1.0 ug/ml. See Tables 3.10, 3.11 and 3.12.

Table 3.10
8270 Surrogate Spiking Solution

Surrogate Spiking Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8270 Surr. Mix BN	5000.0	0.400	100.0	20.0
8270 Surr. Mix AE	10000.0	0.400	100.0	40.0

Table 3.11
8270 Agents Surrogate Spiking Solution

Surrogate Spiking Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
2-Bromophenylmethylsulfide	1000	50	50	1.0

Table 3.12
8270 SIM+SCAN Surrogate Spiking Solution

Surrogate Spiking Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8270 Surr. Mix BN	5000	0.400	100.0	20.0
8270 Surr. Mix AE	10000	0.400	100.0	40.0
o-Terphenyl-d ₁₄	1000	0.100	100.0	1.0

10.12.8 Internal standard solution: A Commercially prepared certified solution of 1,4-Dichlorobenzene d₄, Naphthalene d₈, Acenaphthene d₁₀, Phenanthrene d₁₀, Chrysene d₁₂ and Perylene d₁₂ at 2000 ug/mL in methylene chloride. 5 uL is added to each 500 uL aliquot of sample extract for a final concentration of 20 ug/mL. In addition, Benzo[a]anthracene d₁₂ is added when the samples are analyzed for PAHs in selected ion monitoring (SIM) mode. See Table 3.13 for SIM+SCAN internal standard concentrations. See Table 3.14 for Agents internal standard concentrations.

Table 3.13
8270 SIM+SCAN Internal Standard Solution

Internal Standard Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8270 IS Mix	2000	0.5	1.0	1000
Benz[a]anthracene-d12	1000	0.5	1.0	500

Table 3.14
8270 Agents Internal Standard Solution

Internal Standard Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
8270 IS Mix	2000	100	1.0	200

10.12.9 Spiking standards (matrix and control samples): Prepare a spiking solution in acetone or methanol that contains target compounds for water and sediment / soil samples. 1.0 ml is added to quality control and matrix spike samples. The concentration of these compounds are five times higher for waste samples. If other compounds of interest are to be monitored they can be added at an appropriate level and noted in the standard preparation log. If client requests, spiking solution can be altered to match the target analytes of interest. See Tables 3.15 and 3.16.

Table 3.15
8270 Analyte Spiking Solution

Spiking Solution	Stock Standard Conc. (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
MegaMix	1000	1.000	50.0	20.0
Benzidines	2000	0.500	50.0	20.0
Custom Mix	2000	0.500	50.0	20.0

Table 3.16
8270 Agents Analyte Spiking Solution

Spiking Solution	Stock Standard Conc. (ug/ml)	Standard Volume (ul)	Final Volume (ml)	Final Concentration (ug/ml)
1,4-Thioxane	1000	50	50.0	1.0
1,4-Dithiane	1000	50	50.0	1.0

10.12.10 DFTPP: Decafluorotriphenylphosphine solution in methylene chloride (See Table 3.17). This compound is used in tuning the GC/MS. To acquire the mass spectrum of DFTPP, three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged.

The DFTPP standard must also contain Pentachlorophenol, Benzidine, and DDT to assess GC column performance and injection port inertness.

Table 3.17
DFTPP Standard Solution

Spiking Solution	Stock Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
DFTPP	1000	0.500	10.0	50.0

NOTE: All standards are stored at -10°C. Opened stock standards expire in six months or sooner if comparison with quality control check samples indicates a problem. An intermediate stock standard or working standard shall not exceed expiration date criteria. All subsequent standards made from the intermediate stock standards expire on the same date as the stock standard. If more than one standard is added to a solution the expiration date will be the same as the stock standard with the earliest expiration date.

11.0 Sample Collection, Preservation, and Storage

11.1 Aqueous samples are collected in 1-L amber glass containers with Teflon lined lids. Aqueous samples are to be collected in duplicate. Solid samples are collected in 250-mL wide mouth glass containers with Teflon-lined lids. All samples are preserved by cooling to 4°C. The soil samples must be extracted within 14 days and water samples must be extracted within 7 days from the date of collection.

11.1 Sample extracts are stored under refrigeration and analyzed within 40 days of extraction.

11.2 All soil samples are weighed on the top loading balance which is connected to a computer so that all weights can be automatically entered into an Excel spread sheet. The spreadsheets are saved so the data can be transferred electronically to the LIMS system.

12.0 Quality Control

12.1 This SOP is designed to follow a variety of different projects and program requirements. Table 5 is designed to illustrate the control steps and provisions required to adequately produce acceptable data.

12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.3 Program Specific Limits: Samples analyzed under the guidance of certain programs; such as the Department of Defense Quality Systems Manual (DoD/QSM) or Louisville Chemistry Guidance (LCG), require their own specified limits. For these samples follow the limits specified in the manuals for that program.

13.0 Calibration & Standardization

13.1 Calibration

- 13.1.1 The initial calibration for SW-846 chromatographic methods involves the analysis of standards containing the target compounds at a minimum of five different concentrations covering the working range of the instrument
- 13.1.2 For each compound and surrogate of interest, prepare calibration standards at a minimum of five different concentrations by adding volumes of one or more stock standards to a volumetric flask and diluting to volume with methylene chloride.
- 13.1.3 The lowest concentration calibration standard that is analyzed during an initial calibration curve establishes the method's quantitation limit based on the final volume of the sample extract described in the preparative method or employed by the laboratory.
- 13.1.4 Internal standard calibration involves the comparison of instrument responses from the target compounds in the sample to the response of specific standards added to the sample or sample extract prior to injection. The ratio of the peak area or height of the internal standard in the sample or sample extract is compared to a similar ratio derived for each calibration standard. The ratio is termed the response factor (RF), and is also known as a relative response factor in other methods.
- 13.1.4.1 Internal standards are recommended in SW846-8270D. These internal standards are: 1,4-Dichlorobenzene d_4 , Naphthalene d_8 , Acenaphthene d_{10} , Phenanthrene d_{10} , Chrysene d_{12} , and Perylene d_{12} . In addition, Benzo[a]anthracene d_{12} is added when the samples are analyzed for PAHs in selected ion monitoring (SIM) mode. The use of MS detectors makes internal standard calibration practical because the masses of the internal standards can be resolved from those of the target compounds even when chromatographic resolution cannot be achieved.
- 13.1.4.2 In preparing calibration standards for use with internal standard calibration, add the same amount of the internal standard solution to each calibration standard, such that the concentration of each internal standard is constant across all of the calibration standards, whereas the concentrations of the target analytes will vary. 5.0 μL of a solution containing the internal standards at a concentration of 2,000.0 $\mu\text{g/mL}$ is added to each 500.0 μL of standard or sample extract. This results in an internal standard concentration of 20.0 $\mu\text{g/mL}$ in the extract. For SIM+SCAN analysis the internal standard solution is at 1,000.0 $\mu\text{g/mL}$ resulting in a concentration of 10.0 $\mu\text{g/mL}$ in the extract, except for Benz[a]anthracene- d_{12} which is at half of this concentration (500.0 $\mu\text{g/mL}$ in the IS solution, 5.0 $\mu\text{g/mL}$ in the extract). The mass of each

internal standard added to each sample extract immediately prior to injection into the instrument must be the same as the mass of the internal standard in each calibration standard. The volume of the solution spiked into sample extracts is such that minimal dilution of the extract occurs (e.g., 5.0 uL of solution added to a 500.0 uL final extract results in only a negligible 0.1% change in the final extract volume which can be ignored in the calculations).

13.1.4.3 An ideal internal standard concentration would yield a response factor of 1 for each analyte. However, this is not practical when dealing with more than a few target analytes. Therefore, as a general rule, the amount of internal standard shall produce an instrument response (area counts) that is no more than 100 times that produced by the lowest concentration of the least responsive target analyte associated with the internal standard. This results in a minimum response factor of approximately 0.01 for the least responsive target compound.

13.1.5 For each of the initial calibration standards, calculate the RF values for each target compound relative to one of the internal standards as follows;

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

A_s = Peak area of the analyte or surrogate.

A_{is} = Peak area of the internal standard.

C_s = Concentration of the analyte or surrogate in ug/mL.

C_{is} = Concentration of the internal standard in ug/mL.

13.1.6 Linear calibration using the average response factor. Response factors are a measure of the slope of the calibration relationship and assume that the curve passes through the origin. Under ideal conditions, the factors will not vary with the concentration of the standard that is injected into the instrument. In practice, some variation is to be expected. However, when the variation, measured as the relative standard deviation (RSD), is less than or equal to 20%, the use of the linear model is generally appropriate, and calibration curve can be assumed to be linear and to pass through the origin. To evaluate the linearity of the initial calibration, calculate the RF, the standard deviation, and the relative standard deviation.

$$\text{Mean RF} = \overline{RF} = \frac{\sum_{i=1}^n RF_i}{n}$$

$$SD = \sqrt{\left(\frac{\sum_{i=1}^n (RF_i - \overline{RF})^2}{n-1} \right)}$$

$$RSD = \frac{SD}{\overline{RF}} \times 100$$

13.1.7 The average response factor (ARF) for all calibration levels is used when determining sample concentration and is calculated (along with the standard deviation) to evaluate the linearity of the curve (SW-846 Method 8000C sec. 11.5). When ARFs are not acceptable, results are sometimes calculated using linear (1st order) regression curves and/or quadratic (2nd order) curves. Internal standard quantitation is also used when generating linear and non-linear calibrations. All equations and acceptance criteria follow the examples in SW-846, Method 8000C (sec. 11.5).

13.1.8 Linear Calibration: If the RSD of the calibration factor is greater than 20% over the calibration range, then linearity through the origin cannot be assumed. If this is the case, the analyst can employ a regression equation that does not pass through the origin. This approach can also be employed based on the past experience of the instrument response. The regression will produce the slope and intercept terms for a linear equation in the form:

$$y = mx + b$$

y = instrument response (peak area or height)

m = Slope of the line

x = Concentration of the calibration standard

b = The intercept

13.1.9 The use of origin (0,0) as a calibration point is not allowed. However, most data systems and many commercial software packages will allow the analyst to “force” the regression through zero. This is not the same as including the origin as a fictitious point in the calibration. It can be appropriate to force the regression through zero for some calibrations (SW-846 Method 8000C sec. 11.5.2.1). The use of linear regression cannot be used as a rationale for reporting results below the calibration range.

13.1.10 Non-Linear Calibration: In situations where the analyst knows that the instrument response does not follow a linear model over a sufficiently wide working range, or when the other approaches described here have not met the acceptance criteria, a non-linear calibration model can be employed. When using a calibration model for quantitation, the curve must be continuous, continuously differentiable and monotonic over the calibration range. The model chosen shall have no more than four parameters, i.e., if the model is polynomial, it can be no more than third order as in the equation:

$$y = ax^2 + bx + c$$

- 13.1.1 The statistical considerations in developing a non-linear calibration model require more data than the more traditional linear approaches described above. Linear regression employs five calibration standards for the linear model, a quadratic model requires a minimum of six calibration standards. The coefficient of determination (COD) is calculated as follows:

$$\text{COD} = \frac{\sum_{i=1}^n (y_{\text{obs}} - \bar{y})^2 - \left(\frac{n-1}{n-p} \right) \sum_{i=1}^n (y_{\text{obs}} - Y_i)^2}{\sum_{i=1}^n (y_{\text{obs}} - \bar{y})^2}$$

y_{obs} = Observed response (area) for each concentration of the calibration curve.

$\bar{y}$ = Mean observed response from the initial calibration.

Y_i = Calculated response at each concentration from the initial calibrations.

n = Total number of calibration points (6 points for quadratic equation).

p = Number of adjustable parameters in the polynomial.

- 13.1.2 Under ideal conditions, with a “perfect” fit of the model to the data, the coefficient of the determination will equal 1.0. In order to be an acceptable non-linear calibration, the COD must be greater than or equal to 0.99. Weighting in a calibration model can significantly improve the ability of the least squares regression to fit the data calibrations (SW-846 Method 8000C sec. 11.5.3).

13.2 Calibration Criteria

- 13.2.1 Before analysis of any samples or standards can begin, the GC/MS system must be hardware tuned so a 25 ng injection of Decafluorotriphenylphosphine (DFTPP) passes the tuning criteria listed in Table 4.0. These criteria must be demonstrated each 12-hour shift during which samples are analyzed.

Table 4.0
DFTPP Tuning Criteria

Mass	Ion Abundance Criteria
51	10-80% of Base Peak
68	<2% of mass 69
70	<2% of mass 69
127	10-80% of Base Peak
197	<2% of mass 198
198	Base peak, or >50% of Mass 442
199	5-9% of mass 198
275	10-60% of Base Peak
365	> 1.0% of mass 198
441	Present but < 24% of mass 442
442	Base peak or > 50% of mass 198
443	15-24% of mass 442

13.2.2 To acquire the mass spectrum of DFTPP, three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction to eliminate column bleed or instrument background noise is accomplished using a single scan acquired no more than 20 scans prior to the elution of DFTPP.

13.2.3 The DFTPP standard must also contain Pentachlorophenol, Benzidine, and DDT to assess GC column performance and injection port inertness. Degradation of DDT to DDE and DDD must not exceed 20%. Benzidine and Pentachlorophenol shall be present at their normal responses and peak tailing shall be evaluated. Benzidine and Pentachlorophenol must have tailing factors less than 2.

THIS DOCUMENT IS UNCONTROLLED WHEN PRINTED

- 13.2.4 Calibration Standards - Calibration standards are prepared at a minimum of five concentration levels and are prepared from the intermediate stock standards. One of the concentration levels shall be at a concentration near, but above, the detection limit and at or below the reporting limit. The remaining concentration levels shall correspond to the expected range of concentrations found in real samples and shall contain each analyte for detection by this method. If the measured relative standard deviation (RSD) is less than or equal to 20%, the use of the linear model is generally appropriate, and calibration curve can be assumed to be linear and to pass through the origin. Linear Calibration: If the RSD of the calibration factor is greater than 20% over the calibration range, then linearity through the origin cannot be assumed. In this case, the analyst can employ a regression equation that does not pass through the origin. This approach can also be employed based on the past experience of the instrument response. The regression will produce the slope and intercept terms for a linear equation. In situations where the analyst knows that the instrument response does not follow a linear model over a sufficiently wide working range, or when the other approaches described here have not met the acceptance criteria, a non-linear calibration model can be employed. When using a calibration model for quantitation, the curve must be continuous, continuously differentiable and monotonic over the calibration range.
- 13.2.5 System Performance Check Compounds (SPCC) are the most common target analytes and are part of the initial calibration and the continuing calibration verification standard (CCV). A CCV must be made during each 12 hour shift. The SPCCs in the initial calibration and CCV must meet a minimum response factor. See Table 4.1.
- 13.2.6 Initial Calibration Verification (ICV): The initial calibration verification standard (different lot # or manufacturer from the initial calibration standard) shall verify the initial calibration curve. The initial calibration verification standard involves the analysis of all target analytes each time the initial calibration is performed. The SPCCs must meet minimum response factor given in Table 4.1. The percent drift of all target compounds must be less than or equal to 20%.
- 13.2.7 Calibration Verification Standard (CCV): A standard solution that is used to check the validity of a calibration curve on a daily basis. It also provides information on satisfactory maintenance and adjustment of the instrument during sample analysis. The SPCCs must meet minimum response factor given in Table 4.1. The percent drift of all target compounds must be less than or equal to 20%.
- 13.2.8 The relative retention time (RRT) of each compound in each calibration standard shall agree within 0.06 RRT units.

TABLE 4.1
System Performance Check Compounds and Minimum Response Factors

Table 4.1		
#	Compound Name	Minimum Response Factor
1	Benzaldehyde	0.010
2	Bis(2-chloroethyl) ether	0.700
3	Phenol	0.800
4	2-Chlorophenol	0.800
5	Bis(2-chloroisopropyl) ether	0.010
6	2-Methylphenol	0.700
7	Acetophenone	0.010
8	Hexachloroethane	0.300
9	N-Nitrosodi-n-propylamine	0.500
10	3 & 4-Methylphenol	0.600
11	Nitrobenzene	0.200
12	Isophorone	0.400
13	2-Nitrophenol	0.100
14	2,4-Dimethylphenol	0.200
15	Bis(2-chloroethoxy) methane	0.300
16	2,4-Dichlorophenol	0.200
17	Naphthalene	0.700
18	4-Chloroaniline	0.010
19	Caprolactam	0.010
20	Hexachlorobutadiene	0.010
21	4-Chloro-3-methylphenol	0.200
22	2-Methylnaphthalene	0.400
23	Hexachlorocyclopentadiene	0.050
24	1,2,4,5-Tetrachlorobenzene	0.010
25	2,4,6-Trichlorophenol	0.200
26	2,4,5-Trichlorophenol	0.200
27	1,1'-Biphenyl	0.010
28	2-Chloronaphthalene	0.800
29	2-Nitroaniline	0.010
30	Acenaphthylene	0.900
31	Dimethylphthalate	0.010
32	2,6-Dinitrotoluene	0.200
33	Acenaphthene	0.900
34	3-Nitroaniline	0.010
35	2,4-Dinitrophenol	0.010
36	Dibenzofuran	0.800

Table 4.1		
37	2,4-Dinitrotoluene	0.200
38	4-Nitrophenol	0.010
39	2,3,4,6-Tetrachlorophenol	0.010
40	Fluorene	0.900
41	4-Chlorophenyl phenyl ether	0.400
42	Diethyl phthalate	0.010
43	4-Nitroaniline	0.010
44	4,6-Dinitro-2-methylphenol	0.010
45	N-Nitrosodiphenylamine & Diphenylamine	0.010
46	4-Bromophenyl phenyl ether	0.100
47	Hexachlorobenzene	0.100
48	Atrazine	0.010
49	Pentachlorophenol	0.050
50	Phenanthrene	0.700
51	Anthracene	0.700
52	Carbazole	0.010
53	Di-n-butyl phthalate	0.010
54	Fluoranthene	0.600
55	Pyrene	0.600
56	Butyl benzyl phthalate	0.600
57	3,3'-Dichlorobenzidine	0.010
58	Benzo(a)anthracene	0.800
59	Chrysene	0.700
60	Bis(2-ethylhexyl)phthalate	0.010
61	Di-n-octylphthalate	0.010
62	Benzo(b)fluoranthene	0.700
63	Benzo(k)fluoranthene	0.700
64	Benzo(a)pyrene	0.700
65	Indeno(1,2,3-cd)pyrene	0.500
66	Dibenz(a,h)anthracene	0.400
67	Benzo(g,h,i)perylene	0.500

14.0 Procedure

14.1 Water Extraction (Method SW-846,3510C)

14.1.1 Pre-rinse all glassware to be used in the extraction with methylene chloride (HPLC Grade).

14.1.2 Mark the meniscus on the bottle for later determination of sample volume.

- 14.1.3 One method blank (MB) and laboratory control spike (LCS) must be prepared with each batch of 20 samples or less. Prepare each by adding one liter of Milli-Q water to a clean amber glass sample jar.
- 14.1.4 One sample from each batch of 20 samples or less must be selected for use in the preparation of a matrix spike (MS) and matrix spike duplicate (MSD). In order of preference:
 - 14.1.4.1 Select the sample where two full volume extra matrix was provided; use the extra volume supplied for a full volume MS and MSD.
 - 14.1.4.2 Select a sample where one extra sample bottle was provided and split the sample into two equal portions, one for the MS and one for the MSD.
 - 14.1.4.3 Select a sample where no extra sample was provided and split it into three equal portions, one for the parent sample, one for the MS, and one for the MSD.
 - 14.1.4.4 For the last two situations concerning sacrificing a sample volume versus the inability to run a MS/MSD contact the project manager for proper procedure.
- 14.1.5 To all samples add 1.0 mL of the surrogate standard mix by using a 1.0 ml syringe. In addition, add 1.0 mL of the proper spiking solution to the MS/MSD and LCS.
 - 14.1.5.1 Surrogate and/or spike shall be added directly to the sample jar.
 - 14.1.5.2 Reseal the sample jar and gently shake sample to mix.
 - 14.1.5.3 If it is necessary to prepare split MS/MSD samples, the samples shall be quantitatively split using graduated cylinders and spiking shall occur directly into the graduated cylinder. Swirl gently to mix.
 - 14.1.5.4 From the sample jar (or graduated cylinder), quantitatively transfer the sample into a 2-liter separatory funnel.
 - 14.1.5.5 Check and adjust the pH to <2 with 1:1 sulfuric acid.
 - 14.1.5.6 Add 60 mL of methylene chloride to the sample jar (or graduated cylinder) and swirl to rinse sides of vessel. Transfer methylene chloride into the separatory funnel as well.
- 14.1.6 The sample is extracted by the automated shaker. Shake the samples vigorously for two minutes.
- 14.1.7 Allow the organic layer to separate from the water phase for a minimum of 10 minutes. Decant the lower layer into a 250 ml beaker. If the emulsion interface between layers is more than one-third the size of the solvent layer,

the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and can include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods. Check sample pH to insure acidic conditions.

- 14.1.8 Repeat the extraction two more times using fresh 60 mL portions of methylene chloride.
- 14.1.9 After the third extraction of the acidified sample, adjust the pH >12 with 10N sodium hydroxide.
- 14.1.10 Extract three more times with 60 ml portions of methylene chloride as described above. The solvent from the basic pH extraction shall be collected into a separate 250 ml beaker from the acid extraction solvent.
- 14.1.11 Determine the sample volume by filling the sample bottle to the mark with water and transferring it to a "Class A TC" 1 liter graduated cylinder for measurement. Note all sample volumes on the extraction bench sheet (available on the network archive at Archive\Raw Data\Inprocess Data\Semi-Volatiles Bench Sheets\PREP TEMPLATES\8270 Prep).
- 14.1.12 Samples that are very dark or appear to have petroleum or other organic material may require cleanup prior to analysis. This will require further consultation with the analyst and/or project manager. Refer to GPC SOP Rev 0.
- 14.1.13 Record all lot numbers, prepping analyst, times and dates on prep bench sheet (see FSV6-02).
- 14.1.14 Refer to section 14.6 for sample concentration.

14.2 Soil and Tissue Extraction (Method SW-846, 3546) Microwave extraction

- 14.2.1 Preparing the extraction tubes for use: extraction tubes, caps and plugs are washed in the dishwasher, rinsed with Methanol and baked in 110 C oven for 1 hour. After they have cooled, rinse the extraction cell (tubes, plugs and caps) with Methylene chloride.
- 14.2.2 Decant and discard any water layer from sediment sample. Mix sample thoroughly, especially composite samples. Discard any foreign objects such as sticks, leaves, and rocks.
- 14.2.3 Dry sediment/soil and dry waste samples amenable to grinding: Grind or otherwise reduce the particle size of the waste so that it either passes through a 1-mm sieve or can be extruded through a 1-mm hole. The addition of a drying agent (e.g. sodium sulfate or diatomaceous earth) can make the sample more amenable to grinding. Dry samples as much as possible, as water will cause un-even heating of the tubes.

- 14.2.4 Gummy, fibrous, or oily materials not amenable to grinding, shall be cut, shredded, or otherwise reduced in size to allow mixing and maximum exposure of the sample surfaces for the extraction. The addition of a drying agent (e.g. sodium sulfate or diatomaceous earth) can make the sample easier to mix. Wipe samples can be placed directly into the cell.
- 14.2.5 Weigh approximately 10.0 g of sample to the nearest 0.01 g in a 250-mL beaker and record the final weight on prep bench sheet (see FSV6-02). Add 2.5 g of diatomaceous earth to the sample. Mix well. The samples shall be a free flowing powder. If sample is not free flowing, add more diatomaceous earth and/or sodium sulfate so the sample is mixed in such a way that will allow the sample to pass through a 1 mm sieve.
- 14.2.6 Transfer the ground sample in a 75 mL extraction cell. There should be a minimum head space of 25%.
- 14.2.7 One method blank and laboratory control spike must be prepared with each batch of 20 samples or less. Prepare by adding 10.0 g of sand and 2.5g of diatomaceous earth to a clean 250 ml beaker. Transfer sample to extraction cell.
- 14.2.8 One sample from each batch of 20 samples or less must be selected for use in the preparation of a matrix spike (MS) and matrix spike duplicate (MSD). Select the sample and transfer approximately 40 grams to a 250 ml beaker. Mix well. Weigh three individual 10 grams aliquots of sample. Add drying agent. Transfer each sample aliquot to separate extraction cells. If there is no sample available to perform a matrix spike/matrix spike duplicate, contact project management. Default QC is a laboratory control spike duplicate.
- 14.2.9 To all samples, add 1.0 mL of the 8270 surrogate standard mix by using a 1.0 ml syringe. In addition, add 1.0 mL of the 8270 spiking solution to the matrix spike/matrix spike duplicate and laboratory control spike (laboratory control spike duplicate).
- 14.2.10 Add 20 ml of (1:1) methylene chloride: acetone extraction solution to each tube. Insert tube plug and attach the cap to the extractor cell, making sure the cap is straight, screw on and torque with wrench.
- 14.2.11 Shake each tube for 10 seconds to ensure the soil is mixed with the extraction solvent.
- 14.2.12 Place the extractor tube on the carousel in the appropriate slots for the number of tubes being used. Less than 16 use inside ring, greater than 16, use the outside ring then fill the inside ring. Schedule CEM Mars and begin the cycle. (NOTE: There must be a minimum of 8 samples, if less, use sand/solvent blanks to make up the shortage.)
- 14.2.13 Record all lot numbers, prepping analyst, times and dates on prep bench sheet (see FSV6-02)

14.2.14 Samples need to be shaken for 30 seconds to ensure sample residue is removed from tube wall prior to being poured out for concentration. Refer to section 14.6 for sample concentration.

14.2.15 Samples that are very dark or appear to have petroleum or other organic material may require cleanup prior to analysis. This will require further consultation with the analyst and/or project manager. Refer to GPC SOP Rev 0.

14.3 Waste Dilution Extraction (SW846-3580)

14.3.1 (Refer to SOP FO-10 for subsampling guidance) for samples consisting of multiphase separations.

14.3.2 Pre-rinse "Class A" 10 ml volumetric with Methylene chloride.

14.3.3 One method blank and laboratory control spike must be prepared with each batch of 20 samples or less. One sample from each batch of 20 samples or less must be selected for use in the preparation of a matrix spike (MS) and matrix spike duplicate (MSD).

14.3.4 Place the 10 ml volumetric on analytical balance (capable of accurately recording weight to the 0.001 g). Using a Pasteur pipet, transfer 1.0 g (to the nearest 0.1 g) to the volumetric. Record the weight on bench sheet (see FSV6-02).

14.3.5 Fill the volumetric half way with methylene chloride.

14.3.6 To all samples add 1.0 mL of the surrogate standard mix by using a 1.0 ml syringe. In addition, add 1.0 mL of the 8270 spiking solution to the matrix spike/matrix spike duplicate and laboratory control spike (laboratory control spike duplicate).

14.3.7 Bring samples up to volume with methylene chloride and cap for storage.

14.3.8 Add 2.0 grams of conditioned sodium sulfate to a 15ml amber vial with a Teflon cap. Transfer sample from the 10 ml volumetric flask to the 15ml vial.

14.3.9 Record all lot numbers, prepping analyst, times and dates on prep bench sheet (see FSV6-02)

14.3.10 Shake sample for two minutes.

14.3.11 Loosely pack disposable Pasteur pipets with 2-3 cm glass wool plugs. Filter the extracts through the glass wool and collect 5ml of the extract in a tube or vial.

- 14.3.12 No concentration step is need for this extraction. Samples that are very dark or appear to have petroleum or other organic material may require cleanup prior to analysis. This will require further consultation with the analyst and/or project manager. Refer to GPC SOP Rev 0.

14.4 Sample Concentration

- 14.4.1 Place glass microfiber filter paper into a glass funnel. Fill the filter paper two-thirds of the depth with Na_2SO_4 . Rinse filter paper, Na_2SO_4 , funnel, K-D apparatus, and concentrator tube with methylene chloride.
- 14.4.2 Quantitatively pour the extract through the filter and funnel seated on a 500 ml Kuderna-Danish (K-D) for water samples or a 250mL Kuderna-Danish (K-D) for soil samples, apparatus complete with concentrator tube. For Microwave extraction, shake tube for 30 seconds then pour both the extraction solution and sample matrix from the microwave tube into the funnel and filter paper seated on the K-D apparatus, being careful to not allow the extract to splash out of the funnel as the sample matrix pours into it. Rinse the beaker, VOA vial or Microwave tube three times with methylene chloride. Add these rinses through the filter and funnel into the K-D apparatus. Add a boiling chip to the K-D flask prior to placing it on the heated water bath. Wet a three ball Snyder column with approximately 2-mL of methylene chloride. Attach the Snyder column.
- 14.4.3 Place the K-D in the heated water bath so the concentrator tube is immersed in the water and the lower rounded surface of the K-D is bathed in steam. At the proper rate of distillation the balls of the column will actively chatter, but the chambers will not flood (set the knob of the temperature control to ~5 or 60°C). It is critical that the analyst watch the extract as it distills. THE EXTRACT MUST NOT GO TO DRYNESS.
- 14.4.4 When the extract volume reaches approximately 5-7 mL, remove the K-D from the bath. Slightly tilt the apparatus and rotate to aid in solvent drainage from the Snyder column. Allow it to cool completely
- 14.4.5 Remove the Snyder column, rinse the ground glass joints with a small amount of methylene chloride and then remove the K-D flask. Turn on the heating unit for the Organomation. The water bath shall be about 35°C. Place sample concentrator tube into the nitrogen blow down apparatus. Allow a gentle stream of nitrogen to interact with the extract. There shall be no splashing or excessive movement upon the surface of the extract. Allow the extract to evaporate down to 0.8 ml. Remove concentrator tube from water bath and by using a Pasteur pipet, bring sample extract up to 1.0 ml volume with methylene chloride.
- 14.4.6 Transfer the 1 mL of the extract to a labeled amber screw-cap injection vial. Record the final extract on the injection extraction bench sheet (see FSV6-02).

- 14.4.7 Record all lot numbers, prepping analyst, times and dates on prep bench sheet (see FSV6-02)
- 14.4.8 The sample extract is now ready for analysis. If samples are not analyzed immediately store the sample extract in a freezer.
- 14.4.9 Samples that are very dark or appear to have petroleum or other organic material may require cleanup prior to analysis. This will require further consultation with the analyst and/or project manager. Refer to attachment GPC SOP Rev 0.

15.0 Data analysis and Calculations

15.1 Sample Sequence

- 15.1.1 Allow the sample extract to warm to room temperature. Just prior to analysis, add 5.0 uL of the internal standard solution to 0.5 ml of the concentrated sample extract obtained from sample preparation. Alternatively, 2.0 uL of internal standard solution is added to 0.2 mL of sample extract in a vial insert.
- 15.1.2 Before initial calibration or sample analysis a priming standard (a standard solution at high concentration, such as the top point of the calibration curve) can be injected at a level up to twice the highest linearity point.
- 15.1.3 Before analysis of any samples or standards can begin, the GC/MS system must be hardware tuned so an injection (50 ng or less) of Decafluorotriphenylphosphine (DFTPP) passes the tuning criteria listed in Table 3. The DFTPP standard must also contain Pentachlorophenol, Benzidine, and DDT to assess GC column performance and injection port inertness. Degradation of DDT to DDE and DDD must not exceed 20%. Benzidine and Pentachlorophenol shall be present at their normal responses and peak tailing evaluated. Benzidine and Pentachlorophenol must each have tailing factors less than 2. These criteria must be demonstrated each 12-hour shift during which samples are analyzed.
- 15.1.4 Verify calibration each twelve hour shift by injecting a Continuing Calibration Verification standard (CCV), containing target analytes, prior to conducting any sample analysis. A CCV must be injected at the beginning of each twelve hour shift following the DFTPP tune. The SPCCs must meet a minimum response factor of 0.050. The percent drift of the CCCs must be less than or equal to 20%. If the percent difference or percent drift for a compound is less than or equal to 20%, then the initial calibration for that compound is assumed to be valid. Due to the large number of compounds that are analyzed by this method, it is expected that some compounds will fail to meet the criterion. In cases where compounds fail, they can still be reported as non-detects if it can be demonstrated that there was adequate sensitivity to detect the compound at the applicable quantitation limit. For

situations where the failed compound is present, the concentrations must be reported as estimated values.

- 15.1.5 The internal standard responses and retention times in the CCV standard must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 seconds from the last calibration check, the chromatographic system must be inspected for malfunctions and corrections must be made, as required. If the extracted ion chromatographic profile area for any of the internal standards changes by a more than a factor of two (-50% to +100%), when compared to the CCV level from the calibration, then the mass spectrometer must be inspected for malfunctions and corrections must be made. Reanalysis of CCVs and associated samples while the system was malfunctioning is necessary. The retention times and standard reference spectra in the method are updated from the CCV for each 12 hour sequence.
- 15.1.6 Samples can be directly injected after the successful analyses of the initial calibration curve, ICV, DFTPP, and CCV. There can be up to 20 samples in an analytical batch. A matrix spike/matrix spike duplicate and laboratory control spike must be analyzed with every analytical batch. Recoveries shall be compared to laboratory generated QC limits or client specified limits for all surrogate, matrix spike/matrix spike duplicate and laboratory control spike injections. Samples that are very dark or appear to have petroleum or other organic material may require cleanup prior to analysis. This will require further consultation with the analyst and/or project manager. Refer to attachment GPC SOP Rev 0.

15.2 Sample Calculations

- 15.2.1 Re-arranging the equation from sec. 10.1.5 to calculate the "as-analyzed" value yields:

$$C_s = \frac{A_s \times C_{is}}{A_{is} \times RF}$$

RF = Average Response Factor

A_s = Peak area of the analyte or surrogate.

A_{is} = Peak area of the internal standard.

C_s = Concentration of the analyte or surrogate in ug/mL.

C_{is} = Concentration of the internal standard in ug/mL.

- 15.2.2 Once the target components of the extract have been identified and quantitated, the "as-analyzed" value is converted to the "as-received" concentration as follows:

Water Matrix:

$$\frac{(\mu\text{g/mL injected}) \times (\text{mL extract final volume}) \times (\text{dilution factor})}{(\text{volume of sample extracted, in L})} = \mu\text{g/L}$$

Soil Matrix:

$$\frac{(\mu\text{g/mL injected}) \times (\text{mL extract final volume}) \times (\text{dilution factor})}{(\text{weight of sample extracted, in g})} = \mu\text{g/g}$$

16.0 Method Performance

See QAM Appendix 9.

17.0 Pollution Prevention

See QAM Appendix 9.

18.0 Data Assessment & Acceptance Criteria for QC Measures

18.1 If the response for any quantitation ion exceeds the initial calibration range of the GC/MS, the sample extract must be diluted and reanalyzed. Additional internal standards must be added to the diluted extract to maintain the same concentration as in the calibration standards. Samples suspected of containing high levels of contamination or samples with known historical data may need to be diluted prior to analysis. Multiple dilutions may be needed to cover the entire working range of the current calibration.

18.2 The qualitative identification of compounds determined by this method is based on retention time and on comparison of the sample mass spectrum, after background correction, with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated by the laboratory using the conditions of this method (SW846-8270D). The mass spectral library is updated with each new calibration. The characteristic ions from the reference mass spectrum are defined as the three ions of greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions occur in the reference spectrum. Compounds are identified when the following criteria are met.

18.2.1 The intensities of the characteristic ions of a compound must maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target compound at a compound-specific retention time will be accepted as meeting this criterion.

18.2.2 The relative retention times (RRT) of each compound in each calibration standard agree within 0.06 RRT units.

18.2.3 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum.

THIS DOCUMENT IS UNCONTROLLED WHEN PRINTED

- 18.2.4 Structural isomers that produce very similar spectra are identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomeric peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs. Diastereomeric pairs that are separable by the GC are identified, quantitated and reported as the sum of both compounds by the GC.
- 18.2.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra are important. Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra and in qualitative identification of compounds. When analytes co-elute (i.e., only one chromatographic peak is apparent), the identification criteria can be met, but each analyte spectrum will contain extraneous ions contributed by the co eluting compound.
- 18.3 For samples containing components that are not a part of the normal target list, a library search may be required for the purpose of tentative identification. Tentatively identified compounds (TICs) are needed only when requested or required by a particular project or program. Data system library search routines shall not use normalization routines that would misrepresent the library or unknown spectra when compared to each other. Use the following as guidance for reporting TICs.
- 18.3.1 Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) shall be present in the sample spectrum.
- 18.3.2 The relative intensities of the major ions agree within $\pm 30\%$.
- 18.3.3 Molecular ions present in the reference spectrum shall be present in the sample spectrum.
- 18.3.4 Ions present in the sample spectrum but not in the reference spectrum shall be checked for possible background contamination. They shall also be reviewed for possible co elution with another compound.
- 18.3.5 Ions present in the reference spectrum but not in the sample spectrum shall be checked against the possibility of subtraction from the sample spectrum due to background contamination or co-eluting peaks. Some data reduction programs can create these discrepancies
- 18.4 Once a compound has been identified, the quantitation of that compound will be based on the integrated abundance of the primary characteristic ion from the extracted ion chromatographic profile. Quantitation is performed by the data system using the internal standard technique. The internal standard used shall be the one listed in Table 1.2.

Quantitation is performed using the RF averages from the initial calibration and not the continuing calibration check (CCV).

- 18.4.1 Where applicable, the concentration of any non-target analytes (TICs) identified in the sample shall be estimated. The same formulas that are used for target compounds are used with the following modifications: The areas A_x and A_{is} are from the total ion chromatograms, and the RF for the compound is assumed to be one.
- 18.4.2 The resulting TIC concentration is reported indicating: (1) that the value is an estimate, and (2) which internal standard was used to determine concentration. Use the nearest internal standard free of interferences.

18.5 Reporting Quantitative Analysis

- 18.5.1 When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. Once the standard retention times and mass ions are compared to the sample retention times, the sample data can be reported. Assessments of all spiked and calibration control samples and standards shall also be finalized before reporting the data.
- 18.5.2 When the analyst has finished processing the analytical batch, the results are electronically transferred to the LIMS system where weight to volume corrections, dilution factors and percent solids adjustments are made. Once the final results have been verified, a checklist (FSV6-01) is filled out and signed confirming that all the data has been thoroughly scrutinized. At this point the data is turned over to another qualified analyst for final validation. The second analyst confirms the results and electronically marks them validated and signs the checklist. Finally, the validated results are made available to the client services personnel in order for the data to be given to the client or appropriate agencies.
- 18.5.3 An electronic copy of the data is then filed and archived. The package includes: the sequence run log, checklist, bench sheet copy, the LIMS run log, LIMS PREP sheet, verification of calibration data and chromatograms/quant reports. The sequence run log and the analytical run are e-initialed and dated by the analyst. Each sequence file header is labeled with the date of sequence.

19.0 Corrective Measures for Out-of-Control Data

See QAM Appendix 9.

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

See QAM Appendix 9.

21.0 Waste Management

See QAM Appendix 9.

22.0 Equipment/Instrument Maintenance, Computer Hardware & Software & Troubleshooting

See QAM Appendix 9.

23.0 References

- 23.1 CT Laboratories Quality Manual, current revision.
- 23.2 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.
- 23.3 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.
- 23.4 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.
- 23.5 USEPA, SW-846, Method 8000C, Rev. 3, March 2003.
- 23.6 USEPA, SW-846, Method 8270D Rev. 4, January 1998.
- 23.7 USEPA, SW-846, Method 3510C Rev. 3, December 1996.
- 23.8 USEPA, SW-846, Method 3545A Rev. 1, February 2007.
- 23.9 USEPA, SW-846, Method 3546 Rev. 0, February 2007.
- 23.10 USEPA SW-846, Method 3580A, Rev. 1, July 1992
- 23.11 USEPA SW-846, Method 3640A Rev. 1, September 1994.

24.0 Tables, Diagrams, Flowcharts And Validation Data

Table 5
Semivolatile Organic Compounds - Method 8270D Quality Control Requirements

Quality Control Item	Frequency	Acceptance Criteria	Corrective Action
Tune Check (50ng or less DFTPP)	Every 12 hours.	Ensure correct mass assignment. DFTPP % Relative abundance criteria as specified in Table 4. Pentachlorophenol tailing ≤ 2 , Benzidine tailing ≤ 2 DDT breakdown $\leq 20\%$.	Retune. Do not proceed with analysis until DFTPP spectrum meets criteria.
Initial Calibration	Each time the instrument is set up and when CCCs and SPCCs in the continuing calibration verification (CCV) do not meet criteria.	1. Average relative response factors (RRFs) for SPCCs <u>(See Table 4.1)</u> 2. % RSD for RRFs for all target compounds $\leq 15\%$. IF RF % RSD $> 15\%$ use linear curve, $r \geq .995$, or quadratic curve, $r^2 \geq .990$. 3. LGC, NELAC, QSM, or other programs/agencies may require different criteria than stated here. Program and/or project specific criteria shall be followed as stated in their documents.)	Correct system and recalibrate. Criteria must be met before sample analysis can begin. Any samples reported from data not meeting these criteria must be qualified (Z).
Initial Calibration Verification standards (ICV)	Immediately following the ICAL.	1. Second source (different lot or manufacturer than ICAL). 2. RRF for SPCCs $\geq$ minimum from Table 4.1 3. % Deviation. for RRFs for all target compounds $\leq 20\%$. $\leq 20\%$ drift for linear curve and non-linear curves. 3 LCG, QSM, NELAC, or other programs/agencies may require different criteria than stated here. Program and/or project specific criteria shall be followed as stated in their documents.	Correct system and recalibrate. Criteria must be met before sample analysis can begin. If %drift $> 20\%$ then confirm the integrity of the second source standard by reanalysis, and/or determine if it's a sporadic problem involving compounds that are typically poor performers. Sample results reported that have %drift failures must be qualified (Z). QSM allows no tolerances for % D. Problem compounds need to be addressed on a project to project basis.

Table 5 (Continued)
Semivolatile Organic Compounds - Method 8270D Quality Control Requirements

Quality Control Item	Frequency	Acceptance Criteria	Corrective Action
Continuing Calibration Verification standards (CCV)	Every 12 hours.	1. RRF for SPCCs $\geq$ minimum from Table 4.1 2. All target compounds- $\leq 20\%$ Deviation for RRFs, $\leq 20\%$ Drift for linear curve and non linear curves- 3. LCG, QSM, NELAC, or other programs/agencies may require different criteria than stated here. Program and/or project specific criteria are followed as stated in their documents.	Correct system and recalibrate. Criteria must be met before sample analysis can begin. If % drift $> 20\%$ correct problem if determinable then reanalyze, and/or determine if it's a sporadic problem involving compounds that are typically poor performers. Sample results reported that have %D failures must be qualified (Z). QSM allows no tolerance for % D. Problem compounds need to be addressed on a project to project basis
Internal Standards (ISTD)	Added to all blanks, standards, and samples.	1. Peak area within -50% to +100% of area in CCV level of ICAL. 2. Retention time (RT) within 30 sec of RT for associated CCV standard. 3. LCG, QSM, NELAC, or other programs/agencies may require different criteria than stated here. Program and/or project specific criteria are followed as stated in their documents.	Inspect instrument for malfunctions; correct identified malfunctions, then reanalyze samples. If no instrument malfunction identified proceed as follows: * Re-extract and reanalyze sample, or reanalyze sample at a dilution. * If reanalysis is outside limits the data is qualified (S). Follow specified criteria as stated in Shell or other documentation.
Method Blank (MB)	One per prep batch/20 samples per matrix. The MB is used to document contamination resulting in the analytical process and is carried through the complete sample preparation and analytical procedure.	1. Concentration of analytes of concern are to be less than the highest of either: Method detection limit, 5% of the regulatory limit for that analyte, or 5% of the measured concentration in the sample. (10% for QSM) 2. ACOE/QSM: $< 1/2$ MRL. 3. Follow criteria according to specific program/agency.	Reanalyze to determine if instrument or laboratory background contamination was the cause. If the method blank is still non-compliant, re-prepare and reanalyze blank and samples. For ACOE/QSM data, if $< 1/2$ MRL no action required. If no sample remains for re-prepping, or if re-prepped data still contains contamination, flag data with (B) qualifier.

Table 5 (Continued)
Semivolatile Organic Compounds - Method 8270D Quality Control Requirements

Quality Control Item	Frequency	Acceptance Criteria	Corrective Action
Laboratory Control Sample (LCS)	One per prep batch of 20 samples. Must undergo all sample preparation procedures. Spiking solution are to contain all target compounds with concentrations at or near the mid-point of the calibration range.	1. Client specified limits. 2. QSM – use LCS criteria. 3. In-house limits.	If LCS recoveries are within control limits then no action is required. If the LCS exceeds control limits, reanalyze the LCS. If LCS recoveries are still outside control limits, re-extract and reanalyze samples. If sample is not available for re-extraction then qualify data for the failing analytes with a (Q). Exception: If the LCS recoveries are high with no associated positives then no further action is taken.
Matrix Spike/Matrix Spike Duplicate	One set per prep batch of 20 samples. Must undergo all sample preparation procedures. Must be spiked with target compounds with concentrations at or near the mid-point of the calibration range.	1. Client specified limits. 1. QSM – use LCS criteria. 3 .In-house limits..	If LCS is acceptable, then report probable matrix interference. Qualify data if the recoveries are low (M). If recoveries are high and there are no detects in the un-spiked sample then that data does not require flagging. Qualify data for RPD failures (Y) when there is a detect for the failing compounds (non-detected compounds are not qualified). Exception: If a compound is already qualified for a LCS failure then no RPD qualifier is applied.

Table 5 (Continued)
Semivolatile Organic Compounds - Method 8270D Quality Control Requirements

Quality Control Item	Frequency	Acceptance Criteria	Corrective Action
Qualitative/Quantitative Issues	If detection level of any compound in a sample exceeds the detection level of that compound in the highest level standard, the sample must be diluted to approximately mid-level of the calibration range and reanalyzed.	The instrument level of all compounds must be within the calibration range for all samples. The sample analyzed immediately after a high level sample must display concentrations of the high level target compounds less than the RL or greater than 5X the RL	Dilute the sample to bring the level of the highest concentration of target compounds within the calibration range. If any data is reported with any results over range then those results are to be flagged (X). A sample displaying concentrations of target compounds between the RL and 5x the RL that was analyzed immediately after a high level sample must be re-analyzed. If the results do not agree within the RL, report only the second analysis.
Surrogate	1. Calibrated as target compounds. 2. Added to all blanks, samples, and QC samples, as a part of the internal standard-surrogate spiking mixture.	1. Client specified limits. 2. QSM – use LCS criteria. 3. In-house limits.	Rerun sample. If no apparent matrix interference is noticed, re-extract sample. If no sample is available, qualify the surrogate with “S”. QSM – For QC and field samples, correct problem, re-prepare and re-analyze all samples with failed surrogates in the associated batch, if sufficient sample material is available.
Retention Time Window (RTW)	Retention Times will be set using the midpoint of the calibration curve or the RTs in the CCV run at the beginning of the analytical sequence.	RTs of analytes must be within +/- .06 RRT units of the RRT of the CCV.	.

FSV6-01
8270D Analysis Data Review Checklist (Example)

8270D Analysis Data Review Checklist

Sequence Date	Analyst / Data Interpreter	Independent Reviewer	Date of Review	Approved
				Yes or No

Instructions: Complete one checklist per analytical run. Enter the appropriate response for each question. Each “No” response requires an explanation in the Comments section, and may require the initiation of a Nonconformance Report.

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
1. INITIAL CALIBRATION (ICAL)						
a. Was the initial calibration performed using a minimum of five standard concentration levels?	Lowest standard at or near MRL					
b. SPCC responses.	Avg. RRF $\geq$ Table 4.1					
c. Linearity.	RSD $\leq$ 15%, or $r \geq 0.995$, $r^2 \geq 0.990$ for regression.					
d. Were the standards used for the ICAL uniquely identified?						
e. Was there a DFTPP standard analyzed prior to the ICAL?						
2. INITIAL CALIBRATION VERIFICATION (ICV)						
a. Were there a second source ICVs for all target analytes analyzed after the initial calibration and prior to analysis of any samples?	Second source					
b. Were the SPCC within QC limits	RRF $\geq$ Table 4.1					
c. Were all compounds within QC limits	%D $\leq$ 20%					
d. Were the ICVs uniquely identified (i.e. Standard Number)?						
3. CONTINUING CALIBRATION VERIFICATION (CCV)						
a. Were CCVs for target analytes analyzed at the beginning of the sequence and after every 12 hours.						
b. Were SPCC compounds acceptable?	RRF $\geq$ Table 4.1					

FSV6-01
8270D Analysis Data Review Checklist (Continued)

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
c. Were the recoveries for the CCVs acceptable?	%D≤20%,					
d. Was each CCV uniquely identified (i.e. Standard Number)?						
4. DFTPP						
a. Was a DFTPP tune check ran at the beginning of every twelve hour shift?						
b. Were the relative abundance criteria met?						
c. Was the peak tailing acceptable for Pentachlorophenol and Benzidine?	Tailing factor ≤ 2					
d. Was the breakdown of DDT to DDE and DDD acceptable	≤ 20%					
5. BLANKS						
a. Was method blank (MB) analyzed prior to the analysis of samples?						
b. Were the MB results less than the detection limit (MDL)?	< MDL,(QSM<1/2RL)					
If no, were positive hits in the samples < 20x the amount in the blank flagged with a “B”. (<10X for QSM).	< 20x (qualify data) > 20x (no action)					
c. Was a MB prepped and analyzed at a frequency of one per Prep Batch?	Batch ≤ 20 samples					
6. LABORATORY CONTROL SAMPLE (LCS)						
a. Was a LCS analyzed at a frequency one per Prep Batch?	Batch ≤ 20 samples					
b. Were the LCS recoveries in each LCS within the acceptance criteria?	In-house limits or client specified limits					
If no, and the recoveries were low, flag those analytes “Q”. If the recoveries were high, only flag the detects (>RL) for those analytes “Q”.						
7. MATRIX SPIKES						
a. Was a matrix spiked (MS) sample analyzed at a frequency one per Prep Batch?	Batch ≤ 20 samples					
b. Were MS recoveries in each MS within the acceptance criteria?	In-house limits or client specified limits					

FSV6-01

8270D Analysis Data Review Checklist (Continued)

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
8. LABORATORY CONTROL SPIKE / MATRIX SPIKE DUPLICATE						
a. Was a duplicate matrix spike or laboratory control spike sample analyzed at a frequency one per Prep Batch?	Batch ≤ 20 samples					
b. Were MSD or LCSD recoveries within the acceptance criteria?	In-house limits or client specified limits					
c. Is the relative percent difference (RPD) for each analyte between a matrix spike (MS) and matrix spike duplicate (MSD) within the acceptance criteria? (same criteria for LCS and LCSD)	In-house limits or client specified limits					
9. SAMPLES (INCLUDING BLANKS, STANDARDS, AND QC SAMPLES)						
a. Are chromatogram characteristics, including peak shapes and areas, consistent with those of the CCV?						
b. Are surrogate recoveries for all samples, blanks, standards, and QC samples within acceptance criteria?						
c. Were all samples having analytes detected in amounts exceeding the calibration range diluted and reanalyzed?						
d. Were all samples extracted within holding times and analyzed within 40 days of extracting?	Analysis within 40 days of extraction					
e. Did the samples require additional cleanup steps? (i.e. GPC)	GPC, Treatments					
10. RECORDS AND REPORTING						
a. Are Run, Prep Batch and Extraction sheets, Summary sheets, Sequence file, initial and rerun raw and process data present in the data file?						
b. Are reported results whose amounts exceeded the acceptance criteria flagged with an appropriate qualifier and, if needed, a NCR completed?						
c. Do all values, dilution factors and qualifiers listed on the raw reports match the LIMS data?						
d. Is the ICAL method referenced on the Raw Data?						

FSV6-02 Semivolatiles 8270 Extraction Bench Sheet (Example)

Method 8270-SV GC/MS Extraction Bench Sheet (SOP Reference #'s 8270C, 8270D, 8270 SIM)																					
3510=WATER 3545=PFE or 3546=Microwave >> (PFE=Pressurized Fluid Extraction)		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Prep Batch #:</td><td></td></tr> <tr><td>Prep Method:</td><td></td></tr> <tr><td>Analyst:</td><td></td></tr> <tr><td>Start Date:</td><td></td></tr> <tr><td>Start Time:</td><td></td></tr> <tr><td>End Date:</td><td></td></tr> <tr><td>End Time:</td><td></td></tr> </table>		Prep Batch #:		Prep Method:		Analyst:		Start Date:		Start Time:		End Date:		End Time:		Matrix: _____ Balance Used: _____ Ave MW temp(*C): _____ Initial Concentration By: _____ Date: _____ GPC Cleanup? (yes/no): _____ Date: _____ Final Concentration By: _____ Date: _____			
Prep Batch #:																					
Prep Method:																					
Analyst:																					
Start Date:																					
Start Time:																					
End Date:																					
End Time:																					
Reagent Lots>>>		Sodium Sulfate _____ Diatomaceous Earth _____ Dionex Solution _____ Methylene Chloride _____ Acetone _____ Sulfuric Acid _____ Sodium Hydroxide _____																			
Microwave Cell #	Sample ID	Comments	(Solids) Sample Weight (g)	(Liquids) Sample Volume (L)	Final Volume (ml)	pH Adj. <2 (Yes/No)	pH Adj. >12 (Yes/No)														
		(MB)			1.0																
		(LCS)			1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
					1.0																
		(MS)	Parent Sample		1.0																
		(MSD)			1.0																
MB=Method Blank, LCS=Laboratory Control Sample, MS=Matrix Spike & MSD=Matrix Spike Duplicate																					
MS/MSD/LCS Spike Amount (ml): _____ 1 Surrogate Spike Amount (ml): _____ 1 Spike Concentration (ug/mL): _____ Surrogate Spike Conc. (ug/mL): _____ Spike Reference #: _____ Surrogate Spike Reference #: _____																					
Relinquished to: _____ Reviewed By: _____ Date: _____ Date: _____																					

**Revision
Number**

Description of Changes

Date

00	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	04/22/2014

STANDARD OPERATING PROCEDURE
SV 010 Explosives by Modified Method 8330B

Review Date: 03/12/2014



3/12/2014

Technical Review by:

Date



4/1/2014

Approved by: QA Manager

Date

Table of Contents

<u>Section Title</u>	<u>Page Number</u>
<i>Semi-Volatile 8330B Explosives Analysis with Extended Analyte List</i>	4
<i>Table 1: Explosives Target Analyte List</i>	5
<i>Table 2.0: Secondary Column Pump Program Solvent Usage</i>	7
<i>Table 2.1: NQ Secondary Column Pump Program Solvent Usage</i>	7
<i>Table 3.0: Explosives Intermediate Working Standard Concentration</i>	11
<i>Table 3.1: Explosives Intermediate Working Standard Concentration (Second Source for ICV)</i>	11
<i>Table 3.2: Nitroguanidine (NQ) Intermediate Working Standard Concentration</i>	11
<i>Table 3.3: Nitroguanidine (NQ) Intermediate Working Standard Concentration (Second Source for ICV)</i>	12
<i>Table 3.4: Surrogate (12-DNB) Intermediate Working Standard Concentration</i>	12
<i>Table 3.5: Calibration Points for 8330B Explosives Linearity</i>	13
<i>Table 3.6: Calibration Points for Nitroguanidine</i>	14
<i>Table 3.7: Explosives ICV Working Standard</i>	15
<i>Table 3.8: Nitroguanidine ICV Working Standard</i>	15
<i>Table 3.9: Explosives CCV Working Standard</i>	15
<i>Table 3.10: Nitroguanidine CCV Working Standard</i>	15
<i>Table 4: Summary of Method Objectives for Method 8330B</i>	31
<i>Table 5: 8330B Explosives Analysis Data Review Checklist</i>	34
<i>Table 6: 8330A/8330B Bench Sheet</i>	37

1.0 Identification of the Test Method

This method is designed to follow procedures and QC requirements found in EPA SW-846 methods 8330B, 3535, and 8332 for the quantitation of various explosive compounds in extracts from a variety of different solid and aqueous matrices. The method also incorporates USACCREL nitroguanidine (NQ) sample preparation guidelines for determination of NQ in solid, aqueous, and tissue sample matrices.

2.0 Applicable Matrix or Matrices

Explosives are quantitated from a variety of matrices. This method is applicable to many types of samples, including ground water, surface water, wastewater, soils, sediments and tissue.

3.0 Detection Limits

Method detection limits (MDLs) vary from compound to compound. Water MDLs for samples prepped by normal solid phase extraction (SPE) methods (Method 3535) typically fall in the range of 0.1 ug/L to 4.0 ug/L (excluding NQ). Water MDLs for MDLs prepped using low level SPE methods are usually between 0.01 ug/L and 0.4 ug/L. NQ water MDLs are prepped by a high level method and fall in the range of 20 ug/L to 30 ug/L. Soil MDLs for all compounds are between 0.05 mg/kg and 0.55 mg/kg. Procedures for conducting MDL studies can be found in CT Laboratories Initial Method Performance and Reporting SOP.

4.0 Scope and Application

- 4.1 Method SW-846 8330B-extended analyte list is used to determine the quantitation of various explosive compounds in extracts from solid and aqueous matrices. High Performance Liquid Chromatography (HPLC) is employed with two columns and a dual wavelength UV detector. Target compounds determined by this method are listed in Table 1.
- 4.2 This method is a dual column analysis. The secondary chromatographic column is used to confirm or report final results in conjunction with the primary column. Each column uses the same QC criteria for the reporting of analytical results. The order of elution of the target analytes is different for the primary column as compared to the secondary column. Times of elution are reflected in the analytical method.

Table 1
Explosives Target Analyte List

Analytes
HMX
RDX
1,2-dinitrobenzene (1,2-DNB) (SSTD)
1,3,5-trinitrobenzene (135-TNB)
1,3-dinitrobenzene (13-DNB)
Tetryl
Nitrobenzene (NB)
2,4,6-trinitrotoluene (246-TNT)
4-amino-2,6-dinitrotoluene (4-AM-26-DNT)
2-amino-4,6-dinitrotoluene (2-AM-46-DNT)
2,6-dinitrotoluene (26-DNT)
2,4-dinitrotoluene (24-DNT)
2-nitrotoluene (2-NT)
3-nitrotoluene (3-NT)
4-nitrotoluene (4-NT)

Nitroglycerin (NG)
PETN
3,5-dinitroaniline (35-DNA)
Nitroguanidine (NQ)

5.0 Method Summary

- 5.1 This method describes procedures for isolating nitroaromatic and nitroamine compounds through sample preparation from aqueous, solid, and tissue matrices (reference methods SW846-3535, 8330B, and USACCREL nitroguanidine sample preparation).
- 5.2 A sample of a known volume or weight is extracted or diluted with solvent. The resulting solution is filtered and analyzed on an HPLC that is equipped with a dual wavelength UV detector and employs a dual column technique.
- 5.3 The procedures contained within this method are restricted to use by or under the supervision of trained analysts. Each analyst must demonstrate the ability to generate acceptable results.

6.0 Definitions

- 6.1 Triplicate soil sample (TSS): For QSM, three subsamples are taken from a sample expected to contain the highest levels of explosives within the quantitation range of the method. The RSD for the results above the reporting limit must not exceed 20%. There will be one triplicate per batch of 20 samples. If explosives levels are unknown, a sample will be chosen at random for triplicate analysis. If the client has designated a sample to be used for matrix spike/matrix spike duplicate analysis, and there is no historical information about the samples, then the client designated QC sample shall be used for triplicate analysis.
- 6.2 For standard laboratory definitions, see QAM Appendix 10.
- 6.3 For a list of common acronyms and abbreviations, see QAM Appendix 7.

7.0 Interferences

- 7.1 Solvents, reagents, glassware, and other sample processing hardware can yield artifacts and /or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems can be necessary. Refer to each method for specific guidance on quality control procedures.
- 7.2 Tetryl is an unstable compound that decomposes rapidly, especially in water/methanol solutions and in the presence of heat. In addition, the degradation products of tetryl interfere with the quantitation of other compounds. Water samples or sample extracts suspected of containing tetryl can be acidified to pH<3 to help stabilize the sample. Also, samples containing tetryl will not be exposed to temperatures above room temperature.

8.0 Safety

- 8.1 Gloves and protective clothing will be worn to protect against unnecessary exposure to hazardous chemicals and contaminants in samples. All activities performed while following this procedure will utilize appropriate laboratory safety systems.
- 8.2 The toxicity of chemicals used in this method has not been precisely defined. Each chemical will be treated as a potential health hazard, and exposure to these chemicals will be minimized.

- 8.3 Because of the explosive nature of some of the target analytes and their derivatives, special care will be taken when handling standard neat materials and in the infrequent cases where water and soil samples are highly contaminated. Do not dry standards and samples at oven temperatures, and do not grind suspected highly contaminated soils. Visual inspection of solid samples is very important and any samples having a chemical appearance or that appear as a finely ground grayish-white material shall be treated as highly contaminated.

9.0 Equipment and Supplies

- 9.1 A complete High Performance Liquid Chromatography (HPLC) analytical system with auto-injection and all required accessories including syringes, analytical columns, dual wavelength UV detector, column heater, and EZ Chrom Elite data acquiring system.

9.1.1. Shimadzu System Controller (Model SCL-10A)

9.1.2. Two Shimadzu Liquid Chromatograph pump units (Model LC-10AS) with pump program settings that vary according to analytical column being used and analysis being performed.

9.1.2.1. Primary column: Restek Pinnacle II C18, 5 μ m, 250x4.6 mm, catalog #9214575 in conjunction with a Restek Pinnacle II C18 pre-column, 5 μ m, 20x4.0 mm, catalog #921450220.

9.1.2.2. Primary column pump parameters (excluding NQ analysis):

Mobile phase = 57.5% MeOH/42.5% H₂O

Run time = 16.1 minutes (isocratic)

Flow rate = 1.0 mL/min

9.1.2.3. Primary column pump parameters for NQ:

Mobile phase = 55% MeOH/45% H₂O

Run time = 7 minutes (isocratic)

Flow rate = 1.2 mL/min

9.1.2.4. Secondary column: Restek Ultra II Aromax, 5 μ m, 250x4.6mm, catalog #9607575 in conjunction with a Restek Ultra II Aromax pre-column, 5 μ m, 20x4.0 mm, catalog #960750220.

9.1.2.5. Secondary column pump parameters (excluding NQ analysis):

Flow rate = 1.2 mL/min

Table 2.0
Secondary Column Pump Program Solvent Usage

Time (min)	%MeOH/%H ₂ O
0	64/36
25	64/36
26	85/15
37.5	85/15
38	64/36
41	stop

9.1.2.6. Secondary column pump parameters for NQ:

Flow rate = 1.2 mL/min

Table 2.1
NQ Secondary Column Pump Program Solvent Usage

Time (min)	%MeOH/%H ₂ O
0	50
1	70
2	70
12	70
12.1	50
15	stop

9.1.3. Shimadzu Column Oven (Model CTO-10ASvp) set at 26°C.

9.1.4. Shimadzu Auto Injection System (Model SIL-10A), injection volume = 100 uL.

9.1.5. Shimadzu UV-Vis Detector (Model SPD-10AV) set to the following parameters:

For NQ analysis, wavelength = 254 nm and 263 nm

For all other analytes, wavelength = 210 nm and 254 nm

9.1.6. HP Desktop PC with Windows XP Professional Operating System (Version 2002; service pack 3).

9.1.7. EZChrom Elite software for data management (Version 3.1; Build 3.1.0.2384).

9.1.8. Instrument operating parameters and mobile phase composition are subject to change to improve overall chromatography (note changes in the Instrument Maintenance Logbook).

9.2 12-port Solid Phase Extraction (SPE) Manifold (Visiprep DL, Supelco #57044 or equivalent)

9.2.1. Disposable valve liners, PTFE (Supelco #57059)

9.2.2. 12 - PTFE large volume samplers for 6 mL SPE cartridges (Supelco #57275)

9.3 1-2000 mL PyrexPlus plastic-coated, heavy wall, graduated side arm filtering flask (VWR #29410-996, or equivalent)

9.4 15 mL glass centrifuge tubes with graduations, 17 x 120mm (Pyrex, Fisher #05-507-5B, or equivalent)

9.5 SPE extraction cartridges (Phenomenex, Strata SDB-L, #8B-S014-HCH, 6 mL, 500 mg or equivalent).

9.6 Syringes (disposable) B-D #301604, 10-mL plastic syringe or equivalent.

9.7 Filtration discs (disposable) Restek 0.22 um PTFE, 25 mm, #26144, or equivalent.

9.8 Analytical balances (Fisher, #XD-2200) -capable of accurately weighing to 0.0001 grams (for standard preparation) and to the nearest 0.01 gram (for sample preparation).

9.9 Analytical balance (Denver Instruments APX 6001 or equivalent) capable of weighing the drying pan and sample to the nearest 0.1 gram (for determination when a soil sample is dry).

- 9.10 Spatulas- stainless steel. (VWR #57952-253 or equivalent)
- 9.11 Eberbach Reciprocal Mechanical Shaker (Eberbach Model 6000, or equivalent)
- 9.12 Mortar and pestle (Fisher #12990).
- 9.13 Ultrasonic bath (Fisher, #FS-28)-modified for temperature control (<30 C) by constant flow through of cold tap water during the entire sonication process.
- 9.14 Graduated cylinders –1000 mL (Pyrex, VWR #24709-771, or equivalent).
- 9.15 20 mL Repipet Dispenser, glass and Teflon (VWR #53528-190, or equivalent).
- 9.16 Beakers - 250 mL (Pyrex, VWR #13912-207, or equivalent) and 600 mL (Pyrex, VWR #13912-240, or equivalent).
- 9.17 Erlenmeyer flasks – 500 mL (Pyrex, VWR #29136-081, or equivalent)
- 9.18 Rubber stoppers, No. 7 (VWR #59580-262, or equivalent).
- 9.19 Vials - 2 mL (NSC, # 4000-186w) and 15 mL (Supelco, #27003) amber screw cap vials with Teflon lined caps, 20 mL (Fisher, #033374) vials (glass), 60 mL screw cap vials with Teflon lined caps (C&G #LX64-A030-A01A) or equivalents.
- 9.20 Pasteur Pipettes (VWR, #53283-911).(Used whole for sample transfers, etc. or with tips removed for soil subsampling)
- 9.21 Syringes (glass) 10 uL (Hamilton #24557 or equivalent), 100 uL (Hamilton #24563 or equivalent), 1.0 mL (Hamilton #24575 or equivalent), and 5.0 mL (Hamilton#201780 or equivalent).
- 9.22 Volumetric flask - Class A Volumetric flask – 5 mL (VWR #29619-98, or equivalent), 10 mL (VWR #29620-084, or equivalent), 25 mL (VWR #29620-109, or equivalent), 50 mL (VWR #29620-120, or equivalent), 100 mL (VWR #29620-142, or equivalent), and 200 mL (VWR #29620-164, or equivalent).
- 9.23 Vortex tubes (Pyrex, # 264828)-15 mL, glass or equivalent.
- 9.24 Kuderna-Danish (K-D) apparatus:
 - 9.24.1. Concentrator tube, 10.0 mL, graduated. (Fisher # K570051-1025).
 - 9.24.2. Evaporation flask- 500 mL or 250 ml (Fisher # K570035-0250).
 - 9.24.3. Snyder column- Three-ball macro (Fisher # K503000-0121).
 - 9.24.4. Polyacetal 19/22 clamps (VWR #KT675300-0019).
- 9.25 Funnels – glass. (VWR #154-08 or equivalent)

10.0 Reagents and Materials

- 10.1 Deionized water (In-house MilliQ processed reagent water).

- 10.2 Silica sand or soil- analyte free. Purify by heating at 400° C for 4 hours in a shallow glass tray. Mesh size 4020 (80% will pass through a #60 sieve) or equivalent. Will be stored in air tight glass jars located in a cupboard under the counter in the soil grinding lab or in the extractions lab and used within 5 years of purifying.
- 10.3 50:50 methanol:Millipore water. Prepared by mixing 1 L HPLC grade methanol with 1 L Millipore water. Mix well and allow bubbles to subside. Expires 6 months after preparation, not to exceed expiration date of methanol.
- 10.4 Acetonitrile, HPLC grade. Stored under the extractions lab hood and used within one year of opening or before the manufacturer's expiration date.
- 10.5 Methanol, HPLC grade. Stored under the extractions lab hood and used within one year of opening or before the manufacturer's expiration date.
- 10.6 Methylene chloride, HPLC grade. Stored under the extractions lab hood and used within one year of opening or before the manufacturers expiration date. Or stored in large carboy tank provided by manufacturer and used by the manufacturer's expiration date.
- 10.7 Formic Acid, 98% or equivalent. Stored under the prep lab hood and used within one year of opening or before the manufacturer's expiration date.
- 10.8 Sodium sulfate (granular, anhydrous 60/120 mesh, JT Baker # 3375-05) or equivalent. If sodium sulfate passes in house lot check, it can be used as is. Otherwise condition sodium sulfate by heating to 400°C for 4 hours in a shallow glass tray loosely covered with foil and recheck for purity. Sodium sulfate will be stored in airtight glass jars at room temperature in the extractions lab and used within one year of opening or before the manufacturer's expiration date.
- 10.9 Boiling chips, carborundum, approximately 10/40 mesh (methylene chloride rinsed) (Fisher # 09-191-12) equivalent. Stored in extractions lab.
- 10.10 Filter- Glass Microfiber 12.5 cm (Ahlstrom, MG # F136-1250, or equivalent).
- 10.11 Stock Standards -Stock Standards are purchased from vendors who provide certified solutions. Standards are stored at -10°C to -20°C in a freezer reserved for standard solutions. Unopened standards shall have the manufactures suggested expiration date. Stock standards, once opened, expire within one year or sooner if routine QC indicates a problem and are not to exceed the manufactures expiration date. Stock standards are saved in a capped vial in the original box in the freezer (-10°C to -20°C). The following list of stock standards are commercially prepared certified standards, such as:

8330 Calibration Standard: Restek #33905 at 1000 ug/ml

8330 Calibration Mix 1: Cerilliant #ERE-011 at 100 ug/ml

8330 Calibration Mix 2: Cerilliant #ERE-012 at 100 ug/ml

3,5-Dinitroaniline: Restek #31661 at 1000 ug/ml

3,5-Dinitroaniline: AccuStandard #M-8330-ADD-4 at 100 ug/ml

1,2-Dinitrobenzene (surrogate): Restek #31453 at 1000 ug/ml

1,2-Dinitrobenzene(surrogate): Cerilliant#ERD-110S at 1000 ug/ml

PETN standard: Restek #31600 at 1000 ug/ml

PETN standard: Cerilliant #P-037 at 1000 ug/ml

Nitroglycerin standard: Restek #31498 at 1000 ug/ml

Nitroglycerin standard: Cerilliant #T-002 at 1000 ug/ml

Nitroguanidine standard: Restek #31602 at 1000 ug/ml

Nitroguanidine standard: AccuStandard #M-8330-ADD-6 at 100 ug/ml

10.12 Preparation of intermediate and calibration standards is documented in the explosives standards logbook. Each standard is labeled with a unique standard number to allow for tracking.

10.13 Intermediate Working Stock Standards (Spiking Solutions):

10.13.1. These standards are diluted stock standards so that the concentration levels are manageable for the working range of the HPLC. They expire within six months of preparation, or sooner if routine QC indicates a problem. The expiration date of the intermediate standards shall not exceed the expiration date of the stock standard from which they were made.

10.13.2. The intermediate working standards are prepared at an optimum level from the stock standard. (Table 3.0, Table 3.1, Table 3.2, Table 3.3, and Table 3.4). These standards are used for making the calibration curves and for spiking QC samples.

Table 3.0
Explosives Intermediate Working Standard Concentration

Stock Standard Name	Stock Standard Concentration (ug/ml)	Stock Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8330 Calibration Standard	1000	0.100	10	10.0
Nitroglycerin	1000	0.400	10	40.0
PETN	1000	0.400	10	40.0
3,5-Dinitroaniline	1000	0.100	10	10.0
Surrogate (12-DNB)	1000	0.100	10	10.0

Table 3.1
Explosives Intermediate Working Standard Concentration (second source for ICV)

Stock Standard Name	Stock Standard Concentration (ug/ml)	Stock Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8330 Mix A	100	1.00	10	10.0
8330 Mix B	100	1.00	10	10.0
Nitroglycerin	1000	0.400	10	40.0
PETN	1000	0.400	10	40.0
3,5-Dinitroaniline	100	1.00	10	10.0
Surrogate (12-DNB)	1000	0.100	10	10.0

Table 3.2
Nitroguanidine (NQ) Intermediate Working Standard Concentration

Stock Standard Name	Stock Standard Concentration (ug/ml)	Stock Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
Nitroguanidine	1000	0.100	10	10.0
Surrogate (12-DNB)	1000	0.100	10	10.0

Table 3.3
Nitroguanidine (NQ) Intermediate Working Standard Concentration (second source for ICV)

Stock Standard Name	Stock Standard Concentration (ug/ml)	Stock Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
Nitroguanidine	1000	0.100	10	10.0
Surrogate (12-DNB)	1000	0.100	10	10.0

Table 3.4
Surrogate (12-DNB) Intermediate Working Standard Concentration

Stock Standard Name	Stock Standard Concentration (ug/ml)	Stock Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
Surrogate (12-DNB)	1000	0.100	10	10.0

10.14 Calibration standards: An initial calibration of the listed explosive compounds in Table 1 is performed using a minimum of 5 calibration points. Such standards will be used to demonstrate the linearity of the UV detector corresponding to the expected concentrations found in real samples (Table 3.5 and Table 3.6 below).

10.14.1. The calibration standards are made by taking known aliquots of the intermediate standard (Table 3.0 and Table 3.2) and diluting them to volume in a 1:1 solution of acetonitrile: 0.1% formic acid in water, or for NQ analysis, in a 1:1 solution of methanol: water.

10.14.2. The calibration standards are stored in the refrigerator (0°-6°C) and must be used within one day of preparation (excluding NQ). NQ standards may be stored for up to 6 months, with their expiration date not to exceed that of the stock standard from which they were made. Alternative standard concentrations for the calibration curve can be prepared to meet client or program specified criteria.

Table 3.5
Calibration Points for 8330B Explosives Linearity

Linearity Points	Intermediate Working Standard Component	Intermediate Working Standard Component Concentration (ug/mL)	Intermediate Working Standard Volume (ml)	Final Volume (ml)	Final Component Concentration (ug/ml)
1	8330 Cal. Std.	10.0	0.005	1.00	0.05
	NG	40.0			0.20
	PETN	40.0			0.20
	35-DNA	10.0			0.05
	12-DNB	10.0			0.05
2	8330 Cal. Std.	10.0	0.010	1.00	0.10
	NG	40.0			0.40
	PETN	40.0			0.40
	35-DNA	10.0			0.10
	12-DNB	10.0			0.10
3	8330 Cal. Std.	10.0	0.025	1.00	0.25
	NG	40.0			1.00
	PETN	40.0			1.00
	35-DNA	10.0			0.25
	12-DNB	10.0			0.25
4	8330 Cal. Std.	10.0	0.050	1.00	0.50
	NG	40.0			2.00
	PETN	40.0			2.00
	35-DNA	10.0			0.50
	12-DNB	10.0			0.50
5	8330 Cal. Std.	10.0	0.100	1.00	1.00
	NG	40.0			4.00
	PETN	40.0			4.00
	35-DNA	10.0			1.00
	12-DNB	10.0			1.00
6	8330 Cal. Std.	10.0	0.200	1.00	2.00
	NG	40.0			8.00
	PETN	40.0			8.00
	35-DNA	10.0			2.00
	12-DNB	10.0			2.00
7	8330 Cal. Std.	10.0	0.300	1.00	3.00
	NG	40.0			12.00
	PETN	40.0			12.00
	35-DNA	10.0			3.00
	12-DNB	10.0			3.00

Table 3.6
Calibration Points for Nitroguanidine

Linearity Points	Intermediate Working Standard	Intermediate Working Standard Concentration (ug/mL)	Intermediate Working Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
1	NQ intermediate 12-DNB	10.0 10.0	0.004 0.004	1.0	0.04 0.08
2	NQ intermediate 12-DNB	10.0 10.0	0.008 0.008	1.0	0.08 0.16
3	NQ intermediate 12-DNB	10.0 10.0	0.020 0.020	1.0	0.20 0.40
4	NQ intermediate	10.0	0.050	1.0	0.50
5	NQ intermediate	10.0	0.100	1.0	1.00
6	NQ intermediate	10.0	0.200	1.0	2.00
7	NQ intermediate	10.0	0.300	1.0	3.00

10.15 Initial Calibration Verification (ICV): The initial calibration verification standard (different manufacturer or lot number from the initial calibration standard) shall verify the initial calibration curve.

10.15.1. The ICV standard involves the analysis of all the target compounds each time the initial calibration is performed and must meet specified recovery criteria for all components prior to sample analysis.

10.15.2. The ICV is prepared from intermediate standards (Table 3.1 and Table 3.3) diluted in 1:1 acetonitrile: 0.1% formic acid in water (or 1:1 methanol: water for NQ) at the same concentration as calibration point 4 of the standard curve. See Table 3.7 and Table 3.8 for ICV preparation details.

Table 3.7
Explosives ICV Working Standard

ICV Standard Component	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8330 Mix A	10.0	0.050	1.0	0.50
8330 Mix B	10.0			0.50
NG	40.0			2.00
PETN	40.0			2.00
35-DNA	10.0			0.50
12-DNB	10.0			0.50

Table 3.8
Nitroguanidine ICV Working Standard

ICV Standard Component	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
NQ	10.0	0.050	1.0	0.50
12-DNB	10.0			0.50

10.16 Continuing Calibration Verification (CCV) Standard (Table 3.9 and Table 3.10): A working standard solution used to check the validity of a calibration curve on a daily basis. The CCV is prepared the same way and at the same concentration as the calibration point 4 of the calibration curve.

Table 3.9
Explosives CCV Working Standard

CCV Standard Component	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
8330 Cal. Std.	10.0	0.250	5.0	0.50
NG	40.0			2.00
PETN	40.0			2.00
35-DNA	10.0			0.50
12-DNB	10.0			0.50

Table 3.10
Nitroguanidine CCV Working Standard

CCV Standard Component	Intermediate Standard Concentration (ug/ml)	Standard Volume (ml)	Final Volume (ml)	Final Concentration (ug/ml)
NQ	10.0	0.250	5.0	0.50
12-DNB	10.0			0.50

10.17 0.1% formic acid solution preparation - Add 4.0 mL formic acid to 4.0 L Millipore water. Mix well.

11.0 Sample Collection, Preservation, and Storage

11.1 Aqueous samples are collected in 1-L amber glass containers with Teflon lined lids. Aqueous samples are

to be collected in duplicate for high-level analysis or regular SPE analysis and in triplicate for low-level SPE analysis. Solid samples are collected in 250-mL wide mouth glass containers with Teflon-lined lids. All samples are preserved by cooling to 4°C. The solid samples must be extracted within 14 days and water samples must be extracted within 7 days of the date of collection.

11.2 Sample extracts are stored in the refrigerator and analyzed within 40 days of extraction.

12.0 Quality Control

12.1 This SOP is designed to follow a variety of different projects and programs requirements. Table 4 is designed to illustrate the control steps and provisions required to adequately produce acceptable data.

12.2 Contract Specific Sample Analysis: For certain samples, limits are specified by the QAPP (Quality Assurance Project Plan) associated with a given project. For these samples follow the limits specified in the QAPP for that project.

12.3 Program Specific Limits: Samples analyzed under the guidance of certain programs; such as the Department of Defense Quality Systems Manual (DoD/QSM) or Louisville Chemistry Guidance (LCG), require their own specified limits. For these samples follow the limits specified in the manuals for that program.

13.0 Calibration and Standardization

13.1 Calibration

13.1.1. The initial calibration for SW-846-8330B chromatographic method involves the analysis of standards containing the target compounds at a minimum of five different concentrations covering the working range of the instrument across two dissimilar analytical columns. Each column must meet the initial calibration and continuing calibration criteria found in Table 4.

13.1.2. The identification of analytes such as explosives is performed by retention times. Retention time windows are crucial to the identification of target compounds.

13.1.3. Compare the retention time of each analyte in the calibration standard with the absolute retention time windows established in accordance with Method 8000 Section 11.6.

13.1.4. Make three injections of the target analyte standards over a course of 72-hour period.

13.1.5. Each retention time must be to three decimal places. Calculate the mean and standard deviation of the target analytes. The width is 3x the standard deviation of the mean absolute retention time during the 72 hour period or 0.03 minutes, which ever is higher. If the standard deviation is 0.000, the laboratory will include more data points or use the default value of 0.01 minutes.

13.1.6. Each analyte in each standard must fall within its respective retention time window. The retention time shall be set using the midpoint standard of the initial calibration curve or the value in the continuing calibration verification standard at the beginning of the analytical shift.

13.1.7. If the analytes fall outside the established retention time window, the HPLC system must either be adjusted so that a second analysis of the standard target analytes fall within their retention time windows, or a new initial calibration must be performed and new retention time windows established.

13.1.8. For each compound of interest, prepare calibration standards at a minimum of five different concentrations as described above in section 10.15. Note: QSM requires that the LOQ or the lowest point in the curve, which ever is greater, be used for the reporting limit.

13.1.8.1. Calibration standards are injected directly into the high pressure liquid chromatograph. An

external calibration technique is employed. One of the external standards will be at a concentration near, but above the method detection limit. If the $RSD \leq 20\%$ (15% for QSM), the correlation of $r \geq 0.995$, or $r^2 \geq 0.990$ is obtained then the calibration is deemed acceptable.

- 13.1.8.2. The lowest concentration calibration standard that is analyzed during an initial calibration curve, establishes the method's quantitation limit based on the final volume of the sample extract described in the preparative method or employed by the laboratory.
- 13.1.8.3. External standard calibration involves comparison of instrument response from the target compounds in the calibration standards. Sample peak areas are compared to peak areas of the standards. The ratio of the detector response to the amount of analyte in the calibration standard is defined as the calibration factor (CF).
- 13.1.8.4. Linear calibration using the average calibration or response factor: When calculating, both calibration factors and response factors are a measure of the calibration relationship and assume that the curve passed through the origin. If the relative standard deviation (RSD), is less than or equal to 20% (less than or equal to 15% for QSM), the use of the linear model is generally appropriate, and the calibration curve can be assumed to be linear and to pass through the origin.
- 13.1.8.5. Linear calibration using a least squared regression: When the RSD of the calibration or response factors is greater than 20% (15% for QSM) over the calibration range, linearity through the origin cannot be assumed. The approach is to employ a regression equation that does not pass through the origin. This approach can also be employed based on past experience of the instrument response.
- 13.1.8.6. Non-linear calibration: Non-linear calibration is not allowed by EPA method 8330B.
- 13.1.8.7. A minimum of five calibration points must be analyzed (six points if using a quadratic or second order model). If more calibration points are analyzed, points from the upper end of the calibration curve may be dropped if necessary, but no calibration point may be dropped from the middle of the calibration curve. (For example: If seven calibration points are analyzed, then the seventh point may be dropped, or the seventh and sixth points may be dropped, but the sixth point or any lower numbered point alone may not be dropped from the middle of the curve.)
- 13.1.8.8. Check the validity of the calibration by analyzing an ICV. The variance of any given compound shall not be more than +/- 15% difference (20% for QSM). This standard must be prior to sample analysis. If the percent drift or the percent difference criteria are not met then the subsequent sample analysis for that analyte is not acceptable.
- 13.1.8.9. For QSM projects, the lowest standard must be re-analyzed (re-calculated) and meet +/-20% recovery criteria prior to the analysis of samples
- 13.1.8.10. Continuous checking of the validity of the calibration is done by analyzing CCVs. The variance of any given compound shall not be more than +/- 15% difference (20% for QSM). This standard must be ran at the beginning, every 20 samples or every 12-hour interval (which ever comes first), and at the end of the analysis run. (Note: QSM samples must have CCVs injected every ten field samples.)

13.2 Calibration Calculations

- 13.2.1. When determining explosives by the external standard technique, calculate the calibration factor (CF) for each peak in each of the initial calibration standards using the equation below.

$$CF = \frac{\text{Peak Area (or Height) in the Standard}}{\text{Total Mass of the Standard Injected (in Nanograms)}}$$

- 13.2.2. The calibration factors from the initial calibration are used to evaluate the linearity of the initial calibration. This involves the calculation of the mean calibration factor, the standard deviation, and the relative standard deviation (RSD) for each multi-component peak.

$$\text{Mean CF} = \frac{\sum_{i=1}^n CF_i}{n}$$

$$SD = \sqrt{\frac{\sum_{i=1}^n (CF_i - \text{Mean CF})^2}{n-1}}$$

$$RSD = \frac{SD}{\text{Mean CF}} \times 100$$

- 13.2.3 Linear Calibration: If the RSD of the calibration factor is greater than 20% over the calibration range (15% for QSM), then linearity through the origin cannot be assumed. If this is the case, the analyst can employ a regression equation that does not pass through the origin. This approach can also be employed based on the past experience of the instrument response. The regression will produce the slope and intercept terms for a linear equation in the form:

$$y = mx + b$$

y = instrument response (peak area or height)

m = Slope of the line

x = Concentration of the calibration standard

b = y-intercept

- 13.2.4 The analyst will not force the line through the origin, but have the intercept calculated from the five data points. The use of origin (0,0) as a calibration point: the use of linear regression will not be used as a rationale for reporting results below the calibration range.

- 13.2.5 A linear least squares regression attempts to construct a linear equation of the form: $y = mx + b$, by minimizing the differences between the observed results (y_i , the response calculated from the constructed equation). The regression equation is:

$$y_i' = ax_i + b$$

where:

a = Regression coefficient or the slope of the line

b = y-intercept

y_i' = Predicted (or calculated) response for the i^{th} calibration standard.

x_i = Mass of analyte in the i^{th} calibration standard aliquot

introduced into the instrument.

The sum of the squares of the differences is minimized to obtain a and b:

$$\sum_{i=1}^n (y_i - y_i')^2$$

where n is the total number of calibration points. The regression calculations attempt to minimize the sum of squares, hence the name “least squares regression.”

Weighting the sum of the squares of the differences can significantly improve the ability of the least squares regression to fit the linear model to the data. The general form of the sum of the squares of the differences containing the weighting factor is:

$$\sum_{i=1}^n w_i (y_i - y_i')^2$$

where:

w_i = Weighting factor for the calibration standard ($w=1$ for unweighted least squares regression).

y_i = Observed instrument response (area or height) for the i^{th} calibration standard.

y_i' = Predicted (or calculated) response for the i^{th} calibration standard.

n = Total number of calibration standards.

- 13.2.6 Least Squares Equation (LSQ) weighting method to be used for calculation of least squares regression fits, either $1/x$ or $1/x^2$, gives increased importance to smaller concentrations and areas. LSQ Weight can be applied to linear, quadratic, and cubic fits only.

14.0 Procedure

14.1 Explosives Water Extraction by SPE (Method 3535)

- 14.1.1. Pre-rinse all glassware to be used in the extraction with Acetonitrile (HPLC Grade).
- 14.1.2. Water samples may be prepared using either the high-level, regular SPE or low-level SPE methods. Regular and low-level SPE sample preparation is described below, starting with 14.1.3. To analyze water samples by the high level method, combine 5.0 mL of sample with appropriate volumes of surrogate and/or spiking solutions in a 10 mL volumetric flask. Add acetonitrile to reach a final volume of 10 mL. Mix well and filter the sample through a 0.22-micron filter. Discard the first three mL of filtrate and transfer a portion to a 2.0 mL amber vial for analysis.
- 14.1.3. For regular SPE analysis, quantitatively measure 500 mL of sample to be extracted. In low-level SPE analysis, a full liter of sample is extracted. Mark the meniscus on the 1 L amber glass collection jar so that the sample volume can be measured after sample extraction. All initial sample volumes need to be noted on the extraction bench sheet.
- 14.1.4. Clean and rinse (with acetonitrile and purified water) the extraction manifold, its valves, and Teflon samplers, and any other equipment used in the extraction process that can come into contact with the sample.
- 14.1.5. One method blank (MB) and laboratory control spike (LCS) must be prepared with each batch of 20 samples or less. Prepare by measuring 500 mL of Milli-Q water into a 1 L amber jar for

regular SPE analysis and 1 L of Milli-Q water for low-level SPE analysis.

- 14.1.6. One sample from each batch of 20 samples or less will be selected for use in the preparation of a matrix spike (MS) and a matrix spike duplicate (MSD). For regular SPE analysis, select the sample and from the glass sample collection jar, quantitatively measure 500 mL of sample to a 1 L amber jar to be spiked and extracted. For low-level SPE analysis, mark the meniscus on the jars selected for the MS/MSD and spike and extract the entire jar.
- 14.1.7. To the method blank and all samples being tested for explosives, add 0.5 mL of the surrogate standard (Table 3.4) at 10.0 ug/mL for regular SPE preparation and 0.2 mL surrogate standard for low-level SPE preparation.
- 14.1.8. To the control spike and the matrix spike/matrix spike duplicate pair add 0.5ml of intermediate (spiking) standard described in Table 3.0 above for regular SPE and 0.2 mL spiking standard for low-level SPE.
- 14.1.9. Assemble the SPE extraction manifold by inserting the disposable Teflon liners into the flow control valves and then close valves. Connect the manifold to the waste collection vessel, which is then connected to the in-house vacuum system.
- 14.1.10. Mount the SPE extraction cartridges onto the flow control valves and rinse them with 3-4 volumes of methylene chloride to remove phthalate contamination. Do this by opening the valves and turning on the house vacuum. Condition the cartridges using 10-15 mLs of acetonitrile at a flow rate of approximately 10 mL/minute (To obtain the 10 mL /minute flow turn on the house vacuum and set the regulator on the manifold to around 4-5 mm/Hg. Fine adjustments will be necessary). Be careful not to let the cartridge go dry.
- 14.1.11. Follow up the acetonitrile conditioning by rinsing the cartridges with 10-15 mL DI H₂O at a flow rate of approximately 10 mL/minute. Label each cartridge with the ID of the sample, blank, or spike that is to be extracted. Be careful not to let the cartridge go dry.
- 14.1.12. Attach the appropriate end of the clean Teflon samplers to the SPE cartridges while placing the weighted end into the sample. When all needed lines are attached, pull the sample, spike, and/or blank through the cartridges by applying the vacuum at a rate of approximately 10 mL/minute. Waste will be collected into the manifold's basin and into the waste vessel and must be monitored and emptied as needed so the liquid does not get into the vacuum line. If all the positions on the manifold are not being used be sure to close the valves at those positions.
- 14.1.13. When a sample is completely drawn through a particular cartridge close the valve to that cartridge. When all samples are drawn through their cartridges shut off the vacuum and close all valves. Remove the Teflon samplers from the cartridges and the samples. Fill each cartridge with DI water, open the valves and draw the water through under low vacuum. This will remove the water droplets on the inside wall of the cartridge. Allow the cartridges to dry under vacuum for approximately 5 minutes to remove as much water as possible. Shut off the vacuum and close the valves again. Empty the manifold basin and the waste vessel.
- 14.1.14. Remove the lid to the manifold and place inside the basin a sample tray containing the, appropriately labeled, 15 mL graduated centrifuge (or equivalent) tubes for collection of the eluted extract. Alternatively, use screw cap culture tubes for collection.
- 14.1.15. Elute the samples and their associated QC samples by passing a 5.0 mL aliquot of acetonitrile through the extraction cartridges at about 1 mL/minute. Collect the eluate in the collection tubes. Bring the final sample volume to 5 mL with acetonitrile. If using culture tubes, the sample will

need to be transferred with a Pasteur pipette to a class A 5 mL volumetric flask and brought to volume with acetonitrile. Record the eluate volume on the extraction bench sheet.

14.1.15.1. Note: If per client specification, the samples are to undergo gel-permeation chromatography (GPC) clean-up, it is necessary for them to be eluted from the SPE cartridges using a 5.0 mL aliquot of methylene chloride rather than acetonitrile. The eluate is collected into a 13mm x 100mm disposable glass culture tube. The collected eluate may contain a small layer of water on the top that will need to be removed using a disposable glass Pasteur pipet.

14.1.15.2. The procedure for GPC clean-up is described in the SOP SV -014.

14.1.15.3. Following the GPC clean-up, samples will need to be concentrated and exchanged back to acetonitrile. This procedure is described in section 14.2 below.

14.1.16. For regular SPE, bring the final sample volume to 5 mL with acetonitrile.

14.1.17. Prior to analysis, dilute the final extract 50 % (v/v) with 0.1% formic acid in water. Store the final extract in an amber vial and refrigerate until analysis. Mix well and filter the sample through a 0.22-micron filter. Discard the first 1-2 mL of filtrate (for low level samples, only discard the first few drops as sample volume is very limited) and transfer a portion to a 2.0 mL amber vial for analysis.

14.2 Concentration (for samples that have undergone GPC cleanup only)

14.2.1. Place glass microfiber filter paper into a glass funnel. Fill the filter paper two-thirds full with sodium sulfate. Rinse filter paper, sodium sulfate, funnel, K-D apparatus, and concentrator tube with methylene chloride.

14.2.2. Quantitatively pour the extract taken from the GPC instrument through the filter and funnel seated on a 250mL Kuderna-Danish (K-D) apparatus complete with concentrator tube. Rinse the glass collection tube three times with methylene chloride. Add these rinses through the filter and funnel into the K-D apparatus. Add a boiling chip to the K-D flask prior to placing it on the heated water bath. Wet a three ball Snyder column with approximately 2-mL of methylene chloride. Attach the Snyder column.

14.2.3. Place the K-D in the heated water bath so the concentrator tube is immersed in the water and the lower rounded surface of the K-D is bathed in steam. At the proper rate of distillation the balls of the column will actively chatter, but the chambers will not flood (set the knob of the temperature control to 5~6). It is critical that the analyst watches the extract as it distills. THE EXTRACT CANNOT GO TO DRYNESS.

14.2.4. When the extract volume reaches approximately 5-7 mL, remove the K-D from the bath. Slightly tilt the apparatus and rotate to aid in solvent drainage from the Snyder column. Allow it to cool.

14.2.5. Pour 30 mL of acetonitrile through the top of the Snyder column and allow solvent to completely empty from the Snyder column into the KD. Turn the knob of the temperature control of the water bath heater to 8~9. Mix the contents of the KD by slightly tilting and placing it upright several times using care so that the content does not spill out of the Snyder column. Concentrate the extract to approximately 4-mL. Remove the K-D apparatus from the bath. As above, slightly tilt the apparatus and rotate to aid in solvent drainage. Allow it to cool completely.

- 14.2.6. Remove the Snyder column, wipe off the water from the bottom of the K-D flask and the concentration tube with a paper towel and then remove the K-D flask.
- 14.2.7. Turn on the heating unit for the Organomation and adjust the temperature control so that the water bath is about 35°C. Place sample concentrator tube into the nitrogen blow down apparatus. Allow a gentle stream of nitrogen to interact with the extract. There shall be no splashing or excessive movement upon the surface of the extract. Allow the extract to evaporate down to approximately 0.8 ml. Remove concentrator tube from water bath and use a Pasteur pipet to bring sample extract up to a 1.0-ml volume with acetonitrile. Highly contaminated samples may not adequately concentrate down to 1mL. Such samples shall be transferred to an appropriate volume volumetric flask and brought to volume with acetonitrile. Transfer 1-mL of the extract to an amber labeled screw-cap injection vial. Record the final extract volume on the extraction bench sheet.

14.3 Explosives Solid and Tissue Extraction by Sonication

- 14.3.1. Prepare solid samples for extraction by first examining the sample matrix for physical presence of contamination (see Safety, 8.0). Remove by gloved hand any extraneous, obvious non-soil components (paper, plant material, etc).
- 14.3.2. See the Grinding of Multi-incremental Samples by Puck Mill SOP (GT-002) for procedures regarding soil sample homogenization by the puck mill.
- 14.3.2.1. For QSM, a 100 g laboratory control sample (LCS), spiked with all target analytes of interest, is prepared and taken through all grinding steps. To the LCS - add 10.0 mL of methylene chloride containing the following: 0.2 mL of 8330 stock standard at 1000 ug/mL, 0.2 mL 3,5-dinitroaniline stock standard at 1000 ug/mL, and 0.2 mL 1,2-DNB surrogate stock standard at 1000 ug/mL, 0.4 mL NG stock standard at 1000 ug/mL, and 0.4 mL PETN stock standard at 1000 ug/mL.
- 14.3.2.2. This is best done by placing the 100g of soil to be spiked into a glass baking dish and gently shaking the dish back and forth to level out the soil.
- 14.3.2.3. Using a glass disposable Pasteur pipet, drizzle the methylene chloride and standard solution in a spiral pattern onto the soil.
- 14.3.2.4. Using a metal spatula or equivalent device, work the solution into the soil manually so that no moisture is visible before placing the soil into the metal puck mill bowl for grinding. (Note: A certified reference material / LCS may be purchased from either ERA or Wibby Environmental).
- 14.3.3. The MS/MSD samples for both QSM and non-QSM work and the LCS for non-QSM work are not taken through the puck mill grinding portion of the procedure after spiking. The MS/MSD samples for QSM work are for matrix evaluation only and are taken and spiked post-grinding from the same ground sample as the parent subsample is taken.
- 14.3.4. Per client or project specifications, samples may not undergo the puck mill grinding procedure described above, but will be ground by mortar and pestle instead (if deemed safe to do so).
- 14.3.4.1. Air dry samples at room temperature and in the dark.
- 14.3.4.2. Rinse the mortar and pestle with acetonitrile and allow to dry thoroughly.
- 14.3.4.3. Place approximately 50 grams of dried sample into the mortar and grind sample so that it

will pass through a 10-mesh sieve.

- 14.3.4.4. Place the ground sample into a sealed 4 ounce amber jar and label the jar with the appropriate sample number.
- 14.3.4.5. Wash the mortar and pestle with warm soapy water and dry thoroughly with a towel or allow to air dry.
- 14.3.5. Weigh 10 grams of sample, grinding blank (or grinding blank composite), method blank (purified sand or soil), matrix spike, matrix spike duplicate and LCS (non-homogenized: purified sand or soil; homogenized: spiked and homogenized LCS) to the nearest 0.01 g into a 40 mL vial.
 - 14.3.5.1. Use the trimmed down glass Pasteur pipet sampling tubes to transfer homogenized soil samples in small quantities into the 60 mL vial. (For small samples that have not undergone puck mill homogenization a metal spatula may be used for sample transfer.)

(Note: QSM V 4.2 requires the following: Entire ground sample is mixed, spread out on a large flat surface (e.g. baking tray), and 30 or more randomly located increments are removed from the entire depth to create a subsample of ~10g.)
 - 14.3.5.2. For homogenized soil samples, the grinding blank may be used as the method blank also, since it is taken through all steps of the prep procedure.
 - 14.3.5.3. For QSM, all homogenized soil samples are required to have one sample per batch prepped and analyzed in triplicate. If there is any information on which sample may contain the highest concentrations of analytes then that sample should be chosen. Otherwise, use the client-designated QC sample. If the client did not designate a QC sample, then choose a sample at random for triplicate analysis.
- 14.3.6. Add 2.00 mL 12-DNB surrogate solution at 10 ug/mL to all client samples and the method blank and/or grinding blank only (spiking solution added to LCS/MS/MSD samples already contains the appropriate amount of surrogate).
- 14.3.7. To the MS/MSD samples, add 2.0 mL of standard spiking solution described in Table 3.0 above.
- 14.3.8. Add acetonitrile to each sample to reach a total final volume of 20 mL (be sure to account for any volume added by surrogate or spike).
- 14.3.9. Mix samples with acetonitrile well by first shaking vigorously for 10-20 seconds or until all soil is visibly wet and not stuck to the bottom of the vial. Place samples on the mechanical shaker on the highest setting and allow to shake for 10 minutes.
- 14.3.10. Sonicate samples for 18 hours in the temperature controlled (< 30° C) ultrasonic bath.
- 14.3.11. Wipe samples are directly added to the 40 mL amber sample vial (no sample weight), 2.00 mL surrogate is added, and they are brought to 20 mL final volume with acetonitrile. Mix well by shaking vigorously for 10 seconds. Place the sample(s) into a temperature controlled ultrasonic bath (<30 C) and sonicate for 18 hours.
- 14.3.12. After sonication, allow the sample to settle for at least 30 minutes. Remove 2.0 mL of the supernatant and combine it with 2.0 mL of 0.1 % formic acid solution. Alternatively, shake the sample and remove 2.0 mL. Add 18 mL 0.1% formic acid solution to the extraction vial and allow settling for at least 30 minutes.

- 14.3.13. Place the supernatant in a disposable syringe, attach a 0.22-micron filter disc, and filter it into the 15 mL amber vials (or directly into 2 mL amber vials used in analysis). Discard the first 1-2 mL of supernatant before adding to the vials. Store the final extract in the refrigerator (0°-6°C) until analysis.

14.4 Water Sample Preparation of Nitroguanidine (NQ) by High Level Prep

- 14.4.1. Pre-rinse all glassware to be used in the preparation with acetonitrile (HPLC Grade).
- 14.4.2. Nitroguanidine water samples are prepared using the high-level method. For the method blank and client samples, combine 5.0 mL of sample with 0.5 mL surrogate at 10.0 ug/mL in a 10 mL volumetric flask. For LCS, MS, and MSD samples, combine 5.0 mL sample with 0.5 mL NQ intermediate at 10.0 ug/mL. Add methanol to reach a final volume of 10 mL. Mix well by corking and inverting the flask several times. Filter the sample through a 0.22-micron filter. Discard the first 1-2 mL of filtrate and transfer a portion to a 2.0 mL amber vial for analysis.

14.5 Soil Extraction of Nitroguanidine (NQ) by Sonication

- 14.5.1. Prepare solid samples for extraction by first examining the sample matrix for a physical presence of contamination (see Safety, 8.0). Samples will be allowed to air dry at room temperature. Per client or project specifications, the samples will undergo either mortar and pestle or puck mill homogenization as described above.
- 14.5.2. See the Grinding of Multi-incremental Samples by Puck Mill SOP (GT-002) for procedures regarding soil sample homogenization by the puck mill.
- 14.5.3. Weigh 5 grams of sample to the nearest 0.1 g into a 40-mL vial and label the vials with the sample numbers. As noted in section 14.3.5.1 above, QSM V 4.2 requires that samples homogenized by the puck mill be spread out on a baking sheet and that 30 or more randomly chosen aliquots of soil be used to create the 5 gram subsample. With client approval, the trimmed down glass Pasteur pipet sampling tubes may be used to transfer the soil to the vials.
- 14.5.4. One method blank and control spike must be prepared with each batch of 20 samples or less. Prepare by adding 5 grams of organic free silica sand or soil that has previously been determined to be clean to a 40-mL vial. For homogenized samples, the grinding blank may be used as the method blank.
- 14.5.5. One sample from each batch of 20 samples or less must be used in the preparation of a MS and a MSD. Weigh 5 grams of the parent sample into each of two 40-mL vials for the MS/MSD pair.
- 14.5.6. Prior to extraction, add to the method blank and all field samples, 1.0 mL of surrogate spiking solution at 10.0 ug/mL. To the matrix spike/matrix spike duplicate and control spike add 1.0 mL NQ intermediate solution described in Table 3.2.
- 14.5.7. For homogenized samples, a homogenized NQ LCS shall be prepared and taken through all grinding steps.
- 14.5.7.1. Prepare an LCS spiking solution by placing 0.200 mL NQ stock standard at 1000 ug/mL and 0.200 mL surrogate stock standard at 1000 ug/mL into a 10 mL volumetric flask containing methanol. Bring to volume with methanol, cap, and invert to mix.
- 14.5.7.2. Place 100g of soil to be spiked into a glass baking dish and gently shake the dish back

and forth to level out the soil.

- 14.5.7.3. Using a glass disposable Pasteur pipette, drizzle the prepared standard solution in a spiral pattern onto the soil.
- 14.5.7.4. Using a metal spatula or equivalent device, work the solution into the soil manually so that no moisture is visible before placing the soil into the metal puck mill bowl for grinding. (Note: A certified reference material / LCS may be purchased from either ERA or Wibby Environmental).
- 14.5.8. To all client and QC samples, add 50:50 Millipore water: methanol to reach a final total volume of 20 mL. Shake well for 10-20 seconds until all soil is wet and none remains stuck to the bottom of the vial. Place on the mechanical shaker for 10 minutes at the highest setting. Place the sample(s) into a temperature controlled ultrasonic bath <30 C) and sonicate for 2 hours. Remove from sonicator and allow samples to settle for 30 minutes.
- 14.5.9. Finally, place the supernatant in a disposable syringe, attach a 0.22-micron filter disc, and filter it into the 2 mL amber vials used in analysis. Discard the first 1-2 mL of supernatant before adding to the vials. Store the final extract in the refrigerator (0°-6°C) until analysis.

15.0 Data Analysis and Calculations

15.1 Sample Sequence

- 15.1.1. Before initial calibration or sample analysis, an instrument blank must be analyzed to determine baseline characteristics.
- 15.1.2. If instrument calibration is required, the calibration points shall come after the instrument blank and be immediately followed by the ICV injection. The calibration must be verified by a passing ICV before sample analysis can occur. The variance of any given compound in the ICV shall not be more than +/- 15% difference (20% for QSM). See Table 4 for acceptance criteria and corrective actions.
- 15.1.3. Verify calibration each twelve-hour shift by injecting a Continuing Calibration Verification standard (CCV), prior to conducting any sample analysis. A CCV must be injected at the beginning of the sequence (or following the ICV when calibrating) and at intervals of no less than one per 20 sample injections or twelve hours (whichever comes first) and at the end of each sequence (every 10 samples for QSM). The variance of any given compound shall not be more than +/- 15% difference (20% for QSM). See Table 4 for acceptance criteria and corrective actions.
- 15.1.4. Before sample analysis, inject a method blank to demonstrate that the instrument, as well as the extraction procedure, is free from contamination. All compounds must be below the method detection limit (< ½ the reporting limit and <1/10 the amount measured in any sample for QSM). See Table 4 for acceptance criteria and corrective actions.
- 15.1.5. Samples can be directly injected after the successful analyses of the calibration curve, ICV, CCV, and method blank. There can be up to 20 samples in an analytical batch. A matrix spike/matrix spike duplicate and laboratory control spike must be analyzed with every analytical batch. Recoveries must be within laboratory generated QC limits or client specified limits for all surrogate, matrix spike/matrix spike duplicate and laboratory control spike injections. See Table 4 for acceptance criteria and corrective actions.

- 15.1.6. All detects in the associated sample must be confirmed with a second column. Detects are identified and quantitated on the primary column. Results must be confirmed or reported at +/- 40 % on the secondary column. If no anomalies are noted, review the chromatographic conditions. If there is no evidence of chromatographic problems, then it is appropriate to report the lower result (method 8000C). Specific projects and/or programs will require that the higher result or both of the results be reported. See Table 4 for guidance and corrective actions.
- 15.1.7. Each sample analysis must be bracketed with passing continuing calibration verification standards. If the continuing calibration verification standard fails to meet QC criteria, all samples that were injected after the last standard that met QC criteria must be re-analyzed.

15.2 Sample Calculations

- 15.2.1. The computer software determines the concentration of each analyte in the sample. It calculates the amount of compound from the peak area, using the calibration curve. Linear regression of standard responses (R) against their known concentration (C in ug/ml), derives the following equation:

$$C = mR + b$$

- 15.2.2. Using the slope (m) and the intercept (b) from this equation, the concentration of the sample (ug/ml) is calculated and appears on the report page following the chromatogram.

Water samples:

$$C_s = [(C_c)(V_E)(D)]/V_s$$

Soil samples:

$$C_s = [(C_c)(V_E)(D)]/(W)$$

Wipe samples:

$$C = [(C_c)(V_E)(D)]$$

Where: C_s = Concentration of sample in ug/L for waters and mg/kg on a dry weight basis for soils

C_c = Concentration from the curve (ug/ml)

C = Concentration in total ug

V_E = Total volume of sample extract (after concentration) in ml

V_s = Volume of water sample in liters

D = Dilution factor if extract was diluted

W = Weight of dried soil sample in grams

16.0 Method Performance

- 16.1 Certified standard solutions, properly maintained instrumentation, and analyst experience and expertise are critical elements in producing accurate results. Standards and instrument performance are continually checked by analyzing external performance test samples provided by the appropriately accredited agencies. Internal blind spikes are also utilized to check analyst performance.

- 16.2 Initial demonstration of capability (IDC) is another technique used to ensure acceptable method performance. An analyst must demonstrate initial precision and accuracy through the analysis of 4-5 laboratory control spikes for each matrix and sample type. After analysis, the analyst calculates the average recovery ($\bar{x}$) and the relative standard deviation (RSD) of the recoveries for each analyte. In the absence of specific criteria found in the SW-846 methods or project or program specific limits, the default criteria of 70-130% recovery and 20 % RSD are used until internal limits are generated (Method 8000B, sec. 8.4.9).
- 16.3 The LOD check sample is analyzed quarterly (or with each prep batch if it is determined that samples are received less frequently than once per quarter) to confirm instrument sensitivity (e.g. to verify that the method detection limits are still achievable). The LOD check samples are taken through all preparation and extraction steps used for actual samples. The recovery criteria for LOD check samples are the ability to detect all compounds. If any given compound is not detected, the LOD check is spiked at a higher level and analyzed again. Detection limits for those compounds not detected on the initial LOD check analysis need to be raised to match the LOD check analysis at which they were detected.
- 16.4 The LOQ check sample is analyzed quarterly (or with each prep batch if it is determined that samples are received less frequently than once per quarter). The LOQ check samples are taken through all preparation and extraction steps used for actual samples. The recovery criteria for LOQ check samples are the same as LCS acceptance ranges established in the QSM manual. If any given compound does not meet the recovery criteria, the LOQ check is spiked at a higher level and analyzed again. The reporting limit for those compounds that did not meet the initial recovery criteria must be raised to match the LOQ check analysis level at which the recovery criteria were met.
- 16.5 Creating and monitoring control charts is also important for maintaining and improving method performance. Currently all SSTD, MS, MSD, and LCS recoveries are monitored with the use of the LIMS system. The data collected is used to recognize trends in recovery performance, as well as for generating new in-house QC limits. Default accuracy limits of 70-130 % recovery and a precision limit 20 % RSD are used until enough data points are generated to provide usable internal limits. Client and/or Project specific limits are also used frequently in sample analyses.

17.0 Pollution Prevention

See QAM Appendix 9

18.0 Data Assessment and Acceptance Criteria for Quality Control Measures

- 18.1 If the initial analysis of a sample or a dilution of the sample has a concentration of a particular explosive compound that exceeds the calibration range, the sample must be re-analyzed at a dilution.
- 18.2 The qualitative identification of each explosive determined by this method is based on retention time. This method employs a dual column comparison on dissimilar phases. The retention time is updated with the midpoint of each new calibration and is continually updated with the continuing calibration verification standards (CCVs). A new method ID is provided for each new method with updated retention times or alteration to the operating initial calibration method. If an alteration occurs (other than daily retention time updates), project management and the QA officer will be notified. A description of the alteration will be addressed in the client notes or case narrative.

18.3 Reporting Quantitative Analysis

- 18.3.1. When the analysis of an analytical batch or sequence has been completed, the data is processed and prepared for reporting. Once the standard retention times have been compared with the sample retention times, the sample data can be reported. Assessments of all spiked, calibration control

samples, and standards will also be finalized before reporting the data.

18.3.2. When the analyst has finished processing the analytical batch, the results are electronically transferred to the LIMS system where weight to volume corrections, dilution factors, and percent solids adjustments are made. Once the final results have been verified, a checklist (FSV10-01) is filled out and signed confirming that all the data has been thoroughly scrutinized. At this point, the data is turned over to another qualified analyst for final validation. The second analyst confirms the results, electronically marks them validated, and signs his or her portion of the checklist (the checklist is included in this SOP). Finally, the validated results are made available to the client services personnel in order for the data to be given to the client or appropriate agencies.

18.3.3. An electronic copy of the data is then filed and archived. The package includes; the sequence run log, a copy of the bench sheet, the LIMS run log, LIMS prep sheet, verification of calibration data, and each sample, the chromatogram. All the data is to be initialed and dated by the analyst. Each sequence file header will be labeled by the date of sequence.

19.0 Corrective Measures for Out-of-Control Data

See QAM Appendix 9

20.0 Contingencies for Handling Out-of-Control or Unacceptable Data

See QAM Appendix 9

21.0 Waste Management

See WS-001

22.0 Equipment/Instrument Maintenance, Computer Hardware and Software & Troubleshooting

See QAM Appendix 9

23.0 References

22.1 USEPA, SW-846, 3rd Ed. "Determinative Chromatographic Separations", Method 8000C. March 2003.

22.2 USEPA, SW-846 Method 8330B. October, 2006.

22.3 USEPA, SW-846 Method 8332. December, 1996.

22.4 USACE, Methods Manual for Detection of PEP Compounds, EPA Method 8330, May 19, 1999.

22.5 USACE/CRREL, Methods for Determining Nitroguanidine in Soil and Water, Special Report 89-35, November 1989.

22.6 USACE/CRREL, Stability of Nitroguanidine in Moist, Unsaturated Soils, Special Report ERDC/CRREL TR-05-2, February 2005.

22.7 USEPA, SW-846, "Organic Extraction and Sample Preparation", Method 3500B Revision 2. December 1996.

22.8 CT Laboratories Quality Assurance Manual current revision.

22.9 Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.0, July 2013 or most recent revision.

22.10 National Environmental Laboratory Accreditation Conference (NELAC), 2003 NELAC Standard Chapters 1 to 6, EPA/600/R-04/003, June 5, 2003 or most recent version.

22.11 ISO. 2005. General requirements for the competence of testing and calibration laboratories. ISO17025.

23.0 Tables, Diagrams, Flowcharts, and Validation Data

Table 4
Summary of Method Quality Objectives for Method 8330B- Explosives

Quality Control Element	Frequency of Implementation	Acceptance Criteria	Corrective Action
Initial Calibration (ICAL)	Initial Calibration prior to sample analysis. Minimum of 5 calibration standards with the lowest standard at or below the RL. For QSM, once the curve or line is generated, the lowest calibration point must be re-analyzed.	1. RSD for each analyte $\leq 15\%$ 2. Linear – least squares regression $r \geq 0.995$. 3. Non-linear regression is not acceptable for method 8330B analyses. 4. Apparent signal-to-noise ratio at the RL must be at least 5:1 for QSM.	Linearity must fit one of acceptance criteria, or the curve must be reanalyzed. No samples can be run without a valid ICAL. This applies to all analytes and both analytical columns. For QSM, the reanalysis of the first point after calibration is complete must generate results for all analytes that are within $\pm 20\%$ of the true value. If all analytes do not pass, it will be necessary to correct any problems and to repeat the initial calibration.
Initial Calibration Verification (ICV)	After initial calibration (ICAL)	Difference $\leq 15\%$ QSM difference $\leq 20\%$	If ICV falls outside QC criteria, reanalysis must take place. If ICV still fails, it will be necessary to correct the problem, or it will be appropriate to repeat the initial calibration curve. QSM: No samples will be analyzed until the problem has been corrected and a passing ICV is obtained.
Continuing Calibration Verification (CCV)	Every twelve hours or every twenty samples (which ever comes first) QSM: Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	Difference $\leq 15\%$ QSM difference $\leq 20\%$	If CCV falls outside QC criteria, reanalysis must take place. If CCV still fails, it will be necessary to correct to problem, or it will be appropriate to repeat the initial calibration curve or to qualify the analyte with “Z”. Exception to the above, if the acceptance limits are exceeded high and the analyte is not detected in the sample the verification standard has passed (analyte would have been detected if present). QSM: When a CCV fails, all samples analyzed after the last passing CCV will need to be re-analyzed. No samples will be analyzed until the problem has been corrected. Flagging is only appropriate in cases where the samples cannot be re-analyzed.
Retention Time Window (RTW)	Retention Times will be set using the midpoint standard in the ICAL or the RT in the CCV run at the beginning of each analytical shift.	Shift less than ± 3 times the absolute Standard Deviation from the 72 hour RTW study, with a minimum width of 0.03 minutes	No samples shall be analyzed without a verified retention time window. If a retention time shift occurs, th problem shall be corrected and the samples re-analyzed. It may be appropriate to recalibrate as well.

Table 4 Summary of Method Quality Objectives for Method 8330B- Explosives			
Quality Control Element	Frequency of Implementation	Acceptance Criteria	Corrective Action
MDL/study/LOD/LOQ verification check	MDL study shall be performed at initial setup and then at a frequency in accordance with program specifications. LOD and LOQ Verification Checks shall be performed quarterly for QSM or with each prep batch if it is determined that samples are received less often than quarterly.	LOD checks must produce a signal at least 5 times the instrument's noise level. LOQ check recoveries must pass the established LCS control limits for each analyte.	Samples can not be analyzed without a valid MDL. QSM: If LOD/LOQ checks fail, re-analyze at the same level. If second analysis fails, re-prepare at a higher spike level. If not analyzed quarterly, must be prepped and analyzed with each batch.
Method Blank (MB)	1 per sample batch ≤ 20 samples of the same matrix	Analytes must not be higher than the highest of the following: 1/2 MRL, or 5% of the associated sample concentration. QSM = 1/2 MRL or 10% of the associated sample concentration	If sample is available and within holding times, samples associated with method blank need to be re-prepped. If no sample is available, qualify the data with a "B" to all associated positives when less than 20X blank concentration or less than 10X blank concentration for QSM. QSM: Apply "B" to all results for the specific analytes in all samples in the associated preparatory batch.
Soil Grinding Blank	QSM - Between each sample. With client permission, may be generated after every 10 samples and/or composited into one final grinding blank sample.	Can be analyzed individually or composited. No target analytes detected greater than 1/2 the RL	If the composite grinding blank exceeds the acceptance criteria B-flag ALL the associated samples. If any individual grinding blank exceeds acceptance criteria B-flag ONLY the sample following that blank.
Laboratory Control Sample (LCS)	1 per sample batch ≤ 20 samples of the same matrix QSM - a 250 g solid reference material must be spiked with all analytes of interest and taken through all grinding, prep and analytical steps.	In-house limits, or program or client specified limits	Correct problem, then re-analyze the LCS. If LCS recoveries are still outside QC control limits, then re-prepare and reanalyze the LCS and all samples in the associated batch for the failed analytes in the samples, if sample is available. Qualify the failing analytes in all samples with a "Q" qualifier. Flagging is only appropriate in cases where samples can not be re-prepped or re-analyzed.
Matrix Spike (MS)	1 per sample batch ≤ 20 samples of the same matrix	1.) Client specified limits. 2.) QSM – use LCS criteria 3.) In-house limits. For QSM: For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken.	No action is taken based on MS recovery alone, use of professional judgment. For recoveries outside QC criteria, qualify out lying compound with "M" in the parent sample. QSM: Contact the client as to additional measures to be taken.

Table 4
Summary of Method Quality Objectives for Method 8330B- Explosives

Quality Control Element	Frequency of Implementation	Acceptance Criteria	Corrective Action
Matrix Spike Duplicate (MSD)	1 per sample batch $\leq$ 20 samples of the same matrix	1.) Client specified limits. 2.) QSM – use LCS criteria 3.) In-house limits. For QSM: For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Relative percent difference (RPD) $<$ 30%.	No action is taken based on MSD results alone, use of professional judgment. . For recoveries outside QC criteria, qualify out lying compound with “M” in the parent sample. If RPD is outside QC criteria, then qualify the out lying compounds with “Y” in the parent sample. QSM: Contact the client as to additional measures to be taken.
Triplicate soil sample	QSM - 1 per sample batch $\leq$ 20 samples of the same matrix. Can not be performed on any type of blank sample.	The RSD for results above the RL must not exceed 20%	Corrective action must be taken if this criterion is not met (e.g., the grinding process should be investigated to ensure samples are being reduced to a sufficiently small particle size) Apply a ‘J’ flag if the corrective action does not solve the problem and no sample available.
Surrogates	Every sample and QC	In-house Limits, or program or client specified limits	Rerun sample. If no apparent matrix interference noticed re-extract sample. If no sample is available, qualify the surrogate with “S”. QSM: For QC and field samples; correct problem, re-analyze, if no apparent interference, re-prep and re-analyze all failed samples or failed surrogates in the associated batch, if sample material is available. If no sample available, apply “S” to the specific sample.
Target Analyte Confirmation	Whenever a positive is detected on one column, analyzed on a 2nd column.	If present: $RPD \leq 40\%$	If not present , Do not report value. If present and $RPD \leq 40\%$ QSM: Report data from the primary analytical column as appropriate. Non-QSM: Reporting the lower of the two values may be appropriate unless otherwise specified. If present and $RPD > 40\%$ QSM: Report data from both columns with a “P” qualifier. Non-QSM: Report lower of the two values, may be appropriate, with a “P” qualifier. Certain projects/clients/programs may require reporting the higher of the two values.

FSV10-01
8330B Analysis Data Review Checklist

Sequence Date	Analyst / Data Interpreter	Independent Reviewer	Date of Review	Approved
				Yes or No

Instructions: Complete one checklist per *analytical run*. Enter the appropriate response for each question. Each “No” response requires an explanation in the Comments section and may require the initiation of a Nonconformance Report.

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
1. INITIAL CALIBRATION (ICAL)						
a. Was the Explosive initial calibration performed using a minimum of five varying standard concentration levels?	Lowest standard at or near MRL					
b. Is the variation between calibration response factors for all concentration levels <15% RSD, is $r^2 > .990$, or $r > 0.995$ for the regression line?	RSD <15%, $r^2 > .990$, $r > 0.995$					
c. Was each ICAL uniquely identified (i.e. Standard Number)?						
d. Was an initial calibration blank (ICB) analyzed?						
2. INITIAL CALIBRATION VERIFICATION (ICV)						
a. Was there a second source ICV for all target analytes analyzed after the initial calibration and prior to analysis of any samples?	Second source					
c. Were the recoveries for the ICV between 85-115% (80-120% for QSM).	% Recovery					
d. Was the ICV uniquely identified (i.e. Standard Number)?						
3. CONTINUING CALIBRATION VERIFICATION (CCV)						
a. Were CCVs analyzed at the beginning of the sequence, after every 12 hours or every 20 samples (which ever comes first) (every 10 field samples for QSM) and at the end of the analytical run?						
b. Were the recoveries for the CCVs between 85-115% (80-120% for QSM)?	%Recovery					
c. Was each CCV uniquely identified (i.e. Standard Number)?						

FSV10-01

8330B Analysis Data Review Checklist Continued

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
4. BLANKS						
a. Was a method blank (MB) analyzed prior to the analysis of samples?						
b. Was the MB result less than ½ the reporting limit (RL) or 5% of the sample amount (QSM: less than ½ the RL and <10% of the sample amount)?						
c. Was a MB prepped and analyzed at a frequency of one per Prep Batch?	Batch ≤20 samples					
5. LABORATORY CONTROL SAMPLE (LCS)						
a. Was a LCS analyzed at a frequency of one per Prep Batch?	Batch ≤20 samples					
b. Were the LCS recoveries in each LCS within the acceptance criteria?	Per program					
6. MATRIX SPIKES						
a. Was a matrix spiked (MS) sample analyzed at a frequency one per Prep Batch?	Batch ≤20 samples					
b. Were MS recoveries in each MS within the acceptance criteria?	Per program					
7. MATRIX SPIKE DUPLICATE						
a. Was a duplicate matrix spike sample analyzed at a frequency one per Prep Batch?	Batch ≤20 samples					
b. Were MSD recoveries within the acceptance criteria?	Per program					
c. Is the relative percent difference (RPD) between a matrix spike (MS) and its duplicate (MSD) within the acceptance criteria?	Per program QSM: 30%RPD					

FSV10-01

8330B Analysis Data Review Checklist Continued

Requirement:	Acceptance Criteria	Analyst Review		Independent Review		Comments: (indicate reference to an attachment if necessary)
		Yes	No	Yes	No	
8. SAMPLES (INCLUDING BLANKS, STANDARDS, AND QC SAMPLES)						
a. Are chromatogram characteristics, including peak shapes and areas, consistent with those of the CCV?						
b. Are surrogate recoveries for all samples, blanks, standards, and QC samples within acceptance criteria?						
c. Were all samples having analytes detected in amounts exceeding the calibration range diluted and reanalyzed?						
d. Were all samples extracted within holding times and analyzed within 40 days of extracting?	Analysis within 40 days of extraction					
e. Was there a acetonitrile:H ₂ O injection preformed prior to sample analysis?						
f. If any analytes were detected in the soil grinding blanks were the associated samples B-flagged?	< ½ RL					
g. Was the batch soil triplicate results RSD within acceptance criteria?	< 20%					
9. RECORDS AND REPORTING						
a. Are Run, Prep Batch and Extraction sheets, Summary sheets, Sequence file, initial and rerun raw and process data present in the PDF file?						
b. Are all chromatograms dated and initialed?						
c. Are reported results whose amounts exceeded the acceptance criteria flagged with an appropriate qualifier and, if needed, a NCR completed?						
d. Do all values, dilution factors and qualifiers listed on the raw reports match the LIMS data?						
e. Is the ICAL method referenced on the Raw Data?						

FSV10-03 Percent RSD Template

Triplicate Sample Analysis Relative Standard Deviation Calculations

Analyst:

Sample ID:

Analysis Date:

Data path:

C:\Instarch\hplc
2\data\

Analyte	Analyte Concentration (ug/mL)						
	Parent Sample	Duplicate Sample	Triplicate Sample	Mean Conc. (ug/mL)	Standard Deviation	%RSD	Flag (>20% RSD)
HMX				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RDX				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3,5-Trinitrobenzne				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dinitrobenzene (SSTD)				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dinitrobenzene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
tetryl				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
3,5-dinitroaniline				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Nitrobenzene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2,4,6-Trinitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-amino-4,6-Dinitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-amino-2,6-Dinitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2,6-Dinitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2,4-Dinitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Nitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-Nitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
3-Nitrotoluene				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Nitroglycerin				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
PETN				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

FSV10-05 Nitroguanidine Percent RSD Template

Triplicate Sample Analysis Relative Standard Deviation Calculations

Analyst:

Sample ID:

Analysis Date:

Data path: C:\Instarch\HPLC 2\Data\

Analyte	Analyte Concentration (ug/mL)						
	Parent Sample	Duplicate Sample	Triplicate Sample	Mean Conc. (ug/mL)	Standard Deviation	%RSD	Flag (>20% RSD)
Nitroguanidine (NQ)				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1.2-Dinitrobenzene (SSTD)				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

FSV10-04
RPD Template

Analytical Run #:

Relative Percent Difference (RPD) Calculation for P-qualified 8330B Analytes by Sample Number				
Sample #	Analyte	Primary Value (ug/mL)	Confirmation Value (ug/mL)	RPD
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!
				#DIV/0!

UNCONTROLLED WHEN PRINTED

Revision Number	Description of Changes	Date
05	Document changed to incorporated administrative requirements of ISO 17025 and QSM 5.0. Descriptions of changes have not been tracked in previous versions of this document.	03/12/2014

This page intentionally left blank.

Attachment C3

Field Sampling Audit Checklist

This page intentionally left blank.

Example Checklist for Field Sampling Audit

Sampling Organization	Date of Evaluation	Name and Affiliation of Evaluator

Item to be Evaluated	Y	N	N/A	Comments
Part 1: Sampling and Analysis Plan (SAP)				
1.1 General Information				
Is there a sampling plan?				
Are there procedures for the transportation, handling, protection, storage, retention and/or disposal of samples, including all provisions necessary to protect the integrity of the sample?				
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?				
Does the sampling process address the factors to be controlled to ensure the validity of the environmental test and calibration results?				
Is there a process for documenting corrective actions taken in the field?				
1.2 Standard Operating Procedures (SOPs)				
Are there SOPs for field activities available at the location where sampling is taking place and are they accessible to all sample collectors?				
Are the SOPs official documents (e.g., signed and dated)?				
Have the SOPs been approved for the project?				
Part 2: Organization, Management & Personnel (not checked on site)				
Are the sampling personnel's qualifications and/or training certifications adequate for the tasks performed?				
Are names of all sampling personnel recorded?				
Do sampling personnel meet minimum qualifications specified in the contract?				
If the sampling organization is supporting a larger organization, are there any arrangements that could cause a conflict of interest?				
Does the sampling agency have policies or procedures to ensure client confidentiality and propriety rights?				
Are staff training records maintained and up to date?				

Item to be Evaluated	Y	N	N/A	Comments
Part 3: Equipment				
3.1 General Equipment information				
Is the type of equipment sufficient for the sampling project?				
Is the quantity of equipment sufficient for the sampling project?				
Is the following information recorded for each piece of equipment that will be used for sampling project:				
Maintenance and repair procedures for equipment or instrument?				
Routine cleaning procedures?				
Filling solution replacement for probes?				
Parts replacement for instruments or probes?				
Calendar date for each procedure performed?				
Names of personnel performing maintenance and repair tasks?				
Description of malfunctions associated with any maintenance and repair?				
Vendor service records?				
Inclusive rental dates, types and unique descriptions of rental equipment?				
Is the equipment storage procedure acceptable?				
Is there an existing QC check on sampling equipment?				
3.2 Field Instrument 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?				
Are field instruments properly calibrated and calibrations recorded in a bound field log book?				
For each instrument unit used for the sampling project, is the following information recorded for all calibrations:				
Unique identification (designation code) for the instrument?				
Date and time of each calibration and calibration verification?				
Instrument reading or result (display value) for all calibration verifications, with appropriate measurement units?				
Names of analyst performing each calibration or verification?				
Designation of each calibration standard used linked to the associated records for the calibration standard?				
The acceptance criteria for each calibration and verification standard used?				
The assay specifications or acceptance criteria for any QC standard or sample used to independently verify the calibration of the standard?				

Item to be Evaluated	Y	N	N/A	Comments
Are all corrective actions performed on the instrument prior to attempting re-verification or recalibration of the instrument linked to the records required for preventive maintenance?				
Does the field instrumentation documentation include the standard concentrations used for calibration?				
Did all field-testing equipment and instrumentation brought to the field appear to function properly?				
Are manufacturer's suggested maintenance activities and any repairs performed and documented for all applicable equipment and instruments?				
3.3 Containers				
Are sample containers well organized, properly prepared, protected from contamination, and ready for use?				
Are proper sample containers and sizes used for each type of sample?				
Are certificates of analysis for pre-cleaned bottles maintained on file?				
Are all containers and container caps free of cracks, chips, discolorations and other features that might affect the integrity of the collected samples?				
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.				
Is equipment constructed of materials appropriate for the analytes of interest?				
Is equipment brought to the field pre-cleaned?				
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?				
Are cleaning steps in all procedures used for decontamination documented either by description or reference to an SOP?				
Are there current maintenance records for all field equipment?				
Part 4: Sampling Event Information				
For all samples, is the following information recorded and transmitted to the client?				
Site name and address?				
Date and time of sample collection?				
Name of sampler responsible for sample transmittal?				
Unique field identification code for each sample container or group of containers?				
Total number of samples collected?				
Required analyses for each sample container or group of containers?				
Sample preservation used for each container or group of containers?				

Item to be Evaluated	Y	N	N/A	Comments
Comments about samples, sample sources or other relevant field conditions?				
Identification of common carrier used to transport the samples, when applicable?				
Are shipping invoices and related records from common carriers archived with the field records, when applicable?				
Are sampling locations adequately documented in a bound field log book using indelible ink?				
Are photos taken and is a photo log maintained?				
4.1 Field QC				
Are trip blanks and/or field blanks collected as specified in the approved sampling plan?				
Are field blanks collected after equipment is decontaminated in the field?				
Are field blanks collected if no equipment was cleaned by the sampling organization?				
Are additional samples for matrix spike/matrix spike duplicate analyses collected?				
Are all QC samples collected in the same manner as the routine field samples?				
Part 5: Sample Management				
5.1 Collection				
Are the samples taken from a representative point of the source?				
Are the samples homogenous where appropriate?				
When possible, does sampling originate from the suspected least contaminated location first and progress to the suspected most contaminated location?				
Are samples for different analyte groups collected in the appropriate order?				
Are samples collected for all required analyses?				
Are samples to be tested for dissolved metals filtered prior to preservation?				
Is every effort made to prevent cross-contamination of samples?				
Are gloves worn by all samplers handling purging equipment, sampling equipment, measurement equipment, and sample containers?				
Are new, clean unpowdered gloves used for each glove change?				
Is care taken to avoid contact with sample and sample container interiors?				
Are VOC sample containers protected from any fuel sources and fuel-powered equipment?				
Do VOC sample containers remain capped until just prior to sample collection and do they remain capped after sample collection?				
Where applicable, are samples collected for measurement of dissolved components, filtered, preserved with acid, and placed on ice within 15 minutes of collection?				

Item to be Evaluated	Y	N	N/A	Comments
5.2 Collection Devices				
Is sample collected using an intermediate collection device?				
Are intermediate collection devices rinsed with ample amounts of site water prior to collecting the sample?				
Is rinse water from intermediate devices discarded away from and downstream of the sampling location?				
Is the use of intermediate collection devices avoided when sampling for VOC's, oil and grease, or microbiologicals, where practical?				
Are any intermediate collection devices constructed of material appropriate for the analytes to be measured?				
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?				
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?				
Are the unique identification codes for samples recorded in a manner that links the codes to all other field records associated with the samples?				
Is waterproof indelible ink used to label containers?				
5.4 Storage				
Are samples for different parameters segregated during storage?				
Are samples stored on ice?				
Is the cooler clearly labeled?				
Are samples properly preserved (if applicable)?				
5.5 Preservation				
Do all sample preservation techniques conform to SOP or method requirements?				
Are all samples properly preserved within 15 minutes, as applicable?				
Are the preparation and dispensing of preservatives documented and traceable?				
Is preservation information and verification recorded for each sample, as applicable?				
Are samples placed on ice immediately after collection, if applicable?				
If the samples are found to contain cyanide, are they NOT acidified?				
5.6 Delivery				
Are samples protected during delivery to prevent breakage?				
Are samples shipped in a timely manner?				

Item to be Evaluated	Y	N	N/A	Comments
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?				
Are all sampling-derived waste containers properly labeled?				
Is all sampling-derived waste properly disposed of?				
5.8 Documentation				
Is waterproof ink used for all paper documentation?				
Are the date and time of sample collection recorded for all samples?				
Are the ambient field conditions recorded for all samples?				
Is a specific description of each sampling location (source) recorded?				
Does the chain of custody/traffic report include the following: date, time, sample numbers, sampler names, shipping method, number of samples, matrix, and comments?				
Is preservation information recorded on the chain of custody/traffic report?				
Are copies of traffic reports or COC sent to the proper recipients?				
Are deviations, additions, or exclusions from the documented sampling procedure recorded in detail with the associated sampling information?				
Are these deviations included in all documents containing environmental test and/or calibration results?				
Are these deviations communicated to the appropriate personnel?				
Are all errors in documentation (if applicable) corrected and initiated without obliteration?				
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?				
Are certificates of assay, grade and other vendor specifications for all standards and reagents retained and recorded for the standards and reagents?				
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?				
Are the expiration dates for all calibration standards and reagents recorded?				
Are expired standards and reagents verified prior to use during sample collection?				
Are all steps used for preparation of standards or reagents in-house documented either by description or reference to an SOP?				

Item to be Evaluated	Y	N	N/A	Comments
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?				
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?				
6.2 pH				
Are all samples requiring pH adjustment tested for proper pH preservation?				
Is at least one sample per analyte group requiring pH adjustment tested for proper preservation during repeat sampling?				
Is pH paper or a pH electrode inserted into sample containers?				
Do the pH meter and electrode system meet SOP specifications for accuracy, reproducibility and design?				
Are all measurements corrected for temperature (manual or automatic)?				
Is a pH 7 buffer used as the first calibration standard?				
For pH, do all calibration verifications meet the acceptance criteria?				
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?				
Are all sample measurements associated with acceptable calibration verifications?				
Is the pH meter system checked on a weekly basis to ensure >90% theoretical electrode slope?				
Are the field instrument probes rinsed with deionized or distilled water between standard solutions and between sample measurements?				
Are instrument pH readings allowed to stabilize before pH values are recorded?				
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?				
Unless otherwise specified, are applicable samples filtered using a 0.45-µm pore size?				
6.4 Temperature				
Do the temperature measurement devices meet SOP and/or sampling event specifications for design and measurement resolution?				

Item to be Evaluated	Y	N	N/A	Comments
Are all sample measurements associated with calibration verifications of the temperature measurement device at a minimum of two temperatures using a NIST-traceable thermometer?				
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?				
Are all temperature measurements chronologically associated with acceptable calibration verifications?				
Are the temperature device readings allowed to stabilize before measurement values were recorded?				
6.5 Conductivity				
Do the specific conductance meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?				
Do all calibration verifications meet the acceptance criterion?				
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?				
Are all conductivity measurements chronologically associated with acceptable calibration verifications?				
Are all conductivity measurements corrected for temperature (manual or automatic)?				
Is the instrument allowed to stabilize before measurement values are recorded?				
6.6 Turbidity				
Does the turbidimeter meet the SOP and/or sampling event specifications for accuracy and reproducibility?				
Are all sample measurements associated with acceptable calibration verifications?				
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?				
Are the sample cells (optical cuvettes) inspected for scratches and discarded or coated with a silicone oil mask, as necessary?				
Are the sample cells (optical cuvettes) optically matched for calibrations and sample measurements?				
Are the sample cells (optical cuvettes) cleaned with detergent and deionized or distilled water between standard solutions and between sample measurements, as applicable?				
Are the sample cells (optical cuvettes) rinsed with sample prior to filling with sample for measurement?				

Item to be Evaluated	Y	N	N/A	Comments
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?				
6.7 Dissolved Oxygen				
Do the dissolved oxygen meter and electrode system meet the SOP and/or sampling event specifications for accuracy and reproducibility?				
Are all sample measurements associated with acceptable calibration verifications?				
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?				
Are all measurements corrected for temperature (manual or automatic)?				
Are all measurements corrected for salinity, where applicable (manual or automatic)?				
Is the salinity (conductivity) sensor calibration verified?				
Is the dissolved oxygen electrode stored in a water-saturated air environment when not in use?				
Are the dissolved oxygen readings allowed to stabilize before measurement values were recorded?				

This page intentionally left blank

Attachment C4

Data Usability Assessment Form

This page intentionally left blank.

Data Usability Assessment**Name of Data Set:****Prepared By:****Date:**

Data or Measurement Quality Objective	Yes	No	Comments
Planning documents available?			
Project objectives identified?			
Sample design described?			
QA/QC procedures defined?			
Field documents available for review?			
Sample site locations/description provided?			
Sample types and numbers defined?			
Field SOPs defined?			
Field calibrations recorded?			
QC samples documented?			
COC record documents?			
Complete data packages available?			
Specified methods used and detection limits met?			
Accuracy of data appropriate?			
Precision of data appropriate?			
Representativeness of data appropriate?			
Completeness of data appropriate?			
Comparability of data appropriate?			
Sensitivity of methods appropriate?			
Do the data satisfy the project goals and meet the quality objectives?			

This page intentionally left blank

Appendix D

Accident Prevention Plan

This page intentionally left blank.

Accident Prevention Plan

**FORMER GUN AND MORTAR RANGE
(RFAAP-002-R-01)**

SITE INVESTIGATION

at

Radford Army Ammunition Plant, Virginia

August 2015

Submitted to:



**United States Army Corps of
Engineers, Baltimore District**

10 South Howard Street
Baltimore, MD 21201



Submitted by:

Bering Sea Environmental, LLC.

615 E, 82nd Avenue, Suite 200
Anchorage, AK 99518

This page intentionally left blank.

Signature Page

This plan has been prepared and reviewed as denoted by the signatures below.

Plan Preparer		
Daniel Sciarro 720-236-5104 HDR EOC Health and Safety Manager		14 Aug 2015
Plan Approval		
Stephen Coffee 303-754-4200 HDR Certified Industrial Hygienist		14 Aug 2015
Plan Concurrence		
Sarah Skrobialowski 757-604-1173 BSEn Project Manager		14 Aug 2015

This page intentionally left blank

TABLE OF CONTENTS

Signature Page.....	i
1.0 General Information.....	1-1
1.1 Background.....	1-1
1.1.1 Project Description.....	1-1
1.1.2 Objective.....	1-5
1.1.3 Contractor Accident Experience.....	1-5
1.1.4 Phases of Work.....	1-6
2.0 Statement of Safety and Health Policy.....	2-1
2.1 Project Health and Safety Compliance Program.....	2-1
3.0 Lines of Authority.....	3-1
3.1 Identification and Accountability of Personnel.....	3-1
3.1.1 Project Manager.....	3-1
3.1.2 Site Safety and Health Officer.....	3-2
3.1.3 Health and Safety Manager.....	3-2
3.1.4 BSEn Corporate Safety Officer.....	3-3
3.1.5 Employees.....	3-3
3.2 Lines of Authority Regarding Safety.....	3-3
3.3 Updates and Revisions.....	3-3
4.0 Subcontractors and Suppliers.....	4-1
4.1 Means for Controlling and Coordinating Subcontractors.....	4-1
4.2 Safety Responsibilities of Subcontractors.....	4-1
5.0 Training.....	5-1
5.1 Safety Indoctrination.....	5-1
5.2 Mandatory Training and Certificates.....	5-1
5.2.1 OSHA HAZWOPER Training.....	5-1
5.2.2 OSHA 8-hr HAZWOPER Supervisory Training.....	5-2
5.2.3 Site Safety and Health Officer Training.....	5-2
5.2.4 First Aid, CPR Training and Blood-borne Pathogen Training.....	5-2
5.2.5 Project Visitors.....	5-3
5.3 Emergency Response Training.....	5-3
5.4 New Hire Orientation.....	5-3
5.5 Project Indoctrination.....	5-5
5.6 Safety Meetings.....	5-6
5.7 Tailgate Safety Meetings.....	5-6
5.8 Procedures for Periodic Safety and Health Training for Supervisors and Employees.....	5-6
6.0 Safety and Health Inspections.....	6-1
6.1 Daily Safety and Inspection Log.....	6-1
7.0 Safety and Health Expectations and Compliance.....	7-1
7.1 Radford SI Project-Specific Safety Goals, Objectives, and Expectations.....	7-1
7.2 Stop Work Order.....	7-1

7.3	On-Site Reporting of Unsafe Conditions/Practices	7-2
7.4	Policies and Procedures Regarding Noncompliance with Safety Requirements	7-2
7.5	Company Procedures for Holding Managers and Supervisors Accountable for Safety	7-3
8.0	Accident Reporting	8-1
8.1	Exposure Data (Person-Hours Worked)	8-2
8.2	Accident Investigations, Reports, and Logs	8-2
9.0	Safety Plans.....	9-1
9.1	Emergency Response Plan.....	9-4
9.1.1	Procedures and Tests.....	9-4
9.1.2	Pre-Emergency Planning	9-4
9.1.3	Personnel Lines of Authority for Emergency Situations	9-5
9.1.4	Procedures for Emergency Recognition and Site Evacuation	9-5
9.1.5	Decontamination and Medical Treatment of Injured Personnel	9-6
9.1.6	Emergency Medical Facilities.....	9-6
9.1.7	Material Safety Data Sheets/Safety Data Sheets	9-9
9.1.8	Criteria for Alerting Local Community Responders	9-9
9.1.9	Emergency Responders Escort Requirements	9-9
9.1.10	Emergency Telephone Locations and Protocol	9-9
9.1.11	Critique of Response and Follow up.....	9-10
9.1.12	Emergency Response Plan Tests	9-10
9.2	Fire Fighting Plan	9-11
9.3	Alcohol and Drug Abuse Prevention Plan.....	9-11
9.4	Site Sanitation Plan	9-12
9.4.1	Housekeeping.....	9-12
9.4.2	Material Storage.....	9-12
9.4.3	Material Disposal	9-12
9.4.4	Drinking Water	9-13
9.4.5	Toilet Facilities	9-13
9.4.6	Washing Facilities.....	9-13
9.5	Medical Support.....	9-13
9.5.1	Medical Surveillance	9-14
9.5.2	Injury and Illness.....	9-14
9.5.3	Emergency Medical Communications.....	9-15
9.5.4	First Aid and CPR.....	9-15
9.5.5	Recordkeeping	9-16
9.6	Blood-borne Pathogens	9-16
9.6.1	Blood-borne Pathogens Exposure Control Plan	9-17
9.6.2	Hand-washing Provisions	9-17
9.6.3	Cleaning Equipment.....	9-18
9.6.4	Contaminated Sharps	9-18
9.6.5	Blood-borne Pathogens Exposure Personal Protective Equipment	9-18
9.6.6	Housekeeping.....	9-19
9.6.7	Regulated/Clinical Waste Disposal.....	9-20
9.6.8	Hepatitis B Vaccine	9-20

9.6.9	Declining Vaccination	9-21
9.6.10	Recordkeeping	9-21
9.6.11	Delayed Vaccination Request	9-21
9.6.12	Post-Exposure Evaluation and Follow-up.	9-21
9.6.13	Interaction with Health Care Professionals.....	9-22
9.6.14	Training.....	9-22
9.7	Wild Land Fire Prevention Plan	9-23
9.8	Hazard Communication Plan	9-24
9.8.1	General HAZCOM Plan Requirements	9-24
9.9	Respiratory Protection Plan	9-28
9.10	Health Hazard Control Program	9-28
9.11	Severe Weather Plan	9-29
9.11.1	Severe Weather Monitoring and Prevention.....	9-29
9.12	Lightning.....	9-29
9.13	Emergency Planning	9-30
9.13.1	Communication.....	9-30
9.13.2	Daily Schedule.....	9-31
9.14	Fire Prevention.....	9-31
9.14.1	Portable Fire Extinguisher Use	9-32
9.14.2	Fire Extinguishers Inspection Procedure	9-33
9.15	Personal Protective Equipment	9-34
9.15.1	Maintenance of PPE.....	9-35
9.15.2	Wet Weather	9-35
9.15.3	Personal Protective Equipment by Task	9-35
9.15.4	Personal Protective Equipment Training	9-38
9.15.5	Record Keeping	9-38
10.0	References.....	10-1

Tables

Table 1-1	Summary of BSEn's Accident Experience	1-5
Table 1-2	Summary of HDR's Accident Experience.....	1-6
Table 3-1	Project Personnel	3-1
Table 4-1	Subcontractors.....	4-1
Table 9-1	Applicability of Safety Plans	9-1
Table 9-2	Emergency Reference List.....	9-10
Table 9-3	Minimum Contents of First Aid Kit.....	9-16
Table 9-4	PPE Specifications	9-36

Figures

Figure 1-1	Property Location Map, Former Gun and Mortar Range (RFAAP-002-R-01) .1-3
Figure 9-1	Directions to Carilion New River Valley Medical Center.....9-7

Attachments

- A. Site Specific Health and Safety Plan
- B. Activity Hazard Analyses
- C. Health and Safety Forms
- D. Health and Safety Personnel Qualifications and Resumes
- E. Material Safety Data Sheets/Safety Data Sheets

Acronyms and Abbreviations

°F	degrees Fahrenheit
AAP	Army Ammunition Plant
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
ANSI	American National Standards Institute
BBP	Blood-borne Pathogen
BSEn	Bearing Sea Environmental, LLC
CDC	Center of Disease Control
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
COR	Contracting Officer Representative
CP	Competent Person
CPR	Cardiopulmonary Resuscitation
CWM	Chemical Warfare Materiel
DFARS	Defense Federal Acquisition Regulation Supplement
EAP	Emergency Action Plan
ECP	Exposure Control Plan
EMR	Experience Modification Rate
EMS	Emergency Medical Services
F-B	flash to bang
ft	feet/foot
GPS	Global Positioning System
HAZCOM	Hazard Communication
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV	Hepatitis B Virus
HDR EOC	HDR Environment, Operations and Construction, Inc.
HDR	HDR, Inc.
HIV	Human Immunodeficiency Virus
hr	hour
HPC	Hepatitis C
H&S	Health and Safety
HSM	Health and Safety Manager

IAW	in accordance with
lb	pound
MC	Munitions Constituents
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PASS	Pull, Aim, Squeeze, and Sweep
PM	Project Manager
PPE	Personal Protective Equipment
SDS	Safety Data Sheet
SI	Site Investigation
SOH	Safety and Occupational Health
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers
UXO	Unexploded Ordnance

1.0 General Information

Accident prevention is a primary focus for Bering Sea Environmental, LLC (BSEn), as well as a recognized responsibility in which we achieve compliance and strive toward the ultimate goal of zero safety accidents or incidents. All personnel working under the Site Investigation (SI) Accident Prevention Plan (APP) will be thoroughly familiar with the programs, plans, and procedures outlined in this APP prior to conducting work at the site.

This APP will be a living document and will be administrated by the designated management identified in this APP during the duration of this project. In addition, it shall be dually noted that there is an official overall requirement that no work by the contractor (BSEn) or subcontractors shall be performed unless the Competent Person (CP)/Site Safety and Health Officer (SSHO) is present on the job site, in accordance with (IAW) EM 385-1-1 Appendix A 03.d.7 and 03.d.1 (USACE, 2014).

BSEn has the ultimate responsibility for the implementation of this Safety and Occupational Health (SOH) program for its own employees, all subcontractors, and all others on the work site, to include the strict enforcement of the outlined programs and plans herein.

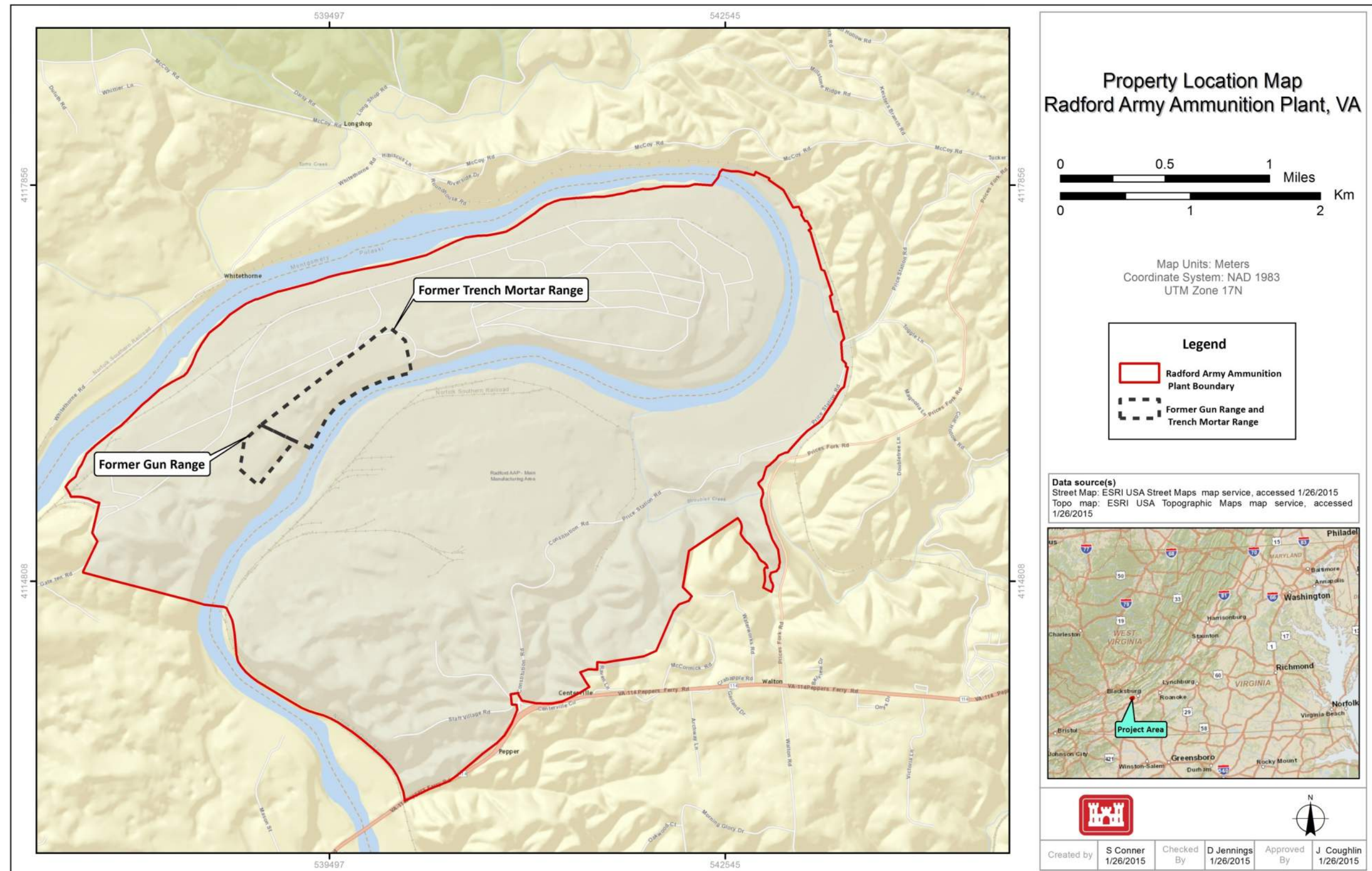
1.1 Background

1.1.1 Project Description

BSEn was issued Contract Number W912QR-13-D-0001, Task Order 0001, which includes a SI of the Former Gun and Mortar Range (RFAAP-002-R-01) at Radford Army Ammunition Plant (AAP), Virginia, in support of the Military Munitions Response Program (MMRP). The Former Gun and Mortar Range (RFAAP-002-R-01) is shown on **Figure 1-1**. SI fieldwork is presently scheduled for September, 2015 and expected to last two weeks. This APP is Appendix D of the SI Work Plan for the Former Gun and Mortar Range (RFAAP-002-R-01). Descriptions of the SI fieldwork are provided in the SI Work Plan. This SI includes visual surveys and sampling of surface soils for munitions constituents. BSEn has contracted HDR, Inc. (HDR) to assist in the performance of the field effort.

This page intentionally left blank

Figure 1-1 Property Location Map, Former Gun and Mortar Range (RFAAP-002-R-01)



This page intentionally left blank.

1.1.2 Objective

The objective of this task order is to perform an SI for munitions and explosives of concern (MEC) and munitions constituents (MC) for the Former Gun and Mortar Range (RFAAP-002-R-01) of Radford AAP. BSEn has prepared this APP to address all on-site work performed by BSEn and its subcontractors. The APP describes protocols necessary for the anticipation, recognition, evaluation, and control of hazards associated with the SI. This APP defines the requirements and designates protocols to be followed during the Radford SI. Applicability of this APP extends to all personnel and visitors inclusive of client personnel and representatives. Through careful planning and implementation of corporate and site-specific health and safety (H&S) protocols, BSEn/HDR will strive for zero accidents and incidents.

1.1.3 Contractor Accident Experience

A company's commitment to safety and its overall management expertise may be measured by an indicator rate originally developed by the insurance industry to calculate policy premiums. Insurance companies refer to this competency indicator as the Experience Modification Rate (EMR). The EMR for a company is a computation that compares a company's annual losses in insurance claims against its policy premiums over a 3-year period, excluding the most current year.

Table 1-1 contains a summary of the accident experience information for BSEn, and **Table 1-2** contains a summary of the accident experience information for HDR, BSEn's prime subcontractor.

Table 1-1 Summary of BSEn's Accident Experience

	2014	2013	2012
Experience modifier rate	0.79	0.83	0.9
Fatalities	0	0	0
Recordable Injury/Illness Rate	0.56	2.49	0.00
Lost Workday Incident Rate	0.00	0.00	0.00
Total Hours Worked	357,505	241,054	265,450

Table 1-2 Summary of HDR's Accident Experience

	2014	2013	2012
Experience modifier rate	0.73	0.70	0.67
Fatalities	0	0	0
Recordable Injury/Illness Rate	0.53	0.57	0.52
Lost Workday Incident Rate	0.06	0.14	0.16
Total Hours Worked	13,295,442	14,349,975	14,315,381

1.1.4 Phases of Work

The phases of the work under at the Radford AAP, Virginia and will include the following:

- Mobilization/ Demobilization
- MEC Inspection Activities
- Quality Control Activities
- Motor Vehicle Operations
- Operating Geophysical Instruments
- Sampling and Analysis Activities

2.0 Statement of Safety and Health Policy

It is the policy of BSEn to provide a safe and healthy workplace for all of our employees and subcontractors. BSEn feels that all accidents are preventable and that safety is a team effort involving all the workforce, supervisors, and management. All BSEn operating locations and working personnel shall maintain the highest commitment to employee H&S. BSEn is equally committed to protecting the client, public property, and our environment from events which could cause harm or economic losses due to BSEn operations. The H&S of every employee and the preservation of a clean environment are fundamental considerations in every business decision and plan and all reasonable precautions will be taken to protect employees from injury and illness.

No operation is so important that it must be done in a manner which permits an unacceptable hazard to personnel, property, clients, or visitors. Safety is a team effort, which must be implemented through the cooperative efforts of management and employees. Therefore, no SI work shall be performed unless the designated competent people outlined in this APP are present and on-site, specifically the CP/SSHO.

2.1 Project Health and Safety Compliance Program

Compliance with the requirements of applicable federal and state laws will be accomplished through a combination of written programs, employee training, workplace monitoring, and system enforcement. BSEn and their prime subcontractor HDR regular inspections by supervisors and H&S personnel, and the culture of ownership and total involvement in the H&S program, will produce an atmosphere of voluntary compliance. However, disciplinary action for violations of project requirements will be taken, when necessary.

The safe and efficient work practices of this company require a spirit of teamwork and cooperation from all employees. Also required are uniform standards of expected behavior. Employees who refuse or fail to follow the standard set forth by this Plan, the Corporate H&S Program, and/or regulatory standards, will subject themselves to disciplinary action up to and including discharge. In cases not specifically mentioned, employees are expected to use good judgment and to direct any questions to their supervisors.

The purpose of this APP is to establish site-specific H&S procedures, practices, and equipment to be implemented and used to protect personnel from the potential hazards associated with the field activities to be performed at the project sites. The APP assigns responsibilities, establishes standard operating procedures (SOPs), and provides for contingencies that could arise while operations are being conducted during the site evaluation.

This page intentionally left blank

3.0 Lines of Authority

All personnel are responsible for continuous adherence to this APP and H&S procedures during the performance of their work. The project personnel identified in the sections below have been designated as competent persons and will assume the authority and responsibility of their assignments herein.

3.1 Identification and Accountability of Personnel

The responsibility for H&S extends from top management to every employee. For this reason, it is each person's duty to notify the SSHO and Project Manager (PM) when a hazardous condition is identified and to make a "stop work" call if the condition represents an immediate danger to life or health, until the SSHO and PM can make a further determination. **Table 3-1** provides the project personnel, their lines of authority, and contact information. Their responsibilities are described in the subsequent paragraphs.

Table 3-1 Project Personnel

Name	Position	Telephone	E-mail
Sarah Skrobialowski	Project Manager	757-604-1173	sskrobialowski@bsenv.com
Daniel Sciarro	HDR EOC Health and Safety Manager (HSM)	720-236-5104	daniel.sciarro@hdrinc.com
Stephen Coffee	HDR Certified Industrial Hygienist (CIH)	303-754-4200	stephen.coffee@hdrinc.com
Darren Harbeck	SSHO/UXO Technician III	303-358-1823	darren.harbeck@hdrinc.com

3.1.1 Project Manager

The PM directs and manages all aspects of the project in compliance with all contract and technical requirements. The PM's responsibilities include serving as the primary liaison for all H&S efforts with the HSM. The PM prepares all correspondence, submittals, and other documentation required for the project and coordinates, schedules, and administers the contract. The PM prepares reports and documentation, supervises inspection personnel, and reviews and approves procurement and subcontract activities.

The PM implements corporate H&S policy and implements the SI APP. The PM may request assistance from corporate resources at any time. He or she is specifically responsible for the following:

- Implementing H&S training requirements at the site. This includes weekly tailgate safety meetings and all applicable formal employee H&S training.
- Immediately reporting to the HSM and the client any incident that results in serious injury or death.

3.1.2 Site Safety and Health Officer

The SSHO shall be responsible for the implementation of this APP and ensure that the planned work objectives reflect adequate H&S considerations. The SSHO will perform site-specific training and briefing sessions for employee(s) prior to the start of field activities at the site and a briefing session each day before starting work. He/she will ensure the availability, proper use, and maintenance of specified personal protective equipment (PPE), decontamination, and other H&S equipment. The SSHO will be present at the site full-time for the duration of field activities and will be responsible for the following:

- Maintaining a high level of H&S awareness among team members and communicating pertinent matters to them promptly.
- Ensuring site compliance with specified H&S requirements and all aspects of the APP. This includes, but is not limited to, use of PPE, decontamination, site control, SOPs used to minimize hazards, safe use of engineering controls, the emergency response plan, spill containment program, and preparation of records.
- Conducting daily safety inspections and record any H&S related issues.
- Stopping work activities if unacceptable health or safety conditions exist and take necessary action to reestablish and maintain safe working conditions.
- Consulting and coordinating any modifications to the APP with the HSM and the PM.
- Conducting accident investigations and prepare accident reports.
- Supervising all site activities.
- Coordinating with the PM and HSM on safety-related matters.
- Determining evacuation routes.
- Presenting daily safety meetings.
- Maintaining logs and records in the field.
- Implementing changes to the APP as directed by the HSM.

Due to the potential MPPEH and MEC hazards at the Former Gun and Mortar Range (RFAAP-002-R-01), the designated SSHO for this SI is qualified as a UXO Technician III or greater, as defined in DDESB TP-18 (DDESB, 2004). As a UXO Technician III, the SSHO will be responsible for implementing anomaly avoidance procedures, as discussed in **Section 9.0** of the SI WP. Certifications supporting the SSHO's qualifications as a UXO Technician III are included in **Attachment D**.

3.1.3 Health and Safety Manager

Responsibilities of the HSM will include the following:

- Overseeing the development and approval of the SI APP.
- Being available for consultation during emergencies.

- Providing consultation as needed to ensure that the APP is fully implemented.
- Coordinating any modifications to the APP with the PM.
- Providing personnel with support for upgrading/downgrading of the level of personal protection.
- Coordinating changes to engineering controls, work practices, and PPE in coordination with the PM's objectives and with concurrence and approval of the plan CIH.

3.1.4 BSEn Corporate Safety Officer

The BSEn Corporate Safety Officer is responsible for the review of the APP and to be available to recommended changes submitted to the HSM, PM, and government's Contracting Officer for final approval. The BSEn Corporate Health and Safety Officer is Brandon Wheeler. The Corporate Safety Officer will report, review, and analyze all incidents IAW **Section 8.0** of this APP. The BSEn Corporate Safety Officer may conduct periodic audits of this project safety plan during the course of contract work on this site.

3.1.5 Employees

Each employee shall ensure that all aspects of the APP are complied with on a daily basis. Only one verbal warning shall be given to individuals not complying with the APP.

3.2 Lines of Authority Regarding Safety

It is important for each employee involved with the project to know and understand the lines of authority. The organizational structure of supervisory personnel for this project is outlined in the Radford SI Work Plan. All personnel will be informed of this organizational structure during the training phase of the project. A final copy of the organizational chart will be posted in the field office or field vehicles in order to provide quick references to anyone needing to report or make suggestions regarding safety issues.

3.3 Updates and Revisions

The development and preparation of this APP has been based on site-specific information provided to BSEn/HDR. Should any unforeseen hazard become evident during the performance of the work, the PM shall bring such hazard to the attention of the HSM, both verbally and in writing, for resolution as soon as possible. In the interim, BSEn/HDR will take necessary actions to maintain safe working conditions in order to safeguard on-site personnel, visitors, the public, and the environment. No changes to the APP will be allowed until the item has been reviewed and an addendum prepared and approved by the HSM. Changes to the APP will be documented and approved by the PM and the HSM. The approval will be accompanied by a formal addendum to the APP.

This page intentionally left blank.

4.0 Subcontractors and Suppliers

Prior to subcontract work being performed, BSEn will prepare and negotiate a subcontract that will identify the scope of services and appropriate terms and conditions. **Table 4-1** details the subcontractors anticipated to supply equipment or render services to personnel working on the project site. All services and vendors will be selected based on government-approved procurement procedures through the BSEn procurement specialist; therefore, the actual subcontractors used may vary from those identified in **Table 4-1**.

Table 4-1 Subcontractors

Subcontractor	Service Provided
HDR, Inc. 8404 Indian Hills Drive Omaha, NE 68114 (402) 399-1000	Services in support of the data gap analysis

4.1 Means for Controlling and Coordinating Subcontractors

Each subcontractor is required to abide by all site H&S regulations and have their own safety plan that addresses the hazards associated with the work that they are being subcontracted to perform. BSEn/HDR will work closely with each subcontractor to ensure that they are aware of the H&S regulation(s) that apply to the work site, and that their safety plan includes adequate hazard mitigation procedures.

4.2 Safety Responsibilities of Subcontractors

All subcontractor personnel arriving on-site to conduct business or provide a service will first attend an initial site-specific safety briefing. If returning to the site, the individual will be required to register and sign in before beginning work. The site-specific safety briefing will inform the individual of the policies and regulations that apply to the subcontractor while on-site. The briefing will also include hazards associated with the individual's area of work, as well as hazards specific to the site. Documentation of the subcontractor's attendance will be generated and the personnel involved will agree to abide by all site regulations.

Subcontractor personnel must report all accidents, fires, injuries, illnesses, and spills immediately to the SSHO. In addition, subcontractors are required to inspect work sites daily for safety deficiencies and correct all deficiencies.

This page intentionally left blank.

5.0 Training

5.1 Safety Indoctrination

Safety indoctrination will be conducted for any personnel who are expected to work on-site for more than one day. Training will be conducted prior to the job start-up and as needed thereafter. The SSHO will conduct initial site-specific training prior to job start-up to ensure that employees have a thorough understanding of the APP and physical, safety, biological, and chemical hazards of the site.

At the completion of safety indoctrination, all employees will be required to sign a form that states they have received site-specific training, and read, understood, agreed with, and will abide by the H&S procedures outlined in the APP. **Attachment C** contains a Plan Acknowledgement form.

5.2 Mandatory Training and Certificates

Field personnel working on this project must be trained in the following:

- HDR General Safety Awareness;
- 40-hour (hr) Hazardous Waste Operations and Emergency Response (HAZWOPER), Initial and current 8-hr refresher;
- 8-hr HAZWOPER Supervisor Training (On-site Supervisors);
- Unexploded Ordnance (UXO) Awareness;
- Defensive Driving;
- Hand Tool Safety;
- Ergonomics;
- Slips, Trips, and Falls;
- Radford AAP APP/Site Safety and Health Plan (SSHP)/Activity Hazard Analysis (AHA).

5.2.1 OSHA HAZWOPER Training

All personnel doing on-site work that will expose them to contaminant-related H&S hazards must comply with training requirements 29 Code of Federal Regulations (CFR) 1910.120 (Occupational Safety and Health Administration (OSHA, 2009)) and 29 CFR 1926.65 (OSHA, 2011a). The HAZWOPER training requirements (40-hr initial HAZWOPER, three-day supervised field experience, 8-hr annual refresher) are applicable to the SI work at Radford AAP. Only HAZWOPER-trained personnel will be used for field work for this project.

5.2.2 OSHA 8-hr HAZWOPER Supervisory Training

All managers and supervisors, directly responsible for, or who supervise employees engaged in hazardous operations are required to have an additional 8 hours of specialized training IAW 29 CFR 1910.120 (OSHA, 2009). Site supervisory personnel shall receive specialized training in which the following subjects are discussed in detail:

- Work Plan Development;
- Overall H&S Program;
- PPE Program;
- Spill Containment Program;
- Hazard Communication (HAZCOM) Program IAW 29 CFR 1910.1200 (Health Hazard Monitoring Procedures and Techniques) (OSHA, 2011c).

5.2.3 Site Safety and Health Officer Training

The SSHO, as a minimum, must produce a copy of their instructor-signed OSHA 30-hr training card (or proof of course completion if within 90 days of having completed the training and card has not yet been issued).

They will have completed:

- The 30-hr OSHA Construction Industry safety class (may be web-based training if the student is able to directly ask questions of the instructor by chat or phone), or
- As an equivalent, formal construction or industry H&S training covering the subjects of the OSHA 30-hr course and the EM 385-1-1 (USACE, 2014) as covered in Appendix A, Paragraph 2.d.(3) applicable to the work to be performed and given by qualified instructors (may be web-based training if the student is able to directly ask questions of the instructor by chat or phone).

5.2.4 First Aid, CPR Training and Blood-borne Pathogen Training

Personnel assigned to conduct fieldwork for this project do not conduct first aid or Cardiopulmonary Resuscitation (CPR) as a primary job function. Rather, selected employees have been trained in CPR and first aid for emergency use only.

Acting in the capacity of a designated emergency first aid provider is not mandatory, and anyone who is uncomfortable with the possibility of being so designated should notify the SSHO.

IAW EM 385-1-1 (USACE, 2014), at least two persons currently certified in CPR and first aid shall be present on-site at all times during site operations. The SSHO and Supervising Team Leads (supervisors) will all have First Aid and CPR training. The training will be equivalent to that provided by the American Red Cross. Personnel trained in First Aid and those expected to

administer First Aid will receive training in controlling exposures to blood-borne pathogens (BBPs). In addition, project staff has immediate access to an Occupational Physician and Occupational Nurse via phone to aid in providing immediate first aid treatment for minor injuries.

The SSHO will institute the BBP Exposure Control Plan (ECP) during site operations for controlling exposures to BBP. The SSHO shall ensure site staff understand the provisions for engineering and administrative controls, Hepatitis B vaccinations, PPE training, record keeping and a Post-ECP in the event of a BBP exposure.

A Post-ECP shall be instituted through requiring immediate medical attention per the recommendations from the Center of Disease Control (CDC) for human immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C (HPC) per EM 385-1-1 03.A.05.c (USACE, 2014). The ECP is located in **Section 9.6.1**.

5.2.5 Project Visitors

When a visitor arrives on-site, a site-specific visitor training will be given by the SSHO. The visitor training will include:

- Location and description of potential hazards and risks;
- Required on-site PPE;
- Location and description of areas that are closed to visitors and the reason why;
- Emergency evacuation and assembly points.

5.3 Emergency Response Training

First aid and CPR training will be required for emergency response. At least two employees per work area will be certified in first aid and CPR. In addition, project staff has immediate access to an Occupational Physician and Occupational Nurse via phone to aid in providing immediate first aid treatment for minor injuries.

Prior to commencement of the project, all site personnel will review and discuss the posted emergency telephone numbers, directions to the nearest hospital, identify the location of first aid kits and BBP kits, and review the emergency procedures. During the project the emergency response plan may be tested with an emergency drill, walk through of emergency response procedures, or additional training to review procedures.

5.4 New Hire Orientation

Newly hired employees will receive the training listed above prior to mobilizing to the job site. In addition, they will receive New Hire H&S Orientation to meet the requirements for new hire SOH orientation training at the time of initial hire of each new employee IAW EM 385-1-1 Appendix A 03.f.1 (USACE, 2014).

All BSEn training will be sent to the employees training files and the employee's supervisor shall ensure the employee is under adequate supervision until the new hire has completed the formal orientation. BSEn is committed to providing employees with a safe and healthy workplace. The safety department has developed an approach to prevent accidents and injuries, and provide a safe working environment for new employees. To accomplish this, both management and employees are required to implement the policy. In order to follow the policy, however, it is essential that new employees become aware of its existence, and the availability of safety related materials and equipment. Through implementation of this new hire orientation, new employees will receive safety orientation training and information on the structure of the safety approach for which their responsibilities and the companies apply, whether that is at the corporate facility or at a new field project.

The following duties must be completed for each new employee:

- Establish H&S training record for the new employee.
- Provide H&S orientation training to the new employee.
- Update employee H&S training record to reflect orientation training.
- Identify employee H&S training needs which are essential to the new employee's current or immediate future assignments.
- Schedule the new employee for the identified training topics.
- Complete the New Employee H&S Orientation Checklist provided in the Attachments to document the H&S orientation of each new employee.

New Employees are required to:

- Provide H&S training history and documentation from previous employers to their supervisors and or the project SSHO (or other, as decided by the HSM) to eliminate unnecessary re-training.

Education or experience may meet some of the training requirements. If applicable, the new employee should provide documentation of the education or experience that meets a specific H&S training requirement. Written documentation is required if prior training is to be accepted by the HSM; in addition applicable SSHOs must approve acceptance of prior training.

- Attend orientation training and any specific training assigned by the HSM.
- Sign and date the New Employee H&S Orientation Checklist to acknowledge completion of the new employee safety orientation and comprehension of the information and training provided.

The designated employee responsible for meeting with the new employee shall provide the following information and training to the new employee:

- Location and contents of the safety equipment storage area (if any).

- Location of the H&S Manual.
- Discussion of disciplinary policy of the H&S Manual.
- Brief awareness training on the Emergency Action Plan (EAP) or Health and Safety Plan or APP/SSHP. The employee will receive a copy of the EAP/APP/SSHP, given details on evacuation routes and location for safety areas for natural/weather related disasters. Emphasize that the EAP/APP/SSHP should be read at their earliest convenience.
- Location of the Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS) for chemicals at the site. Instruct the employee not to bring new chemicals into the field or workplace without consulting the HSM or SSHO.
- Evaluate and document any H&S training from previous employers.
- Identify training needs of new employee, based on expected assignments.
- Inform the employee of the current schedule for awareness training, and the location where the awareness training is held.

5.5 Project Indoctrination

Prior to the start of the project, all personnel will participate in an initial indoctrination safety meeting to review and discuss the APP. The SSHO will ensure that the anticipated site hazards are summarized and explained to all personnel and that all personnel are aware of the precautions necessary to minimize their exposure to each specific hazard.

The following subjects will be discussed during the site safety indoctrination meeting:

- Lines of authority;
- Phases and sequence of work;
- Safe work practices;
- Work site communication;
- Potential chemical, physical, and biological hazards;
- Hazard controls;
- Contaminants known to be associated with all phases of work;
- Required PPE;
- Equipment used;
- Site control;
- Decontamination procedures;
- Emergency Response Plan;
- Access, egress, and evacuation routes;

- Emergency notifications;
- Route to hospital;
- Field forms and job site postings.

5.6 Safety Meetings

All members of the field team will attend a pre-field kick-off safety meeting. A Safety Kick-off Meeting Form (**Attachment C**) will be completed prior to field work listing all Radford SI team members who have been given the safety kick-off briefing and to ensure all team members are qualified to perform the intended tasks. A daily log listing team members and any potential safety problems will be maintained in the field supervisor log book.

5.7 Tailgate Safety Meetings

Tailgate safety meetings will also be conducted prior to the start of field work each day. Topics discussed during the daily tailgate meetings will include, but will not be limited to:

- The type of activity that will be conducted that day;
- Team assignments and proper techniques and requirements for the day's activities;
- Review the appropriate AHAs;
- Expected work conditions (i.e. precipitation, extreme temperatures, etc.).

The topics covered during the tailgate meeting will be recorded on the Daily Safety Meeting Form (**Attachment C**). Field personnel in attendance will also be listed.

5.8 Procedures for Periodic Safety and Health Training for Supervisors and Employees

Mandatory requirements for periodic H&S training for supervisors and employees will be based on job description, project function, tasking, accountability, and authority. Supervisors and employees alike shall keep up training and certificates that are applicable to their job scope and the requirements of this project (i.e. vehicle operators, HAZWOPER certifications, CPR, First Aid, etc.) and the requirements that accompany their refresher or recertification training. The SSHO shall be responsible for the implementation of periodic H&S training and record retention on-site and shall also ensure that the planned work objectives are conducted with staff reflecting adequate and current H&S training certificates. The SSHO will perform site-specific training and briefing sessions as needed for supervisors and employee(s) as directed by the HSM. Prior to the start of any field activities at the site a tailgate safety session will reinforce this requirement with the on-site team.

6.0 Safety and Health Inspections

6.1 Daily Safety and Inspection Log

The SSHO will conduct daily safety inspections. Safety inspections are conducted by physically walking around the work areas and observing conditions for routine and emergency access, evacuation technique, PPE, work practices, site access control, first aid equipment, firefighting equipment, and sanitation. The inspections may include conversations with personnel. All site personnel will be expected to recognize H&S related issues that could arise during the conduct of the daily site activities.

Any H&S related issues must be noted on a daily basis in the SSHO daily field notes and the Hazard Reporting Form and Corrective Action Report Form located in **Attachment C**. If deficiencies in H&S are noted, they will be recorded in the daily field notes and will be corrected immediately. Project personnel will be responsible for notifying the SSHO and PM of any deficiencies noted. Information included for recording H&S issues include recording the date the safety deficiency was noted, a description of the deficiency, the name of the person responsible for correcting the deficiency, a projected resolution date, and a final resolution date.

This page intentionally left blank.

7.0 Safety and Health Expectations and Compliance

The Corporate Health and Safety Program has been developed and implemented to establish policies intended to ensure that all operating locations and working personnel maintain the highest commitment to safety, health, and to the environment.

7.1 Radford SI Project-Specific Safety Goals, Objectives, and Expectations

The safety goals for the SI at Radford AAP are to achieve the following:

- 100% compliance with this APP by all site personnel;
- Zero OSHA recordable incidents;
- Zero lost-time incidents;
- Zero chargeable vehicle incidents;
- No adverse impacts to public health or the environment from site activities.

7.2 Stop Work Order

All Radford SI employees have the authority and the responsibility to stop work in the event any employee observes unsafe conditions or failure of the subcontractor to adhere to its safe work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the employee or subcontractor of their responsibilities for the means and methods of the work or any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the employee or subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, any employee can and should immediately stop work and alert all affected individuals. Remove all affected employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM and SSHO.

When repeated non-compliance or unsafe conditions are observed, notify the employee's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (**Attachment C**) until adequate corrective measures are implemented. Consult the SSHO to determine what the contract dictates for actions to pursue in event of non-compliance including work stoppage.

7.3 On-Site Reporting of Unsafe Conditions/Practices

Responsibility for effective H&S management extends to all levels of the project and requires good communication between employees, supervisors, and management. Accident prevention requires a pro-active policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the safety of our projects staff, visitors, equipment, or the environment.

All unsafe conditions or unsafe practices will be corrected immediately. HDR/BSEn has zero tolerance of unsafe conditions or unsafe practices. No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition.
- The unsafe condition or practice will be brought to the attention of the worker's direct supervisor unless the unsafe condition or practice involves the employee's direct supervisor. If so, the SSHO needs to be notified at once by the responsible employee.
- Either the responsible employee or responsible employee's direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SSHO and PM.
- The SSHO or PM will act promptly to correct the unsafe condition or practice.
- Details of the incident or situation will be recorded by the employee in the field logbook.

7.4 Policies and Procedures Regarding Noncompliance with Safety Requirements

BSEn strives to provide employees with a safe and healthful place to work. Employees are expected to comply with company rules and regulations in a joint effort to achieve this goal. Failure to comply with rules and procedures outlined in this APP, and in the Corporate H&S Program Manual, will result in progressive disciplinary action; including verbal and written warnings which may lead to suspension or discharge. If an employee is found to be grossly negligent, immediate discharge will result.

Any employee who has caused an accident because of gross negligence, carelessness, or horseplay may be suspended or terminated. In the event of discrepancies between directives in this APP and the Corporate H&S Program Manual, directives in this APP take precedence.

7.5 Company Procedures for Holding Managers and Supervisors Accountable for Safety

Managers and supervisors are responsible for the safety of operations under their control. The safety performance of their projects will be evaluated during monthly project reviews as well as during their annual performance evaluation. Managers and supervisors will be thoroughly trained in hazard recognition and control. Failure to ensure compliance with the rules and procedures outlined in the Corporate H&S Program Manual or this APP will result in progressive disciplinary action, including verbal and written warnings that may lead to suspension or discharge.

This page intentionally left blank.

8.0 Accident Reporting

This section provides the procedures to be followed for implementing the accident reporting provisions of EM 385-1-1 1.D.04 and 1.D.05 (USACE, 2014) and applies to all activities performed for this project. An Accident Reporting Form is provided in **Attachment C**.

All accidents will be reported to the United States Army Corps of Engineers (USACE) Baltimore District PM as soon as possible, but no more than 24 hours following the accident. BSEn/HDR will thoroughly investigate the accident and submit the findings of the investigation along with appropriate corrective actions to the Contracting Officer Representatives' (COR) Chief of Baltimore Safety and Occupational Health Office as soon as possible, but no later than five working days following the accident. Accidents will be reported to USACE using ENG Form 3394, located in **Attachment C**.

Accidents meeting any of the following criteria are required to be reported within 24 hours IAW EM 385-1-1 (USACE, 2014):

- 1) Property damage, where damage exceeding \$5,000.00 is a recordable incident;
- 2) Injuries resulting in days away from work;
- 3) Illnesses resulting in days away from work;
- 4) Injuries resulting in employee job transfer or restricted duties.

An accident will be reported immediately to the USACE Baltimore District PM if any of the following occur as a result of the accident:

- 1) A fatal injury;
- 2) A permanent total disability;
- 3) A permanent partial disability;
- 4) The in-patient hospitalization of one or more people resulting from a single occurrence;
- 5) Property damage exceeding \$500,000.00.

All employees and subcontractors' employees shall immediately report any incident (including incidents and accidents as defined in the section above) in which they are involved or witness to their supervisor.

The BSEn, HDR, or subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the BSEn PM.

The employee shall immediately report the following information to the HSM and PM by phone and e-mail:

- Project name and location;
- Date and time of incident;

- Description of incident;
- Extent of known injuries or damage;
- Level of medical attention;
- Preliminary root cause/corrective actions.

The HSM shall immediately inform the PM (or available alternate) of spills, potential environmental permit compliance, or any environmental situation that could result in a notice of violation from an agency.

The BSEn team shall comply with all applicable statutory incident reporting requirements such as those to OSHA, the police, or state or Federal environmental agency. The PM will notify the client contacts.

All incidents will be thoroughly investigated and a written report will be provided to the client.

HDR uses an Accident/Injury Report Form (**Attachment C**) for all work-related injuries and illnesses sustained by its employees IAW recordkeeping requirements.

The PM shall complete the form and email it to the HSM within 8 hours of the accident, injury or incident.

8.1 Exposure Data (Person-Hours Worked)

The PM will report exposure hours to the USACE Baltimore COR as part of the weekly status report for this project. The exposure hours consist of the number of hours worked by personnel in the field, including all subcontractors.

8.2 Accident Investigations, Reports, and Logs

Records and reports will be maintained concerning occupational injuries and illnesses IAW 29 CFR 1904 (OSHA, 2011d), and this information is provided to the HSM immediately.

Person(s) who become ill or injured during work activities must immediately inform the SSHO, regardless of the severity of the illness or injury. All employees who are injured will receive medical assistance through the WorkCare Incident Intervention Care Team. A call will be made to this 24-hour number within one hour of the injury and prior to seeking treatment via a physician. The 24-hour number is:

(888) 449-7787

In the event that the medical emergency is severe enough, the SSHO or PM will order a cessation of work and site personnel will immediately notify off-site emergency personnel via 911. All personnel at the work site will use the buddy system, staying within sight of their partner. If a partner becomes incapacitated or severely ill, Emergency Medical Services (EMS)

will be notified. In the event that a cessation of work is ordered, all personnel should act as follows:

- Assist the SSHO, if required, in decontaminating the victim and administering first aid;
- Leave the contaminated area and undergo decontamination prior to entering the worker rest area; and
- Assist emergency response personnel when requested.

All workers receiving medical treatment, other than first aid, by a medical professional will obtain a medical release on the date of treatment stating one of the following:

- The employee is not fit for duty;
- The employee is fit for restricted duty; or
- The employee is fit for duty.

A copy of the release will be attached to the accident report and submitted to the USACE Baltimore District PM.

This page intentionally left blank.

9.0 Safety Plans

Required plans identified in USACE EM-385-1-1 (USACE, 2014) were reviewed for applicability to this project. The plans (programs and procedures) deemed applicable to this project are provided in the sections listed below.

Table 9-1 Applicability of Safety Plans

Plan	Applicability
a. Layout plans (04.A.01)	Not applicable
b. Emergency response plans:	Applicable Section 9.1 of this APP describes the emergency response plan that shall be implemented by HDR employees to handle emergencies. Procedures will be implemented to minimize the possibility of an emergency situation. The procedures outlined below are designed to ensure that the workforce reacts quickly and appropriately to emergency situations, thereby protecting the health and well being of the individual workers
(1) Procedures and tests (01.E.01)	Applicable Section 9.1.1 of the APP contains the applicable emergency response procedures.
(2) Spill plans (01.E.01, 06.A.02)	Not applicable
(3) Firefighting plan (01.E.01, 19)	Applicable Site personnel will carry a fire extinguisher
(4) Posting of emergency telephone numbers (01.E.05)	Applicable Emergency numbers are provided in Table 9-2 . This page will be provided in all project vehicles.
(5) Man overboard/abandon ship (19.A.04)	Not applicable
(6) Medical Support (03.A.02; 03.D)	Applicable Section 9.5 of the APP provides information on medical support. Personnel will call the Incident Intervention Care Team for medical assistance when injured. The SSHO will be trained in CPR and first aid, and at least two employees certified in CPR and first aid will be on-site at all times.
c. Plan for prevention of alcohol and drug abuse (01.C.02)	Applicable The Alcohol and Drug Abuse Prevention Plan is presented in Section 9.3 of the APP. Staff will be tested for cause. If the SSHO has reason to believe an employee is under the influence of alcohol or drugs, the employee will be sent for testing.

Table 9-1 Applicability of Safety Plans (Continued)

Plan	Applicability
d. Site sanitation plan (Section 02)	Applicable The Site Sanitation Plan is presented as Section 9.4 of the APP. BSEn will establish and maintain hygienic sanitation provisions for all site employees at Radford AAP as specified in EM 385-1-1, Section 2.0 (USACE, 2014).
e. Access and haul road plan (4.B)	Not applicable
f. Respiratory protection plan (05.G)	Not applicable If respiratory hazards are identified at the site during project execution, a Respiratory Protection Plan will be instituted as discussed in Section 9.9 of the APP.
g. Health hazard control program (06.A)	Applicable The Health Hazard Control Program is discussed in Section 9.10 of the APP.
h. Hazard communication program (01.B.06)	Applicable The HAZCOM Plan is discussed in Section 9.8 of the APP.
i. Process Safety Management Plan (06.B.04)	Not applicable
j. Lead abatement plan (06.B.05 and specifications)	Not applicable
k. Asbestos abatement plan (06.B.05 and specifications)	Not applicable
l. Radiation Safety Program (06.E.03.a)	Not applicable
m. Abrasive blasting (06.H.01)	Not applicable
n. Heat/Cold Stress Monitoring Plan (06.I.02)	Applicable The Cold and Heat Stress Monitoring Plans are discussed in Sections 6.0 and 7.0 of the SSHP.
o. Crystalline Silica Monitoring Plan (Assessment)(06.M)	Not applicable
p. Night operations and lighting plan (07.A.08))	Not applicable
q. Fire Prevention Plan (09.A)	Applicable The Fire Prevention Plan is presented in Section 9.14 of the APP.

Table 9-1 Applicability of Safety Plans (Continued)

Plan	Applicability
r. Wild Land Fire Management Plan (09.K)	Applicable The Wild Land Fire Management Plan is presented in Section 9.7 of the APP.
s. Hazardous energy control plan (12.A.01)	Not applicable
t. Critical lift procedures (16.H)	Not applicable
u. Contingency plan for severe weather (19.A.03)	Applicable The Contingency Plan for Severe Weather is presented in Section 9.11 of the APP.
v. Float Plan (19.F.04)	Not applicable
w. Site-Specific Fall Protection & Prevention Plan (21.C)	Not applicable
x. Demolition plan	Not applicable
y. Excavation/trenching plan (25.A.01)	Not applicable
z. Emergency rescue (tunneling)(26.A)	Not applicable
aa. Underground construction fire prevention and protection plan (26.D.01)	Not applicable
bb. Compressed air plan (26.I.01)	Not applicable
cc. Formwork and shoring erection and removal plans (27.C)	Not applicable
dd. PreCast Concrete Plan (27.D)	Not applicable
ee. Lift slab plans (27.E)	Not applicable
ff. Steel erection plan (27.F.01)	Not applicable
gg. Site Safety and Health Plan for HTRW (28.B)	Applicable The SSHP is presented as Attachment A of the APP.
hh. Blasting Safety Plan (29.A.01)	Not applicable
ii. Diving Plan (30.A.13)	Not applicable
jj. Confined Space Program (34.A)	Not applicable

9.1 Emergency Response Plan

Site personnel must be prepared to respond and act quickly in the event of an emergency, accidental contaminant release or spill. Emergency preparedness and response procedures will aid in protecting site workers and the surrounding environment. Preplanning measures to avoid personal injury or exposure will include employee training on fire, spills, explosion prevention and protection, and how to implement safe work practices.

9.1.1 Procedures and Tests

Emergencies may occur at the site to include fires, personal injuries, and natural events like storms. The SSHO is responsible for taking necessary action and contacting the appropriate emergency contacts and project management in case of an emergency.

9.1.2 Pre-Emergency Planning

Site personnel will be prepared to respond quickly in the event of an emergency. Any emergency that is life threatening, or which poses a potential threat to the public will be considered a situation requiring outside assistance and provisions shall be established between BSEn/HDR, local emergency responders, and the servicing emergency medical facility that specifies the responsibilities of on-site personnel, emergency response personnel, and the emergency medical facility in the event of an on-site emergency. During any on-site emergency, work activities in the affected area will cease until the emergency is brought under control. The measures for emergency pre-planning include employee training on:

- Fire and explosion prevention and protection;
- Safe work practices to avoid personal injury or exposure;
- Lines of Authority for emergency situations;
- Criteria for emergency medical recognition and site evacuation;
- Nearest designated medical facility.

The SSHO will ensure that the following emergency equipment is available in the work areas that the equipment is inspected as required by regulations and HDR policies:

- Fire extinguishers – monthly visual inspection, annual refill and servicing, and 12-year hydrostatic test;
- First aid kits – weekly inspection (per EM 385-1-1) (USACE, 2014).

Project personnel will only respond to on-site incidents within their training and competency.

9.1.3 Personnel Lines of Authority for Emergency Situations

The lines of authority for emergency situations that might occur during the SI activities are as follows:

- The SSHO shall be notified of emergencies immediately.
- The SSHO has primary responsibility for responding to and correcting emergency situations, but every worker has stop work authority. This responsibility may include taking appropriate measures to protect the safety of workers, subcontractors, and the public. Possible actions may involve evacuation of personnel from the area.
- The SSHO is also responsible for ensuring that appropriate persons and emergency response personnel are notified, corrective measures are being implemented, and follow-up reports completed.

After the emergency incident has been resolved, a complete Accident/Incident Report Form will be completed by the SSHO and provided to the PM and client representative. The Accident/Incident Report Form is located in **Attachment C**.

9.1.4 Procedures for Emergency Recognition and Site Evacuation

Potential emergencies that may occur at Radford AAP include, but are not limited to:

- Vehicle incidents;
- Fires or explosions;
- Unintentional detonation of MEC;
- Discovery of Chemical Warfare Materiel (CWM).

Employees will use their safety training to seek and recognize the signs of a possible emergency and prevent it if possible. The signs of these types of emergencies include:

- Loud noises;
- Smells attributed to CWM (i.e., freshly mowed grass, almonds, fishy odors);
- Smoke;
- Injured personnel or personnel appearing dazed, confused, or lethargic.

Several warning systems may be used, depending on the worksite conditions or emergency involved, including:

- Verbal communications;
- Air horns;
- Portable hand-held radios.

Fires, explosions, or releases of volatile liquids may require evacuation of the work area if the incident is of such magnitude that on-scene personnel cannot control it. Evacuation shall occur in the sequence listed below:

- Personnel will leave the area via the most direct route.
- Personnel leaving the site will proceed immediately to their designated muster area for a head count.
- Employees are prohibited from leaving the muster area until specifically released by their supervisor or the SSHO.
- The escape route, emergency gathering location, and alternates will be identified, reviewed with project personnel, and posted.

In the event that site evacuation is required, a continuous, uninterrupted air horn will be sounded for approximately 10 seconds. Air horns will be located in the work area or a vehicle horn will be used. Personnel in the support zone or exclusion zone will immediately report to the pre-established muster point for a head count and further instructions. Individuals will stay at the muster point until the contingency is secured or further instructions are given.

9.1.5 Decontamination and Medical Treatment of Injured Personnel

Site workers are not expected to come into contact with contaminated media. Therefore, decontamination procedures will typically not be required in an emergency. All injuries occurring on the site, no matter how minor, will be reported immediately to the SSHO. The SSHO will evaluate the extent of the injury, arrange for appropriate medical attention, and investigate the cause of the injury.

9.1.6 Emergency Medical Facilities

Maps with the routes for the site-designated hospitals are presented in **Figure 9-1**. A copy of the hospital route map must be readily available in each site vehicle that will be used to transport accident victims to the hospital.

The nearest hospital, Carilion New River Valley Medical Center, is located approximately 11 miles from the site. Directions to Carilion New River Valley Medical Center are provided below.

Directions to Carilion New River Valley Medical Center:

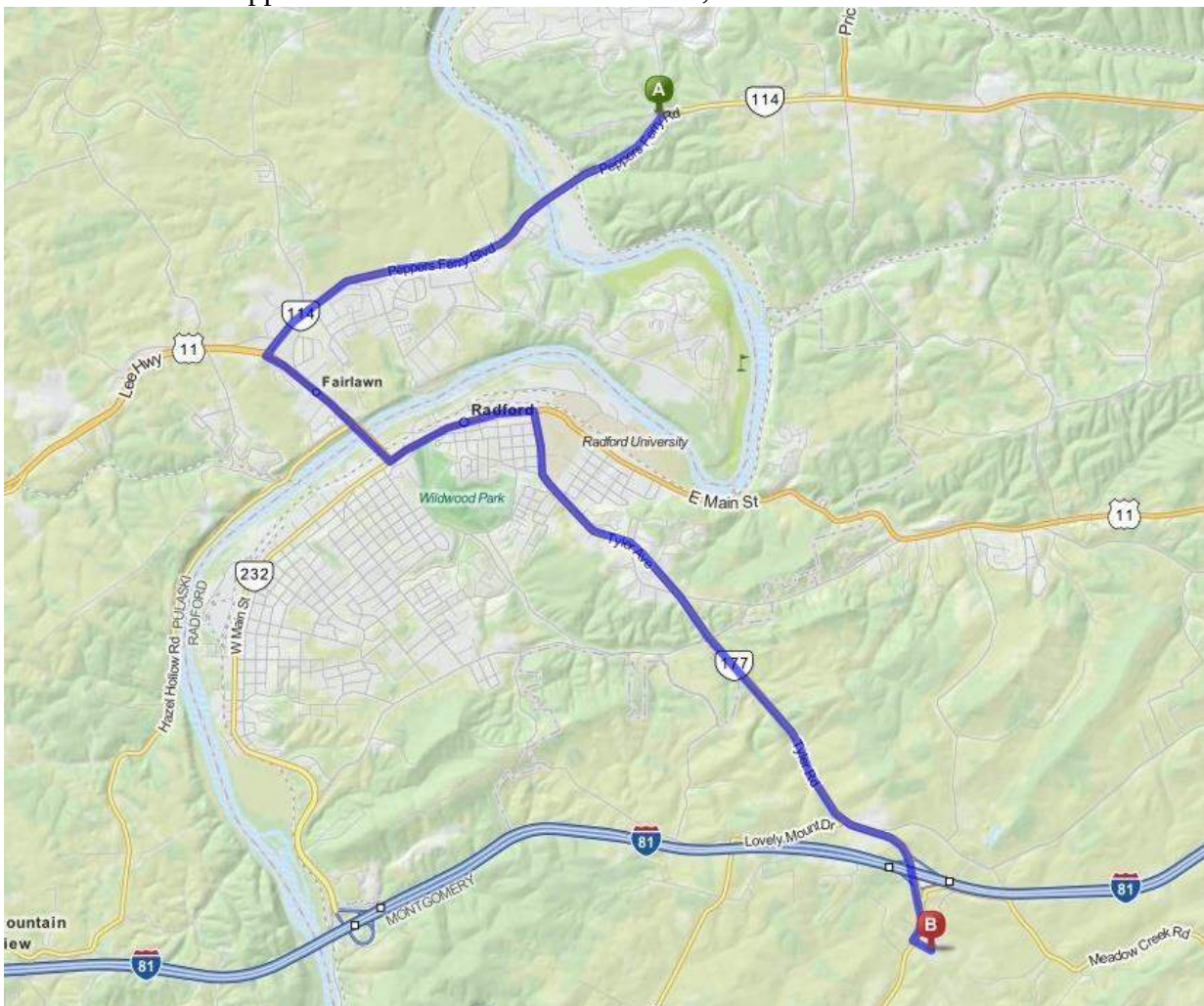
1. Start out going southwest on VA-114/Peppers Ferry Road NW toward Riverview Road.
Continue to **follow** VA-114.
2. Turn **left** onto Lee Highway/US-11 N.
3. Turn **left** onto W Main Street/US-11/VA-232. Continue to follow W Main Street.
4. Turn **right** onto Tyler Avenue/VA-117.
5. Stay **straight** onto Tyler Road.
6. Turn **left** onto Lamb Circle.
7. Address is on the **left**.

Figure 9-1 Directions to Carilion New River Valley Medical Center.

2900 Lamb Circle, Christiansburg, VA 24073.

Phone: (540) 731-2000

Approximate Drive Time: 16 Minutes, Distance 10.17 Miles



This page intentionally left blank

9.1.7 Material Safety Data Sheets/Safety Data Sheets

MSDS/SDSs will be available on site and accessible to all personnel for any hazardous chemicals used during the SI activities at Radford AAP. In an emergency involving chemical exposure, the relevant MSDS/SDSs will be made available to emergency responder personnel.

9.1.8 Criteria for Alerting Local Community Responders

If any of the following criteria are met, the SSHO, with concurrence from the USACE on-site representative, will notify local community responders:

- Explosion or fire;
- Discovery of CWM;
- Chemical spill greater than 10 gallons of liquid or solid material.

9.1.9 Emergency Responders Escort Requirements

In the event an emergency response entry is required, all emergency responders will be escorted. Site safety training for emergency responders is not required unless the responder makes several site visits for the purpose of other non-emergency events. The SSHO shall suspend activities during an emergency and shall escort (as appropriate) any untrained responders requiring access to the site during the declared emergency.

9.1.10 Emergency Telephone Locations and Protocol

Emergency response telephone numbers will be posted in the site trailer or staging area and provided in each team vehicle. In addition, emergency telephone information will be kept at the job site per USACE EM 385-1-97 Section 01.A.06 (USACE, 2008a) and EM 385-1-1(01.E.05) (USACE, 2014). Emergency contact phone numbers are provided in **Table 9-2**. In the event of an emergency contact via phone, the following information should be given:

- Name;
- Telephone number;
- Address;
- Location, if different than address;
- Brief, accurate description of emergency; be concise (i.e., vehicle fire, chemical fire, personal injury from vehicle accident, unconscious person, heat stress victim; state if there is chemical contamination of victim, etc.);
- DO NOT hang up until information is repeated back to you and is accurate! Hang up only when advised by the person who received your call;
- Notify the site contact of the expected arrival of the responding emergency vehicles.

Table 9-2 Emergency Reference List

Name	Contact Information
Incident Intervention Care Team 24 Hour Injury Response	888-449-7787
Hospital: Carilion New River Valley Medical Center. 2900 Lamb Circle, Christiansburg, VA 24073.	Off-Base Emergency: 911 Main Line: Phone: (540) 731-2000
BSEn PM: Sarah Skrobialowski	757-604-1173 sskrobialowski@bsenv.com
HDR Technical Manager: John Coughlin	443-745-4163 John.Coughlin@hdrinc.com
HDR EOC HSM: Daniel Sciarro	720-236-5105 Daniel.sciarro@hdrinc.com
HDR CIH: Stephen Coffee	303-754-4200 Stephen.coffee@hdrinc.com
Poison Control Center	800-424-9300
Chemical Transportation Emergency Center	800-424-9300
National Response Center	800-424-8802

9.1.11 Critique of Response and Follow up

The HSM, SSHO will discuss any emergency responses, review the events leading up to the incident and review the response to each incident. Lessons learned from an emergency response will be summarized by the HSM and discussed with HDR personnel and subcontractors.

9.1.12 Emergency Response Plan Tests

During the project the emergency response plan may be tested with an emergency drill, walk through of emergency response procedures or additional training to review procedures. See USACE EM 385-1-1 Section 01.E (USACE, 2014).

On-site response training during initial orientation, as well as periodic drills and reviews at each work area will include:

- Employee alarm system (air horn);
- Evacuation procedures, routes, meeting places, and accountability;
- Control of fuel sources;
- Fire extinguisher education (no employee is permitted to attempt to fight a fire beyond incipient stage);
- Rescue operations, as necessary.

9.2 Fire Fighting Plan

An emergency plan to ensure employee safety in case of fire has been prepared IAW EM 385-1-1 (01.E.01, 09.k.1, 19.A.01 and 19.A.04) (USACE, 2014).

At a minimum all major workplace fire hazards, potential ignition sources, types of fires, and suppression equipment to control a fire, and responsibilities of employees shall be discussed with the project affected personnel at the beginning of the day, at the safety brief, prior to on-site work activities. This training should include all project fire hazards, materials and processes, ways to suppress or control an emergency, and the emergency evacuation procedures.

If a fire occurs, the following procedures will be implemented at Radford.

- Alarm and notify personnel within the immediate area of the fire.
- Go directly to the nearest telephone and summon the Fire Department by dialing 911.
- Only fight fires with an extinguisher if you have been trained and it has not exceeded the incipient stage.
- Evacuate the area if the fire cannot be extinguished safely.
- Notify the SSHO.

9.3 Alcohol and Drug Abuse Prevention Plan

The Drug-Free Workplace Act of 1988 set as a goal the elimination of the effects of illegal drugs in the workplace. Because of the inherently hazardous nature of the work performed, the importance of creating and maintaining a safe drug-free working environment is paramount. BSEn and HDR maintain the Corporate Alcohol and Drug Abuse Prevention Plan IAW Defense Federal Acquisition Regulation Supplement (DFARS) Subpart 252.223-7004 (DoD, 1998).

A proactive drug and alcohol use prevention program for all workers ensures that no employee uses illegal drugs or consumes alcohol during work hours or no employee is under the influence of drugs or alcohol during work hours. The SSHO will watch and make sure that no one is working under the influence. If an employee or subcontractor is suspected of being under the influence, they will be immediately removed from the site and required to submit to a drug screening.

All employees working on this project must pass a drug screening as a contingency to working on the Radford AAP SI. BSEn and HDR also conduct random drug tests on individuals throughout the year. A drug test will be performed on any project worker involved in an incident or accident. If a site employee fails a drug screening, they will be removed from the job site at a minimum, and may be discharged.

9.4 Site Sanitation Plan

BSEn/HDR will establish and maintain hygienic sanitation provisions for all site employees as specified in USACE EM 385-1-1, Section 02 (USACE, 2014).

9.4.1 Housekeeping

Housekeeping will be priority on-site. Daily safety briefings shall include the importance of daily project housekeeping. All subcontractors will be made aware of their respective responsibilities in maintaining good housekeeping. There will be regularly scheduled trash pickups in place and any contaminated trash will be segregated for proper disposal. Housekeeping is an identified safety concern and will be highlighted throughout regular inspections. The following housekeeping provisions will be maintained during the activities at the Radford project site:

- All BSEn/HDR work areas and means of access will be maintained safe and orderly.
- Sufficient personnel and equipment shall be provided to ensure compliance with these housekeeping rules.
- Work areas will be inspected daily.
- Any unsatisfactory area findings shall be reported and corrected. Work shall not be allowed in those areas until they comply with these housekeeping requirements.
- All stairways, passageways, gangways, and access ways shall be kept free of materials, supplies, and obstructions at all times.
- Tools, materials, extension cords, hoses, or debris shall not cause tripping or other hazards.
- Tools, materials, and equipment subject to displacement or falling shall be secured.
- Scrap and lumber should be secured in a way that is not in the immediate working area and cleared from access ways to prevent near corner mishaps.
- Protruding nails, sharp cornered timber, scrap, and trash metals shall be removed, hammered, or placed in a manner as to not cause harm or injury to work area employees.

9.4.2 Material Storage

Material should be stacked so that it is as low as possible and in no case higher than 4 feet (ft) unless properly stored on racks and secured by positive means.

9.4.3 Material Disposal

Non-hazardous waste material and rubbish shall be placed in containers and located in designated areas. The contents shall be properly disposed of daily.

9.4.4 Drinking Water

An adequate supply of cool water via a water dispenser and/or bottled water will be supplied and provisions will be made as necessary to provide safe drinking water at all field locations. Potable water will be made available from either a pressurized source or commercially available bottled water. Drinking cups will be supplied so personnel will neither drink directly from the source of water nor have to share drinking cups. Sources of non-potable water shall be labeled clearly as such.

9.4.5 Toilet Facilities

If suitable existing sanitary facilities are not located nearby, portable toilet facilities, such as chemical toilets, will be provided on site. Sanitary facilities will be available and arrangements will be made for routine servicing and cleaning of the portable toilets.

9.4.6 Washing Facilities

Permanent and portable washing facilities will be provided within the site support area. All vehicles will be equipped with portable hand-washing support, to decontaminate at all times when need be. Soap, clean water, washbasins, and single-use towels should be available for personnel use.

9.5 Medical Support

On-site medical support and off-site medical arrangements, including rescue and medical duties for those employees who are to perform them, and the name (s) of on-site personnel trained in first aid and CPR will be documented and maintained on-site by the SSHO. The SSHO will brief site workers and visitors on medical support arrangements.

The SSHO will have current CPR and first aid training, and at least two employees certified in CPR and first aid will be on-site at all times. Employees receiving minor injuries will call the Incident Intervention Care Team to receive immediate first aid treatment as identified in **Section 9.5.2**. To prevent this transmission during the rendering of medical assistance, SI activities require these universal precautions be implemented:

- Avoid all contact with blood or other bodily fluids (i.e., vomit, saliva);
- Wear appropriate PPE (gloves, resuscitation face shield) when there is a chance of contact with potentially infectious materials;
- Warn employees in surrounding area of potential hazard;
- Provide appropriate first aid only to the level that you feel qualified and comfortable to provide;
- Report all BBP exposure incidents to the SSHO;
- Decontaminate all equipment and surfaces contaminated with blood/bodily fluids;

- Employees exposed to potentially contaminated materials shall wash-up immediately following the exposure.

9.5.1 Medical Surveillance

All personnel performing on-site work that will result in exposure to contaminant-related H&S hazards shall be enrolled in a medical surveillance program that complies with OSHA standards 29 CFR 1904 (OSHA, 2011d), 1910.120 (f) (OSHA, 2009) and 1926.65(f) (OSHA, 2011a). The HAZWOPER medical surveillance required by 29 CFR 1910.120 (OSHA, 2009) and 1926.65 (f) (OSHA, 2011a) is applicable for this project. On-site personnel must have completed a pre-placement (pre-hire) or annual physical examination that complies with the requirements of 29 CFR 1910.120(f) (OSHA, 2009); and will have been certified as fit to work by an Occupational Physician certified in occupational medicine by the American Board of Preventive Medicine. Certification of medical surveillance program participation shall be appended to the SSHP. The certification shall include employee name, date of last examination, and name of examining physician(s). The required written physician's opinion shall be made available upon request to the government's designated authority. All medical records and requirements shall be maintained IAW 29 CFR 1910.1020 (OSHA, 2011b), and EM 385-1-1 Section 3 (USACE, 2014).

9.5.2 Injury and Illness

Employees that are injured on the job contact the SSHO and initiate the emergency response procedures outlined below:

- Contact EMS by calling 911 if the injury is life-threatening.
- If your injury is not life threatening please call our occupational physician at the number below before you are seen by a physician. This number is in service 24/7. A qualified HDR first aid provider can also support minor injuries on-site after contacting WorkCare at the number below:

**WorkCare
Incident Intervention Care Team
1-888-449-7787**

HDR employees with any injury (other than life-threatening) are required to call the medical hotline.

- An occupational nurse or occupational physician provides treatment advice via phone. This could be any of the following:
 - If the employee is to be seen by a physician, WorkCare will call ahead to the local clinic or hospital and discuss the case with the treating physician.

- If first aid is the recommended treatment, WorkCare continues to follow up with the employee until they have healed. Continued follow up could be anywhere from 1-45 days, depending upon the injury.
- WorkCare will notify HDR immediately concerning the injured person. If additional treatment beyond first aid is required, the injured personnel will be transported to the nearest medical center designated in this APP/SSHP or a location designated by the WorkCare occupational physician.
- Any injury or illness (whether on or off the job) may require work restrictions after the employee returns to work. If the injury or illness required a visit with a physician, the attending physician must complete an appropriate return to work form and it must be provided to HDR and the on-site SSHO prior to the employee returning to work. The return to work form must be documented in the employee's file on-site.

9.5.3 Emergency Medical Communications

Two types of communication systems will be available for workers. One system will ensure adequate communication between site personnel (radios) and the other (mobile or satellite phone) will ensure the ability to contact personnel and emergency assistance off-site.

9.5.4 First Aid and CPR

At least two employees certified in CPR and first aid will be on-site at all times.

Each vehicle will be provided with a trauma/first aid kit. The SSHO will ensure the contents of each kit are inspected weekly. Missing items will be immediately ordered and replaced in the kits. Replacement items can be ordered through Mid Continental Safety at www.midsafe.com. The minimum contents for the trauma kit are listed in **Table 9-3**.

Table 9-3 Minimum Contents of First Aid Kit

Item and Minimum Size	Minimum Quantity
Sterile Kerlix 4-1/2" X 4.5 yds	1
Three cut adhesive tape	1
Kwik Kold Jr. instant ice pack	1
Bloodstopper compress	1
5" X 9" Sterile ABD pads	2
J&J Surgipads 8" X 10"	2
Mylar rescue blanket	1
Eyewash 4 oz.	1
Co-flex bandage 3" X 5 yds.	1
Sodium chloride 0.9% 500 ml	1
Micro Shield protection pack	1
Disposable gloves 2/pair	1
Gauze pads 4" X 4"	15
1" X 3" Woven adhesive strips	25
1-7/8" X 3-3/4" Plastic large strips	10
Burn-free burn dressing, 4" X 4"	1
2" Gauze bandage	2
Triangular bandage	1
Para-Medic shear	1
Forceps 4-1/2"	1
Lister bandage scissor	1
Alcohol wipes	10
PVP iodine wipes	10
Thermometer – temple style	1

9.5.5 Recordkeeping

All medical records and safety training records will be maintained by the SSHO.

9.6 Blood-borne Pathogens

The ECP is designed to reduce the possibility of exposures to BBPs by anticipating possible exposure scenarios and developing ways to avoid them before they occur. The plan will be updated whenever changes are made that could affect employee exposures to BBPs. All employees with potential exposure must be trained on the details of the ECP. The ECP is required by OSHA's BBP Regulation (29 CFR 1910.1030 (OSHA, 2011)) and the USACE EM 385-1-1 03.A.05 (USACE, 2014) for employees with potential occupational exposure. The BBP ECP covers employees with routine exposure and those with potential incidental exposure. The plan is part of the SSHP (29 CFR 1910.120 (OSHA, 2009)) or a comprehensive emergency response plan (29 CFR 1910.120 (q) (OSHA, 2009)) or this APP. PPE is included

in this plan for the injury response personnel on each AHA and BBP training is also outlined in **Section 5.2.4** of this APP.

This BBP ECP presents information on the nature of blood-borne diseases to help employees reduce or eliminate potential exposure while working on Radford AAP SI site activities. “Blood-borne Pathogens” means pathogenic microorganisms that are present in human blood and bodily fluids, and which cause disease in humans. These pathogens include, but are not limited to, HBV and HIV.

9.6.1 Blood-borne Pathogens Exposure Control Plan

The purpose of the below ECP is to establish control for employees with the potential for exposure to these disease agents. This ECP applies to exposures to blood or other potentially infectious materials while working at Radford AAP conducting SI activities. This ECP detailed below will be administered locally by the SSHO. The SSHO shall:

- Provide initial training on this APP and ECP to all applicable project staff, and make sure that this plan is readily available; and
- Interface with the HSM regarding any unsafe project site conditions that have been discovered, and need addressing or interpretation.

There is always the potential for accidents resulting in injuries that require first aid/CPR. If the injured person is host to an infectious agent, then these potentially infectious materials may be transmitted during the first aid process. To prevent this transmission during the rendering of medical assistance, SI activities require these universal precautions be implemented:

- Avoid all contact with blood or other bodily fluids (i.e., vomit, saliva);
- Wear appropriate PPE (gloves, resuscitation face shield) when there is a chance of contact with potentially infectious materials;
- Warn employees in surrounding area of potential hazard;
- Provide appropriate first aid only to the level that you feel qualified and comfortable to provide;
- Report all BBP exposure incidents to the SSHO;
- Decontaminate all equipment and surfaces contaminated with blood/bodily fluids;
- Employees exposed to potentially contaminated materials shall wash-up immediately following the exposure.

9.6.2 Hand-washing Provisions

Hand-washing facilities will always be made available for employees who are exposed to blood/potentially infectious materials. A thorough soap-water wash should be performed. At project sites, however, hand-washing facilities are not always immediately available. If potable water for hand/face washing is not available, the SSHO will be responsible for ensuring that

either an antiseptic cleanser in conjunction with clean cloth/paper towels or antiseptic towelettes are available on-site. These items can be obtained locally. Following this interim field cleaning, the affected employee(s) should then travel to the nearest plumbed facility and thoroughly wash their exposed body parts with soap and water. If employees incur exposure to their skin or mucous membranes, then those areas shall be washed or flushed with water (as appropriate) as soon as feasible following contact.

9.6.3 Cleaning Equipment

Equipment which has become contaminated with blood/potentially infectious materials shall be examined prior to servicing or shipping and shall be decontaminated unless decontamination of the equipment is not feasible. A readily observable label shall be attached to the equipment if portions remain contaminated. This information shall be conveyed to all affected employees, servicing representatives and/or manufacturers as appropriate prior to handling, servicing, or shipping so that appropriate precautions will be taken.

9.6.4 Contaminated Sharps

To minimize both the physical and biological hazard associated with contaminated sharps (e.g. used diabetic needles), they shall be placed into puncture-resistant leak-proof containers dedicated specifically for that purpose. The sharps container must be marked with the universal biohazard symbol. To address this requirement, the SSHO shall provide rigid sharps containers if when need be, properly labeled, and present for employees. These containers are the only proper disposal for self-administered medicinal syringes (e.g., diabetes, etc.) – DO NOT dispose of needles, syringes, etc., in the general trash containers. Not only is this in violation of national/provincial regulations, but it is very hazardous to the firms engaged in refuse collection and transfer, as these sharps may harbor residual blood.

9.6.5 Blood-borne Pathogens Exposure Personal Protective Equipment

All PPE used will be provided without cost to employees. Site H&S officers will be responsible for ensuring that appropriate equipment is available at Radford SI sites. PPE typically required for protection against BBPs includes:

- Sample gloves (e.g., latex, nitrile, etc.)
- Safety glasses (minimum eye protection)
- Liquid splash goggles (preferred eye protection if available)
- Full-face shield (if potential to splash on face and in mouth)
- Liquid-impervious clothing (coated Ty-Vek)
- CPR disposable resuscitation face shield with one-way exhalation valve (for use only by CPR trained personnel)

All PPE will be cleaned, laundered, and disposed of as necessary by the employees as soon as possible following the contamination event.

All garments, which are penetrated by blood, shall be removed as soon as feasible and disposed of as regulated waste. Gloves shall be worn where it is reasonably anticipated that employees will have hand contact with blood or other potentially infectious materials. “Reasonably” means that there is an obvious and significant potential for contact with infectious materials, based on visual observations of the victim, knowledge either of the victims medical history or of the required first aid necessary, or of some other apparent factor. This does not mean that gloves must be worn in shaking hands with a healthy worker, in touching intact skin, or in rendering minor assistance where exposure to infectious agents is not anticipated. Disposable gloves used are not to be reused. They are to be replaced as soon as possible when they become contaminated, torn, punctured, or when their ability to function as a barrier is compromised. Gloves shall be discarded between recipients when rendering assistance to multiple victims. Impervious utility gloves (i.e., Butyl, Nitrile, Latex, etc.) may be decontaminated for re-use provided that the integrity of the glove is not compromised, but must be discarded if they are cracked, peeling, torn, punctured, exhibit other signs of deterioration or when their ability to function as a barrier is compromised.

Chin-length face shields in combination with eye protective devices such as goggles or glasses with affixed solid side shields, are required to be worn whenever splashes, spray, splatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose or mouth contamination can reasonably be anticipated. Situations which might require such protection include the administering of first aid when a break in a vein or artery has occurred, resulting in the forceful generation of copious quantities of blood. The implementation of universal precautions for BBP also requires that skin-protective clothing be worn. There are no foreseeable the Radford SI where this type of clothing would be required as standard attire. The SSHO will be responsible for determining if such protective clothing is necessary on a site-specific basis.

9.6.6 Housekeeping

Timely decontamination of areas will therefore be necessary if surfaces or equipment come in contact with blood or other body fluids. BBP decontamination will be accomplished as follows:

- Wash affected areas with a 10 percent bleach/water solution (one part bleach, nine parts water - chlorine is an especially effective BBP disinfectant). Once decontaminated, materials are no longer considered regulated waste for disposal purposes;
- Rinse with clear water until all visible blood and body fluids have been cleaned up;
- Dispose water generated during the decontamination in the sanitary sewer or absorb on paper towels for disposal;
- Add all solid waste generated to the “Red Bag” waste stream see (**Section 9.6.7**).

9.6.7 Regulated/Clinical Waste Disposal

Any materials or items contaminated with bodily fluids, that have not been decontaminated, are considered “regulated/clinical waste.” These materials or items remain potentially infectious, and thus must be disposed of outside the normal waste stream.

Regulated/clinical waste shall be placed in containers which are closable and constructed to contain all contents and prevent leakage of fluids during handling, storage, transport, or shipping. All containers holding regulated/clinical waste must be identifiable as such. There are two options to accomplish this. One option is to label the container by placing a “Biohazard” sign, which includes the following symbol.



The other option is to place all regulated waste in a colored bag, dedicated specifically for that method of identification. This is acceptable, as long as affected employees know this is our selected system of regulated waste disposal, and that a “colored” bag means that the contents are potentially infectious. OSHA requires biohazard bags that are red or orange so all Radford activities and clean-up and disposal operations will follow suit.

Whichever method is employed, the container must be securely closed prior to disposal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping. Sharp objects that may protrude through or puncture the bag must not be placed into colored bags. Both contaminated sharps and other contaminated regulated/clinical waste shall be picked up and disposed of by a local licensed biomedical waste disposal firm. Local offices or their building management shall arrange for disposal.

In addition to the above disposal practices, as mandated by 29 CFR 1910.1030 (OSHA, 2011), all state, and local regulations shall be complied with during the disposal of regulated/clinical waste. For assistance in determining additional local regulations, please contact the HSM.

9.6.8 Hepatitis B Vaccine

Employees who have been identified as having likely exposure to blood or other potentially infectious materials will be offered the HBV vaccine, at no cost to the employee. This is a 3-shot regimen that occurs over a 6 month period. The vaccine will be offered within 10 working days of their initial assignment to work involving the potential for occupational exposure to blood or other potentially infectious materials, unless the employee has previously had the

vaccine or wishes to submit to antibody testing which shows the employee to have sufficient immunity.

Immunized employees, who continue to work for years in work situations where exposure is likely, should consult their personal physician about the need for a booster shot and when it may be needed. Currently, the vaccine is for immunization against HBV only.

9.6.9 Declining Vaccination

After receiving information on the hazards of HBV and the vaccine procedure, employees may voluntarily choose to decline the vaccination. OSHA mandates that all employees who decline the HBV vaccine sign a waiver which includes the employee's name, date, office, and uses the following wording, reprinted from Appendix A of the 1910.1030 standard (OSHA, 2011):

"I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring HBV infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine, at no charge to myself. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccination series at no charge to me."

An HBV Vaccine Declination form is available upon request from notification to the SI HSM.

9.6.10 Recordkeeping

Any waivers will be kept for proper recordkeeping and documentation.

9.6.11 Delayed Vaccination Request

Employees who initially decline the vaccine but later wish to receive it (assuming exposure is still present) may then have the vaccine provided at no cost.

SSHO will be responsible for assuring the vaccine is offered, the waivers are signed, etc.

9.6.12 Post-Exposure Evaluation and Follow-up.

If any Radford SI activity incurs an exposure incident, it should be immediately reported to the SSHO. This employee will be offered post-exposure medical evaluation and follow-up.

The SSHO, HSM, and employee will jointly work to ensure this is completed expeditiously.

This follow-up will include the following:

- Documentation of the route of exposure and the circumstances related to the incident.
- Identification and documentation of the source individual, unless identification is infeasible or prohibited by state or local law. (If necessary, the blood of the source individual will be tested (after consent is obtained) for HIV/HBV infectivity. Results of

testing of the source individual will be made available to the exposed employee, and employee shall be informed about the applicable laws and regulations concerning disclosure of the identity and infectivity of the source individual.

- Collection and testing of the employee's blood for HIV/HBV serological status. (The blood sample will be preserved for up to 90 days to allow the employee to decide if the blood should be tested for HIV serological status. However, if the employee decides prior to that time that the testing will or will not be conducted; then the appropriate action can be taken and the blood sample discarded.)
- Post exposure prophylaxis IAW current recommendations of U.S. and International Public Health Services.
- Counseling concerning precautions to take during the period after the exposure incident and information on what potential illnesses to be alert for.

9.6.13 Interaction with Health Care Professionals

A written opinion shall be obtained from the health care professional that evaluates employees. Written opinions will be obtained in the following instances:

- 1) When the employee is sent to obtain the hepatitis B vaccine (Verification vaccination series was given, and employee was medically fit to receive vaccine).
- 2) Whenever the employee is sent to a health care professional following an exposure incident.

Health care professionals shall be instructed to limit their opinions to:

- 1) Whether the HBV vaccine is indicated and if the employee has received the vaccine, or for evaluation following an incident.
- 2) That the employee has been informed of the results of the evaluation, and
- 3) That the employee has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials. Note that the written opinion to the employer is not to reference any personal medical information.

9.6.14 Training

Employees who respond to incidents involving potential exposure to BBP will receive training at the time of initial assignment and at least annually thereafter. The training program shall address the following:

- An accessible copy of the applicable regulatory text of the BBP Standard (29 CFR 1910.1030 (OSHA, 2011)) and an explanation of its contents.
- A general explanation of the epidemiology and symptoms of blood-borne diseases.
- An explanation of the modes of transmission of BBP.

- An explanation of this ECP and the means by which the employee can obtain a copy of the written plan.
- An explanation of the use and limitations of methods that will prevent or reduce exposure including appropriate engineering controls, work practices and PPE.
- Information on the types, proper use, location, removal, handling, decontamination, and disposal of PPE.
- An explanation of the basis for selection of PPE.
- Information on the HBV vaccine, including information on its effectiveness, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge.
- Information on the appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials.
- An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the middle follow-up that will be made available.
- Information on the post-exposure evaluation and follow-up that the employer is required to provide for the employee following an exposure incident.
- An explanation of the signs and labels and/or color-coding.
- An opportunity for interactive questions and answers with the person conducting the training session.

9.7 Wild Land Fire Prevention Plan

Facilities and areas with potential exposure to wild land fires, whether prescribed or unplanned requires a fire management plan IAW EM 385-1-1 (09.K.01) (USACE, 2014).

During dry weather, the potential for fire exists in any grassy perimeter regions of Radford. Sparks from operating equipment, or even contact with hot catalytic converters can cause dry vegetation to catch fire. Vehicles and equipment will not be left idling or parked in or around areas where they may cause a fire.

Equipment and vehicles will stay on cleared areas and/or on roadways wherever practical. Drivers are responsible to inspect under and around their parked or stopped vehicles to insure the vehicle will not contribute to a fire. All vehicles will be equipped with one 10 pound (lb) ABC rated fire extinguisher. In the event of a fire or explosion, the police, fire department, and ambulance service, will be notified in addition to the client representative and the PM.

On-site fire extinguishers may be used on incipient stage fires only if the employee has been trained on proper fire extinguishing practices and feels comfortable doing so.

In addition, the following measures will be implemented during work activities to minimize the risk of fire and/or explosion:

- Smoking is not permitted in work areas; only in designated smoking areas.
- Flammable liquids will be stored only in approved containers.
- Work areas will be cleared of excess vegetation and obstructions wherever practical.
- Vehicles shall not be left running unattended.

9.8 Hazard Communication Plan

This HAZCOM Plan will serve as the site requirements for HAZCOM and shall be implemented by the SSHO to provide specific information about any on-site manufactured hazardous substances, including chemical hazards and the control of those hazards. The written HAZCOM Plan includes information on container labeling, the use of an MSDS/SDS and personnel training. Hazardous waste substances are excluded from this plan. The purpose of HAZCOM is to ensure that the hazards of all chemicals covered in the program are communicated to (1) all Radford site personnel and visitors. This plan was developed to comply with all applicable provisions of the OSHA HAZCOM Standard(s), 29 CFR 1910.1200 (OSHA, 2011c) & 29 CFR 1926.59 (OSHA, 2011a).

Note: OSHA has incorporated the Globally Harmonized System of Classification and Labeling of Chemicals into the 2012 revision of the HAZCOM Standard (OSHA, 2012). Significant changes to hazard classification, labeling, and safety data sheets will be fully implemented by June 1, 2016.

9.8.1 General HAZCOM Plan Requirements

The SSHO must ensure that project personnel can immediately obtain the required information about chemicals of concern during an emergency.

HDR employees are prohibited from bringing chemical products, including over-the-counter commercial products, into the workplace without first notifying the SSHO, and receiving their approval.

Outside sales vendors are also prohibited from providing “free” samples of commercial/industrial office chemical products, unless such products are accompanied by an MSDS/SDS, and approved for use by the SSHO or HSM.

ON-SITE CHEMICAL INVENTORY

- 1) Initial Survey. The SSHO will survey the site to identify existing chemicals that pose a hazard to site/ area employees. The SSHO will refer to the criteria presented in 29 CFR 1910.1200 (especially 1910.1200(b)(6) (OSHA, 2011c), included as **Attachment A** to

this Plan) to make the determination as to which chemical or mixture should be included. If there is any question, the chemical should be included.

- 2) Discarding Unwanted or Outdated Chemical Products. During the initial survey, the SSHO may discover chemicals that are no longer used, outdated, etc. The SSHO should collect these chemical products, and in agreement with the PM, properly dispose of them with the disposal methods recommended by the manufacturer or State solid waste agency.
- 3) New Chemical Products. Before new products are purchased, an MSDS or SDS must be obtained from the supplier or manufacturer and reviewed by the SSHO. Items to be addressed include:
 - a) Is this chemical really necessary for our operation? Is the quantity appropriate? Are there any hazards identified in Section 2 of the MSDS/SDS that indicates the chemical ingredients are extremely toxic, flammable or explosive?
 - b) Is the product stable at room temperature, or will it degrade into a more hazardous substance?
 - c) Would a less toxic/hazardous commercial product equally serve our needs?
 - d) If not completely used up, is disposal of the residue an environmental problem?

Upon completion of the inventory, the SSHO will then make a written list of the retained chemicals and ensure there is an MSDS/SDS on-site.

CONTAINER LABELING

All containers of chemicals must be labeled, in English with the following information (at a minimum):

- 1) Product Identifier
- 2) Signal Word, “Danger” or “Warning” (there may be non-hazardous chemicals that do not require a signal word).
- 3) Hazard Statements
- 4) Precautionary Statements
- 5) Hazard Pictograms
- 6) Name, address and telephone number of manufacturer, importer, or other responsible party.
- 7) Supplementary Information (optional)

Note: If non-English speaking employees will be using chemicals, information shall be presented in their language as well.

The SSHO will examine each container and verify that each has an appropriate label. The SSHO will rely on the manufacturer’s accuracy as to label contents and does not have to verify that the label information is correct.

Radford site employees shall not remove or deface labels on incoming containers of chemicals. The purpose of these labeling requirements is to ensure that any employee using, or affected by the use of a chemical, can identify the chemical and learn any safety precautions and health hazard information in an expedited manner. This is critically important when an employee is exposed to a corrosive chemical (e.g., acid, base), and needs to quickly determine the proper washing, flushing or medical treatment necessary for minimization of injury.

Transference of chemicals If chemicals covered by this program are purchased in bulk and later transferred to smaller temporary individual containers, labels must be affixed to the individual containers presenting the same label information as required on the label from the manufacturer, or the product identifier and words, pictures, symbols or a combination thereof, which in combination with other information immediately available to employees, provide specific information regarding the hazards of the chemicals. For small temporary containers where the complete listing of the label information is impractical (due to container space restrictions), it is permissible to mark both the temporary container and the original bulk source container with a common referencing name or number, as long as all affected employees are trained on this identifying system.

MATERIAL SAFETY DATA SHEETS/SAFETY DATA SHEETS

A hard-copy MSDS or SDS for each hazardous chemical present at the site will be maintained. All MSDS/SDS will be collected and will be clearly labeled and maintained in a conspicuous location such as a site SSHO vehicle. Additionally, each employee may access and retrieve or review any MSDS/SDS maintained for the site.

When a new product or chemical is received, the SSHO should review the accompanying MSDS/SDS and determine the degree of training necessary. If identical or similar in chemical hazards, routes of exposure, health effects and medical treatment, the SSHO may only need to reference past training. If, however, the new chemical has unique or significantly different exposure, affected or treatment characteristics, then new training to all affected employees must be conducted, and documented prior to use.

Site personnel who use chemical products are required to carry the corresponding MSDS/SDS with them, along with a copy of this HAZCOM plan. Site chemical hazards will be communicated to the SSHO and employees through daily safety meetings (“tailgate” safety meetings) held at during an initial site orientation or (“Project kickoff”) meeting. Information on chemical use should also be transmitted to outside contractors during these meetings.

Site employees will be instructed on the following:

- Contents of 29 CFR 1910.1200 (OSHA, 2011c), 29 CFR 1926.59 (OSHA, 2011a), and if applicable 49 CFR Part 171 (US Government Publishing Office, 2015)
- Chemicals and their hazards in the work area

- Location of MSDS/SDS and this written plan
- Chemical routes of exposure (inhalation, skin contact, ingestion)
- How to prevent exposure to the hazardous chemicals
- Procedures to follow if they are exposed to the chemicals
- How to read and interpret labels and MSDS/SDSs for hazardous substances
- Emergency spill procedures
- Proper storage and labeling

Before any new hazardous chemical is introduced on site each site employee will be given information and training. This training shall include all possible hazards a site employee may encounter while working SI activities, including:

- Hazard recognition
- Chemicals involved and their hazardous properties
- Physical hazards – Fire/Explosion
- Methods of avoiding hazards (monitoring instruments, proper PPE, etc.)
- Location of medical facilities and proper response actions

CHEMICALS ON THE PROJECT SITE

It is the responsibility of the SSHO to provide all outside contractor employees with information on the chemicals on a project site. It shall be the responsibility of the SSHO and PM to provide subcontractors with the following information. (NOTE: Subcontractors are responsible for training their own employees):

- Location of the Site HAZCOM Plan, which includes the following:
 - o MSDS/SDS for project work area
 - o HAZCOM Program (this HAZCOM Plan and the APP)
- Labeling system employed (if unique).
- Any special precautionary measures to be employed by the outside contractor to protect their employees from chemical and/or physical hazards posed by chemical usage.
- Location of nearest necessary emergency equipment (fire extinguisher, eyewash, shower, phone, first aid kit, etc.)

An MSDS/SDS for each of the following chemicals anticipated to be used on site are presented in **Attachment E** of this APP:

- Fire Extinguishers;
- Insect Repellent;
- Alconox.

Fire extinguishers will be maintained on site as a safety precaution for the purpose of extinguishing incipient-stage fires. They will be of the size, type, and quantity specified in the Fire Prevention Plan (**Section 9.14**).

Insect repellent will be kept on site for use as a preventive measure to avoid personnel exposure to bites from disease vectors such as mosquitoes and ticks. Quantities will be personal use amounts (e.g., one can or bottle per person).

Alconox will be used as a detergent when decontaminating re-useable sampling equipment. It will be stored in the form of a dry powder, to be mixed with water according to the manufacturer's instructions prior to use. It is anticipated that no more than one 4-lb container of Alconox will be brought on site.

The chemicals listed above will be kept in an accessible location in the work vehicles; therefore, a location map is not appropriate for these chemicals. If any chemicals must be brought on site that require special storage arrangements, a map will be generated and kept on site to be provided with the MSDS/SDSs to responding personnel in the event of an emergency.

9.9 Respiratory Protection Plan

Use of respirators is not expected during the Radford AAP SI activities. In the event that respiratory hazards are identified by the SSHO during project execution, HDR and BSEn will implement a respiratory protection program IAW 29 CFR 1910.134 (OSHA, 2011e), and EM 385-1-1 (05.E.03) (USACE, 2014). All site personnel required to use respiratory protection devices will have received equipment-specific training and will be cleared by an occupational physician for respirator use. The training covers the use, limitations, inspection, maintenance, and cleaning of respiratory protection devices. Daily site-specific briefing/training will reinforce knowledge as necessary.

9.10 Health Hazard Control Program

HDR and BSEn will implement a health hazard control program IAW EM385-1-1 (06.A.02) (USACE, 2014). All operations, materials, and equipment will be evaluated to determine the presence of hazardous environments or if hazardous or toxic agents could be released into the work environment during operations. The SSHO, under the supervision of the HSM, has prepared AHAs for all Radford project phases to identify all substances, agents, and environments that present a hazard and to establish hazard control measures. For new activities, a separate AHA will be prepared. All AHAs will be reviewed at least annually by the SSHO and HSM to ensure that they provide adequate protection of workers, the public, and the environment.

9.11 Severe Weather Plan

During the course of field operations, severe weather may be encountered, including thunderstorms, rainstorms, tornados, and other unsafe weather conditions (i.e., high winds).

Criteria indicating that severe weather conditions may exist include:

- High winds (greater than 40 miles per hour – depending on the tree cover and other site-specific conditions);
- Tornado or severe storm watch or warning in place for the area;
- Visible lightning;
- Extreme temperatures (e.g., greater than 100 degrees Fahrenheit [°F] or less than 32°F);
- Heavy rainfall or fog that makes footing treacherous and visibility difficult.

9.11.1 Severe Weather Monitoring and Prevention

In the event of severe weather, it may be necessary to cease operations and evacuate the site. The SSHO will be responsible for being aware of local weather forecasts and monitoring the weather. Weather forecasts will be monitored using a combination of local radio and television broadcasts, internet, and a weather radio. Should severe weather threaten, the SSHO will be responsible for deciding if site operations should cease.

In the event that work is suspended, the SSHO will notify the teams and individuals via radio or cellular telephone. These individuals will be responsible for relaying the work suspension to other personnel in their areas. All personnel will cease operations, secure equipment, if time permits, and expeditiously move to designated assembly areas for further instruction. Once the severe weather hazard has passed, the SSHO will provide notification that work may resume.

9.12 Lightning

Lightning's distance from a given person's position can be estimated by noting the time from its flash to the bang of the associated thunder. For each 5-second count from flash to bang (F-B), lightning is one mile away. Thus, an F-B of 10 means that lightning is two miles away and an F-B of 15 means that lightning is 3 miles away, and so on. Because the distance from Strike A to Strike B to Strike C can be 0.5 to 1.5 miles apart, the lightning safety evacuation plan will be implemented at a count of 50 (10 miles), or as soon as lightning is observed or thunder is heard.

The key to safety during a potential thunderstorm is to know the most likely point where lightning might strike and to anticipate the path of travel of the charge that is drawn from it. For example, if you are working on a hill, anticipate that the hill will sustain a strike and avoid places on that hill.

Use the following information to avoid lightning strikes:

- Stay away from the isolated or large trees. Stay farther from isolated trees than the height of the tree.
- When on exposed talus or scree (rock fields with no tree protection) stay nearer the smaller rocks.
- In open areas, seek a low place such as a ravine or valley, but be alert for flash floods.
- In all cases, stay away from sources of water (e.g. streams, lakes, puddles or even small pools of water collected on rocks). Water is an excellent conductor of electricity.
- The optimal location would be sheltered by small trees in a ravine, away from water and rock overhangs. As an electrical charge traveling along the ground reaches an overhang, it will very likely arc across to your body and travel through it rather than along the rock.
- If your team is a large group of people, spread out as much as possible to reduce the risk of multiple casualties.
- If you take shelter in a cave, stay away from the entrance. As the lightning passes through the ground, it will travel near the opening of the cave and will use a body as a bridge to pass from one side of the entrance to the other.
- Avoid body positions that would allow the charge to pass through the body. Whenever possible, drop to your knees and bend forward putting your hands on your knees. Try not to place your hands on the ground, as this would increase the chance of entry and exit points resulting at opposite extremes. NEVER lie flat on the ground. Occupy the smallest area possible.
- At all times, wear shoes and stay on something insulated such as dry clothing, packs, ropes or tree branches. When there is a hazard of lightning, remove all exposed metal objects from your clothes. These objects become hazardous not only because they present a possible target for a direct strike but also because they will heat up significantly and fuse clothing or flesh as the current passes through the body on an indirect strike.

9.13 Emergency Planning

This section provides for site emergency planning and communication.

9.13.1 Communication

The following means of communication will be available to employees, depending upon the service available.

- Hand held Radios - Each team leader will have a radio;
- Cellular Phones – Each team will have a cellular telephone.

Radio Protocols During an Emergency

1. Use simple, concise language to relay the type of emergency. Remain calm when relaying information over the radio.
2. Have your location information readily available; handheld or vehicle Global Positioning System (GPS) units can be used to find coordinate information.
3. Stay calm and clearly enunciate, spell out information or use the International Phonetic Alphabet (e.g. Alpha, Bravo, etc.) if necessary.
4. Keep your information focused and answer any questions to the best of your ability. Avoid excessive details or unnecessary information.
5. Do not relay private information over the radio.

9.13.2 Daily Schedule

The SSHO will ensure that the following is completed at the beginning of each day:

- A complete list of each person in the field and their expected work location;
- Notification to the PM should any significant changes or missing personnel should occur throughout the day.

9.14 Fire Prevention

Staff will remain diligent concerning awareness of fires that may start in the project area. During dry weather, the potential for fire exists in any grassy perimeter regions of Radford. Sparks from operating vehicles or equipment, or even contact with hot catalytic converters can cause dry vegetation to catch fire. Vehicles and equipment will not be left idling or parked in or around areas where they may cause a fire. Equipment and vehicles will stay on cleared areas and/or on roadways wherever practical. Drivers are responsible to inspect under and around their parked or stopped vehicles to insure the vehicle will not contribute to a fire. All vehicles will be equipped with one 10-lb ABC rated fire extinguisher. In the event of a fire or explosion, the local EMS will be notified in addition to the client representative and the PM.

The following fire prevention measures will be implemented at all times by the field staff during construction, operation, and maintenance of the projects:

- One 10-lb ABC rated fire extinguisher shall be maintained within 50 ft of wherever more than 5 gallons of flammable or combustible liquids (or 5 lbs of flammable gas) are being used.
- Two 10-lb ABC rated fire extinguishers will be maintained in each vehicle assigned to the project.
- No smoking will be allowed during field work.
- Do not allow any fires or barbecues on the transmission line right-of-way, at material yards, substations, access roads, or other construction areas.

- Instruct all field personnel about emergency response for fire events.
- Clear away all flammable material for a minimum of 10 ft, including snags (fallen or standing dead trees), from areas of operation where a spark, fire, or flame could be generated.
- If a fire does start by accident, immediate steps will be taken to extinguish it (if it is safe to do so) using the available fire extinguisher.

A fire prevention plan to ensure employee safety in case of fire has also been prepared IAW EM 385-1-1 (01.E.01, 09.k.1, 19.A.01 and 19.A.04) (USACE, 2014) and IAW the National Fire Protection Association (NFPA) 241 (NFPA, 2013).

At a minimum all fire hazards, potential ignition sources, types of fires, and suppression equipment to control a fire, and responsibilities of employees shall be discussed with the project affected personnel at the beginning of the day, at the safety brief, prior to on-site work activities. This training should include all project fire hazards, materials and processes, ways to suppress or control an emergency, and the emergency evacuation procedures.

If a fire occurs, the following procedures will be implemented:

- Alarm and notify personnel within the immediate area of the fire.
- Go directly to the nearest telephone and summon the Fire Department by dialing 911.
- Only fight fires with an extinguisher if you have been trained and it has not exceeded the incipient stage.
- Evacuate the area if the fire cannot be extinguished safely.
- Notify the SSHO.

9.14.1 Portable Fire Extinguisher Use

Before using a portable fire extinguisher, be sure you have an unobstructed escape route should you fail to extinguish the fire. This is critical. Know what materials are burning and be sure the extinguisher you are using is capable of fighting the fire. Consider the possible danger posed by nearby toxic or highly flammable materials being impinged by the fire.

- Keep your back to an exit.
- Stand 8 to 20 ft away from the fire, depending on the size of the fire. Many times people will approach to within a few feet to begin extinguisher application and the force of the projected agent will scatter the burning material, spreading the fire.
- It is always better to begin application too far away and then approach, rather than the opposite.

To discharge the extinguisher, follow the four-step Pull, Aim, Squeeze, and Sweep (**PASS**) procedure:

- **PULL**: PULL the pin. This unlocks the operating lever and allows you to discharge the extinguisher. The pin will be tied in place with a plastic tie, which can make pulling the pin out difficult. Trick: Twist the pin, using your wrist, to break the plastic tie as you pull. This makes removal considerably easier.
- **AIM**: AIM low. Point the extinguisher hose (or nozzle) at the base of the fire. Hold the extinguisher canister in a vertical position during use.
- **SQUEEZE**: SQUEEZE the handle lever. This discharges the extinguisher agent. Squeeze the lever ALL the way down. Do not worry about “saving” your extinguishing agent - you actually want to empty the extinguisher as rapidly as possible. Fully discharge the unit. During use, releasing the lever will stop the discharge.
- **SWEEP**: SWEEP from side to side. Moving carefully toward the fire, keep the extinguisher aimed at the base of the fire and sweep back and forth until the flames appear to be out. Watch the fire area. If the fire reignites, repeat the process.

If the fire does not begin to go out immediately, leave the area at once!

WARNING: Portable fire extinguishers discharge faster than most people think. A 10-lb. ABC rated unit will completely discharge within 15–17 seconds.

VERIFY. Always be sure the fire department inspects the fire site, even if you think you have extinguished the fire. They will record the incident, which may prove necessary for insurance purposes.

9.14.2 Fire Extinguishers Inspection Procedure

All fire extinguishers used in outside service or on project sites will have hard (plastic, metal, or laminated) annual inspection tags, to prevent environmental deterioration. The SSHO is responsible for daily use inspections of all portable fire extinguishers maintained on this project to ensure that they are in proper working condition and have not been tampered with or physically damaged. Fire extinguishers are located in each field truck and all trailers used for housing staff and equipment.

In addition, a monthly inspection should also occur and will consist of verifying that the following five conditions are present:

- The pin and seal are in place;
- Pressure gauge (if present) indicates acceptable pressure;
- Extinguisher hose or nozzle are in good condition and free from obvious cracks, deficiencies or obstructions;
- Annual inspection tag is attached and indicates inspection within the past 12 months; and
- Access to the extinguisher is not blocked or obstructed.

9.15 Personal Protective Equipment

Selection of the appropriate PPE is a complex process, which takes into consideration a variety of factors. Key factors involved in this process are identification of the hazards or suspected hazards, routes of potential exposure to employees (inhalation, skin absorption, ingestion, and eye or skin contact), and the performance of the PPE materials (and clothing seams) in providing a barrier to these hazards. The amount of protection provided by PPE is material-hazard specific. That is, protective equipment materials will protect well against some hazardous substances and poorly, or not at all, against others.

Other factors in this selection process to be considered are matching the PPE to the employee's work requirements and task-specific conditions. The durability of PPE materials, such as tear strength and seam strength, is considered in relation to the employee's tasks. The effects of PPE in relation to heat stress and task duration are a factor in selecting and using PPE.

The levels of PPE will need to be reassessed if any of the following occur:

- Presence of or potential for previously unidentified chemicals or conditions;
- Changes in ambient weather conditions;
- Assignment of new tasks or expansion in the scope of a previously evaluated task.

The following is a description of the level modified "D" PPE that will be required during the project. Level Modified "D" consists of:

- Long pants (Non-static producing material such as cotton);
- Long or short sleeve shirt (Non-static producing material such as cotton);
- American National Standards Institute (ANSI) Z-87.1 approved eye protection;
- ANSI Type II reflective vests;
- ANSI approved over the ankle safety-toed boots;
- Leather work gloves when handling any sharp or rough edges;
- Viton or Nitrile gloves when handling contaminated soil or groundwater;
- Viton or Nitrile gloves in conjunction with leather gloves when handling contaminated soil or groundwater if there is a potential for sharp or rough edge injuries.

PPE required for protection against BBP during CPR/First Aid responders includes:

- Responder gloves (e.g., latex, nitrile, Viton, etc.);
 - No latex if a team member has an allergy to latex;
- Safety glasses with side shields (minimum eye protection);
- Liquid splash goggles (preferred eye protection if available, not mandatory);
- Full-face shield (if potential for splash onto face, especially the mouth);

- Liquid-impervious clothing (Tyvek) if the possibility exists for blood to soak into and through the responder's clothing;
- CPR pocket mask or equivalent when performing CPR.

Each of the PPE items listed above will be made available to each employee.

9.15.1 Maintenance of PPE

All PPE will be inspected when received from the distributor, prior to use, and whenever questions arise as to the proper functioning of the equipment. PPE will be inspected for:

- General cleanliness;
- Material degradation;
- Proper functioning of adjustable, moving, or mechanical parts.

Protective equipment must be stored properly to prevent damage or malfunction due to exposure to moisture, sunlight, damaging chemicals, extreme temperatures, and impact. Many equipment failures can be directly attributed to improper storage.

All PPE must be cleaned by employees prior to storage, according to the manufacturer's recommendations. PPE will not be stored in a wet condition. PPE hung up to dry will be located in an area free from contamination.

Improperly functioning equipment must be immediately removed from service.

9.15.2 Wet Weather

Employees must have appropriate wet weather gear at all times while working on this project. This includes:

- Rain jacket;
- Rain pants; and
- Water resistant boots (these must fit over safety boots or contain safety toe/metatarsal guard).

A change of clothes should be kept in the vehicle so staff can change if their clothing becomes wet.

9.15.3 Personal Protective Equipment by Task

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards. Verification and certification of assigned PPE by task is completed below. **Table 9-4** presents the PPE to be worn for specific tasks. Field staff shall follow and sign the AHA on-site to ensure specific PPE continuity.

Table 9-4 PPE Specifications

Site Name/Task	Level	PPE
UXO/MEC Inspection Activities	Modified D	• Long pants (Non-static producing material such as cotton) • Long sleeve shirt (Non-static producing material such as cotton) • ANSI Z-87.1 approved eye protection • ANSI Type II reflective vests when operating near traffic • ANSI approved over the ankle boots • Leather work gloves when handling any sharp or rough edges PPE required for protection against BBP during CPR/First Aid responders includes: ➤ Responder gloves (e.g., latex, nitrile, Viton, etc.) No latex if a team member is allergic. ➤ Safety glasses with side shields (minimum eye protection) ➤ Liquid splash goggles (preferred eye protection if available, not mandatory) ➤ Full-face shield (if potential for splash on face and in mouth) ➤ Liquid-impervious clothing (Tyvek) if the possibility exists for blood to soak into and through the responder's clothing CPR Pocket mask or equivalent when performing CPR
Performing Quality Control Activities		• Long pants (Non-static producing material such as cotton) • Long sleeve shirt (Non-static producing material such as cotton) • ANSI Z-87.1 approved eye protection • ANSI Type II reflective vests when operating near traffic • ANSI approved over the ankle boots • Leather work gloves when handling any sharp or rough edges
Operating Motor Vehicles		• Long pants (Non-static producing material such as cotton) • Long sleeve shirt (Non-static producing material such as cotton) • ANSI Z-87.1 approved eye protection • ANSI Type II reflective vests • ANSI approved over the ankle boots • ANSI-approved hard hat when near the heavy equipment or other overhead hazards

Table 9-4 PPE Specifications (Continued)

Site Name/Task	Level	PPE
Sampling and Analysis Activities	Modified D	• Long pants (Non-static producing material such as cotton); • Long sleeve shirt (Non-static producing material such as cotton); • ANSI Z-87.1 approved eye protection; • ANSI Type II reflective vests; • ANSI approved over the ankle boots; • Leather work gloves when handling any sharp or rough edges; • Viton or Nitrile gloves when handling contaminated soil or groundwater; • Viton or Nitrile gloves in conjunction with leather gloves when handling contaminated soil or groundwater if there is a potential for sharp or rough edge injuries; • Hearing protection when near heavy equipment operations; • ANSI-approved hard hat when near the heavy equipment or other overhead hazards.
Upgrade		Downgrade
• Request from individual performing tasks; • Change in work tasks that will increase contact or potential contact with hazardous materials; • Known or suspected presence of dermal or inhalation hazards.		• New information indicating that situation is less hazardous than originally thought; • Change in site conditions that decrease the hazard; • Change in work task that will reduce contact with hazardous materials.
NOTES: • Modifications are as indicated. HDR will provide PPE only to HDR employees. • Ear protection should be worn when conversations cannot be held at distances of one meter (3 ft) or less without shouting. • Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C, or B) is permitted only when the PPE requirements have been approved by the HSM and CIH.		

9.15.4 Personal Protective Equipment Training

Any worker required to wear PPE shall receive training in the proper use and care of PPE prior to utilization. The SSHO shall conduct this training on site with the PPE provided and training shall be documented in writing (i.e., documented in the SSHO logbook or using a training sign-in sheet). Periodic retraining shall be offered as needed. The training shall include, but is not limited to, the following subjects:

- When PPE is necessary for SI activities;
- How to properly don, doff, adjust, and wear PPE;
- The limitations of PPE;
- The proper care, maintenance, useful life expectancy, and disposal of PPE.

After the training, the on-site employees shall demonstrate they understand the components of the PPE and how to use PPE properly, or they shall be retrained.

9.15.5 Record Keeping

Written records shall be kept on-site of the names of staff members trained, the type of training provided, and the dates when training occurred. Training records shall also be forwarded to the HSM for review.

10.0 References

- DDESB. (2004, December 20). *DoD Explosive Safety Board (DDESB) Technical Paper 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel*. Retrieved 2011, from Department of Defense Explosives Safety Board:
http://www.ddesb.pentagon.mil/TP18_122004.pdf
- DoD. (1998, August 17). *Defense Federal Acquisition Regulation Supplement*. Retrieved from
<http://www.acq.osd.mil/dpap/dars/dfarspgi/current/index.html>
- NFPA. (2013). *NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations*. Retrieved from National Fire Protection Association:
<http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=241>
- OSHA. (2009, July 1). *Code of Federal Regulations (CFR) Title 29 Part 1910.120 - Hazardous waste operations and emergency response*. Retrieved 2011, from Government Printing Office, CFR: <http://www.gpo.gov/fdsys/pkg/CFR-2009-title29-vol5/pdf/CFR-2009-title29-vol5-sec1910-120.pdf>
- OSHA. (2011, July 01). *OSHA Code of Federal Regulations (CFR) Title 29 CFR 1910.1030, Bloodborne pathogens*. Retrieved 2012, from Government Printing Office:
<http://www.gpo.gov/fdsys/pkg/CFR-2011-title29-vol6/pdf/CFR-2011-title29-vol6-part1910-subpartZ.pdf>
- OSHA. (2011a, July 01). *Title 29 Part 1926, Safety and health regulations for construction. 1926.65-Hazardous waste operations and emergency response, 1926.59-Hazard Communications*. Retrieved 2012, from Government Printing Office:
<http://www.gpo.gov/fdsys/pkg/CFR-2010-title29-vol8/pdf/CFR-2010-title29-vol8-sec1926-65.pdf>
- OSHA. (2011b, June 8). *Access to employee exposure and medical records*. Retrieved from Toxic and Hazardous Substances:
https://www.osha.gov/pls/oshaweb/owadis.show_document?p_table=STANDARDS&p_id=10027
- OSHA. (2011c, July 01). *OSHA; CFR Title 29 CFR Part 1910.1200, Hazard Communication*. Retrieved 2012, from Government Printing Office: <http://www.gpo.gov/fdsys/pkg/CFR-2011-title29-vol6/pdf/CFR-2011-title29-vol6-part1910-subpartZ.pdf>
- OSHA. (2011d, July 02). *Title 29 CFR Part 1904, Recording and Reporting Occupational Injuries and Illness*. Retrieved 2012, from Government Printing Office:

<http://www.gpo.gov/fdsys/pkg/CFR-2011-title29-vol5/pdf/CFR-2011-title29-vol5-part1904.pdf>

OSHA. (2011e, July 02). OSHA, *CFR Title 29 Part 1910.134 Respiratory Protection*. Retrieved 2012, from Government Printing Office: <http://www.gpo.gov/fdsys/pkg/CFR-2011-title29-vol5/pdf/CFR-2011-title29-vol5-sec1910-134.pdf>

OSHA. (2012, March 26). *Hazard Communication*. Retrieved from Final Rule: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=22607

US Government Publishing Office. (2015). *Title 49: Transportation, Part 171: General Information, Regulations, and Definitions*. Retrieved from Electronic Code of Federal Regulations: <http://www.ecfr.gov/>

USACE. (2008a, September 15). *EM 385-1-97, Safety and Health Requirements Manual*. Retrieved 2012, from USACE Engineer Manual: <http://140.194.76.129/publications/eng-manuals/em385-1-97/toc.htm>

USACE. (2014, November 30). EM 385-1-1, Safety and Health Requirements. Washington, D.C.: Department of the Army, U.S. Army Corps of Engineers.

Attachment A

Site Safety and Health Plan

This page intentionally left blank.

Site Safety and Health Plan
for the
SITE INVESTIGATION
at the
FORMER GUN AND MORTAR RANGE
(RFAAP-002-R-01)
Radford Army Ammunition Plant, Virginia

August 2015

Submitted to:



**United States Army Corps of Engineers,
Baltimore District**

10 South Howard Street
Baltimore, MD 21201

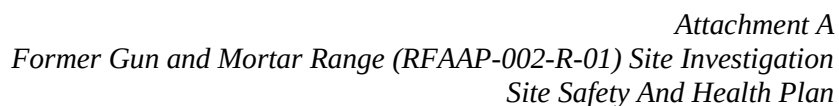
Submitted by:



Bering Sea Environmental, LLC.

615 E, 82nd Avenue, Suite 200
Anchorage, AK 99518

This page intentionally left blank.



I have read, understand, and I agree to abide by the provisions as detailed in this Site Safety and Health Plan (SSHP). Failure to comply with these provisions may lead to disciplinary action that may include dismissal from the work site, termination of employment, or, for subcontractors, termination of the work contract.

Date

[illegible]

This page intentionally left blank.

Signature Sheet

SITE SAFETY AND HEALTH PLAN

Site Investigation

Former Gun and Mortar Range (RFAAP-002-R-01)

Radford Army Ammunition Plant, Virginia

Plan Preparer		
Daniel Sciarro 720-236-5104 HDR EOC Health and Safety Manager		14 Aug 2015
Plan Approval		
Stephen Coffee 303-754-4200 HDR Certified Industrial Hygienist		14 Aug 2015
Plan Concurrence		
Sarah Skrobialowski 757-604-1173 BSEn Project Manager		14 Aug 2015

This page intentionally left blank.

TABLE OF CONTENTS

Signature Sheet.....	iii
1.0 Purpose.....	1-1
2.0 Site Description and Contamination Characterization	2-1
2.1 Site History, Previous Studies, Prior Uses and Activities	2-1
2.2 Contamination Characterization	2-1
2.3 Phases of Work Requiring Activity Hazard Analysis.....	2-6
3.0 Classic Safety	3-1
3.1 Slip, Trip, and Fall Hazards	3-1
3.2 Fire Hazards	3-1
4.0 Explosive Ordnance Safety	4-1
4.1 Hazard Identification	4-1
4.2 Hazard Mitigation and Prevention	4-1
5.0 Biological Hazards	5-1
5.1 Bees and Wasps	5-1
5.1.1 Hazard Identification	5-1
5.1.2 Hazard Mitigation and Prevention	5-1
5.2 Spiders.....	5-3
5.2.1 Hazard Identification	5-3
5.2.2 Hazard Mitigation and Prevention	5-3
5.3 Snakes	5-4
5.4 Hazardous Plants.....	5-5
5.4.1 Hazard Mitigation and Prevention	5-6
5.4.2 Hazardous Insects and Animals	5-7
6.0 Cold Stress	6-1
6.1 Hypothermia	6-1
6.1.1 Symptoms	6-1
6.1.2 Early Symptoms.....	6-1
6.1.3 Late Symptoms	6-1
6.1.4 First Aid	6-1
6.2 Frostbite	6-2
6.2.1 Symptoms	6-2
6.2.2 First Aid	6-2
6.3 Trench Foot.....	6-3
6.3.1 Symptoms	6-3
6.3.2 First Aid	6-3
6.4 Chilblains	6-3
6.4.1 Symptoms	6-3
6.4.2 First Aid	6-4
6.5 Equivalent Chill Temperature	6-4
7.0 Heat Stress	7-1

7.1	Heat Disorders	7-1
7.1.1	Heat Rash (Prickly Heat)	7-1
7.1.2	Heat Cramps and Heat Syncope	7-1
7.1.3	Heat Exhaustion	7-2
7.1.4	Heat Stroke.....	7-2
7.2	General Heat Stress First Aid	7-3
7.3	Prevention of Heat Disorders.....	7-4
7.3.1	Provision of Water (or other drinking fluids)	7-4
7.3.2	Access to Shade (Rest Area).....	7-4
7.3.3	Additional Health Measures	7-5
7.3.4	Heat Stress Monitoring Plan	7-5
7.3.5	Heat Stress Training.....	7-6
7.4	Emergency Assistance Procedure	7-6
8.0	Action Levels and Methods to Mitigate Hazards.....	8-1
8.1	Upgrades/Downgrades in Levels of PPE	8-1
8.2	Work Stoppage.....	8-2
8.3	Emergency Evacuation of On-Site personnel	8-3
8.4	Prevention and/or Minimization of Public Exposures	8-3
9.0	Staff Organization, Qualifications, and Responsibilities	9-1
10.0	Exposure Monitoring.....	10-1
11.0	Standard Operating Procedures, Engineering Controls and Work Practices	11-1
11.1	Site Rules	11-1
11.1.1	Buddy System	11-1
11.1.2	Chemical Warfare Materiel Procedures.....	11-2
11.2	Work Permit Requirements.....	11-2
11.3	Material Handling Procedures	11-3
12.0	Site Control Measures	12-1
13.0	Personal Hygiene and Decontamination	13-1
14.0	Equipment Decontamination	14-1
15.0	Logs, Reports, and Recordkeeping.....	15-1
15.1	Field Change Request	15-1
15.2	Medical and Training Records.....	15-1
15.3	Exposure Records	15-1
15.4	Accident and Incident Report	15-1
15.5	Health and Safety Field Logbooks.....	15-2
15.6	Closeout Safety Report	15-2
15.7	Required Postings	15-3
16.0	Resources	16-1

Tables

Table 2-1	Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01)	2-1
Table 2-2	Polycyclic Aromatic Hydrocarbons	2-6
Table 2-3	Administrative Controls.....	2-7
Table 5-1	Hazardous Plants.....	5-5
Table 6-1	Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)	6-5
Table 8-1	Action Levels and Methods to Mitigate Hazards for Radford AAP SI	8-1

This page intentionally left blank.

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
AAP	Army Ammunition Plant
ACGIH	American Conference of Governmental Industrial Hygienists
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
BSEn	Bearing Sea Environmental, LLC
Ca	Carcinogen
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CPR	Cardiopulmonary Resuscitation
CWM	Chemical Warfare Materiel
DDESB	Department of Defense Explosives Safety Board
DoD	Department of Defense
EM	Engineering Manual
EMS	Emergency Medical Services
EOD	Explosive Ordnance Disposal
FSP	Field Sampling Plan
GPS	Global Positioning System
HDR EOC	HDR Environment, Operations and Construction, Inc.
HDR	HDR, Inc.
HSM	Health and Safety Manager
IAW	in accordance with
IDLH	Immediately Dangerous to Life and Health
IDW	Investigation Derived Waste
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
mg/m ³	milligrams per cubic meter
mph	miles per hour
MRS	Munitions Response Site
N.D.	not determined
NIOSH	National Institute for Occupational Safety and Health

PAH	polycyclic aromatic hydrocarbon
PEL	Permissible Exposure Limit
PM	Project Manager
PPE	Personal Protective Equipment
ppm	parts per million
PVC	polyvinyl chloride
REL	Recommended Exposure Limit
RMSF	Rocky Mountain Spotted Fever
SI	Site Investigation
SIWP	Site Investigation Work Plan
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SZ	Support Zone
TAL	target analyte list
TLV	Threshold Limit Value
TWA	Time Weighted Average
VOC	volatile organic compound
USACE	U.S. Army Corps of Engineers
UXO	Unexploded Ordnance

1.0 Purpose

The purpose of this Site Safety and Health Plan (SSHP) is to guide the safe execution of field activities associated with the Radford Army Ammunition Plant (AAP) Site Investigation (SI).

The provisions outlined in this SSHP are mandatory for Bering Sea Environmental, LLC (BSEn), HDR, Inc. (HDR), subcontractors, and any authorized visitors. A copy of this SSHP shall be made available to persons involved with the fieldwork portion of this project.

Subcontractors will follow the SSHP. Site personnel, including authorized visitors, will be required to read and sign the SSHP. The Site Safety and Health Officer (SSHO) will maintain an updated copy of this SSHP in the safety area of the support zone (SZ), and the plan will be made available to all field personnel. Any questions regarding this SSHP or any safety and health issue should be directed to the SSSH.

This page intentionally left blank.

2.0 Site Description and Contamination Characterization

The Site Investigation Work Plan (SIWP), Section 2.0, provides detailed information on site characteristics, history, and current land use at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS.

2.1 Site History, Previous Studies, Prior Uses and Activities

Site history, previous studies, prior uses and activities are addressed in detail in the SIWP (Section 2.0).

2.2 Contamination Characterization

Table 2-1 summarizes the potential Contaminants of Concern, their occupational exposure limits, and their associated signs and symptoms of exposure. These concentrations were used to determine engineering and administrative controls for this Accident Prevention Plan (APP), as well as personal protective equipment (PPE) and site monitoring requirements.

Table 2-1 Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01)

Contaminant	Exposure Limit ^a (mg/m ³)	IDLH (mg/m ³)	Symptoms and Effects of Exposure	Potential Routes of Exposure
Metals				
Aluminum	NIOSH REL : TWA 10 mg/m ³ (total) TWA 5 mg/m ³ (resp) OSHA PEL : TWA 15 mg/m ³ (total) TWA 5 mg/m ³ (resp) ACGIH/ TWA 1(mg/m ³)	N.D.	irritation eyes, skin, respiratory system	inhalation, skin and/or eye contact
Calcium	NIOSH REL : TWA 2 mg/m ³ OSHA PEL : TWA 5 mg/m ³ ACGIH/ TWA 1(mg/m ³)	25 mg/m ³	irritation eyes, skin, upper resp tract; ulcer, perforation nasal septum; pneumonitis; dermatitis	inhalation, ingestion, skin and/or eye contact
Copper	NIOSH REL *: TWA 1 mg/m ³ [*Note: The REL also applies to other copper compounds (as Cu) except Copper fume.] OSHA PEL *: TWA 1 mg/m ³ [*Note: The PEL also applies to other copper compounds (as Cu) except copper fume.]	100 mg/m ³ (as Cu)	irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia	inhalation, ingestion, skin and/or eye contact

Table 2-1 Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01) (Continued)

Contaminant	Exposure Limit ^a (mg/m ³)	IDLH (mg/m ³)	Symptoms and Effects of Exposure	Potential Routes of Exposure
Iron	NIOSH REL : TWA 5 mg/m ³ OSHA PEL : TWA 10 mg/m ³	2500 mg/m ³ (as Fe)	Benign pneumoconiosis with X-ray shadows indistinguishable from fibrotic pneumoconiosis (siderosis)	Inhalation
Magnesium	OSHA PEL †: TWA 15 mg/m ³	750 mg/m ³	irritation eyes, nose; metal fume fever: cough, chest pain, flu-like fever	inhalation, skin and/or eye contact
Manganese	NIOSH REL *: TWA 1 mg/m ³ ST 3 mg/m ³ [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl, Methyl cyclopentadienyl manganese tricarbonyl, and Manganese tetroxide.] OSHA PEL *: C 5 mg/m ³ [*Note: Also see specific listings for Manganese cyclopentadienyl tricarbonyl and Methyl cyclopentadienyl manganese tricarbonyl.]	500 mg/m ³ (as Mn)	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage	inhalation, ingestion
Lead	NIOSH REL *: TWA (8-hour) 0.050 mg/m ³ [*Note: The REL also applies to other lead compounds (as Pb)] OSHA PEL *: [1910.1025] TWA 0.050 mg/m ³ [*Note: The PEL also applies to other lead compounds (as Pb)] ACGIH TLV 0.05 mg/m ³	100 mg/m ³ (as Pb)	Weakness, lassitude; facial pallor; pal eye; weight loss, malnutrition; abdominal pain, constipation; anemia; gingival lead line; tremors; paralysis of wrist and ankles; encephalopathy; kidney disease; irritated eyes; hypotension	inhalation, ingestion, skin and/or eye contact
Antimony	NIOSH REL *: TWA 0.5 mg/m ³ [*Note: The REL also applies to other antimony compounds (as Sb).] OSHA PEL *: TWA 0.5 mg/m ³ [*Note: The PEL also applies to other antimony compounds (as Sb).]	50 mg/m ³ (as Sb)	irritation eyes, skin, nose, throat, mouth; cough; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; anorexia; unable to smell properly	inhalation, ingestion, skin and/or eye contact
Selenium	NIOSH REL *: TWA 0.2 mg/m ³ [*Note: The REL also applies to other selenium compounds (as Se) except Selenium hexafluoride.] OSHA PEL *: TWA 0.2 mg/m ³ [*Note: The PEL also applies to other selenium compounds (as Se) except Selenium hexafluoride.]	1 mg/m ³ (as Se)	irritation eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns; in animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage	inhalation, ingestion, skin and/or eye contact

Table 2-1 Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01) (Continued)

Contaminant	Exposure Limit ^a (mg/m ³)	IDLH (mg/m ³)	Symptoms and Effects of Exposure	Potential Routes of Exposure
Tungsten	NIOSH REL *: TWA 5 mg/m ³ ST 10 mg/m ³ [*Note: The REL also applies to other insoluble tungsten compounds (as W).] OSHA PEL †: none	N.D.	irritation eyes, skin, respiratory system; diffuse pulmonary fibrosis; loss of appetite, nausea, cough; blood changes	inhalation, ingestion, skin and/or eye contact
Zinc	NIOSH REL : Dust: TWA 5 mg/m ³ C 15 mg/m ³ Fume: TWA 5 mg/m ³ ST 10 mg/m ³ OSHA PEL †: TWA 5 mg/m ³ (fume) TWA 15 mg/m ³ (total dust) TWA 5 mg/m ³ (resp dust)	500 mg/m ³	Metal fume fever: chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function	Inhalation
Explosives				
1,3,5-trinitrobenzene	NIOSH REL : TWA 0.5 mg/m ³ [skin] OSHA PEL †: TWA 1.5 mg/m ³ [skin]	500 mg/m ³	irritation skin, mucous membrane; liver damage, jaundice; cyanosis; sneezing; cough, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis (increased blood leukocytes); anemia; cardiac irreg	inhalation, skin absorption, ingestion, skin and/or eye contact
1,3-dinitrobenzene	NIOSH REL : TWA 1 mg/m ³ [skin] OSHA PEL : TWA 1 mg/m ³ [skin]	50 mg/m ³	Anoxia, cyanosis; visual disturbance, central scotomas; bad taste, burning mouth, dry throat, thirst; yellowing hair, eyes, skin; anemia; liver damage	inhalation, skin absorption, ingestion, skin and/or eye contact
2,4,6-trinitrotoluene	NIOSH REL : TWA 0.5 mg/m ³ [skin] OSHA PEL †: TWA 1.5 mg/m ³ [skin]	500 mg/m ³	irritation skin, mucous membrane; liver damage, jaundice; cyanosis; sneezing; cough, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis (increased blood leukocytes); anemia; cardiac irreg	inhalation, skin absorption, ingestion, skin and/or eye contact
2,4-dinitrotoluene	NIOSH REL : Ca TWA 1.5 mg/m ³ [skin] OSHA PEL : TWA 1.5 mg/m ³ [skin]	Ca [50 mg/m ³]	Anoxia, cyanosis; anemia, jaundice; reproductive effects; [potential occupational carcinogen]	inhalation, skin absorption, ingestion, skin and/or eye contact

Table 2-1 Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01) (Continued)

Contaminant	Exposure Limit ^a (mg/m ³)	IDLH (mg/m ³)	Symptoms and Effects of Exposure	Potential Routes of Exposure
2,6-dinitrotoluene	NIOSH REL : Ca TWA 1.5 mg/m ³ [skin] OSHA PEL : TWA 1.5 mg/m ³ [skin]	Ca [50 mg/m ³]	Anoxia, cyanosis; anemia, jaundice; reproductive effects; [potential occupational carcinogen]	inhalation, skin absorption, ingestion, skin and/or eye contact
2-amino-4,6-dinitrotoluene Various isomers of DNT exist	NIOSH REL : Ca TWA 1.5 mg/m ³ [skin] OSHA PEL : TWA 1.5 mg/m ³ [skin]	Ca [50 mg/m ³]	Anoxia, cyanosis; anemia, jaundice; reproductive effects; [potential occupational carcinogen]	inhalation, skin absorption, ingestion, skin and/or eye contact
2-nitrotoluene	NIOSH REL : TWA 2 ppm (11 mg/m ³) [skin] OSHA PEL †: TWA 5 ppm (30 mg/m ³) [skin]	200 ppm	Anoxia, cyanosis; headache, lassitude (weakness, exhaustion), dizziness; ataxia; dyspnea (breathing difficulty); tachycardia; nausea, vomiting	inhalation, skin absorption, ingestion, skin and/or eye contact
3,5-dinitroaniline ³	NIOSH REL : TWA 2 ppm (11 mg/m ³) [skin] OSHA PEL †: TWA 5 ppm (30 mg/m ³) [skin]	200 ppm	Anoxia, cyanosis; headache, lassitude (weakness, exhaustion), dizziness; ataxia; dyspnea (breathing difficulty); tachycardia; nausea, vomiting	inhalation, skin absorption, ingestion, skin and/or eye contact
3-nitrotoluene	NIOSH REL : TWA 2 ppm (11 mg/m ³) [skin] OSHA PEL †: TWA 5 ppm (30 mg/m ³) [skin]	200 ppm	Anoxia, cyanosis; headache, lassitude (weakness, exhaustion), dizziness; ataxia; dyspnea (breathing difficulty); tachycardia; nausea, vomiting	inhalation, skin absorption, ingestion, skin and/or eye contact
4-amino-2,6-dinitrotoluene	NIOSH REL : Ca TWA 1.5 mg/m ³ [skin] OSHA PEL : TWA 1.5 mg/m ³ [skin]	Ca [50 mg/m ³]	Anoxia, cyanosis; anemia, jaundice; reproductive effects; [potential occupational carcinogen]	inhalation, skin absorption, ingestion, skin and/or eye contact
4-nitrotoluene	NIOSH REL : TWA 2 ppm (11 mg/m ³) [skin] OSHA PEL †: TWA 5 ppm (30 mg/m ³) [skin]	200 ppm	Anoxia, cyanosis; headache, lassitude (weakness, exhaustion), dizziness; ataxia; dyspnea (breathing difficulty); tachycardia; nausea, vomiting	inhalation, skin absorption, ingestion, skin and/or eye contact
Hexahydro-1,3,5-trinitro-1,3,5-triazine	NIOSH REL : TWA 5 mg/m ³ OSHA PEL †: none	N.D.	irritation eyes, skin; dermatitis, sensitization skin; dyspnea (breathing difficulty), lassitude (weakness, exhaustion), incoordination, salivation; hypothermia; liver injury	inhalation, skin absorption, ingestion, skin and/or eye contact

Table 2-1 Occupational Exposure Limits for Contaminants of Concern at the Former Gun and Mortar Range (RFAAP-002-R-01) (Continued)

Contaminant	Exposure Limit ^a (mg/m ³)	IDLH (mg/m ³)	Symptoms and Effects of Exposure	Potential Routes of Exposure
Nitrobenzene	NIOSH REL : TWA 1 ppm (5 mg/m ³) [skin] OSHA PEL : TWA 1 ppm (5 mg/m ³) [skin]	200 ppm	irritation eyes, skin; anoxia; dermatitis; anemia; methemoglobinemia; in animals: liver, kidney damage; testicular effects	inhalation, skin absorption, ingestion, skin and/or eye contact
Nitroglycerin	NIOSH REL : ST 0.1 mg/m ³ [skin] OSHA PEL †: C 0.2 ppm (2 mg/m ³) [skin]	75 mg/m ³	throbbing headache; dizziness; nausea, vomiting, abdominal pain; hypotension; flush; palpitations; methemoglobinemia; delirium, central nervous system depression; angina; skin irritation	inhalation, skin absorption, ingestion, skin and/or eye contact
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	NIOSH REL : TWA 5 mg/m ³ OSHA PEL †: none	N.D.	irritation eyes, skin; dermatitis, sensitization skin; dyspnea (breathing difficulty), lassitude (weakness, exhaustion), incoordination, salivation; hypothermia; liver injury	inhalation, skin absorption, ingestion, skin and/or eye contact
Pentaerythritol tetranitrate	NIOSH REL : TWA 10 mg/m ³ (total) TWA 5 mg/m ³ (resp) OSHA PEL †: TWA 15 mg/m ³ (total) TWA 5 mg/m ³ (resp)	N.D.	irritation eyes, respiratory system	inhalation, skin absorption, ingestion, skin and/or eye contact
Trinitrophenyl methyl-nitramine	NIOSH REL : TWA 10 mg/m ³ (total) TWA 5 mg/m ³ (resp) OSHA PEL †: TWA 15 mg/m ³ (total) TWA 5 mg/m ³ (resp)	N.D.	irritation eyes, respiratory system	inhalation, skin absorption, ingestion, skin and/or eye contact
Perchlorates				
Perchlorate		N.D.	irritation eyes, skin, upper respiratory system; dermatitis; in animals: teratogenic effects	inhalation, skin absorption, ingestion, s
Polycyclic Aromatic Hydrocarbons	NIOSH REL : TWA 3.5 mg/m ³ Ca TWA 0.1 mg PAHs/m ³ [Carbon black in presence of PAHs] OSHA PEL : TWA 3.5 mg/m ³	1750 mg/m ³	Carcinogen, pulmonary, gastrointestinal, renal, and dermatologic systems	Inhalation, Ingestion, skin
ACGIH - American Conference of Governmental Industrial Hygienists Ca- Carcinogen IDLH – (OSHA) Immediately Dangerous to Life and Health mg/m ³ – milligrams per cubic meter N.D. Not Determined NIOSH – National Institute for Occupational Safety and Health			PAH-polycyclic aromatic hydrocarbons PEL- (OSHA) Permissible Exposure Limit REL- (NIOSH) Recommended Exposure Limit TLV- (ACGIH) Threshold Limit Value TWA- Time Weighted Average	

Table 2-2 Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbon	Occupational Exposure Limit	Potential Effects
Anthracene	(L) *	Route of exposure: Skin. Carcinogen.
Acenaphthene	NA *	NA
Acenaphthylene	NA *	NA
Benzo[a]anthracene	(L) *	Route of exposure: Skin. Carcinogen.
Benzo[b]fluoranthene	NA *	NA
Benzo[k]fluoranthene	NA *	NA
Benzo[a]pyrene	(L) *	Route of exposure: Skin. Carcinogen.
Benzo[g,h,i]perylene	NA *	NA
Chrysene	(L)	NA
Dibenz(a,h)anthracene	NA *	NA
Fluoranthene	NA *	NA
Fluorene	NA *	NA
Indeno[1,2,3-cd]pyrene	NA *	NA
Naphthalene	10 (ppm) *	Route of exposure: Skin. Upper respiratory tract and eye irritation
Phenanthrene	NA *	NA
Pyrene	NA *	NA
2-Methylnaphthalene	TLV 0.5 *	Route of exposure: Skin. Lower respiratory tract and skin irritation
1-Methylnaphthalene	NA *	NA
Notes: * We do not anticipate any inhalation exposure based on the low soil concentration. TLV- Threshold Limit Value (ACGIH) PEL Permissible Exposure Limit (OSHA) ppm- parts per million mg/m ³ – milligrams per cubic meter NA- Not Established		

2.3 Phases of Work Requiring Activity Hazard Analysis

Individual hazard analyses have been performed for the tasks associated with the SI and analysis at the Former Gun and Mortar Range (RFAAP-002-R-01) Munitions Response Site (MRS). The potential hazards have been identified; control measures have been outlined; training requirements and PPE requirements and equipment inspection procedures have been established.

The Activity Hazard Analyses (AHAs) will be used as training tools for all members involved in the activity and reviewed daily before the specified work activity begins. Any modifications to the existing AHAs shall be coordinated through the Health and Safety Manager (HSM) and

Approved by the identified plan Certified Industrial Hygienist (CIH). The AHAs are included in **Attachment B** of the APP and consider the following activities:

- Assisted Visual Surveys;
- Media (Soil) Sampling;
- Operating Motor Vehicles.

Administrative Controls are presented in **Table 2-3**.

Table 2-3 Administrative Controls

Task	Operation
Performing Unexploded Ordnance (UXO)/Munitions and Explosives of Concern (MEC) Inspection Activities	• Thorough inspection of surface UXO/MEC items. • Use of hand-held metal detector device to locate anomalies. • Live UXO/MEC items will be marked and, if possible, a Global Positioning System (GPS) location noted. Radford AAP will be notified.
Performing Quality Control Activities	• Ensure there are no surface UXO/MEC anomalies. • Ensure all sampling is conducted within the guidelines of the Field Sampling Plan (FSP), Section 6.0 of the SIWP. • Investigate surface anomalies found.
Performing Motor Vehicle Operations	• Inspect vehicles to ensure proper working condition. • Ensure that vehicles are properly equipped. • Conduct motor vehicle operations.
Operating Geophysical Instruments	• Using a hand-held metal detector device to ensure there are no anomalies where soil samples are to be collected. • If required, fiberglass pin flags will be used to mark UXO/MEC material for Explosive Ordnance Disposal (EOD).
Avoiding UXO/MEC at Sample Locations	• Using a hand-held metal detectors devise to ensure there are no anomalies where the soil samples are to be collected.
Performing Sampling and Analysis Activities	• Collecting soil samples for analysis to determine need for further investigation. • Cleaning of sampling tools if required, using appropriate method to prevent cross- contamination of samples

This page intentionally left blank.

3.0 Classic Safety

Physical hazards are associated with the project, which if not identified and addressed may result in accidents and personal injury to the workforce, as well as operational problems. To minimize hazards, standard safety protocols will be followed at all times. The subsections below describe general classic safety precautions for explosion and fire hazards; slip, trip, and fall hazards.

3.1 Slip, Trip, and Fall Hazards

Personnel should exercise caution when walking around the site to avoid trip and fall hazards. If present, holes must be covered, flagged, or marked to warn personnel. If conditions become slippery (e.g. icy surfaces), personnel should take small steps with their feet pointed slightly outward to decrease the probability of slipping and/or use ice traction devices for their footwear. Gravel or sand should be spread in slippery and/or icy areas. Personnel should watch where they are walking and walk only in areas of good stability. Proper site housekeeping, removal of trash, and orderly stacking and removal of materials will reduce slipping and tripping hazards. Proper site housekeeping will be the responsibility of all site personnel.

3.2 Fire Hazards

Fire Prevention is discussed in detail in **Section 9.14** of the APP, and the Fire Fighting Plan is located in **Section 9.2** of the APP.

The following general safety guidelines will be followed to minimize the risk of an explosion and/or fire:

- Smoking is not allowed in work areas. Smoking is permitted only in designated areas. Cigarette butts will be placed into a bottle partially full of water prior to disposal.
- Control “open flame” tools and equipment.
- Protect nearby combustible materials from heat, flames, sparks, and slag by moving or covering them.
- Keep flammables in closed containers. Use National Fire Protection Association-certified safety cans.
- All site workers will have training on the use of portable fire extinguishers. Fire extinguishers will be located at each work site (minimum 4A:80B: C 10-pound Type ABC dry chemical). Each vehicle will have a fire extinguisher (minimum 10B: C dry chemical).
- When using cut off saws, avoid cutting into the wood where nails are present, to prevent possible sparks

This page intentionally left blank

4.0 Explosive Ordnance Safety

4.1 Hazard Identification

MEC and munitions debris (MD) have previously been found at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS. The items observed at the Former Gun and Mortar Range (RFAAP-002-R-01) MRS were determined to be isolated findings. The MEC hazards are discussed in the SIWP. The potential exists for MEC to be present at the site. MEC and anomaly avoidance techniques will be practiced during all SI activities.

Work will be conducted in accordance with (IAW) the following guidance:

- Engineering Manual (EM) 385-1-97 [United States Army Corps of Engineers (USACE, 2008)]
- EM 385-1-1(USACE, 2014).
- Department of Defense (DoD) Manual 6055.09-M (Department of Defense Explosives Safety Board (DDESB, 2004)).

4.2 Hazard Mitigation and Prevention

MEC are not always easily recognized. They may be partially buried and the environment may have altered their appearance. They may have been damaged or partially expended. They come in all sizes and shapes. However, they are all man-made. Treat any man-made object as a potential MEC.

If it is determined MEC is present:

- Remain constantly vigilant. There is no substitute for common sense.
- Do not work alone. Use the “buddy” concept while on site.
- Remember that danger is not determined by size. Small detonators, primers, blasting caps, etc. are more sensitive by design. A small silver object resembling a watch battery may be a fuse or primer for bomblet from a larger canister.
- Light blue practice devices may have explosive spotting charges.
- Brown rocks with rust evident around them are not necessarily inert fragments. Explosive material from a partially detonated device may weather exactly like a piece of iron, but is still explosive. Sometimes these rusty clumps look like soil.
- Avoid heavily vegetated areas. Do not walk through areas where the ground cannot be seen.
- Operate vehicles on clearly marked roads or trails. Where none exist, survey the area on foot where the vehicle will travel.
- Dead vegetation and animals could signal the presence of chemical agents.

When MEC are discovered by non-UXO personnel after entering the work site:

- Do not touch, step on, or move any UXO regardless of the markings or apparent condition, and do not investigate.
- Always assume a man-made object contains a live charge, even practice or inert items. The age or condition of UXO does not decrease its effectiveness. To the contrary, ordnance exposed to the elements for an extended period of time may become more sensitive to shock, movement, friction, etc. because the stabilizing agents in the explosive degrade. Expended pyrotechnic/practice devices may contain red/white phosphorus residue, which may re-ignite spontaneously if subjected to friction or if the crust is broken and the contents exposed to air.
- Notification should be consistent with the WP.
- The item will be reported up the following chain of communication:
 - o Task Manager
 - o BSEn Project Manager (PM)
 - o USACE PM and UXO Safety Official
 - o Installation Restoration Program Manager
 - o EOD

5.0 Biological Hazards

5.1 Bees and Wasps

5.1.1 Hazard Identification

Noxious insects, such as bees, wasps and hornets, are ubiquitous and may be encountered during field activities. Bees build hives in rock crevices and holes in trees, while wasps and hornets build nests in man-made structures and other areas where they are protected from the elements. Their presence in the field is temperature dependent. They are not present in the cold seasons.



Bees, Wasps and Hornets

5.1.2 Hazard Mitigation and Prevention

The following preventative measures should always be taken to minimize the chances of experiencing an insect bite or sting:

- Wear light-colored, smooth-finished clothing.
- Avoid perfumed soaps, shampoos, and deodorants.
- Don't wear cologne or perfume.
- Avoid bananas and banana-scented toiletries.
- Wear clean clothing and bathe daily (sweat may anger bees).
- Wear clothing to cover as much of the body as possible.
- Avoid flowering plants when possible.
- Keep work areas clean. Social wasps thrive in places where humans discard food.
- Remain calm and still if a single stinging insect is flying around (swatting at an insect may cause it to sting).
- If you are attacked by several stinging insects at once, leave the area immediately. Bees release a chemical when they sting, which may attract other bees.
- Go indoors.
- A shaded area is better than an open area to get away from the insects.

- If you are able to physically move out of the area, do not attempt to jump into water. Some insects (particularly Africanized Honey Bees) are known to hover above the water, continuing to sting once you surface for air.
- If a bee comes inside your vehicle, stop the car slowly, and open all the windows.
- Workers with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (Epi Pen) and should wear a medical identification bracelet or necklace stating their allergy.

The two greatest risks from most insect stings are allergic reactions (which can be fatal) and infections. General guidelines to follow if you experience an insect sting are as follows:

- If you are allergic, carry an Epi Pen and ensure your co-workers are informed of your allergy and the location of the Epi Pen.
- Do not give drinks in excess to an employee suffering from an allergic reaction, as this can cause vomiting.
- Remove the stinger by gently scraping it out with a blunt-edged object, such as a credit card or dull knife. Do not try to pull it out; this may release more venom into the body.
- For all types of stings, wash the area carefully with soap and water. Do this two to three times a day until skin is healed.
- Apply a cold pack or an ice pack wrapped in a cloth.
- Apply a paste of baking soda and water for 15 to 20 minutes.
- Over-the-counter acetaminophen products may reduce pain.
- Some over-the-counter antihistamines advertise that they alleviate pain/swelling.
- Any employee who receives multiple stings should seek immediate medical attention.
- Any employee who knows that they are allergic to insect stings/bites should consult their own physician concerning the prudence of carrying self-administered anti-toxin injectable medicine.
- If any sting victim is complaining of a rapid heart-beat and/or tightness in the chest, keep the individual calm and in the shade. Seek medical attention immediately.

A sting in the mouth or nose warrants immediate medical attention, because swelling may block airways. You should also seek emergency care if you see any of the following symptoms, which may indicate an allergic reaction:

- Large area of swelling;
- Abnormal breathing;
- Tightness in throat or chest;
- Dizziness;

- Hives;
- Fainting;
- Nausea or vomiting;
- Persistent pain or swelling (over 72 hours).

5.2 Spiders

5.2.1 Hazard Identification

The black widow and the brown recluse spiders could exist at the site. Only female black widow spiders pose a danger. The female black widow spiders usually have a reddish hourglass shape on the underside of their abdomen. The brown recluse spider is generally yellowish-tan to tan in color. The abdomen is a uniform color with no markings on it. The brown recluse has six eyes arranged in pairs of two and a distinctive violin shape on the top of the thorax.



Black Widow



Brown Recluse

5.2.2 Hazard Mitigation and Prevention

Black widow bites are often immediately painful. The most reliable evidence of a bite is two tiny red puncture marks around which the pain intensifies during the first three hours. The pain continues for 12–48 hours and then gradually subsides. Black widow venom contains a neurotoxin that can cause headache, dizziness, shortness of breath, and often painful abdominal spasms and back pain. Other symptoms include rigidity of limbs, increased blood pressure, and profuse sweating. Death seldom occurs in healthy adults, though children and adults in poor health may die within 12–32 hours from asphyxia. Anyone suspecting a spider bite should receive medical attention as soon as possible. A commercial antidote is available for black widow spider bites.

The bite of the brown recluse spider is usually painless. However, localized burning sensation often develops within the first hour and, during the next 6–12 hours, a small pimple or blister forms. The surrounding tissue begins to darken and take a raised appearance. The venom of this spider can cause extensive tissue damage (necrotic reaction) and, over the next 10 to 14 days, a sunken, open, ulcerated sore up to several centimeters in diameter. It normally takes six to eight weeks for a brown recluse spider bite to heal. A large sunken scar may persist that requires

surgery to repair. Not every brown recluse bite results in ulcer formation. In rare cases systemic complications such as liver or kidney damage result.

Spider bites can be harmful and potentially deadly to humans. Personnel should avoid spiders and webs during the course of the field activities. If you are bitten:

- Seek medical attention.
- If possible, identify the spider to assist your healthcare professional in determining treatment.
- Keep the bitten area lower than the person's heart. If the person was bitten on the arm or leg, immobilize the extremity in a splint.
- Wash the area with soap and water to help prevent infection.
- Place ice wrapped in cloth or cold compresses on the bitten area.
- Remove any rings or constricting items.
- Keep the personnel quiet until medical assistance is available.
- Do not ingest caffeine, alcohol, or tobacco products as these products tend to increase heart rate and blood flow.

5.3 Snakes

The possibility for encountering snakes exists at Radford AAP. Although rare in the southwestern Virginia area, the species of greatest concern is the copperhead (*Agkistrodon contortix*). Copperheads grow to 36 inches and can be recognized by the copper-color head and a reddish-brown hourglass pattern on the body. Copperheads are normally lethargic; once aroused, however, they strike vigorously and may rapidly vibrate their tails. Rocky hillsides are favorite habitats.

To minimize the threat of snake bites, all personnel walking through the brush will be aware of the potential for encountering snakes and will avoid actions that increase the likelihood of encounters (e.g., turning over logs). Additional caution will be exercised around sawdust or rock piles, which are known to support copperheads. In the event of a snake bite, the following rules should be followed:

If bitten by a snake:

- *Keep the victim calm* – the chance of a lethal dose of venom is very unlikely.
- Remove restrictive clothing, jewelry, etc. from the bite area as swelling can cause restricted blood flow and further damage to tissue.
- Immobilize the area bitten and keep below the heart.
- Rinse the bite area with clean water.

- Seek medical attention immediately.
- **Do not apply a tourniquet.** Apply a compression bandage to cover the bite but do not restrict circulation.
- **Do not cut the victim.** This is extremely dangerous and causes more harm to the victim and exposes more blood vessels to the venom.
- **Do not apply ice since ice may cause frostbite.** Cool the area with cold compresses to help to slow circulation.
- **Do not offer any stimulants.** Caffeine, sugar, tobacco, and alcohol products increase heart rate and blood pressure, which will increase the circulation of the venom. Small sips of water are encouraged, especially if the victim is dehydrated. However, if the victim is showing signs of shock or is nauseated, do not administer any liquids.
- Transport the victim to the nearest medical facility and be prepared to answer several questions regarding the incident including:
 - The victim's information if they are unable to respond for themselves;
 - Status of the victim;
 - Time and location of the incident;
 - Identification of the venomous species if possible – attempt to describe the coloration, size, etc. and the habitat of where the animal was seen;
 - Progression of the wound – i.e., does the damage to the area seem to be spreading?
- If immediate transportation is not readily available, call or send for help if you can. Do not leave the victim alone. Move the victim slowly and without unnecessary exertion.

5.4 Hazardous Plants

The following table described poisonous plants common to Virginia.

Table 5-1 Hazardous Plants

Name	Toxicity	Symptoms	Image
Sheep laurel	Toxicity in humans if ingested.	Signs of toxicity occur usually within six hours after the plants are eaten. Symptoms include incoordination, excessive salivation, vomiting, bloat, weakness, muscular spasms, coma, and death.	
Fetterbush	Toxicity in humans if ingested.	Signs of toxicity occur usually within six hours after the plants are eaten. Symptoms include incoordination, excessive salivation, vomiting, bloat, weakness, muscular spasms, coma, and death.	

Table 5-1 Hazardous Plants (Continued)

Name	Toxicity	Symptoms	Image
Sesbania	Toxicity in humans if ingested.	Symptoms are variable and include hemorrhagic diarrhea, but constipation can also occur.	
Poison ivy	Skin irritant	Urushiol oil in this plant causes contact dermatitis. Severe allergic reactions may require medical care.	
Poison oak	Skin irritant	Urushiol oil in this plant causes contact dermatitis. Severe allergic reactions may require medical care.	
Poison sumac	Skin irritant	Urushiol oil in this plant causes contact dermatitis. Severe allergic reactions may require medical care.	

5.4.1 Hazard Mitigation and Prevention

Avoidance of the plants, particularly the stems or needles, is the most effective means of preventing poisoning. Barrier creams are available. If the plant is identified in a sampling area, wearing polyvinyl chloride (PVC) or latex gloves will provide additional protection. A person experiencing symptoms of poisoning should remove contaminated clothing; wash all exposed areas thoroughly with soap and water. Apply calamine or other poison aid lotion if the rash is mild. Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity. Thorough washing of skin and clothing after site work or after potential exposure can reduce the severity of irritation.

After coming in contact with poison ivy, poison oak, or poison sumac, the best way to prevent skin irritation is to treat the area immediately after exposure. Pour a mild solvent (such as rubbing alcohol) over the exposed area followed by plenty of cold water (warm water enhances penetration of the oil). If rubbing alcohol is not available, wash with large quantities of cold

water. If it is too late to prevent the rash, washing the skin to remove excess plant oil will keep the rash from spreading.

5.4.2 Hazardous Insects and Animals

Biological hazards that may be found at Radford AAP include ticks, spiders and snakes. The following sections discuss the potential biological hazards that may be encountered at Radford AAP.

TICKS

From April through October, particular caution will be exercised to prevent site workers from being bitten by deer ticks and potentially contracting Lyme Disease. The Centers for Disease Control has noted an increase of Lyme Disease and Rocky Mountain Spotted Fever (RMSF), which are caused by tick bites. Ticks are small, ranging from the size of a comma up to about 1/4 inch; when embedded in the skin, they may look like a freckle. Ticks live in and near wooded areas, tall grass, and brush.

Lyme Disease - Lyme Disease is caused by deer ticks and lone star ticks that have become infected with spirochetes. Female deer ticks are about 1/4 inch in size, and are black and brick red in color. Male deer ticks are smaller and completely black. Lone star ticks are larger and chestnut brown in color. The illness typically occurs in the summer and is characterized by a slowly expanding red rash that develops in a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or general malaise. At this stage, treatment by a physician usually is effective. If left alone, these early symptoms may disappear, but more serious problems may follow. The most common late symptom of the untreated disease is arthritis. Other problems which may occur include meningitis, neurological abnormalities, and cardiac abnormalities. It is important to note that some people do not get the characteristic rash and may have diminished progress to the later manifestations. Treatment of later symptoms is more difficult than early symptoms and is not always successful.

Rocky Mountain Spotted Fever - RMSF has occurred in this area of the country. It is caused by Rocky Mountain wood ticks and dog ticks which have become infected with rickettsia. Both are black in color.

RMSF disease is transmitted by the infected dog tick *Dermacentor variabilis* and is common in the western U.S. It is important to note that the dog tick is significantly larger than the deer tick, previously discussed. Nearly all cases of RMSF occur in the Spring and Summer, generally several days after exposure to infected ticks. The onset of illness is abrupt, often with high fever, headache, chills, and severe weakness. After the fourth day of fever, victims

develop a spotted pink rash, which usually starts at the hands and feet and gradually extends to most of the body.

The first symptoms of either disease are flu-like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain. If immediately treated by a physician, most individuals recover fully in a short period of time. If not treated, more serious symptoms can occur.

If a site employee believes they have been bitten by a tick, or if any of the signs and symptoms noted above appear, the employee will contact the SSHO, who will authorize the employee to visit a physician for an examination and possible treatment.

The following precautions should be taken when working in areas that might be infested with ticks:

- Cover your body as much as possible. Wear long pants and long-sleeved shirts. Light color clothing makes spotting of ticks easier.
- Try to eliminate possible paths by which the deer tick may reach unprotected skin. For example, tuck bottoms of pants into socks or boots and sleeves into gloves. (Duct tape may be used to help seal cuffs and ankles.) If heavy concentrations of ticks or insects are anticipated or encountered, Tyvek® coveralls may be used for added protection.
- Conduct periodic and frequent (e.g., hourly) surveys of your clothing for the presence of ticks. Remove any ticks and insects that become attached to clothing.
- Spray outer clothing, particularly your pant legs and socks, but not your skin, with an insect repellent that contains permethrin or permethrin, or use a repellent with DEET, which can be applied to the skin.
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible.
- Tuck pant legs into boot tops or tape pants to boot tops to prevent ticks from crawling up the pant leg (this may not be an option at sites where extreme heat stress is anticipated).
- If dressed in Level D or Modified Level D and no other head protection is required, wear a hat to prevent ticks from getting into the hair.

The following actions should be taken if a tick is found:

- If you find a tick, remove it by pulling on it gently with tweezers. Pull straight out and do not twist.
- Do not use matches, a lit cigarette, nail polish, or any other type of chemical to “coax” the tick out.

- Be sure to remove all parts of the tick's body and disinfect the area with alcohol or a similar antiseptic after removal.
- For several days to several weeks after removal of the tick, look for the signs of the onset of Lyme disease, such as a rash that looks like a bulls-eye or an expanding red circle surrounding a light area.
- Look for the signs of the onset of RMSF, such as a rash-like inflammation consisting of red spots under the skin that appear three to ten days after the tick bite.

Removal of ticks is best accomplished using small tweezers. Do not squeeze the tick's body. Grasp it where the mouth parts enter the skin and tug gently, but firmly, until it releases its hold on the skin. Save the tick in a jar labeled with a date, body location of the bite, and place it where it may have been acquired.

Wipe the bite thoroughly with an antiseptic and notify the SSHO as soon as possible. The various stages and symptoms are well recognized and if detected can be treated with antibiotics. Early detection and treatment with antibiotics significantly reduces the severity of Lyme disease and RMSF. If necessary, seek medical attention.

This page intentionally left blank.

6.0 Cold Stress

Cold stress is a factor to be considered while working on this project. The guidelines below will be understood by all site personnel in the event of cold weather work.

6.1 Hypothermia

When exposed to cold temperatures, your body begins to lose heat faster than it can be produced. Prolonged exposure to cold will eventually use up your body's stored energy. The result is hypothermia, or abnormally low body temperature. A body temperature that is too low affects the brain, making the victim unable to think clearly or move well. This makes hypothermia particularly dangerous because a person may not know it is happening and will not be able to do anything about it.

6.1.1 Symptoms

Symptoms of hypothermia can vary depending on how long you have been exposed to the cold temperatures.

6.1.2 Early Symptoms

- Shivering;
- Fatigue;
- Loss of coordination;
- Confusion and disorientation.

6.1.3 Late Symptoms

- No shivering;
- Blue skin;
- Dilated pupils;
- Slowed pulse and breathing;
- Loss of consciousness.

6.1.4 First Aid

Take the following steps to treat a worker with hypothermia:

- Alert the Field Team Leader and request medical assistance.
- Move the victim into a warm room or shelter.
- Remove their wet clothing.

- Warm the center of their body first (i.e. chest, neck, head, and groin) using a blanket or other available items; or use skin-to-skin contact under loose, dry layers of blankets, clothing, towels, or sheets.
- Warm beverages may help increase the body temperature, but do not give alcoholic beverages. Do not try to give beverages to an unconscious person.
- After their body temperature has increased keep the victim dry and wrapped in a warm blanket, including the head and neck.
- If victim has no pulse, begin cardiopulmonary resuscitation (CPR).

6.2 Frostbite

Frostbite is an injury to the body that is caused by freezing. Frostbite causes a loss of feeling and color in the affected areas. It most often affects the nose, ears, cheeks, chin, fingers, or toes. Frostbite can permanently damage body tissues, and severe cases can lead to amputation. In extremely cold temperatures, the risk of frostbite is increased in workers with reduced blood circulation and among workers who are not dressed properly.

6.2.1 Symptoms

Symptoms of frostbite include:

- Reduced blood flow to hands and feet (fingers or toes can freeze);
- Numbness;
- Tingling or stinging;
- Aching;
- Bluish or pail, waxy skin.

6.2.2 First Aid

Workers suffering from frostbite should:

- Get into a warm area as soon as possible.
- Unless absolutely necessary, do not walk on frostbitten feet or toes. This increases the damage.
- Immerse the affected area in warm-not hot-water. The temperature should be comfortable to the touch for unaffected parts of the body.
- Warm the affected area using body heat; for example, the heat of an armpit can be used to warm frostbitten fingers.
- Do not rub or massage the frostbitten area. Doing so may cause more damage.
- Do not use a heating pad, heat lamp, or the heat of a stove, fireplace, or radiator for warming. Affected areas are numb and can be easily burned.

6.3 Trench Foot

Trench foot, also known as immersion foot, is an injury of the feet resulting from prolonged exposure to wet and cold conditions. Trench foot can occur at temperatures as high as 60 degrees Fahrenheit (°F) if the feet are constantly wet. Injury occurs because wet feet lose heat 25 times faster than dry feet. Therefore, to prevent heat loss, the body constricts blood vessels to shut down circulation in the feet. Skin tissue begins to die because of lack of oxygen and nutrients and due to the buildup of toxic products.

6.3.1 Symptoms

Symptoms of trench foot include:

- Reddening of the skin;
- Numbness;
- Leg cramps;
- Swelling;
- Tingling pain;
- Blisters or ulcers;
- Bleeding under the skin;
- Gangrene (the foot may turn dark purple, blue, or gray).

6.3.2 First Aid

Workers suffering from trench foot should:

- Remove shoes/boots and wet socks.
- Dry their feet.
- Place gauze or other cloth between the toes.
- Avoid walking on feet, as this may cause tissue damage.

6.4 Chilblains

Chilblains are caused by the repeated exposure of skin to temperatures just above freezing to as high as 60°F. The cold exposure causes damage to the capillary beds (groups of small blood vessels) in the skin. This damage is permanent and the redness and itching will return with additional exposure. The redness and itching typically occurs on cheeks, ears, fingers, and toes.

6.4.1 Symptoms

Symptoms of chilblains include:

- Redness;
- Itching;

- Possible blistering;
- Inflammation;
- Possible ulceration in severe cases.

6.4.2 First Aid

Workers suffering from chilblains should:

- Avoid scratching.
- Slowly warm the skin.
- Use corticosteroid creams to relieve itching and swelling.
- Keep blisters and ulcers clean and covered.

6.5 Equivalent Chill Temperature

The equivalent chill temperature is the temperature that it feels like outside to people and animals. Equivalent chill temperature is based on the rate of heat loss from exposed skin caused by combined effects of wind and cold. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the both the skin temperature and eventually the internal body temperature. Therefore, the wind makes it feel much colder. If the temperature is 0°F and the wind is blowing at 15 miles per hour (mph), the wind chill is -19°F. At this equivalent chill temperature, exposed skin can freeze in 30 minutes.

The Equivalent Temperature Table, presented in **Table 6-1**, should be reviewed along with local temperature and wind speed data prior to extended work in the cold, and preventative work restrictions and preventions, presented herein, should be followed.

Table 6-1 Cooling Power of Wind on Exposed Flesh Expressed as Equivalent Temperature (under calm conditions)

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
Wind speeds greater than 40 mph have little additional effect.	LITTLE DANGER In < hr with dry skin. Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh within one minute.			GREAT DANGER Flesh may freeze within 30 seconds.				
	Trench foot and immersion foot may occur at any point on this chart											

 Equivalent chill temperature requiring dry clothing to maintain core body temperature above 36 degrees Celsius (°C; 98.6 °F) per cold stress threshold limit value (TLV).

* Developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA.

This page intentionally left blank.

7.0 Heat Stress

7.1 Heat Disorders

The potential for heat stress during the hot months is a concern because of the possible combination of ambient factors such as high air temperature, a few days with high relative humidity, low air movement, high radiant heat, and protective clothing. Because of this the potential exists for:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

7.1.1 Heat Rash (Prickly Heat)

Heat rash is a painful temporary condition caused by clogged sweat pores. Heat rash is caused by the plugging of sweat ducts due to the swelling of the moist keratin layer of the skin which leads to inflammation of the sweat glands. Heat rash appears as tiny red bumps on the skin and can impair sweating, resulting in diminished heat tolerance. Signs and symptoms include:

- Tiny raised blustered red blisters or small pimples.
- Pricking sensations, or itching during heat exposure.
- Most likely to occur on the neck and upper chest, in the groin, under the breasts, and in elbow creases.

Heat rash is usually a mild, temporary condition, although it decreases the body's ability to tolerate heat, as well as being a nuisance.

Treatment: Heat rash can usually be cured by providing cool areas; body powder may also help absorb moisture.

7.1.2 Heat Cramps and Heat Syncope

Heat cramps are characterized by painful intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Heat cramps usually occur after heavy sweating, and often begin at the end of the workday. The cramps are caused by a loss of electrolytes, principally salt. This results in fluids leaving the blood and collecting in muscle tissue, resulting in painful spasms. Symptoms include muscle pain or spasms in the abdomen, arms, or legs.

Heat syncope is a condition caused by pooling of the blood in the extremities, usually related to activities where the person stands without moving for a period of time or sudden rising from a sitting or lying position. Factors that may contribute to heat syncope include dehydration and

lack of acclimatization. The reduced blood volume to the head can cause fainting, which may in turn cause injuries. Symptoms include:

- Light-headedness;
- Dizziness;
- Fainting.

Treatment: Increase water ingestion. Eat normally throughout the day to replace electrolytes.

7.1.3 Heat Exhaustion

Heat exhaustion occurs when the body's thermoregulatory system is not functioning efficiently. Symptoms of heat exhaustion include:

- Heavy sweating;
- Extreme weakness or fatigue;
- Low blood pressure;
- Rapid pulse;
- Dizziness, confusion;
- Nausea;
- Clammy, moist skin;
- Pale or flushed complexion;
- Muscle cramps;
- Normal or slightly depressed body temperature;
- Fast and shallow breathing.

This is the most common form of serious heat illness encountered during field activities. Any worker who is a victim of heat exhaustion may not be exposed to a hot working environment for an absolute minimum of 24 hours and, if fainting has occurred, the victim should not return to work until authorized by a physician.

Treatment: Move victim to a cool area, loosen clothing, and place in a head-low (shock prevention) position, and provide rest and plenty of fluids. Do not give coffee, tea or alcoholic beverages.

7.1.4 Heat Stroke

This is the most serious heat disorder and is life-threatening. Heat stroke is a true medical emergency. This results when the body's heat-dissipating system is overwhelmed and shuts down (thermoregulatory failure). Heat stroke results in a continual rise in the victim's deep core body temperature, which is fatal if not checked. Symptoms may include:

- Hot, dry skin; no perspiration;
- Hallucinations;
- Chills;
- Throbbing headache;
- High body temperature;
- Confusion and/or dizziness;
- Slurred speech;
- Unconsciousness may occur.

Treatment: Call 911. First aid consists of immediately moving the victim to a cool area. Cool the body slowly by immersion in tepid (slightly warm) water or sponging the body with tepid water. Treat for shock and obtain immediate medical assistance. Treatment response time is critical when assisting a victim of heat stroke. Do not give coffee, tea or alcoholic beverages.

7.2 General Heat Stress First Aid

First aid for heat stress conditions consists of proper evaluation of their condition, cooling the victim down, and rehydration. Specific actions which should be taken include:

- First aid trained persons should be summoned to assist in evaluation of the victim's condition.
- If heat stroke is suspected, outside medical responders should be immediately contacted, as this condition should be considered immediately life-threatening. **Call 911** immediately.
- Impermeable clothing should be removed as soon as possible following the required decontamination steps, unless the delay could compromise the victim's health.
- The victim's clothing should be loosened to aid air circulation.
- The victim should be moved to a shaded, cooler location, preferably one that is air-conditioned.
- The victim should sit, or lie down if they are dizzy or at risk of losing consciousness.
- The victim should be encouraged to drink cool water if they are not nauseous or losing consciousness.
- The victim may be cooled down further by:
 - Moistening the head, neck, torso and clothing with tepid water;
 - Spraying, sponging, or showering them with tepid water; and
 - Fanning their body, gently.
- To minimize the risk of shock, do not drench them with cold water, use tepid water, unless advised to do so by medical personnel.

7.3 Prevention of Heat Disorders

It is interesting to note that if a person works continually, for about a week, in a hot environment, he/she tolerates much hotter conditions than initially. This process of adjustment is termed "acclimatization". Acclimatization is essential if work is to be frequently performed in hot environments. Essentially, in acclimatized workers, their core body temperatures and heart rates are slower than non-acclimatized workers, and they sweat more but with less salt loss. Acclimatization to heat can, however, be lost almost as rapidly as it is acquired, if the worker is removed from the hot environment for a few days.

In order to prevent the onset of heat-related disorders, employees should rely on the physiological monitoring methods described above, and practice the following good health measures.

7.3.1 Provision of Water (or other drinking fluids)

Fluids are a key preventative measure to minimize the risk of heat related illnesses. Each employee should have at least one quart per employee per hour for the entire shift. Each vehicle will carry at least five gallons of drinking water. This must be replenished at the beginning of each day. In addition, each employee is responsible for having a container (such as a Camelback or other means) so they can carry water with them throughout the day.

Coffee, tea and other warm and caffeinated beverages must be avoided. In addition, sport drinks and electrolyte replacement drinks are to be consumed in very limited quantities (one per day) as these contain sugar, which utilizes the body's water reserves to digest, thus dehydrating the individual.

Employees are encouraged to maximize water intake and realize that thirst is not an adequate indicator of sweat loss. Water should be consumed at a target rate of one cup every 20 minutes at a minimum.

If water containers are being shared by employees disposable/single use drinking cups need to be provided, or employees may use their own cup. In addition, a supervisor or designated employee shall be assigned to monitor the quantity and condition of the water. When water levels within a container drop below 50%, the water needs to be replenished.

7.3.2 Access to Shade (Rest Area)

Access to rest and shade or other cooling measures are important preventative steps to minimize the risk of heat related illnesses. Employees suffering from (or exhibiting symptoms of) heat illness or believing a preventative recovery period is needed, will be provided access to an area with shade that is either open to the air or provided with ventilation or cooling for a period of no less than five minutes. Such access to shade shall be permitted at all times.

The rest area should be shaded from the sun. Air-conditioned construction offices, trailers and work vehicles make good rest areas. When possible, rest areas should be readily accessible and near supplies of drinking fluids.

7.3.3 Additional Health Measures

To help prevent the onset of heat-related disorders, employees should practice additional good health measures. A victim of a heat-related disorder is permanently predisposed to suffering a recurrence. Every worker is unique in his/her ability to handle heat. Work/rest periods should be based on the individual's capacity to safely handle the heat, not on a predetermined or inflexible time length. Note that alcohol has been commonly associated with the occurrence of heat-related disorders. Alcohol reduces heat tolerance.

7.3.4 Heat Stress Monitoring Plan

The BSEn heat and cold stress program describes the symptoms of heat stress and the heat stress management, training, and prevention program. The SSHO shall initiate the procedures in the program when ambient temperatures reach 70°F if Level A, B, or C PPE is in use or at 75°F if Level D PPE is in use. Once the program has been initiated, workers shall undergo self physiological monitoring, including the recognition of body temperatures and heart rates and any observations of flushed or pale skin, excessive or absent perspiration, or light-headedness.

The following Heat Stress Monitoring Plan and action levels will be used, depending upon ambient site conditions, to monitor the potential for heat stress:

Heart Rate Monitoring: The heart rate should be measured by the radial pulse (at the wrist) for 30 seconds, as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 100 beats per minute or 20 beats per minute above resting pulse. If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats per minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the heart rate is maintained below 100 beats per minute or 20 beats per minute above resting pulse.

Oral Temperature: use a clinical thermometer (three minutes under the tongue) to measure the oral temperature at the end of the work period (before drinking). If the oral temperature exceeds 99.6°F, shorten the next work cycle by one-third without changing the rest period. If the oral temperature exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by another one-third. Field team members will not be allowed to wear Level C PPE or greater when oral temperatures exceed 100°F.

7.3.5 Heat Stress Training

All site employees who work in natural environments are required to complete “Heat Stress Awareness Training”. This course covers the recognition and prevention of heat-related illnesses. Training completion is tracked by HDR Health and Safety. The PM and SSHO will confirm that all field personnel have completed this training before field work begins. Heat stress will also be discussed during project-specific safety indoctrination and during tailgate safety meetings.

7.4 Emergency Assistance Procedure

Employees are directed to immediately report to their SSHO, symptoms or signs of heat illness in themselves, or in co-workers. Employees should not delay in reporting these observations.

To help ensure proper medical care is provided with minimal delay, the SSHO shall take the following steps:

- **Provide First Aid:** Should an employee exhibit signs of possible heat illness, the treatment procedures described above should be implemented.
- **Contact Emergency Medical Services (EMS):** If EMS is required, the SSHO (or a designee) shall contact EMS. Once contact is established, stay on the phone with EMS to provide clear and precise directions to the work site.

8.0 Action Levels and Methods to Mitigate Hazards

Table 8-1 presents the action levels and methods to mitigate hazards during the SI work at Radford AAP.

Table 8-1 Action Levels and Methods to Mitigate Hazards for Radford AAP SI

Category	Action Levels	Mitigation Methods
Upgrades and Downgrades in PPE Levels	• Presence of or potential for previously unidentified chemicals or conditions. • Changes in ambient weather conditions. • Assignment of new tasks or expansion in scope of a previously evaluated task.	• SSHO will assess changed conditions and recommend upgrades and downgrades to PPE.
Work Stoppage	• Adverse weather conditions. • Access by non-essential personnel, authorized visitors, or members of the public. • Safety incident.	• SSHO monitors weather and determines whether to stop work. • If non-essential personnel must enter a restricted area, all work will stop in the area. • If a safety incident occurs, the affected field crews will stop work until incident is stabilized. • Notify USACE and local emergency responders of explosion, fire or chemical warfare materiel (CWM). • Follow provisions of Emergency Response Plan (Section 9.1 of APP).
Emergency Evacuation	• Explosion or fire. • Discovery of CWM.	• Notify USACE and local emergency responders. • Follow provisions of Emergency Response Plan (Section 9.1 of APP).
Prevention and Minimization of Public Exposures	• Member of public must enter restricted area. • Explosion or fire. • Discovery of CWM.	• If non-essential personnel must enter a restricted area, all work will stop in the area. • Notify USACE and local emergency responders. • Follow provisions of Emergency Response Plan (Section 9.1 of APP).

8.1 Upgrades/Downgrades in Levels of PPE

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards. Verification and certification of assigned PPE by task is completed by the HSM and CIH that approved this plan. PPE for each

task is defined in **Table 9-4** of the APP. The levels of PPE will be reassessed if any of the following occur:

- Presence of or potential for previously unidentified chemicals or conditions;
- Changes in ambient weather conditions;
- Assignment of new tasks or expansion in the scope of a previously evaluated task;
- If warranted, the SSHO will upgrade or downgrade PPE based on changing site conditions.

8.2 Work Stoppage

The SSHO will stop work if any of the following conditions occur:

- Adverse weather conditions exist that could endanger site workers or the public as a result of site activities;
- Access by non-essential personnel and/or authorized visitors is required in one or more of the restricted areas of the site;
- A safety incident occurs.

The SSHO will monitor all of these situations and determine when a stop work order is necessary. For a safety incident or authorized visitor, the SSHO will limit the stop work areas to the affected area of the site. Work will resume after the safety issue is stabilized and all non-essential personnel have left the restricted areas.

In addition, all Radford SI site workers have the authority and the responsibility to stop work in the event any employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the employee or subcontractor of their responsibilities for the means and methods of the work or any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the employee or subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, any employee can and should immediately stop work and alert all affected individuals. Remove all affected employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM and SSHO.

When repeated non-compliance or unsafe conditions are observed, notify the employee's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Authority Form (**Attachment C**) until adequate corrective measures are implemented.

Consult the SSHO to determine what the contract dictates for actions to pursue in event of non-compliance including work stoppage.

8.3 Emergency Evacuation of On-Site personnel

The SSHO will order an emergency site excavation of site personnel if there is an imminent danger of harm from any of the following events:

- Explosion;
- Fire;
- Discovery of CWM.

The SSHO will initiate an emergency evacuation of site personnel from an area large enough to prevent injury. The SSHO will establish a unique, site-wide signal for emergency evacuation (e.g., use of a horn), designate an evacuation assembly location, and brief all workers during initial site-specific training. Any changes mandated by changing site conditions will be determined by the SSHO and communicated to workers during the daily tailgate safety briefing.

8.4 Prevention and/or Minimization of Public Exposures

If an unplanned explosion or fire occurs, the SSHO immediately notifies the USACE representative and notifies local emergency responders if needed. The provisions of the Emergency Response Plan (**Section 9.1** of the APP) are implemented by the SSHO.

The SSHO will immediately notify the USACE if CWM is encountered so that USACE may make the required notifications.

This page intentionally left blank.

9.0 Staff Organization, Qualifications, and Responsibilities

The staff organization, qualifications, and responsibilities are discussed in **Section 3.0** of the APP and are not repeated here. Resumes for the HSM, CIH, and SSHO/UXO Technician III for the SI at Radford AAP, VA, are provided in **Attachment D** of the APP.

This page intentionally left blank.

10.0 Exposure Monitoring

Chemical, heat and cold stress may be encountered during field activities. Heat stress and cold stress monitoring and prevention are addressed in **Section 6.0** and **Section 7.0**.

Chemical hazards include potential munitions constituents (MCs), which include explosives, metals, and propellants (including perchlorates). It is unlikely that more volatile contaminants are present in topsoil in significant amounts; the major concern for worker exposure would be ingestion or contact (skin and eyes) with contaminated soil. Thus, air monitoring for MC will not be performed.

Dust emissions are not expected to be a concern during SI activities at Radford AAP. Therefore, a dust monitoring program will not be implemented.

Exposure to chemically-contaminated media during SI activities will typically be limited to soil sampling activities. The following contamination prevention procedures will be implemented:

- Do not handle or touch contaminated materials (soil) directly.
- Use safety glasses and disposable nitrile gloves when handling potentially contaminated materials, soils, or groundwater.
- Make sure all PPE is free of cuts or tears prior to donning, and monitor for damage during use.
- Take special care to protect any skin injuries. If open wounds exist on hands or forearms, handling chemicals or contaminated materials should be restricted or eliminated.
- Do not carry cigarettes, gum, chewing tobacco, or cosmetics into the work area.

This page intentionally left blank.

11.0 Standard Operating Procedures, Engineering Controls and Work Practices

This section describes the standard operating procedures, engineering controls, and work practices to be implemented during this project.

11.1 Site Rules

BSEn will implement site rules to minimize exposure of employees to hazards related to the work activities of this project that would result in injury or illness. The SSHO will monitor the approved engineering controls to ensure compliance with this SSHP and applicable regulations. The following general practices apply to all personnel on this project:

- Check out all equipment before starting work. Do not use faulty or suspect equipment.
- Make sure your protective clothing is in good condition (no holes, rips or tears).
- Do not wipe sweat away from face with your hands. Use a clean towel or paper towel.
- Do not smoke, eat, drink or apply cosmetics during inspection or sampling activities, nor at any time you are in an area where contaminated material is being handled.
- Wash your hands, face, and arms as soon as possible upon exiting from the site and prior to taking rest breaks, lunch breaks, or leaving the site at the end of the workday. These personal hygiene measures are especially important when working in areas where you may be exposed to chemicals in the air or on surfaces.
- Check in and out with the SSHO upon arrival and departure.
- Notify the SSHO immediately if an injury or illness occurs.

Field team members will be familiar with the physical characteristics and requirements of the Radford SI project, including:

- Entering the site through appointed access points;
- Accessibility to equipment and vehicles;
- Communication procedures;
- Hot zones (areas of known or suspected MEC and/or contamination);
- Emergency procedures and evacuation assembly points;
- Locations of protective and emergency equipment and relevant first-aid procedures.

11.1.1 Buddy System

Project employees will use the buddy system. The buddy system is a method of organizing work groups to ensure that that no employee is isolated or alone and that someone else is available to:

- Provide assistance in normal work conditions or during an accident or injury.
- Observe work activities to prevent exposure to hazards.
- Ensure work is performed safely and responsibly.

All on-site personnel will use the buddy system for entry into designated fieldwork areas. The work crew will be paired in teams of two or more. Team members will maintain visual contact with each other and be alert for signs of heat or cold stress or toxic exposure, including visual and non-visual effects of toxic exposure such as:

- Changes in complexion and skin discoloration;
- Changes in coordination or demeanor;
- Excessive salivation and pupillary response;
- Changes in speech pattern;
- Headaches, dizziness, and blurred vision;
- Nausea and cramps;
- Irritation of eyes, skin, or respiratory tract.

11.1.2 Chemical Warfare Materiel Procedures

BSEn is not authorized to conduct CWM activities. In the unlikely event that CWM is identified, all personnel will immediately withdraw upwind to a safe location. BSEn PM and SSHO will notify the USACE PM and together they will notify the appropriate agencies. A minimum of two field technicians will secure the site until relieved by the designated USACE or Radford AAP representatives.

In the highly unlikely event that a CWM incident occurs:

- Work activities will cease and all project personnel will be evacuated from the work location.
- The evacuation will proceed in a direction upwind of the critically affected area, with all personnel assembling in a pre-designated location outside of the jobsite (to be determined and presented as part of the daily tailgate safety briefing).
- The SSHO or designated alternate will take a head count of the assembled employees, and any injured individuals shall be administered first aid.
- If not present at the affected work location, the PM and HSM will be contacted immediately.
- If an unplanned detonation of MEC or a release of chemical contamination occurs, notify the local fire department. Other emergency response actions should proceed as specified in the emergency response action guidance in the Emergency Response Plan.

11.2 Work Permit Requirements

No work permits are anticipated to be required for the SI activities.

11.3 Material Handling Procedures

Various materials and equipment may be handled manually during project operations. Employees working alone should not attempt to lift or move a load that is too heavy for one person – get help. If necessary, wear protective gloves and clothing (i.e., aprons) when handling loads with sharp or rough edges or when there is the potential for chemical exposure. Workers should be properly positioned when pulling or prying objects. Care should be taken when lifting and handling heavy or bulky items to avoid back injuries. The following fundamentals address the proper lifting techniques that are essential in preventing back injuries:

- The size, shape, and weight of the object to be lifted must first be considered.
- The anticipated path to be taken by the lifter should be considered for the presence of slip, trip, and fall hazards.
- Those who have not been trained in proper lifting techniques shall not lift heavy objects.
- If an object is large or not easily carried by one person, two (or more) properly trained people shall be utilized to lift the object.
- Face the load squarely, get a firm footing and spread your feet 12 to 14 inches apart and, if possible, place one foot alongside the object being lifted.
- Bend your knees and get a good grip on the object. Keep your back straight, vertical, and lift by straightening your legs.
- Keep the load close to your body throughout the entire lifting process.
- If it is necessary to turn, change your foot position, **DO NOT TWIST YOUR BODY.**
- When the load is heavy or awkward, use teamwork. Lift slowly and evenly together.
- When two or more workers are required to handle the same object, workers shall coordinate the effort so that the load is lifted uniformly and that the weight is equally divided between the individuals carrying the load. When carrying the object, each worker, if possible, shall face the direction in which the object is being carried.
- When placing an object down, the stance and position are identical to that for lifting. The legs are bent at the knees and the object lowered.
- All waste containers will be properly labeled and stored IAW the specific material therein.

This page intentionally left blank.

12.0 Site Control Measures

Site control is used to minimize potential exposures to workers, to protect the public from the hazards of site activities, and to prevent vandalism.

No person will be allowed on the site during site operations without first being given a site hazard briefing and meeting appropriate medical and training requirements.

Only authorized personnel will enter work zones (regulated areas) associated with field activities. The SSHO will establish the bounds of the regulated areas. The following measures will be taken to maintain site security:

- All workers entering the regulated areas will be subject to the provisions of the APP/SSHP.
- The SSHO will have the responsibility and authority to enforce this requirement.
- A Site Visitors Log, located in the support zone, will be maintained by the SSHO.

This page intentionally left blank.

13.0 Personal Hygiene and Decontamination

One of the most important aspects of decontamination is the prevention of the spread of contamination. Good contamination prevention also minimizes worker exposure. Exposure to chemically-contaminated media during SI activities will typically be limited to well monitoring activities. The following contamination prevention procedures will be implemented:

- Do not handle or touch contaminated materials (soil) directly.
- Use safety glasses and disposable nitrile gloves when handling potentially contaminated materials, soils, or groundwater.
- Make sure all PPE is free of cuts or tears prior to donning.
- Take special care to protect any skin injuries. If open wounds exist on hands or forearms, handling chemicals or contaminated materials should be restricted or eliminated.
- Do not carry cigarettes, gum, chewing tobacco, or cosmetics into the work area.

Potable water will be made available at the site, from either a pressurized source or commercially available bottled water. Drinking cups will be supplied so personnel will neither drink directly from the source of water nor have to share drinking cups. Sources of non-potable water shall be labeled clearly as such.

Portable toilet facilities, such as chemical toilets, will be provided on site. Washing facilities will be provided on site and will be located in the decontamination area or the support area. Soap, clean water, washbasins, and single-use towels will be available for personnel use.

This page intentionally left blank.

14.0 Equipment Decontamination

Disposable, single-use sampling equipment does not require decontamination, and will be used during the SI whenever possible. Any re-useable sampling equipment will be decontaminated before use and after each sample is collected. When all work activities have been completed, contaminated tools used by personnel will be either appropriately decontaminated or properly disposed of IAW the equipment decontamination procedures and Investigation Derived Waste (IDW) plans described in the final work plan.

It is expected that all reusable tools will be constructed of nonporous, nonabsorbent materials, which will aid in decontaminating the tools. Any tool or part of a tool that is made of a porous and absorbent material will be discarded and disposed of IAW the IDW plan if it cannot be properly decontaminated.

Tools will be placed in an impervious area (e.g., decontamination pad, bucket, plastic liner) and thoroughly washed using a soap solution and brushing, followed by rinsing with clean water. All visible particles are to be removed before the tool is considered clean.

This page intentionally left blank.

15.0 Logs, Reports, and Recordkeeping

The following subsections summarize required health and safety logs, reports, and recordkeeping for this contract.

15.1 Field Change Request

Changes at the site may require a plan amendment to initiate a significant change to the SSHP. The HSM is required to approve each amendment to the SSHP with qualified concurrence of a CIH approval.

15.2 Medical and Training Records

Project medical and training records will be maintained on-site and will be made available as requested. Accidents/incidents shall be reported IAW DID MR-015 and EM 385-1-1 (USACE, 2014). Examples of records to retain include:

- Employee contact information and medical surveillance information;
- Employee health and safety training certifications;
- Site-specific accident/ incident documentation;
- Exposure monitoring;
- Emergency notification;
- Visitor's logs;
- Daily Safety Meeting sign in logs;
- Daily Tailgate Safety logs.

HDR has a third party occupational health care contract with WorkCare and all employee medical files are maintained through the WorkCare Administration and can be contacted at 1-800-455-6155.

15.3 Exposure Records

Although unanticipated, any personal monitoring results, laboratory reports, calculations, and air sampling data sheets are part of an employee exposure record. These records will be kept IAW 29 Code of Federal Regulations (CFR) § 1910.1020 (OSHA, 2011). All original exposure records will be maintained and sent to the HDR HSM and CIH. For subcontractor employees, the originals will be maintained onsite and sent to the subcontractor employer; in addition, a copy kept in the project file.

15.4 Accident and Incident Report

Procedures for accident and incident reporting are included in **Section 8.0** of the APP and are not repeated here.

15.5 Health and Safety Field Logbooks

The SSHO will complete and maintain the daily logbook at the site. Logbooks will be used to document important events as they occur. Some general procedures will pertain to the use of all logbooks. The following information will be recorded on each page of all logbooks:

- Initials of persons making entry;
- Date;
- Time of each entry (military time);
- Location;
- The log will be signed at the end of each day or work shift;
- All entries will be made in blue or black ink;
- No pages will be removed from the logbook, and each page will be numbered;
- Any corrections will be made with a single line through the entry and initialed.

The logbook will be used to record daily site conditions and activities. The logbook will contain the following items:

- Names and job titles of all personnel on site;
- Level of protection used;
- Health and safety monitoring equipment used;
- Weather conditions;
- Work and rest schedule (if appropriate);
- A description of the activities as they are occurring;
- Any pertinent health and safety observations;
- Sample number (if appropriate);
- Copies of the logbooks will be submitted to the HSM as necessary. The original logbooks will become part of the exposure records file and will be maintained in the project files.

15.6 Closeout Safety Report

A final safety report will be provided to the HSM summarizing the safety performance achieved during site work. The report will include the following specific elements:

- A description of significant events, exposures, accidents, illnesses, and actions taken to prevent their reoccurrence.
- A description of any state or federal inspections involving the health and safety of site workers.

15.7 Required Postings

The following will be available to all site personnel:

- Department of Labor Minimum Wage;
- Polygraph Protection Act;
- Equal Employment Opportunity;
- Job Safety and Health;
- Family Leave;
- Uniformed Services Employment and Reemployment Rights Act;
- Safety and Health Protection on the Job;
- Discrimination in Employment;
- Emergency Phone Numbers;
- Access to Medical and Exposure Records;
- Notice of Unemployment and Disability Insurance;
- Hearing Protection Standard;
- Whistleblower Protection Act;
- Contract Requirements;
- Drug Policy Poster;
- Posting of Prevailing Wages;
- Policy on Sexual Harassment;
- Policy on Equal Employment Opportunity;
- Accident/Injury Reporting.

This page intentionally left blank

16.0 Resources

- DDESB. (2004, December 20). *DoD Explosive Safety Board (DDESB) Technical Paper 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel*. Retrieved 2011, from Department of Defense Explosives Safety Board:
http://www.ddesb.pentagon.mil/TP18_122004.pdf
- OSHA. (2011, June 8). *Access to employee exposure and medical records*. Retrieved from Toxic and Hazardous Substances:
https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10027
- USACE. (2008, September 15). *EM 385-1-97, Safety and Health Requirements Manual*. Retrieved 2012, from USACE Engineer Manual: <http://140.194.76.129/publications/eng-manuals/em385-1-97/toc.htm>
- USACE. (2014, November 30). *EM 385-1-1, Safety and Health Requirements*. Washington, D.C: Department of the Army, U.S. Army Corps of Engineers. Retrieved 2012, from USACE Engineer Manuals: http://140.194.76.129/publications/eng-manuals/em385-1-1/2008_English/toc.html

This page intentionally left blank.

Attachment B

Activity Hazard Analyses

Mobilization/Demobilization and Operating Motor Vehicles	D-B-1
Assisted Visual Surveys	D-B-7
Soil Sampling	D-B-13

This page intentionally left blank.

ACTIVITY HAZARD ANALYSIS (AHA)

Date: 8-11-2015 Project Title: Radford SI

Overall Risk Assessment Code (use highest code) M

Activity/Task: Operating Motor Vehicles

Title of Person Who Does the Job: All field personnel

Activity/Task Location: Radford AAP, Virginia

Prepared By: D. Sciarro

Approved By (H&S Staff): S. Coffee

Risk Assessment Code (RAC) Matrix

E=Extremely High Risk H=High Risk M=Moderate Risk L=Low Risk		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Motor Vehicle Activities	Injury to staff or damage to equipment due to slips, trips & falls	- Utilize continuous environmental awareness and communicate abnormal or uneven walking surfaces. - Follow slip, trip, and fall protection methods identified in the Project APP/SSHP. - Limit personnel entry and exit for safety in work area. - Think about your body position; avoid over-reaching, hyper-extending / position of extremities. - Wear project approved/ ANSI approved safety boots with ankle protection.	L
Motor Vehicle Activities	Injury to staff or damage to equipment due to lack of safety awareness.	- All personnel must read and sign the applicable HDR Site Safety and Health Plan. - A copy of the APP/SSHP shall be available on the job site. - Designated field staff will provide safety briefings and maintain control over site access to and from the hazardous areas. - Designated safety personnel will conduct site safety briefings at the beginning of each workday. All site personnel will attend each day's briefing and sign an attendance log. - The safety briefings will be used as an opportunity to address any recognized site-specific safety issues that arise or that are outlined in the APP/SSHP. - Safety briefings are used to refresh workers on specific policies and procedures applicable to HDR and the project and to address any new hazards, operations, or hazard control methods to be used. Topics to be discussed and understood by all field staff are but not limited to: - Scope of the days operations;	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		- o Personnel assignments and PPE to be worn; - o Safety precautions expected for each assignment; - o Location of other teams in the area; - o Identification of survey safety equipment required; - o Review the project site specific APP/SSHP; - o Changes in activities or daily operations. - o Changes in site conditions. - o Emergency evacuation routes. - o Emergency duties and procedures. - o Pertinent information that may affect safety within daily work activities. - o Anticipated weather conditions.	
• Motor Vehicle Activities	• Excessive Noise	• Hearing protection will be utilized by personnel operating or working around heavy equipment, maintenance equipment or power tools. A minimum Noise Reduction Rating (NRR) of 30 is required.	L
• Motor Vehicle Activities	• Injury from exposure to biological or animal hazards such as snakes, rodents, insects, or wildlife.	• All members of staff should wear suitable ANSI approved footwear when walking off pathways. • Care should be taken when picking up items from the ground or when moving rocks, trash, etc. • Mosquito nets should be used in mosquito infested areas. • Insect repellant should be used by non-sensitive individuals to prevent mosquito and tick bites. • Footwear and clothing should be knocked or shaken before donning. • Maintain good housekeeping. • Follow any biological prevention methods identified in the Project APP/SSHP. • Feeding and encouragement of feral animals is forbidden.	L
• Motor Vehicle Activities	• Lightning strikes.	• Keep vigilant regarding ongoing and forecasted weather; seek adequate shelter during storms with strong wind and lightning. • A watch will be kept to ensure personnel safety from approaching thunderstorms. • All outside work will cease when lightning is within 5 miles of the work area.	L
• Motor Vehicle Activities	• Employee Injury or Illness while out in remote areas	Emergency medical summons procedures will include the following: • Non-life threatening injuries and illnesses will be managed by the WorkCare Incident Intervention Team. This a 24/7 HDR Injury Reporting line @ 1 (888) 449-7787 • The Occupational Nurse or physician discusses the injury and surrounding circumstances with the injured person. • Employee is provided guidance on appropriate treatment options (triage).	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		• Appropriate treatment details are handled by the Occupational Nurse or physician. • The HDR Health and Safety Director (HSD), hereafter referred to as HSD, is notified by the occupational nurse or physician via email immediately after each contact. • Life threatening illnesses or injuries will require an immediate emergency call to 911. When calling 911 you must initially state "I have a medical emergency". This statement routes you directly to medical services rather than placing your call in line with other types of emergencies. • Serious Incidents must be reported to the HSD immediately. • Serious incidents are those that involve any of the following: - o Work related death, or life threatening injury or illness of an HDR employee, subcontractor, or public; - o Missing person; - o Acts or threats of terrorism; - o Event that involves a fire, explosion, or property damage. • Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment. • All other injuries or illness (even those that are minor and may only require First Aid) which occur at work, while on business travel or commute must be reported to the supervisor, Project Manager, and the HSD.	
• Motor Vehicle Activities	• Employee injury due to vehicle accident or breakdown.	• Vehicles must be kept in a safe mechanically operating condition. • All site personnel operating motor vehicles at the site shall comply with all federal, state, and local traffic regulations. Vehicles used for project activities will be inspected daily and inspection forms will be documented. • All personnel shall wear seat belts. All speed limits will be enforced. • All drivers will drive in a defensive manner and will slow down during hazardous driving conditions. • Backing vehicles should be avoided if possible. Drivers shall do a walk around the vehicle to check to see if there are any potential hazards before backing a vehicle. Use a spotter whenever possible. • In the event of a breakdown or accident, vehicles will be moved off the roadway and warning (hazard) lights shall be put on. Notify proper personnel for assistance.	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Motor Vehicle Activities	Encountering MPPEH or MEC during SI activities.	- Personnel are not anticipated to encounter MEC or MPPEH during SI activities; however, the following general precautions will be taken to ensure the safety of field personnel in the unlikely event that MEC or MPPEH are present at the SI sites. - Field personnel will have basic MEC awareness training. - Field personnel will practice situational awareness and avoid unidentified man-made objects and other suspect items when traveling off of established roads (e.g., walking to/from monitoring wells). - Any item suspected of being MPPEH or MEC will be documented as thoroughly as possible without disturbing the item or potentially endangering personnel. - The item will be flagged with either survey marking tape or a pin flag nearby but caution will be taken not to disturb or touch any identifiable feature of interest. - Field personnel will stop work and consult with the BSEn PM and a UXO Technician II or greater to confirm the discovery. - If a potential MEC/MPPEH hazard is confirmed, the project team will be notified as follows: - Field team leader/SSHO contacts the BSEn PM; - BSEn PM contacts the USACE PM and the Radford APP POC. - EOD will be contacted to respond to any suspected MEC or MPPEH.	M
Motor Vehicle Activities	Injury to visitors or unauthorized personnel in the work area	- Visitors are to be given a basic induction and are to be accompanied until the SSHO or PM is satisfied that they are safe to be alone in the work area. - All authorized visitors must be familiar with any applicable health and safety measures currently being used to provide equal protection. - All essential project visitors working on site will review the site APP/SSHP and AHA. - Site access must be coordinated with the PM.	L

***Step 1:** Review each “hazard” with identified safety “controls.” Determine RAC (see above).

Step 2: Identify the RAC (probability vs. severity) as E, H, M, or L for each “hazard” on AHA. Annotate the overall highest RAC at the top of AHA.

Equipment to be Used	Training Requirements	PPE Requirements
<u>Personal Protective Equipment:</u> • Utility gloves; 2 boxes of nitrile gloves; Safety glasses; Safety vests; Sets of hearing protection (NRR 30 or above); • 2 First aid kits; 2 BBP kit; • Sunscreen; • Insect repellent, • 10lb ABC Fire Extinguisher, • APP/SSHP, AHA's <u>Project Task Equipment:</u> • TBD	<u>Training:</u> • New Hire/ Site Safety Orientation • PPE • Hazard Communication (HAZCOM) <u>Project Specific Training:</u> • 40hr HAZWOPER • 8hr HAZWOPER Refresher/with current medical evaluation. • APP/SSHP with signature on acknowledgement page. • 30hr OSHA Construction Safety (SSHO) • 8hr OSHA Site Supervisor (SSHO) • CPR/ First Aid (2 people) • Unexploded Ordnance Technicians must be qualified IAW the Department of Defense Explosives Safety Board (DDESB) Technical Pamphlet (TP)-18 (DDESB, 2004)	• The levels of PPE will need to be reassessed if any of the following occur: 1. Presence of or potential for previously unidentified chemicals or conditions; 2. Changes in ambient weather conditions; 3. Assignment of new tasks or expansion in the scope of a previously evaluated task. • The following is a description of the level modified "D" PPE that will be required during the project. Level Modified "D" consists of: ✓ Long pants (Non-static producing material such as cotton); ✓ Long or short sleeve shirt (Non-static producing material such as cotton); ✓ American National Standards Institute (ANSI) Z-87.1 approved eye protection; ✓ ANSI Type II reflective vests; ✓ ANSI approved over the ankle safety-toed boots; ✓ Leather work gloves when handling any sharp or rough edges; ✓ Viton or Nitrile gloves when handling contaminated soil or groundwater; ✓ Viton or Nitrile gloves in conjunction with leather gloves when handling contaminated soil or groundwater if there is a potential for sharp or rough edge injuries.

SAFE PRACTICES AND PROCEDURES

☐ Aerial Lifts ☐ Asbestos ☒ Behavior Based Safety ☒ Biological Hazards ☒ Bloodborne Pathogens Exposure Control ☐ Bridge Inspection Safety ☐ Cold Stress ☐ Compressed Gas Safety (EOC) ☐ Crane Platform Safety ☐ Defensive Driving ☐ Demolition Safety ☐ Drill Rig Safety ☐ Drum and Container Handling (EOC) ☐ Drug Program	☐ Electrical Safety ☐ Excavation ☐ Fall Protection ☐ Firearm Safety ☒ First Aid/CPR ☒ Hazard Communication ☒ Heat Stress ☐ Helicopter Safety ☐ Laboratory Safety Plan ☐ Lead & Lead-based Paint ☐ Lockout Tagout ☒ Medical Monitoring ☐ Mine Safety ☒ Noise (Hearing Conservation)	☐ Permit Required Confined Space ☒ Personal Protective Equipment ☒ Portable Fire Extinguishers ☐ Portable Ladders ☐ Railroad Safety ☐ Remote Site Safety ☐ Respiratory Protection ☐ Rope Access Inspection ☐ Scientific Diving Safety ☒ Slip/Trip/Fall ☐ Specialty Vehicle Operation ☐ Temporary Electrical ☐ Traffic Safety ☐ Water Boating Safety

PROTECTIVE EQUIPMENT

☐ Eyewear: Goggles – Chemical Splash ☐ Eyewear: Goggles – Dust ☐ Eyewear: Safety Glasses (Clear) ☒ Eyewear: Safety Glasses (Tinted) ☐ Eyewear: Laser: _____ ☐ Eyewear: Welding Face Shield ☐ Face: Face Shield ☐ Fall Protection: Harness/Lanyard	☒ Footwear: Project / ANSI approved safety boots with ankle protection (Non Steel/ Composite Toe) ☒ Hand: Leather Work Gloves ☐ Hand: Specialty Glove: _____ ☒ Head: Hardhat ☒ Head: Sun protection ☐ Hearing: Earplugs: _____ ☐ Hearing: Earmuffs: _____ ☒ High Visibility Vest: _____	☐ Personal Flotation Device: _____ ☐ Protective Clothing: _____ ☐ Respirator: Half Facepiece: _____ ☐ Respirator: Full Facepiece: _____ ☐ Respirator: Disposable: _____ ☐ Respirator: Airline respirator ☐ Respirator: SCBA

ACTIVITY HAZARD ANALYSIS (AHA)

Date: 8-11-2015 Project Title: Radford SI

Overall Risk Assessment Code (use highest code) M

Activity/Task: Assisted Visual Surveys

Title of Person Who Does the Job: UXO Technician III, Field Technician

Activity/Task Location: Former Gun and Mortar Range MRS

Prepared By: D. Sciarro

Approved By (H&S Staff): S. Coffee

Risk Assessment Code (RAC) Matrix

E=Extremely High Risk H=High Risk M=Moderate Risk L=Low Risk		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Assisted Visual Surveys	Injury to staff or damage to equipment due to slips, trips & falls	- Utilize continuous environmental awareness and communicate abnormal or uneven walking surfaces. - Follow slip, trip, and fall protection methods identified in the Project APP/SSHP. - Limit personnel entry and exit for safety in work area. - Think about your body position; avoid over-reaching, hyper-extending / position of extremities. - Wear project approved/ ANSI approved safety boots with ankle protection.	L
Assisted Visual Surveys	Injury to staff or damage to equipment due to lack of safety awareness.	- All personnel must read and sign the applicable HDR Site Safety and Health Plan. - A copy of the APP/SSHP shall be available on the job site. - Designated field staff will provide safety briefings and maintain control over site access to and from the hazardous areas. - Designated safety personnel will conduct site safety briefings at the beginning of each workday. All site personnel will attend each day's briefing and sign an attendance log. - The safety briefings will be used as an opportunity to address any recognized site-specific safety issues that arise or that are outlined in the APP/SSHP. - Safety briefings are used to refresh workers on specific policies and procedures applicable to HDR and the project and to address any new hazards, operations, or hazard control methods to be used. Topics to be discussed and understood by all field staff are but not limited to: - Scope of the days operations;	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		- o Personnel assignments and PPE to be worn; - o Safety precautions expected for each assignment; - o Location of other teams in the area; - o Identification of survey safety equipment required; - o Review the project site specific APP/SSHP; - o Changes in activities or daily operations. - o Changes in site conditions. - o Emergency evacuation routes. - o Emergency duties and procedures. - o Pertinent information that may affect safety within daily work activities. - o Anticipated weather conditions.	
• Assisted Visual Surveys	• Excessive Noise	• Hearing protection will be utilized by personnel operating or working around heavy equipment, maintenance equipment or power tools. A minimum Noise Reduction Rating (NRR) of 30 is required.	L
• Assisted Visual Surveys	• Injury from exposure to biological or animal hazards such as snakes, rodents, insects, or wildlife.	• All members of staff should wear suitable ANSI approved footwear when walking off pathways. • Care should be taken when picking up items from the ground or when moving rocks, trash, etc. • Mosquito nets should be used in mosquito infested areas. • Insect repellant should be used by non-sensitive individuals to prevent mosquito and tick bites. • Footwear and clothing should be knocked or shaken before donning. • Maintain good housekeeping. • Follow any biological prevention methods identified in the Project APP/SSHP. • Feeding and encouragement of feral animals is forbidden.	L
• Assisted Visual Surveys	• Lightning strikes.	• Keep vigilant regarding ongoing and forecasted weather; seek adequate shelter during storms with strong wind and lightning. • A watch will be kept to ensure personnel safety from approaching thunderstorms. • All outside work will cease when lightning is within 5 miles of the work area.	L
• Assisted Visual Surveys	• Employee Injury or Illness while out in remote areas	Emergency medical summons procedures will include the following: • Non-life threatening injuries and illnesses will be managed by the WorkCare Incident Intervention Team. This a 24/7 HDR Injury Reporting line @ 1 (888) 449-7787 • The Occupational Nurse or physician discusses the injury and surrounding circumstances with the injured person. • Employee is provided guidance on appropriate treatment options (triage).	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		• Appropriate treatment details are handled by the Occupational Nurse or physician. • The HDR Health and Safety Director (HSD), hereafter referred to as HSD, is notified by the occupational nurse or physician via email immediately after each contact. • Life threatening illnesses or injuries will require an immediate emergency call to 911. When calling 911 you must initially state "I have a medical emergency". This statement routes you directly to medical services rather than placing your call in line with other types of emergencies. • Serious Incidents must be reported to the HSD immediately. • Serious incidents are those that involve any of the following: - o Work related death, or life threatening injury or illness of an HDR employee, subcontractor, or public; - o Missing person; - o Acts or threats of terrorism; - o Event that involves a fire, explosion, or property damage. • Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment. • All other injuries or illness (even those that are minor and may only require First Aid) which occur at work, while on business travel or commute must be reported to the supervisor, Project Manager, and the HSD.	
• Assisted Visual Surveys	• Employee injury due to vehicle accident or breakdown.	• Vehicles must be kept in a safe mechanically operating condition. • All site personnel operating motor vehicles at the site shall comply with all federal, state, and local traffic regulations. Vehicles used for project activities will be inspected daily and inspection forms will be documented. • All personnel shall wear seat belts. All speed limits will be enforced. • All drivers will drive in a defensive manner and will slow down during hazardous driving conditions. • Backing vehicles should be avoided if possible. Drivers shall do a walk around the vehicle to check to see if there are any potential hazards before backing a vehicle. Use a spotter whenever possible. • In the event of a breakdown or accident, vehicles will be moved off the roadway and warning (hazard) lights shall be put on. Notify proper personnel for assistance.	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Assisted Visual Surveys	Encountering MPPEH or MEC during SI activities.	- Personnel are not anticipated to encounter MEC or MPPEH during SI activities; however, the following general precautions will be taken to ensure the safety of field personnel in the unlikely event that MEC or MPPEH are present at the SI sites. - Field personnel will have basic MEC awareness training. - Field personnel will practice situational awareness and avoid unidentified man-made objects and other suspect items when traveling off of established roads (e.g., walking to/from monitoring wells). - Any item suspected of being MPPEH or MEC will be documented as thoroughly as possible without disturbing the item or potentially endangering personnel. - The item will be flagged with either survey marking tape or a pin flag nearby but caution will be taken not to disturb or touch any identifiable feature of interest. - Field personnel will stop work and consult with the BSEn PM and a UXO Technician II or greater to confirm the discovery. - If a potential MEC/MPPEH hazard is confirmed, the project team will be notified as follows: - Field team leader/SSHO contacts the BSEn PM; - BSEn PM contacts the USACE PM and the Radford APP POC. - EOD will be contacted to respond to any suspected MEC or MPPEH.	M
Assisted Visual Surveys	Injury to visitors or unauthorized personnel in the work area	- Visitors are to be given a basic induction and are to be accompanied until the SSHO or PM is satisfied that they are safe to be alone in the work area. - All authorized visitors must be familiar with any applicable health and safety measures currently being used to provide equal protection. - All essential project visitors working on site will review the site APP/SSHP and AHA. - Site access must be coordinated with the PM.	L

***Step 1:** Review each “hazard” with identified safety “controls.” Determine RAC (see above).

Step 2: Identify the RAC (probability vs. severity) as E, H, M, or L for each “hazard” on AHA. Annotate the overall highest RAC at the top of AHA.

Equipment to be Used	Training Requirements	PPE Requirements
<u>Personal Protective Equipment:</u> • Utility gloves; 2 boxes of nitrile gloves; Safety glasses; Safety vests; Sets of hearing protection (NRR 30 or above); • 2 First aid kits; 2 BBP kit; • Sunscreen; • Insect repellent, • 10lb ABC Fire Extinguisher, • APP/SSHP, AHA's <u>Project Task Equipment:</u> • Schonstedt GA-52Cx • Trimble GeoXT or GeoXH • Digital camera	<u>Training:</u> • New Hire/ Site Safety Orientation • PPE • Hazard Communication (HAZCOM) <u>Project Specific Training:</u> • 40hr HAZWOPER • 8hr HAZWOPER Refresher/with current medical evaluation. • APP/SSHP with signature on acknowledgement page. • 30hr OSHA Construction Safety (SSHO) • 8hr OSHA Site Supervisor (SSHO) • CPR/ First Aid (2 people) • Unexploded Ordnance Technicians must be qualified IAW the Department of Defense Explosives Safety Board (DDESB) Technical Pamphlet (TP)-18 (DDESB, 2004)	• The levels of PPE will need to be reassessed if any of the following occur: 1. Presence of or potential for previously unidentified chemicals or conditions; 2. Changes in ambient weather conditions; 3. Assignment of new tasks or expansion in the scope of a previously evaluated task. • The following is a description of the level modified "D" PPE that will be required during the project. Level Modified "D" consists of: ✓ Long pants (Non-static producing material such as cotton); ✓ Long or short sleeve shirt (Non-static producing material such as cotton); ✓ American National Standards Institute (ANSI) Z-87.1 approved eye protection; ✓ ANSI Type II reflective vests; ✓ ANSI approved over the ankle safety-toed boots; ✓ Leather work gloves when handling any sharp or rough edges; ✓ Viton or Nitrile gloves when handling contaminated soil or groundwater; ✓ Viton or Nitrile gloves in conjunction with leather gloves when handling contaminated soil or groundwater if there is a potential for sharp or rough edge injuries.

SAFE PRACTICES AND PROCEDURES		
☐ Aerial Lifts ☐ Asbestos ☒ Behavior Based Safety ☒ Biological Hazards ☒ Bloodborne Pathogens Exposure Control ☐ Bridge Inspection Safety ☐ Cold Stress ☐ Compressed Gas Safety (EOC) ☐ Crane Platform Safety ☐ Defensive Driving ☐ Demolition Safety ☐ Drill Rig Safety ☐ Drum and Container Handling (EOC) ☐ Drug Program	☐ Electrical Safety ☐ Excavation ☐ Fall Protection ☐ Firearm Safety ☒ First Aid/CPR ☒ Hazard Communication ☒ Heat Stress ☐ Helicopter Safety ☐ Laboratory Safety Plan ☐ Lead & Lead-based Paint ☐ Lockout Tagout ☒ Medical Monitoring ☐ Mine Safety ☒ Noise (Hearing Conservation)	☐ Permit Required Confined Space ☒ Personal Protective Equipment ☒ Portable Fire Extinguishers ☐ Portable Ladders ☐ Railroad Safety ☐ Remote Site Safety ☐ Respiratory Protection ☐ Rope Access Inspection ☐ Scientific Diving Safety ☒ Slip/Trip/Fall ☐ Specialty Vehicle Operation ☐ Temporary Electrical ☐ Traffic Safety ☐ Water Boating Safety
PROTECTIVE EQUIPMENT		
☐ Eyewear: Goggles – Chemical Splash ☐ Eyewear: Goggles – Dust ☐ Eyewear: Safety Glasses (Clear) ☒ Eyewear: Safety Glasses (Tinted) ☐ Eyewear: Laser: _____ ☐ Eyewear: Welding Face Shield ☐ Face: Face Shield ☐ Fall Protection: Harness/Lanyard	☒ Footwear: Project / ANSI approved safety boots with ankle protection (Non Steel/ Composite Toe) ☒ Hand: Leather Work Gloves ☐ Hand: Specialty Glove: _____ ☒ Head: Hardhat ☒ Head: Sun protection ☐ Hearing: Earplugs: _____ ☐ Hearing: Earmuffs: _____ ☒ High Visibility Vest: _____	☐ Personal Flotation Device: _____ ☐ Protective Clothing: _____ ☐ Respirator: Half Facepiece: _____ ☐ Respirator: Full Facepiece: _____ ☐ Respirator: Disposable: _____ ☐ Respirator: Airline respirator ☐ Respirator: SCBA

ACTIVITY HAZARD ANALYSIS (AHA)

Date: 8-11-2015 Project Title: Radford SI

Overall Risk Assessment Code (use highest code) M

Activity/Task: Media (Soil) Sampling

Title of Person Who Does the Job: Sampling Lead/Sampling Technician

Activity/Task Location: Former Gun and Mortar Range MRS

Prepared By: D. Sciarro

Approved By (H&S Staff): S. Coffee

Risk Assessment Code (RAC) Matrix

E=Extremely High Risk H=High Risk M=Moderate Risk L=Low Risk		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Media Sampling	- Injury due to improper handling of hand tools, - Premature functioning of UXO or initiation of hazardous components associated with UXO and MEC	- All hand tools will be inspected for cleanliness and safety. - Sharp edges and damage will be noted. If the condition of a tool presents a safety hazard, it will be removed from service and replaced. - All hand tools will be cleaned after use to prevent corrosion damage. Reusable sampling equipment is subject to decontamination procedures. - No excavations for samples or intrusive marking (flags) will be conducted without having the qualified UXO tech do a magnetometer sweep for any unforeseen subsurface anomalies. - Any MEC encountered will be reported for assessment and proper disposal.	L
Soil Sampling	Investigative Derived Wastes	- All IDW and rinsates will be collected and contained utilizing adequate eye protection and hand protection. (Nitrile or Viton gloves with ANSI approved safety glasses or goggles) - The wash and rinse stages will be performed over an area that has been covered in plastic sheeting, a trash bag, or another barrier to prevent liquid from escaping. - Small quantities may be absorbed into paper towels and disposed of with the solid IDW. - Larger quantities will be collected into buckets. - Used wash and rinse liquids will be consolidated with the liquid IDW in the IDW drums. - Unused wash and rinse bucket liquids will be covered, temporarily sealed, and stored for use on the next day of sampling. If unused wash	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		and rinse liquids are still present at the end of the project, they will be disposed of as non-hazardous liquid IDW. • All buckets will be appropriately labeled (e.g., rinsate waste, clean wash, clean rinse, used wash, used rinse) to prevent confusion in the field. • Similarly, all spray bottles will be appropriately labeled (e.g., Alconox ® wash, clean water rinse, DI rinse). • Once designated and labeled for a particular content, each spray bottle will only be refilled with that substance. • ANSI approves eye protection and Nitrile gloves will be worn during sampling.	
• Media Sampling	• Injury to staff or damage to equipment due to slips, trips & falls	• Utilize continuous environmental awareness and communicate abnormal or uneven walking surfaces. • Follow slip, trip, and fall protection methods identified in the Project APP/SSHP. • Limit personnel entry and exit for safety in work area. • Think about your body position; avoid over-reaching, hyper-extending / position of extremities. • Wear project approved/ ANSI approved safety boots with ankle protection.	L
• Media Sampling	• Injury to staff or damage to equipment due to lack of safety awareness.	• All personnel must read and sign the applicable HDR Site Safety and Health Plan. • A copy of the APP/SSHP shall be available on the job site. • Designated field staff will provide safety briefings and maintain control over site access to and from the hazardous areas. • Designated safety personnel will conduct site safety briefings at the beginning of each workday. All site personnel will attend each day's briefing and sign an attendance log. • The safety briefings will be used as an opportunity to address any recognized site-specific safety issues that arise or that are outlined in the APP/SSHP. • Safety briefings are used to refresh workers on specific policies and procedures applicable to HDR and the project and to address any new hazards, operations, or hazard control methods to be used. Topics to be discussed and understood by all field staff are but not limited to: - o Scope of the days operations; - o Personnel assignments and PPE to be worn; - o Safety precautions expected for each assignment; - o Location of other teams in the area;	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		- o Identification of survey safety equipment required; - o Review the project site specific APP/SSHP; - o Changes in activities or daily operations. - o Changes in site conditions. - o Emergency evacuation routes. - o Emergency duties and procedures. - o Pertinent information that may affect safety within daily work activities. - o Anticipated weather conditions.	
• Media Sampling	• Excessive Noise	• Hearing protection will be utilized by personnel operating or working around heavy equipment, maintenance equipment or power tools. A minimum Noise Reduction Rating (NRR) of 30 is required.	L
• Media Sampling	• Injury from exposure to biological or animal hazards such as snakes, rodents, insects, or wildlife.	• All members of staff should wear suitable ANSI approved footwear when walking off pathways. • Care should be taken when picking up items from the ground or when moving rocks, trash, etc. • Mosquito nets should be used in mosquito infested areas. • Insect repellant should be used by non-sensitive individuals to prevent mosquito and tick bites. • Footwear and clothing should be knocked or shaken before donning. • Maintain good housekeeping. • Follow any biological prevention methods identified in the Project APP/SSHP. • Feeding and encouragement of feral animals is forbidden.	L
• Media Sampling	• Lightning strikes.	• Keep vigilant regarding ongoing and forecasted weather; seek adequate shelter during storms with strong wind and lightning. • A watch will be kept to ensure personnel safety from approaching thunderstorms. • All outside work will cease when lightning is within 5 miles of the work area.	L
• Media Sampling	• Employee Injury or Illness while out in remote areas	Emergency medical summons procedures will include the following: • Non-life threatening injuries and illnesses will be managed by the WorkCare Incident Intervention Team. This a 24/7 HDR Injury Reporting line @ 1 (888) 449-7787 • The Occupational Nurse or physician discusses the injury and surrounding circumstances with the injured person. • Employee is provided guidance on appropriate treatment options (triage). • Appropriate treatment details are handled by the Occupational Nurse or physician. • The HDR Health and Safety Director (HSD), hereafter referred to as HSD, is	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
		notified by the occupational nurse or physician via email immediately after each contact. - Life threatening illnesses or injuries will require an immediate emergency call to 911. When calling 911 you must initially state "I have a medical emergency". This statement routes you directly to medical services rather than placing your call in line with other types of emergencies. - Serious Incidents must be reported to the HSD immediately. - Serious incidents are those that involve any of the following: - Work related death, or life threatening injury or illness of an HDR employee, subcontractor, or public; - Missing person; - Acts or threats of terrorism; - Event that involves a fire, explosion, or property damage. - Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment. - All other injuries or illness (even those that are minor and may only require First Aid) which occur at work, while on business travel or commute must be reported to the supervisor, Project Manager, and the HSD.	
Media Sampling	Employee injury due to vehicle accident or breakdown.	- Vehicles must be kept in a safe mechanically operating condition. - All site personnel operating motor vehicles at the site shall comply with all federal, state, and local traffic regulations. Vehicles used for project activities will be inspected daily and inspection forms will be documented. - All personnel shall wear seat belts. All speed limits will be enforced. - All drivers will drive in a defensive manner and will slow down during hazardous driving conditions. - Backing vehicles should be avoided if possible. Drivers shall do a walk around the vehicle to check to see if there are any potential hazards before backing a vehicle. Use a spotter whenever possible. - In the event of a breakdown or accident, vehicles will be moved off the roadway and warning (hazard) lights shall be put on. Notify proper personnel for assistance.	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
Media Sampling	Encountering MPPEH or MEC during SI activities.	- Personnel are not anticipated to encounter MEC or MPPEH during SI activities; however, the following general precautions will be taken to ensure the safety of field personnel in the unlikely event that MEC or MPPEH are present at the SI sites. - Field personnel will have basic MEC awareness training. - Field personnel will practice situational awareness and avoid unidentified man-made objects and other suspect items when traveling off of established roads (e.g., walking to/from monitoring wells). - Any item suspected of being MPPEH or MEC will be documented as thoroughly as possible without disturbing the item or potentially endangering personnel. - The item will be flagged with either survey marking tape or a pin flag nearby but caution will be taken not to disturb or touch any identifiable feature of interest. - Field personnel will stop work and consult with the BSEn PM and a UXO Technician II or greater to confirm the discovery. - If a potential MEC/MPPEH hazard is confirmed, the project team will be notified as follows: - Field team leader/SSHO contacts the BSEn PM; - BSEn PM contacts the USACE PM and the Radford APP POC. - EOD will be contacted to respond to any suspected MEC or MPPEH.	M
Media Sampling	Injury to visitors or unauthorized personnel in the work area	- Visitors are to be given a basic induction and are to be accompanied until the SSHO or PM is satisfied that they are safe to be alone in the work area. - All authorized visitors must be familiar with any applicable health and safety measures currently being used to provide equal protection. - All essential project visitors working on site will review the site APP/SSHP and AHA. - Site access must be coordinated with the PM.	L

***Step 1:** Review each “hazard” with identified safety “controls.” Determine RAC (see above).

Step 2: Identify the RAC (probability vs. severity) as E, H, M, or L for each “hazard” on AHA. Annotate the overall highest RAC at the top of AHA.

Equipment to be Used	Training Requirements	PPE Requirements
<u>Personal Protective Equipment:</u> • Utility gloves; 2 boxes of nitrile gloves; Safety glasses; Safety vests; Sets of hearing protection (NRR 30 or above); • 2 First aid kits; 2 BBP kit; • Sunscreen; • Insect repellent, • 10lb ABC Fire Extinguisher, • APP/SSHP, AHA's <u>Project Task Equipment:</u> • Schonstedt GA-52Cx • Trimble GeoXT or GeoXH • Digital camera • Disposable sampling scoops	<u>Training:</u> • New Hire/ Site Safety Orientation • PPE • Hazard Communication (HAZCOM) <u>Project Specific Training:</u> • 40hr HAZWOPER • 8hr HAZWOPER Refresher/with current medical evaluation. • APP/SSHP with signature on acknowledgement page. • 30hr OSHA Construction Safety (SSHO) • 8hr OSHA Site Supervisor (SSHO) • CPR/ First Aid (2 people) • Unexploded Ordnance Technicians must be qualified IAW the Department of Defense Explosives Safety Board (DDESB) Technical Pamphlet (TP)-18 (DDESB, 2004)	• The levels of PPE will need to be reassessed if any of the following occur: 1. Presence of or potential for previously unidentified chemicals or conditions; 2. Changes in ambient weather conditions; 3. Assignment of new tasks or expansion in the scope of a previously evaluated task. • The following is a description of the level modified "D" PPE that will be required during the project. Level Modified "D" consists of: ✓ Long pants (Non-static producing material such as cotton); ✓ Long or short sleeve shirt (Non-static producing material such as cotton); ✓ American National Standards Institute (ANSI) Z-87.1 approved eye protection; ✓ ANSI Type II reflective vests; ✓ ANSI approved over the ankle safety-toed boots; ✓ Leather work gloves when handling any sharp or rough edges; ✓ Viton or Nitrile gloves when handling contaminated soil or groundwater; ✓ Viton or Nitrile gloves in conjunction with leather gloves when handling contaminated soil or groundwater if there is a potential for sharp or rough edge injuries.

SAFE PRACTICES AND PROCEDURES		
☐ Aerial Lifts ☐ Asbestos ☒ Behavior Based Safety ☒ Biological Hazards ☒ Bloodborne Pathogens Exposure Control ☐ Bridge Inspection Safety ☐ Cold Stress ☐ Compressed Gas Safety (EOC) ☐ Crane Platform Safety ☐ Defensive Driving ☐ Demolition Safety ☐ Drill Rig Safety ☐ Drum and Container Handling (EOC) ☐ Drug Program	☐ Electrical Safety ☐ Excavation ☐ Fall Protection ☐ Firearm Safety ☒ First Aid/CPR ☒ Hazard Communication ☒ Heat Stress ☐ Helicopter Safety ☐ Laboratory Safety Plan ☐ Lead & Lead-based Paint ☐ Lockout Tagout ☒ Medical Monitoring ☐ Mine Safety ☒ Noise (Hearing Conservation)	☐ Permit Required Confined Space ☒ Personal Protective Equipment ☒ Portable Fire Extinguishers ☐ Portable Ladders ☐ Railroad Safety ☐ Remote Site Safety ☐ Respiratory Protection ☐ Rope Access Inspection ☐ Scientific Diving Safety ☒ Slip/Trip/Fall ☐ Specialty Vehicle Operation ☐ Temporary Electrical ☐ Traffic Safety ☐ Water Boating Safety
PROTECTIVE EQUIPMENT		
☐ Eyewear: Goggles – Chemical Splash ☐ Eyewear: Goggles – Dust ☐ Eyewear: Safety Glasses (Clear) ☒ Eyewear: Safety Glasses (Tinted) ☐ Eyewear: Laser: _____ ☐ Eyewear: Welding Face Shield ☐ Face: Face Shield ☐ Fall Protection: Harness/Lanyard	☒ Footwear: Project / ANSI approved safety boots with ankle protection (Non Steel/ Composite Toe) ☒ Hand: Leather Work Gloves ☒ Hand: Specialty Glove: Nitrile ☒ Head: Hardhat ☒ Head: Sun protection ☐ Hearing: Earplugs: _____ ☐ Hearing: Earmuffs: _____ ☒ High Visibility Vest: _____	☐ Personal Flotation Device: _____ ☐ Protective Clothing: _____ ☐ Respirator: Half Facepiece: _____ ☐ Respirator: Full Facepiece: _____ ☐ Respirator: Disposable: _____ ☐ Respirator: Airline respirator ☐ Respirator: SCBA

This page intentionally left blank.

Attachment C

Health and Safety Forms

Accident/Incident Report Form	D-C-1
Accident Investigation Form (ENG Form 3394)	D-C-3
Activity Hazard Analysis Form (Blank)	D-C-17
Daily Safety Meeting Form	D-C-19
Acknowledgement Form	D-C-21
Kick-off Health and Safety Meeting Documentation Form	D-C-23
Stop Work Authority Form	D-C-25
Hazard Reporting Corrective Action Form	D-C-27

This page intentionally left blank.

ACCIDENT/INCIDENT REPORT FORM

Part 1 – Incident Details	
Name of Exposed/Injured Employee	
Name of Employee Completing Form	
Incident Date	Incident Time AM or PM (circle one)
Did incident occur within working hours? ☐ YES ☐ NO (occurred during break or before or after shift)	
Location (Check applicable box and enter information as appropriate.) ☐ Active Mine Site (Enter MSHA Mine ID Number) ☐ Client Office (Enter Name of Client) ☐ Field or Construction Site (Enter Project Name) ☐ HDR Office ☐ Parking Lot or Roadway ☐ Railroad (Enter Name of RR) ☐ Other	
Locale (Indicate state/province where incident occurred.)	
Witnesses (indicate name of any HDR or non-HDR witness to the incident)	
Incident Type ☐ YES injury/illness occurred (Go to Part 2) ☐ NO injury/illness put potential for it (Go to Part 3)	
Part 2 – Incidents with Injury/Illness	
Medical Care ☐ No Medical Care Needed (Go to Part 3) ☐ First Aid Given at Work Site (Go to Part 3) ☐ Off-Site Medical Care Required (indicate provider name and address)	
Transitional Duty Evaluation (for injuries that impact your ability to return to your normal job duties) Did you contact your HR Rep for a Transitional Duty Evaluation Form? (If not, do so ASAP!) ☐ Yes ☐ No ☐ Not Applicable	
Workers Compensation (for injuries that require medical care beyond first aid and/or impact your ability to work) Did you contact your HR Rep to file a Workers' Compensation claim? (If not, do so ASAP!) ☐ Yes ☐ No ☐ Not Applicable	
Work Impact ☐ No Missed Time or Restricted Duties ☐ One or More Full Work Days Missed (indicate dates not including date of incident) ☐ One or More Partial Work Days Missed (indicate dates not including date of incident) ☐ Restricted Duties (indicate dates not including date of incident)	

Medication ☐ No Medication Needed ☐ Prescription Medication ☐ Over the Counter Medication (regular strength) ☐ Over the Counter Medication (prescription strength) ☐ Prescription Written But Not Filled	
Description of Medical Treatment (indicate the type of treatment received and the body party affected (e.g., ER visit, hospitalization, physical therapy, MRI/x-Ray/CT scan; stiches/glue; hand splint/brace; soft splint/brace; etc.) 	
Prognosis and Follow Up (describe doctor's orders and indicate if follow up care/appointments are needed) 	
Part 3 – Incident Description, Causative Factors, and Suggestions for Prevention	
Incident Description (Describe in detail what happened and where.) 	
Causative Factors (Describe circumstances contributing to the incident.) 	
Suggestions for Prevention (Describe changes that could prevent the circumstances from reoccurring.) 	
When you are finished with this report, enter it into HDR's online reporting system or give it to your local OSC for entry.	

(For safety staff only)	REPORT NO.	EROC CODE	UNITED STATES ARMY CORPS OF ENGINEERS ACCIDENT INVESTIGATION REPORT For use of this form, see Help Menu and USACE Supplement to AR 385-40 The proponent agency is CESO		REQUIREMENT CONTROL SYMBOL: CEEC-S-8 (R2)
1. ACCIDENT CLASSIFICATION					
PERSONNEL CLASSIFICATION		INJURY/ILLNESS/FATAL		PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED
GOVERNMENT ☐ CIVILIAN ☐ MILITARY		☐		☐ FIRE INVOLVED ☐ OTHER	☐
☐ CONTRACTOR		☐		☐ FIRE INVOLVED ☐ OTHER	☐
☐ PUBLIC		☐ FATAL ☐ OTHER		~~XXXXXXXXXX~~	
2. PERSONAL DATA					
a. NAME (Last, First MI.)		b. AGE	c. SEX ☐ MALE ☐ FEMALE		d. SOCIAL SECURITY NUMBER
e. GRADE					
f. JOB SERIES/TITLE		g. DUTY STATUS AT TIME OF ACCIDENT		h. EMPLOYMENT STATUS AT TIME OF ACCIDENT	
		☐ ON DUTY ☐ TDY ☐ OFF DUTY		☐ ARMY ACTIVE ☐ ARMY RESERVE ☐ VOLUNTEER ☐ PERMANENT ☐ FOREIGN NATIONAL ☐ SEASONAL ☐ TEMPORARY ☐ STUDENT ☐ OTHER (Specify) _____	
3. GENERAL INFORMATION					
a. DATE OF ACCIDENT (YYYYMMDD)	b. TIME OF ACCIDENT (Military Time)	c. EXACT LOCATION OF ACCIDENT			d. CONTRACTOR'S NAME
	hrs.				(1) PRIME
e. CONTRACT NUMBER		f. TYPE OF CONTRACT		g. HAZARDOUS/TOXIC WASTE ACTIVITY	
☐ CIVIL WORKS ☐ MILITARY ☐ OTHER (Specify) _____		☐ CONSTRUCTION ☐ SERVICE ☐ A/E ☐ DREDGE ☐ OTHER (Specify) _____		☐ SUPERFUND ☐ DERP ☐ IRP ☐ OTHER (Specify) _____	
				(2) SUBCONTRACTOR	
4. CONSTRUCTION ACTIVITIES ONLY (Fill in line and corresponding code number in box from list - see help menu)					
a. CONSTRUCTION ACTIVITY (CODE)			b. TYPE OF CONSTRUCTION EQUIPMENT (CODE)		
_____ #			_____ #		
5. INJURY/ILLNESS INFORMATION (Include name on line and corresponding code number in box for items e, f & g - see help menu)					
a. SEVERITY OF ILLNESS/INJURY (CODE)			b. ESTIMATED DAYS LOST	c. ESTIMATED DAYS HOSPITALIZED	d. ESTIMATED DAYS RESTRICTED DUTY
_____ #					
e. BODY PART AFFECTED (CODE)			g. TYPE AND SOURCE OF INJURY/ILLNESS (CODE)		
PRIMARY _____ #			TYPE _____ #		
SECONDARY _____ #					
f. NATURE OF ILLNESS / INJURY (CODE)			SOURCE _____ #		
_____ #					
6. PUBLIC FATALITY (Fill in line and correspondence code number in box - see help menu)					
a. ACTIVITY AT TIME OF ACCIDENT (CODE)			b. PERSONAL FLOTATION DEVICE USED?		
_____ #			☐ YES ☐ NO ☐ N/A		

7. MOTOR VEHICLE ACCIDENT						
a. TYPE OF VEHICLE		b. TYPE OF COLLISION		c. SEAT BELTS		
☐ PICKUP/VAN ☐ AUTOMOBILE ☐ TRUCK ☐ OTHER (Specify) _____		☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER (Specify) _____		USED NOT USED NOT APPLICABLE (1) FRONT SEAT ☐ ☐ ☐ (2) REAR SEAT ☐ ☐ ☐		
8. PROPERTY MATERIAL INVOLVED						
a. NAME OF ITEM		b. OWNERSHIP		c. AMOUNT OF DAMAGE		
(1)						
(2)						
(3)						
9. VESSEL/FLOATING PLANT ACCIDENT (Fill in line and correspondence code number in box from list - see help menu)						
a. ACTIVITY AT TIME OF ACCIDENT (CODE)				a. ACTIVITY AT TIME OF ACCIDENT (CODE)		
#				#		
10. ACCIDENT DESCRIPTION (Use additional paper, if necessary, see attached page 4.)						
11. CAUSAL FACTOR(s) (Read instructions before completing)						
a. (Explain YES answers in item 13)						
						YES NO
DESIGN: Was design of facility, workplace or equipment a factor?						☐ ☐
INSPECTION/MAINTENANCE: Were inspection & maintenance procedures a factor?						☐ ☐
PERSON'S PHYSICAL CONDITION: In your opinion, was the physical condition of the person a factor?						☐ ☐
OPERATING PROCEDURES: Were operating procedures a factor?						☐ ☐
JOB PRACTICES: Were any job safety/health practices not followed when the accident occurred?						☐ ☐
HUMAN FACTORS: Did any human factors such as, size or strength of person, etc., contribute to accident?						☐ ☐
ENVIRONMENTAL FACTORS: Did heat, cold, dust, sun, glare, etc., contribute to the accident?						☐ ☐
CHEMICAL AND PHYSICAL AGENT FACTORS: Did exposure to chemical agents, such as dust, fumes, mists, vapors or physical agents, such as, noise, radiation, etc., contribute to accident?						☐ ☐
OFFICE FACTORS: Did office setting such as, lifting office furniture, carrying, stooping, etc., contribute to the accident?						☐ ☐
SUPPORT FACTORS: Were inappropriate tools/resources provided to properly perform the activity/task?						☐ ☐
PERSONAL PROTECTIVE EQUIPMENT: Did the improper selection, use or maintenance of personal protective equipment contribute to the accident?						☐ ☐
DRUGS/ALCOHOL: In your opinion, was drugs or alcohol a factor to the accident?						☐ ☐
b. WAS A WRITTEN JOB/ACTIVITY HAZARD ANALYSIS COMPLETED FOR TASK BEING PERFORMED AT TIME OF ACCIDENT? (If yes, attach a copy.)						☐ ☐
12. TRAINING						
a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?		b. TYPE OF TRAINING		c. DATE OF MOST RECENT FORMAL TRAINING (YYYYMMDD)		
☐ YES ☐ NO		☐ CLASSROOM ☐ ON JOB				
13. FULLY EXPLAIN WHAT ALLOWED OR CAUSED THE ACCIDENT; INCLUDE DIRECT AND INDIRECT CAUSES (See instruction for definition of direct and indirect causes.) (Use additional paper, if necessary)						
a. DIRECT CAUSE(s) (Attach additional sheets as needed, See page 4)						
b. INDIRECT CAUSE(s) (Attach additional sheets as needed, See page 5)						

14. ACTION(s) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(s)		
DESCRIBE FULLY (Attach additional sheets as necessary, See page 5)		
15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.		
a. BEGINNING (YYYYMMDD)	b. ANTICIPATED COMPLETION (YYYYMMDD)	
c. DATE SIGNED (YYYYMMDD)	d. TITLE OF SUPERVISOR COMPLETING REPORT	e. CORPS SIGNATURE, SUPERVISOR COMPLETING REPORT
c. DATE SIGNED (YYYYMMDD)	d. TITLE OF SUPERVISOR COMPLETING REPORT	e. CONTRACTOR SIGNATURE, SUPERVISOR COMPLETING REPORT
f. ORGANIZATION IDENTIFIER (Division, Branch, Section, etc.,)		g. OFFICE SYMBOL
16. MANAGEMENT REVIEW (1st)		
a. ☐ CONCUR b. ☐ NONCONCUR c. COMMENTS		
DATE (YYYYMMDD)	TITLE	SIGNATURE
17. MANAGEMENT REVIEW (2nd - Chief Operations, Construction, Engineering, etc.,)		
a. ☐ CONCUR b. ☐ NONCONCUR c. COMMENTS		
DATE (YYYYMMDD)	TITLE	SIGNATURE
18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW		
a. ☐ CONCUR b. ☐ NONCONCUR c. ADDITIONAL ACTIONS/COMMENTS		
DATE (YYYYMMDD)	TITLE	SIGNATURE
19. COMMAND APPROVAL		
COMMENTS		
DATE (YYYYMMDD)	COMMANDER SIGNATURE	

10.

ACCIDENT DESCRIPTION *(Continuation)*

13a.

DIRECT CAUSE(s) *(Continuation)*

13b.

INDIRECT CAUSE(s) (Continuation)

14.

ACTION(s) TAKEN, ANTICIPATED, OR RECOMMENDED TO ELIMINATE CAUSE(s) (Continuation)

GENERAL. Complete a separate report for each person who was injured, caused, or contributed to the accident (*excluding uninjured personnel and witnesses*). Use of this form for reporting USACE employee first-aid type injuries not submitted to the Office of Workers' Compensation Programs (OWCP) shall be at the discretion of the FOA commander. Please type or print legibly. Appropriate items shall be marked with an "X" in box(es). If additional space is needed, provide the information on a separate sheet and attach to the completed form. Ensure that these instructions are forwarded with the completed report to the designated management reviewers indicated in sections 16 and 17.

INSTRUCTIONS FOR SECTION 1 - ACCIDENT CLASSIFICATION

(Mark All Boxes That Are Applicable)

a. GOVERNMENT. Mark "CIVILIAN" box if accident involved government civilian employee; mark "MILITARY" box if accident involved U.S. military personnel.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any government civilian employee injury, illness, or fatality that requires the submission of OWCP Forms CA-1 (*injury*), CA-2 (*illness*) or CA-6 (*fatality*) to OWCP; mark if accident resulted in military personnel lost-time or fatal injury or illness.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of \$1000 or more to government property (*including motor vehicles*).

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved an in-house USACE diving activity.

b. CONTRACTOR.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in any contractor lost-time injury/illness or fatality.

(2) PROPERTY DAMAGE - Mark the appropriate box if accident resulted in any damage of \$1000 or more to contractor property (*including motor vehicles*).

(3) VEHICLE INVOLVED - Mark if accident involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" or "PROPERTY DAMAGE" are marked.

(4) DIVING ACTIVITY - Mark if the accident involved a USACE Contractor diving activity.

c. PUBLIC.

(1) INJURY/ILLNESS/FATALITY - Mark if accident resulted in public fatality or permanent total disability. (*The "OTHER" box will be marked when requested by the FOA to report an unusual non-fatal public accident that could result in claims against the government or as otherwise directed by the FOA Commander*).

(2) VOID SPACE - Make no entry.

(3) VEHICLE INVOLVED - Mark if accident resulted in a fatality to a member of the public and involved a motor vehicle, regardless of whether "INJURY/ILLNESS/FATALITY" is marked.

(4) VOID SPACE - Make no entry.

INSTRUCTIONS FOR SECTION 2 - PERSONAL DATA

a. NAME - (*MANDATORY FOR GOVERNMENT ACCIDENTS. OPTIONAL AT THE DISCRETION OF THE FOA COMMANDER FOR CONTRACTOR AND PUBLIC ACCIDENTS*). Enter last name, first name, middle initial of person involved.

b. AGE - Enter age.

c. SEX - Mark appropriate box.

d. SOCIAL SECURITY NUMBER - (*FOR GOVERNMENT PERSONNEL ONLY*) Enter the social security number (*or other personal identification number if no social security number issued*).

e. GRADE - (*FOR GOVERNMENT PERSONNEL ONLY*) Enter pay grade. Example: 0-6; E-7; WG-8; WS-12; GS-11; etc.

f. JOB SERIES/TITLE - For government civilian employees enter the pay plan, full series number, and job title, e.g., GS-O810/Civil Engineer. For military personnel enter the primary military occupational specialty (PMOS), e.g., 15A30 or 11G50. For contractor employees enter the job title assigned to the injured person, e.g., carpenter, laborer, surveyor, etc.

g. DUTY STATUS - Mark the appropriate box.

(1) ON DUTY - Person was at duty station during duty hours or person was away from duty station during duty hours but on official business at time of the accident.

(2) TDY - Person was on official business, away from the duty station and with travel orders at time of accident. Line-of-duty investigation required.

(3) OFF DUTY - Person was not on official business at time of accident.

h. EMPLOYMENT STATUS - (*FOR GOVERNMENT PERSONNEL ONLY*) Mark the most appropriate box. If "OTHER" is marked, specify the employment status of the person.

INSTRUCTION FOR SECTION 3 - GENERAL INFORMATION

- a. DATE OF ACCIDENT - Enter the month, day, and year of accident.
- b. TIME OF ACCIDENT - Enter the local time of accident in military time. Example: 1430 hrs (*not* 2:30 p.m.).
- c. EXACT LOCATION OF ACCIDENT - Enter facts needed to locate the accident scene, (*installation/project name, building number, street, direction and distance from closest landmark, etc.*).
- d. CONTRACTOR NAME
- (1) PRIME - Enter the exact name (*title of firm*) of the prime contractor.
- (2) SUBCONTRACTOR - Enter the name of any subcontractor involved in the accident.
- e. CONTRACT NUMBER - Mark the appropriate box to identify if contract is civil works, military, or other: if "OTHER" is marked, specify contract appropriation on line provided. Enter complete contract number of prime contract, e.g., DACW 09-85-C-0100.
- f. TYPE OF CONTRACT - Mark appropriate box. A/E means architect/engineer. If "OTHER" is marked, specify type of contract on line provided.
- g. HAZARDOUS/TOXIC WASTE ACTIVITY (HTW) - Mark the box to identify the HTW activity being performed at the time of the accident. For Superfund, DERP, and Installation Restoration Program (IRP) HTW activities include accidents that occurred during inventory, predesign, design, and construction. For the purpose of accident reporting, DERP Formerly Used DoD Site (FUDS) activities and IRP activities will be treated separately. For Civil Works O&M HTW activities mark the "OTHER" box.

INSTRUCTIONS FOR SECTION 4 - CONSTRUCTION ACTIVITIES

- a. CONSTRUCTION ACTIVITY - Select the most appropriate construction activity being performed at time of accident from the list below. Enter the activity name and place the corresponding code number identified in the box.

CONSTRUCTION ACTIVITY LIST

1. MOBILIZATION	13. CARPENTRY
2. SITE PREPARATION	14. ELECTRICAL
3. EXCAVATION/TRENCHING	15. SCAFFOLDING/ACCESS
4. GRADING (EARTHWORK)	16. MECHANICAL
5. PIPING/UTILITIES	17. PAINTING
6. FOUNDATION	18. EQUIPMENT/MAINTENANCE
7. FORMING	19. TUNNELING
8. CONCRETE PLACEMENT	20. WAREHOUSING/STORAGE
9. STEEL ERECTION	21. PAVING
10. ROOFING	22. FENCING
11. FRAMING	23. SIGNING
12. MASONRY	24. LANDSCAPING/IRRIGATION
	25. INSULATION
	26. DEMOLITION

- b. TYPE OF CONSTRUCTION EQUIPMENT - Select the equipment involved in the accident from the list below. Enter the name and place the corresponding code number identified in the box. If equipment is not included below, use code 24, "OTHER", and write in specific type of equipment.

CONSTRUCTION EQUIPMENT

1. GRADER	12. DUMP TRUCK (HIGHWAY)
2. DRAGLINE	13. DUMP TRUCK (OFF HIGHWAY)
3. CRANE (ON VESSEL/BARGE)	14. TRUCK (OTHER)
4. CRANE (TRACKED)	15. FORKLIFT
5. CRANE (RUBBER TIRE)	16. BACKHOE
6. CRANE (VEHICLE MOUNTED)	17. FRONT-END LOADER
7. CRANE (TOWER)	18. PILE DRIVER
8. SHOVEL	19. TRACTOR (UTILITY)
9. SCRAPER	20. MANLIFT
10. PUMP TRUCK (CONCRETE)	21. DOZER
11. TRUCK (CONCRETE/TRANSIT MIXER)	22. DRILL RIG
	23. COMPACTOR/VIBRATORY ROLLER
	24. OTHER

INSTRUCTIONS FOR SECTION 5 - INJURY/ILLNESS INFORMATION

- a. SEVERITY OF INJURY/ILLNESS - Reference paragraph 2-10 of USACE Supplement 1 to AR 385-40 and enter code and description from list below.

NOI	NO INJURY
FAT	FATALITY
PTL	PERMANENT TOTAL DISABILITY
PPR	PERMANENT PARTIAL DISABILITY
LWD	LOST WORKDAY CASE INVOLVING DAYS AWAY FROM WORK
NLW	RECORDABLE CASE WITHOUT LOST WORKDAYS
RFA	RECORDABLE FIRST AID CASE
NRI	NON-RECORDABLE INJURY

- b. ESTIMATED DAYS LOST - Enter the estimated number of workdays the person will lose from work.

c. ESTIMATED DAYS HOSPITALIZED - Enter the estimated number of workdays the person will be hospitalized.

d. ESTIMATED DAYS RESTRICTED DUTY - Enter the estimated number of workdays the person, as a result of the accident, will not be able to perform all of their regular duties.

e. BODY PART AFFECTED - Select the most appropriate primary and when applicable, secondary body part affected from the list below. Enter body part name on line and place the corresponding code letters identifying that body part in the box.

GENERAL BODY AREA	CODE	BODY PART NAME	HEAD, EXTERNAL	H1	EYE EXTERNAL
ARM/WRIST	AB	ARM AND WRIST		H2	BOTH EYES EXTERNAL
	AS	ARM OR WRIST		H3	EAR EXTERNAL
TRUNK, EXTERNAL MUSCULATURE				H4	BOTH EARS EXTERNAL
				HC	CHIN
	B1	SINGLE BREAST		HF	FACE
	B2	BOTH BREASTS		HK	NECK/THROAT
	B3	SINGLE TESTICLE		HM	MOUTH/LIPS
	B4	BOTH TESTICLES		HN	NOSE
	BA	ABDOMEN		HS	SCALP
	BC	CHEST			
	BL	LOWER BACK	KNEE	KB	BOTH KNEES
	BP	PENIS		KS	KNEE
	BS	SIDE	LEG, HIP, ANKLE,	LB	BOTH LEGS/HIPS/ ANKLES/
	BU	UPPER BACK	BUTTOCKS		
	BW	WAIST	BUTTOCK	LS	SINGLE LEG/HIP/ ANKLE/BUTTOCK
	BZ	TRUNK OTHER			
HEAD, INTERNAL			HAND	MB	BOTH HANDS
	C1	SINGLE EAR INTERNAL		MS	SINGLE HAND
	C2	BOTH EARS INTERNAL			
	C3	SINGLE EYE INTERNAL	FOOT	PB	BOTH FEET
	C4	BOTH EYES INTERNAL		PS	SINGLE FOOT
	CB	BRAIN			
	CC	CRANIAL BONES	TRUNK, BONES	R1	SINGLE COLLAR BONE
	CD	TEETH		R2	BOTH COLLAR BONES
	CJ	JAW		R3	SHOULDER BLADE
	CL	THROAT, LARYNX		R4	BOTH SHOULDER BLADES
	CM	MOUTH		RB	RIB
	CN	NOSE		RS	STERNUM (BREAST BONE)
	CR	THROAT, OTHER		RV	VERTEBRAE (SPINE, DISC)
	CT	TONGUE		RZ	TRUNK BONES OTHER
	CZ	HEAD OTHER INTERNAL			
ELBOW	EB	BOTH ELBOWS	SHOULDER	SB	BOTH SHOULDERS
	ES	SINGLE ELBOW		SS	SINGLE SHOULDER
FINGER			THUMB	TB	BOTH THUMBS
	F1	FIRST FINGER		TS	SINGLE THUMB
	F2	BOTH FIRST FINGERS			
	F3	SECOND FINGER	TRUNK, INTERNAL	V1	LUNG, SINGLE
	F4	BOTH SECOND FINGERS	ORGANS	V2	LUNGS, BOTH
	F5	THIRD FINGER		V3	KIDNEY, SINGLE
	F6	BOTH THIRD FINGERS		V4	KIDNEYS, BOTH
	F7	FOURTH FINGER		VH	HEART
TOE	F8	BOTH FOURTH FINGERS		VL	LIVER
	G1	GREAT TOE		VR	REPRODUCTIVE ORGANS
	G2	BOTH GREAT TOES		VS	STOMACH
	G3	TOE OTHER		VV	INTESTINES
	G4	TOES OTHER		VZ	TRUNK, INTERNAL; OTHER

f. NATURE OF INJURY/ILLNESS - Select the most appropriate nature of injury/illness from the list below. This nature of injury/illness shall correspond to the primary body part selected in 5e, above. Enter the nature of injury/illness name on the line and place the corresponding CODE letters in the box provided.

* The injury or condition selected below must be caused by a specific incident or event which occurred during a single work day or shift.

GENERAL NATURE CATEGORY	CODE	NATURE OF INJURY NAME	TU	BURN, SCALD, SUNBURN
*TRAUMATIC INJURY OR DISABILITY	TA	AMPUTATION	TI	TRAUMATIC SKIN DISEASES/ CONDITIONS INCLUDING DERMATITIS
	TB	BACK STRAIN	TR	TRAUMATIC RESPIRATORY DISEASE
	TC	CONTUSION; BRUISE; ABRASION	TO	TRAUMATIC FOOD POISONING
	TD	DISLOCATION	TW	TRAUMATIC TUBERCULOSIS
	TF	FRACTURE	TX	TRAUMATIC VIROLOGICAL/INFECTIVE/
	TH	HERNIA	T1	TRAUMATIC CEREBRAL VASCULAR
GENERAL NATURE CATEGORY			CONDITION/STROKE	
	TK	CONCUSSION	T2	TRAUMATIC HEARING LOSS
	TL	LACERATION, CUT	T3	TRAUMATIC HEART CONDITION
	TP	PUNCTURE	T4	TRAUMATIC MENTAL DISORDER, STRESS; NERVOUS CONDITION
	TS	STRAIN, MULTIPLE	T8	TRAUMATIC INJURY - OTHER (EXCEPT DISEASE, ILLNESS)

** A nontraumatic physiological harm or loss of capacity produced by systemic infection; continued or repeated stress or strain; exposure to toxins, poisons, fumes, etc.; or other continued and repeated exposures to conditions of the work environment over a long period of time. For practical purposes, an occupational illness/disease or disability is any reported condition which does not meet the definition of traumatic injury or disability as described above.

**GENERAL NATURE
CATEGORY**

CODE NATURE OF INJURY NAME

****NON-TRAUMATIC ILLNESS/DISEASE OR DISABILITY**

RESPIRATORY DISEASE	RA	ASBESTOSIS	DD	ENDEMIC DISEASE (OTHER THAN CODE TYPES R&S)
	RB	BRONCHITIS	DE	EFFECT OF ENVIRONMENTAL
	RE	EMPHYSEMA		
	RP	PNEUMOCONIOSIS	CONDITION	
	RS	SILICOSIS	DH	HEARING LOSS
VIROLOGICAL, INFECTIVE & PARASITIC DISEASES	R9	RESPIRATORY DISEASE, OTHER	DK	HEART CONDITION
			DM	MENTAL DISORDER, EMOTIONAL STRESS, NERVOUS CONDITION
	VB	BRUCELLOSIS	DR	RADIATION
	VC	COCCIDIOMYCOSIS	DS	STRAIN, MULTIPLE
	VF	FOOD POISONING	DU	ULCER
	VH	HEPATITIS	DV	OTHER VASCULAR CONDITIONS
	VM	MALARIA	D9	DISABILITY, OTHER
	VS	STAPHYLOCOCCUS		
	VT	TUBERCULOSIS	SKIN DISEASE OR	
	V9	VIROLOGICAL/INFECTIVE/ PARASITIC - OTHER	CONDITION	
DISABILITY, OCCUPATIONAL	DA	ARTHRITIS, BURSITIS	SB	BIOLOGICAL
	DB	BACK STRAIN, BACK SPRAIN	SC	CHEMICAL
	DC	CEREBRAL VASCULAR CONDITION; STROKE	S9	DERMATITIS, UNCLASSIFIED

g. TYPE AND SOURCE OF INJURY/ILLNESS (CAUSE) - Type and Source Codes are used to describe what caused the incident. The Type Code stands for an ACTION and the Source Code for an OBJECT or SUBSTANCE. Together, they form a brief description of how the incident occurred. Where there are two different sources, code the initiating source of the incident (see example 1, below). Examples:

(1) An employee tripped on carpet and struck his head on a desk. TYPE: 210 (fell on same level) SOURCE: 0110 (walking/working surface).

NOTE: This example would NOT be coded 120 (struck against) and 0140 (furniture).

(2) A Park Ranger contracted dermatitis from contact with poison ivy/oak.

TYPE: 510 (contact) SOURCE: 0920 (plant)

(3) A lock and dam mechanic punctured his finger with a metal sliver while grinding a turbine blade.

TYPE: 410 (punctured by) SOURCE: 0830 (metal)

(4) An employee was driving a government vehicle when it was struck by another vehicle.

TYPE: 800 (traveling in) SOURCE: 0421 (government-owned vehicle, as driver)

NOTE: The Type Code 800, "Traveling In" is different from the other type codes in that its function is not to identify factors contributing to the injury or fatality, but rather to collect data on the type of vehicle the employee was operating or traveling in at the time of the incident.

Select the most appropriate TYPE and SOURCE identifier from the list below and enter the name on the line and the corresponding code in the appropriate box.

CODE	TYPE OF INJURY NAME	CODE	SOURCE OF INJURY NAME
		0610	EXERTED
	STRUCK	0620	LIFTED, STRAINED BY (SINGLE ACTION)
0110	STRUCK BY		STRESSED BY (REPEATED ACTION)
0111	STRUCK BY FALLING OBJECT	0710	EXPOSED
0120	STRUCK AGAINST	0720	INHALED
	FELL, SLIPPED, TRIPPED	0730	INGESTED
0210	FELL ON SAME LEVEL	0740	ABSORBED
0220	FELL ON DIFFERENT LEVEL	0800	EXPOSED TO
0230	SLIPPED, TRIPPED (NO FALL)		TRAVELING IN
	CAUGHT	CODE	SOURCE OF INJURY NAME
0310	CAUGHT ON	0100	BUILDING OR WORKING AREA
0320	CAUGHT IN	0110	WALKING/WORKING SURFACE (FLOOR, STREET, SIDEWALKS, ETC.)
0330	CAUGHT BETWEEN	0120	STAIRS, STEPS
	PUNCTURED, LACERATED	0130	LADDER
0410	PUNCTURED BY	0140	FURNITURE, FURNISHINGS, OFFICE EQUIPMENT
0420	CUT BY	0150	BOILER, PRESSURE VESSEL
0430	STUNG BY	0160	EQUIPMENT LAYOUT (ERGONOMIC)
0440	BITTEN BY	0170	WINDOWS, DOORS
	CONTACTED	0180	ELECTRICITY
0510	CONTACTED WITH (INJURED PERSON MOVING)		
0520	CONTACTED BY (OBJECT WAS MOVING)		

0200	ENVIRONMENTAL CONDITION	0631	CARBON MONOXIDE
0210	TEMPERATURE EXTREME (INDOOR)	0640	MIST, STEAM, VAPOR, FUME
0220	WEATHER (ICE, RAIN, HEAT, ETC.)	0641	WELDING FUMES
0230	FIRE, FLAME, SMOKE (NOT TOBACCO)	0650	PARTICLES (UNIDENTIFIED)
0240	NOISE	0700	CHEMICAL, PLASTIC, ETC.
0250	RADIATION	0711	DRY CHEMICAL - CORROSIVE
0260	LIGHT	0712	DRY CHEMICAL - TOXIC
0270	VENTILATION	0713	DRY CHEMICAL - EXPLOSIVE
0271	TOBACCO SMOKE	0714	DRY CHEMICAL FLAMMABLE
0280	STRESS (EMOTIONAL)	0721	LIQUID CHEMICAL - CORROSIVE
0290	CONFINED SPACE	0722	LIQUID CHEMICAL - TOXIC
0300	MACHINE OR TOOL	0723	LIQUID CHEMICAL - EXPLOSIVE
0310	HAND TOOL (POWERED; SAW, GRINDER, ETC.)	0724	LIQUID CHEMICAL - FLAMMABLE
0320	HAND TOOL (NONPOWERED)	0730	PLASTIC
0330	MECHANICAL POWER TRANSMISSION APPARATUS	0740	WATER
0340	GUARD, SHIELD (FIXED, MOVEABLE, INTERLOCK)	0750	MEDICINE
0350	VIDEO DISPLAY TERMINAL	0800	INAMINATE OBJECT
0360	PUMP, COMPRESSOR, AIR PRESSURE TOOL	0810	BOX, BARREL, ETC.
0370	HEATING EQUIPMENT	0820	PAPER
0380	WELDING EQUIPMENT	0830	METAL ITEM, MINERAL
0400	VEHICLE	0831	NEEDLE
0411	AS DRIVER OF PRIVATELY OWNED/RENTAL VEHICLE	0840	GLASS
0412	AS PASSENGER OF PRIVATELY OWNED/RENTAL VEHICLE	0850	SCRAP, TRASH
0421	DRIVER OF GOVERNMENT VEHICLE	0860	WOOD
0422	PASSENGER OF GOVERNMENT VEHICLE	0870	FOOD
0430	COMMON CARRIER (AIRLINE, BUS, ETC.)	0880	CLOTHING, APPAREL, SHOES
0440	AIRCRAFT (NOT COMMERCIAL)	0900	ANIMATE OBJECT
0450	BOAT, SHIP, BARGE	0911	DOG
0500	MATERIAL HANDLING EQUIPMENT	0912	OTHER ANIMAL
0510	EARTHMOVER (TRACTOR, BACKHOE, ETC.)	0920	PLANT
0520	CONVEYOR (FOR MATERIAL AND EQUIPMENT)	0930	INSECT
0530	ELEVATOR, ESCALATOR, PERSONNEL HOIST	0940	HUMAN (VIOLENCE)
0540	HOIST, SLING CHAIN, JACK	0950	HUMAN (COMMUNICABLE DISEASE)
0550	CRANE	0960	BACTERIA, VIRUS (NOT HUMAN CONTACT)
0551	FORKLIFT	1000	PERSONAL PROTECTIVE EQUIPMENT
0560	HANDTRUCK, DOLLY	1010	PROTECTIVE CLOTHING, SHOES, GLASSES,
0600	DUST, VAPOR, ETC.		GOGGLES
0610	DUST (SILICA, COAL, ETC.)	1020	RESPIRATOR, MASK
0620	FIBERS	1021	DIVING EQUIPMENT
0621	ASBESTOS	1030	SAFETY BELT, HARNESS
0630	GASES	1040	PARACHUTE

INSTRUCTIONS FOR SECTION 6 - PUBLIC FATALITY

a. ACTIVITY AT TIME OF ACCIDENT - Select the activity being performed at the time of the accident from the list below. Enter the activity name on the line and the corresponding number in the box. If the activity performed is not identified on the list, select from the most appropriate primary activity area (*water related, non-water related or other activity*), the code number for "Other", and write in the activity being performed at the time of the accident.

WATER RELATED RECREATION	19. Camping/picnicking unauthorized area
1. Sailing	20. Guided tours
2. Boating-powered	21. Hunting
3. Boating-unpowered	22. Playground equipment
4. Water skiing	23. Sports/summer (baseball, football, etc.)
5. Fishing from boat	24. Sports/winter (skiing, sledding, snowmobiling etc.)
6. Fishing from bank dock or pier	25. Cycling (bicycle, motorcycle, scooter)
7. Fishing while wading	26. Gliding
8. Swimming/supervised area	27. Parachuting
9. Swimming/designated area	28. Other non-water related
10. Swimming/other area	
11. Underwater activities (skin diving, scuba, etc.)	OTHER ACTIVITIES
12. Wading	29. Unlawful acts (fights, riots, vandalism, etc.)
13. Attempted rescue	30. Food preparation/serving
14. Hunting from boat	31. Food consumption
15. Other	32. Housekeeping
	33. Sleeping
NON-WATER RELATED RECREATION	34. Pedestrian struck by vehicle
16. Hiking and walking	35. Pedestrian other acts
17. Climbing (general)	36. Suicide
18. Camping/picnicking authorized area	37. "Other" activities

b. PERSONAL FLOTATION DEVICE USED - If fatality was water-related was the victim wearing a person flotation device? Mark the appropriate box.

INSTRUCTIONS FOR SECTION 7 - MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE - Mark appropriate box for each vehicle involved. If more than one vehicle of the same type is involved, mark both halves of the appropriate box. USACE vehicle(s) involved shall be marked in left half of appropriate box.

b. TYPE OF COLLISION - Mark appropriate box.

c. SEAT BELT - Mark appropriate box.

INSTRUCTIONS FOR SECTION 8 - PROPERTY/MATERIAL INVOLVED

a. NAME OF ITEM - Describe all property involved in accident. Property/material involved means material which is damaged or whose use or misuse contributed to the accident. Include the name, type, model; also include the National Stock Number (NSN) whenever applicable.

b. OWNERSHIP - Enter ownership for each item listed. (Enter one of the following: USACE; OTHER GOVERNMENT; CONTRACTOR; PRIVATE)

c. \$ AMOUNT OF DAMAGE - Enter the total estimated dollar amount of damage (parts and labor), if any.

INSTRUCTIONS FOR SECTION 9 - VESSEL/FLOATING PLANT ACCIDENT

a. TYPE OF VESSEL/FLOATING PLANT - Select the most appropriate vessel/floating plant from list below. Enter name and place corresponding number in box. If item is not listed below, enter item number for "OTHER" and write in specific type of vessel floating plant.

VESSEL/FLOATING PLANTS

1. ROW BOAT
2. SAIL BOAT
3. MOTOR BOAT
4. BARGE
5. DREDGE/HOPPER
6. DREDGE/SIDE CASTING
7. DREDGE/DIPPER
8. DREDGE/CLAMSHELL, BUCKET
9. DREDGE/PIPE LINE
10. DREDGE/DUST PAN
11. TUG BOAT
12. OTHER

b. COLLISION/MISHAP - Select from the list below the object(s) that contributed to the accident or were damaged in the accident.

COLLISION/MISHAP

1. COLLISION W/OTHER VESSEL
2. UPPER GUIDE WALL
3. UPPER LOCK GATES
4. LOCK WALL
5. LOWER LOCK GATES
6. LOWER GUIDE WALL
7. HAULAGE UNIT
8. BREAKING TOW
9. TOW BREAKING UP
10. SWEEP DOWN ON DAM
11. BUOY/DOLPHIN/CELL
12. WHARF OR DOCK
13. OTHER

INSTRUCTIONS FOR SECTION 10 - ACCIDENT DESCRIPTION

DESCRIBE ACCIDENT - Fully describe the accident. Give the sequence of events that describe what happened leading up to and including the accident. Fully identify personnel and equipment involved and their role(s) in the accident. Ensure that relationships between personnel and equipment are clearly specified. Continue on blank sheets if necessary and attach to this report.

INSTRUCTIONS FOR SECTION 11 - CAUSAL FACTORS

a. Review thoroughly. Answer each question by marking the appropriate block. If any answer is yes, explain in item 13 below. Consider, as a minimum, the following:

- (1) **DESIGN** - Did inadequacies associated with the building or work site play a role? Would an improved design or layout of the equipment or facilities reduce the likelihood of similar accidents? Were the tools or other equipment designed and intended for the task at hand?
- (2) **INSPECTION/MAINTENANCE** - Did inadequately or improperly maintained equipment, tools, workplace, etc. create or worsen any hazards that contributed to the accident? Would better equipment, facility, work site or work activity inspections have helped avoid the accident?
- (3) **PERSON'S PHYSICAL CONDITION** - Do you feel that the accident would probably not have occurred if the employee was in "good" physical condition? If the person involved in the accident had been in better physical condition, would the accident have been less severe or avoided altogether? Was over exertion a factor?
- (4) **OPERATING PROCEDURES** - Did a lack of or inadequacy within established operating procedures contribute to the accident? Did any aspect of the procedures introduce any hazard to, or increase the risk associated with the work process? Would establishment or improvement of operating procedures reduce the likelihood of similar accidents?
- (5) **JOB PRACTICES** - Were any of the provisions of the Safety and Health Requirements Manual (EM 385-1-1) violated? Was the task being accomplished in a manner which was not in compliance with an established job hazard analysis or activity hazard analysis? Did any established job practice (including EM 385-1-1) fail to adequately address the task or work process? Would better job practices improve the safety of the task?
- (6) **HUMAN FACTORS** - Was the person under undue stress (either internal or external to the job)? Did the task tend toward overloading the capabilities of the person; i.e., did the job require tracking and reacting to many external inputs such as displays, alarms, or signals? Did the arrangement of the workplace tend to interfere with efficient task performance? Did the task require reach, strength, endurance, agility, etc., at or beyond the capabilities of the employee? Was the work environment ill-adapted to the person? Did the person need more training, experience, or practice in doing the task? Was the person inadequately rested to perform safely?
- (7) **ENVIRONMENTAL FACTORS** - Did any factors such as moisture, humidity, rain, snow, sleet, hail, ice, fog, cold, heat, sun, temperature changes, wind, tides, floods, currents, dust, mud, glare, pressure changes, lightning, etc., play a part in the accident?

- (8) **CHEMICAL AND PHYSICAL AGENT FACTORS** - Did exposure to chemical agents (*either single shift exposure or long-term exposure*) such as dusts, fibers (*asbestos, etc.*), silica, gases (*carbon monoxide, chlorine, etc.*), mists, steam, vapors, fumes, smoke, other particulates, liquid or dry chemicals that are corrosive, toxic, explosive or flammable, by products of combustion or physical agents such as noise, ionizing radiation, non-ionizing radiation (*UV radiation created during welding, etc.*) contribute to the accident/incident?
- (9) **OFFICE FACTORS** - Did the fact that the accident occurred in an office setting or to an office worker have a bearing on its cause? For example, office workers tend to have less experience and training in performing tasks such as lifting office furniture. Did physical hazards within the office environment contribute to the hazard?
- (10) **SUPPORT FACTORS** - Was the person using an improper tool for the job? Was inadequate time available or utilized to safely accomplish the task? Were less than adequate personnel resources (*in terms of employee skills, number of workers, and adequate supervision*) available to get the job done properly? Was funding available, utilized, and adequate to provide proper tools, equipment, personnel, site preparation, etc.?
- (11) **PERSONAL PROTECTIVE EQUIPMENT** - Did the person fail to use appropriate personal protective equipment (*gloves, eye protection, hard-toed shoes, respirator, etc.*) for the task or environment? Did protective equipment provided or worn fail to provide adequate protection from the hazard(s)? Did lack of or inadequate maintenance of protective gear contribute to the accident?
- (12) **DRUGS/ALCOHOL** - Is there any reason to believe the person's mental or physical capabilities, judgment, etc., were impaired or altered by the use of drugs or alcohol? Consider the effects of prescription medicine and over the counter medications as well as illicit drug use. Consider the effect of drug or alcohol induced "hangovers".

b. **WRITTEN JOB/ACTIVITY HAZARD ANALYSIS** - Was a written Job/Activity Hazard Analysis completed for the task being performed at the time of the accident? Mark the appropriate box. If one was performed, attach a copy of the analysis to the report.

INSTRUCTIONS FOR SECTION 12 - TRAINING

- a. **WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?** - For the purpose of this section "trained" means the person has been provided the necessary information (*either formal and/or on-the-job (OJT) training*) to competently perform the activity/task in a safe and healthful manner.
- b. **TYPE OF TRAINING** - Mark the appropriate box that best indicates the type of training; (*classroom or on-the-job*) that the injured person received, before the accident happened.
- c. **DATE OF MOST RECENT TRAINING** - Enter YYYYMMDD of the last formal training completed that covered the activity task being performed at the time of the accident.

INSTRUCTIONS FOR SECTION 13 - CAUSES

- a. **DIRECT CAUSES** - The direct cause is that single factor, which most directly lead to the accident. See examples below.
- b. **INDIRECT CAUSES** - Indirect causes are those factors which contributed to but did not directly initiate the occurrence of the accident.

Examples for section 13:

- a. Employee was dismantling scaffold and fell 12 feet from unguarded opening.

Direct cause: failure to provide fall protection at elevation. Indirect causes: failure to enforce USACE safety requirements; improper training/motivation of employee (*possibility that employee was not knowledgeable of USACE fall protection requirements or was lax in his attitude towards safety*); failure to ensure provision of positive fall protection whenever elevated; failure to address fall protection during scaffold dismantling in phase hazard analysis.

- b. Private citizen had stopped his vehicle at intersection for red light when vehicle was struck in rear by USACE vehicle. (*Note: USACE vehicle was in proper/safe working condition*).

Direct cause: failure of USACE driver to maintain control of and stop USACE vehicle within safe distance.

Indirect cause: failure of employee to pay attention to driving (*defensive driving*).

INSTRUCTIONS FOR SECTION 14 - ACTION TO ELIMINATE CAUSE(s)

DESCRIPTION - Fully describe all the actions taken, anticipated, and recommended to eliminate the cause(s) and prevent reoccurrence of similar accidents/illnesses. Continue on blank sheets of paper if necessary to fully explain and attach to the completed report form.

INSTRUCTIONS FOR SECTION 15 - DATES FOR ACTION

- a. **BEGIN DATE** - Enter the date YYYYMMDD when the corrective action(s) identified in section 14 will begin.
- b. **COMPLETE DATE** - Enter the date YYYYMMDD when the corrective action(s) identified in section 14 will be completed.
- c. **DATE SIGNED** - Enter YYYYMMDD that the report was signed by the responsible supervisor.
- d.e. **TITLE AND SIGNATURE** - Enter the title and signature of supervisor completing the accident report. For a GOVERNMENT employee accident/illness the immediate supervisor will complete and sign the report. For PUBLIC accidents the USACE Project Manager/Area Engineer responsible for the USACE property where the accident happened shall complete and sign the report. For CONTRACTOR accidents the Contractor's project manager shall complete and sign the report and provide to the USACE supervisor responsible for oversight of that contractor activity. This USACE supervisor shall also sign the report. Upon entering the information required in 15c., 15d., 15e., 15f. and 15g. below, the responsible USACE supervisor shall forward the report for management review as indicated in section 16.

f. **ORGANIZATION NAME** - For GOVERNMENT employee accidents enter the USACE organization name (*Division, Branch, Section, etc.*) of the injured employee. For PUBLIC accidents enter the USACE organization name for the person identified in block 15d. For CONTRACTOR accidents enter the USACE organization name for the USACE office responsible for providing contract administration oversight.

g. **OFFICE SYMBOL** - Enter the latest complete USACE Office Symbol for the USACE organization identified in block 15f.

INSTRUCTIONS FOR SECTION 16 - MANAGEMENT REVIEW (1st)

1ST REVIEW - Each USACE FOA shall determine who will provide 1st management review. The responsible USACE supervisor in section 15d. shall forward the completed report to the USACE office designated as the 1st Reviewer by the FOA. Upon receipt, the Chief of the Office shall review the completed report, mark the appropriate box, provide substantive comments, sign, date, and forward to the FOA Staff Chief (*2nd review*) for review and comment.

INSTRUCTIONS FOR SECTION 17 - MANAGEMENT REVIEW (2nd)

2ND REVIEW - The FOA Staff Chief (*i. e., FOA Chief of Construction, Operations, Engineering, Planning, etc.*) shall mark the appropriate box, review the completed report, provide substantive comments, sign, date, and return to the FOA Safety and Occupational Health Office.

INSTRUCTIONS FOR SECTION 18 - SAFETY AND OCCUPATIONAL HEALTH REVIEW

3RD REVIEW - The FOA Safety and Occupational Health Office shall review the completed report, mark the appropriate box, ensure that any inadequacies, discrepancies, etc. are rectified by the responsible supervisor and management reviewers, provide substantive comments, sign, date and forward to the FOA Commander for review, comment, and signature.

INSTRUCTION FOR SECTION 19 - COMMAND APPROVAL

4TH REVIEW - The FOA Commander shall (*to include the person designated Acting Commander in his absence*) review the completed report, comment if required, sign, date, and forward the report to the FOA Safety and Occupational Health Office. Signature authority shall not be delegated.

This page intentionally left blank.

ACTIVITY HAZARD ANALYSIS (AHA)

Date: _____ Project Title: _____

Overall Risk Assessment Code (use highest code)

Activity/Task: _____

Title of Person Who Does the Job: _____

Activity/Task Location: _____

Prepared By: _____

Approved By (H&S Staff):

Risk Assessment Code (RAC) Matrix

E=Extremely High Risk
H=High Risk
M=Moderate Risk
L=Low Risk

		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Job Steps	Potential Hazards	Actions to Eliminate or Minimize Hazards	RAC*
•	•	•	
•	•	•	
•	•	•	
•	•	•	
•	•	•	
•	•	•	
•	•	•	
•	•	•	

***Step 1:** Review each “hazard” with identified safety “controls.” Determine RAC (see above).

Step 2: Identify the RAC (probability vs. severity) as E, H, M, or L for each “hazard” on AHA. Annotate the overall highest RAC at the top of AHA.

Equipment to be Used	Training Requirements	PPE Requirements
•	•	•

SAFE PRACTICES AND PROCEDURES		
☐ Aerial Lifts ☐ Asbestos ☐ Behavior Based Safety ☐ Biological Hazards ☐ Bloodborne Pathogens Exposure Control ☐ Bridge Inspection Safety ☐ Cold Stress ☐ Compressed Gas Safety (EOC) ☐ Crane Platform Safety ☐ Defensive Driving ☐ Demolition Safety ☐ Drill Rig Safety ☐ Drum and Container Handling (EOC) ☐ Drug Program	☐ Electrical Safety ☐ Excavation ☐ Fall Protection ☐ Firearm Safety ☐ First Aid/CPR ☐ Hazard Communication ☐ Heat Stress ☐ Helicopter Safety ☐ Laboratory Safety Plan ☐ Lead & Lead-based Paint ☐ Lockout Tagout ☐ Medical Monitoring ☐ Mine Safety ☐ Noise (Hearing Conservation)	☐ Permit Required Confined Space ☐ Personal Protective Equipment ☐ Portable Fire Extinguishers ☐ Portable Ladders ☐ Railroad Safety ☐ Remote Site Safety ☐ Respiratory Protection ☐ Rope Access Inspection ☐ Scientific Diving Safety ☐ Slip/Trip/Fall ☐ Specialty Vehicle Operation ☐ Temporary Electrical ☐ Traffic Safety ☐ Water Boating Safety
PROTECTIVE EQUIPMENT		
☐ Eyewear: Goggles – Chemical Splash ☐ Eyewear: Goggles – Dust ☐ Eyewear: Safety Glasses (Clear) ☐ Eyewear: Safety Glasses (Tinted) ☐ Eyewear: Laser: _____ ☐ Eyewear: Welding Face Shield ☐ Face: Face Shield ☐ Fall Protection: Harness/Lanyard	☐ Footwear: _____ ☐ Hand: Leather Work Gloves ☐ Hand: Specialty Glove: _____ ☐ Head: Hardhat ☐ Head: Sun protection ☐ Hearing: Earplugs: _____ ☐ Hearing: Earmuffs: _____ ☐ High Visibility Vest: _____	☐ Personal Flotation Device: _____ ☐ Protective Clothing: _____ ☐ Respirator: Half Facepiece: _____ ☐ Respirator: Full Facepiece: _____ ☐ Respirator: Disposable: _____ ☐ Respirator: Airline respirator ☐ Respirator: SCBA

DAILY/WEEKLY SAFETY MEETING

Date: _____

Time: _____

Activity/Task Location: _____

Client: _____

REVIEW INCIDENTS/NEAR MISSES:

-

ACTIVITIES OF DAY DISCUSSED/HAZARD ASSESSMENT (LIST DAY'S TASKS & PPE):

-

EMPLOYEE SUGGESTIONS:

-

TEAM/SELF AUDIT AND CORRECTIVE ACTIONS:

-

ATTENDEES:

Name (print)	Signature

Name (print)	Signature

MEETING CONDUCTED BY:

Name (printed)

Signature

This page intentionally left blank.

**WORKER/VISITOR REVIEW AND ACKNOWLEDGEMENT
OF THE SITE HEALTH AND SAFETY PLAN**

or

ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN

Project Title: _____

Project Number: _____

Activity/Task Location: _____

Contract #/Task Order #: _____

I have been briefed on and understand the requirements of the Site Health and Safety Plan (HASP) or Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP) for the above site. By signing below, I acknowledge and agree to follow the HASP or APP/SSHP for this project.

Date	Name (Printed)	Company	Signature

This page intentionally left blank.

Project Name/Number:

Activity/Task:

Date: _____

Activity/Task location:

REVIEW TOPICS (CHECK OFF LIST AS COMPLETED):

- ☐ Review Activity Hazard Analysis (AHA) forms for the day's work.
- ☐ Discuss relevant health and safety protocols.
- ☐ Discuss emergency procedures and equipment (satellite phone, whistles, horns, etc.).
- ☐ Identify/bring specific personal protective equipment and other required safety gear.
- ☐ Identify necessary medications and individual crew member's medical situations/precautions (if staff is willing to share with crew).
- ☐ Ensure everyone is comfortable with the daily plan of action, safety, and any other issues/concerns.

NOTES/COMMENTS:

TEAM MEMBER SIGNATURES:

By signing below, I certify that I have reviewed and understand the health and safety provisions for this project.

Name (printed)	Signature	Name (Printed)	Signature

FIELD CREW LEADER'S SIGNATURE:

Signature: _____

Date: _____

This page intentionally left blank.

STOP WORK AUTHORITY

All staff have the authority and responsibility to STOP work when a potential hazard has been identified.

**Identify Unsafe
Condition**

STOP Work

Correct the Hazard

Document and Notify

Resume Work



PROJECT NAME:	
PROJECT NUMBER:	
DATE OF OBSERVATION:	TIME:
HDR-VERSAR EMPLOYEE OBSERVING:	
LOCATION ON PROJECT SITE:	
DESCRIPTION OF OBSERVED POTENTIALLY UNSAFE CONDITION:	
CHANGES MADE TO CORRECT THE HAZARD:	
WORK RESUMED AT (DATE/TIME):	

HAZARD REPORTING - CORRECTIVE ACTION FORM

EMPLOYEE REPORT OF HAZARD

Is there an immediate threat of death or serious physical harm?

Yes ☐

No ☐

Provide information that will help locate the hazard, such as the office, project, or location and/or the supervisor's name.

Briefly describe the hazard you believe exists and the approximate number of employees exposed to it.

If this hazard has been called to anyone's attention, as far as you know, please provide the name of the person or committee notified and the approximate date.

Submitted By (Optional):

Date:

MANAGEMENT EVALUATION OF REPORTED HAZARD

Final action taken:

All actions completed by (initials):

Date:

Tracking Number:

CORRECTIVE ACTION HAZARD FOLLOW-UP DOCUMENTATION

What was the hazard:

What possible injury or illness could (or did) result from the hazard:

Who/what was exposed to the hazard:

What was the frequency the hazard occurred:

What was the duration of the hazard:

What interim protection was provided:

What corrective action was taken:

Corrective Action was taken by:

Completion Date:

Follow-up check made on:

Date:

Was any additional action taken?:

Signature of manager or supervisor:

Date:

Is corrective action still in place: Yes ☐ No ☐

Three month follow-up check made on

made by

Tracking Number:

Attachment D

Health and Safety Personnel Qualifications

Site Safety and Health Officer	D-D-1
Health and Safety Manager	D-D-9
Certified Industrial Hygienist	D-D-16
CPR and First Aid Certifications	D-D-27

This page intentionally left blank.

Darren L. Harbeck

UXO - Technician III

Mr. Harbeck has more than 21 years of experience in Unexploded Ordnance (UXO) and Explosive Ordnance Disposal (EOD) operations. As a Senior UXO Supervisor (SUXOS) he supervises all field operations of a UXO project that include site mobilization and demobilization, site setup, coordination with subcontractors, ensures compliance with all project planning documentation, ensures implementation of the QC/QA program, supervises geophysical and UXO teams, manages explosives delivered and stored on project site, safely manages on-site disposal of munitions and explosives of concern (MEC) items, and ensures all procedures for processing munitions potentially presenting explosive hazards (MPPEH) are adhered to. Mr. Harbeck has expertly supervised surface and subsurface ordnance removal operations at various military and Formerly Used Defense Sites (FUDS) in the United States. He has managed the coordination, administrative, and operational components of UXO location and recovery teams performing clearance and disposal operations on a multitude of vintage and current ordnance items in wide ranging environments.

EDUCATION

Naval Explosive Ordnance Disposal School 05/13/1995

REGISTRATIONS

OSHA 40HR HAZWOPER
OSHA 8HR HAZWOPER Refresher
OSHA 8HR Supervisor Training
OSHA 30HR Construction Safety
50HR Site Safety Officer
USACE Construction Quality Management
Excavation Competent Person Training
Confined Space: Entry Supervisor (ENT & ATT)
Red Cross First Aid & CPR

INDUSTRY TENURE

21 years

HDR TENURE

3 years

OFFICE LOCATION

Englewood, CO

AWARDS

2013 HDR Pathfinder Award of Excellence, for Production & Performance.

RELEVANT EXPERIENCE

Eglin AFB, SR 123 Multi-lane Reconstruction Project

FDOT, Eglin AFB, Florida, 05/2014 – Present. Description/Role: Senior UXO Supervisor. Oversight of all field operations for approximately 10 personnel. Duties include implementation of all planning documentation, field procedure development, staffing, quality control, cost control, Explosive Safety Submission implementation, safely manage on-site disposal of MEC, supervise the processing of all MMPEH, and document and ship all MDAS (material documented as safe) for demilitarization. Removal Action consisting of construction support, anomaly avoidance, visual surveys, technology assisted surface removal, mag and dig/map and dig of 140 acres.

Eglin AFB, MBBA Culvert Restoration, Mid Bay Bridge Authority, Ft. Walton Beach Florida 05/2014-05/2014. Description/Role: UXO Technician III. Executed anomaly avoidance for five culvert excavations and replacements.

Air-To-Ground Gunnery Range Removal Action, USACE-Omaha, Aurora, Colorado 10/2012-01/2014. Description/Role: Senior UXO Supervisor. Oversight of all field operations for approximately 30 personnel. Duties included the implementation of all planning documentation, field procedure development, explosives licensing/permitting, staffing, quality control, public participation, cost control, Explosive Safety Submission implementation, safely manage on-site disposal of MEC, supervised the processing of all MMPEH, documented and shipped all MDAS for demilitarization, audit all field generated paperwork, write Daily/Weekly Site Reports. Removal Action consisting of visual surveys, technology assisted surface removal, mag and dig/map and dig of 411 acres. To date the project has removed over 5756 lbs. of munitions debris and 20 MEC disposal events.

Tennessee Pass Range Complex, Former Camp Hale, RI/FS, USACE-Omaha, Camp Hale, CO 06/2012–10/2012. Description/Role: UXO Technician III, Served as a Team leader for a 7 person UXO team during intrusive operations, escorted a 3

person team during visual surveys, and removal/disposal of MEC/MD.

NON-HDR EXPERIENCE

Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 05/2005–02/2012.

Description/Role: Alternate Senior UXO Supervisor/UXO Tech III, UXO Tech II. Supervised all site activities to include team operations, satisfactory completion of all grids, demolition operations, incoming shipments of explosives, weekly explosives inventories, inspect all Munitions Debris for energetic materials, audit all field generated paperwork, and write Daily/Weekly Site Reports when performing as the Alternate SUXOS. Perform as Site Safety Officer in Primary's absence. Review all Project Procedures, Work Plan, Site Safety and Health Plan, Explosive Safety Submission, State and Federal Regulations to ensure site compliance. Performed as a Team Leader for a 7 person UXO Team during surface and subsurface clearance operations.

Buckley AFB CSE Phase II, USACE-Omaha, Aurora, Colorado 10/2009–09/2010.

Description/Role: Alternate Senior UXO Supervisor/UXO Technician III. Supervised all site activities to include team operations, satisfactory completion of all grids, demolition operations, incoming shipments of explosives, weekly explosives inventories, inspect all Munitions Debris for energetic materials, audit all field generated paperwork, and write Daily/Weekly Site Reports when performing as the Alternate SUXOS. Served as UXO Team Leader of Comprehensive Site Evaluation Phase II, including lead remediation and removal of firing berm. Investigation and removal/disposal of MEC and MD.

Schofield Barracks Active Range Complex, USACE, Zapata, Schofield Barracks, Hawaii 10/2004–04/2005.

Description/Role: UXO Technician II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD.

Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 05/1999 – 10/2004.

Description/Role: UXO Tech II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Activities conducted also included OB/OD pit excavations, sift plant operations, anomaly avoidance, MC sampling, construction support, and visual surface sweeps. Removal Action activities occurred on 12 OAC's including mortar, rocket, bombing, and gunnery targets.

Balboa Range, Panama, USACE-Huntsville, Panama 01/1999 – 05/1999.

Description/Role: UXO Technician II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Removal Action activities were in support of the planned construction to widen the panama canal.

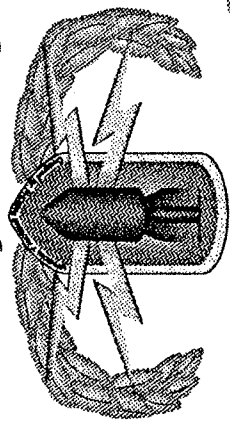
Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 07/1998 – 01/1999.

Description/Role: UXO Tech II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Activities conducted also included OB/OD pit excavations, sift plant operations, anomaly avoidance, construction support, and visual surface sweeps. Removal Action activities occurred on 12 OAC's including mortar, rocket, bombing, and gunnery targets.

Military EOD Assignments, Fort Carson, Colorado, United States Army, 94th EOD 07/1995 – 08/1998.

Description/Role: EOD Sergeant, Served as an EOD team member, unit armor, and Training NCO.

Naval School Explosive Ordnance Disposal



Certificate of Completion

Presented to

SPC Darren L. Harbeck, USA

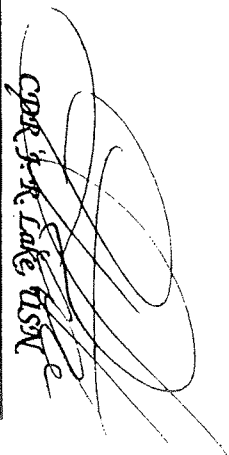
For having successfully completed the prescribed course of study for

EXPLOSIVE ORDNANCE DISPOSAL

PHASE 1 & 11 - SURFACE

on this, the Thirteenth day of June 1995.




CDR J. R. Lake, USN
Commanding Officer



United States Army
Headquarters, 52D Ordnance Group (EOD)



Fort Gillem, Georgia

This is to certify that:

SPC Darren L. Harbeck, 336-68-2043

having completed 40 hours of instruction and demonstrated knowledge of the
Hazardous Materials Incident Command System and the environmental regulations
regarding military ordnance and explosive waste, is hereby designated a

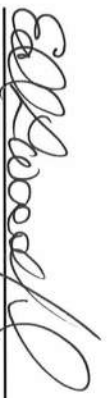
Specialist Employee for Ordnance and Explosive Waste

IAW 29 CFR 1910.120(q)(5)

19 July 1996

Date




EDWARD L. WOODFORD, CHMM
Primary Instructor

Certificate of Completion

This certifies that

Darren Harbeck

Has Successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA and EPA Regulations As Well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs

Julius P. Griggs
Instructor #892

150219579010

Certificate Number

2/19/2015

Issue Date



UNLIMITED, Inc.

OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-869-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training
Want to be sure this certificate is valid? Visit safetyunlimited.com/verification



This certificate is awarded to

Darren Harbeck

for the successful completion of the course

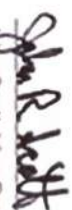
8-Hour HAZWOPER Supervisor Training

Hours: 8 hours 0 min Credits: 0

Completion Date: 5/6/2010




Monique S. Voelke, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



This certificate is awarded to

Darren Harbeck

for the successful completion of the course

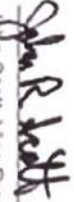
OSHA 30 Hour Construction Safety

Hours: 30 hours 0 min Credits: 0

Completion Date: 5/6/2010




Monique S. Vocke, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



This certificate is awarded to

Darren Harbeck

for the successful completion of the course

Site Safety Officer

Hours: 50 hours 0 min Credits: 0

Completion Date: 5/7/2010




Monique S. Vocke, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



Daniel Sciarro

HDR Health and Safety Specialist I

Mr. Sciarro demonstrates superior performance and technical skills in many areas with specific regard to Environmental, Health, and Safety (EH&S) management. Mr. Sciarro is a EH&S Manager, consultant, and trainer. His primary focus is to provide leadership to implement safety performance in-line with HDR's missions, goals, and objectives. Mr. Sciarro assists in overseeing operational EHS planning for various proposals and site specific projects, as well as assures HDR's Policy and Procedures is IAW with applicable Federal, state, and local regulations.

EDUCATION

Masters of Applied Science,
Occupational Safety and Health/
Environmental Management,
Columbia Southern University, 2015

Bachelor of Science, Occupational
Safety and Health, Columbia
Southern University, 2013

Associate of Science, Occupational
Safety and Health, Columbia
Southern University, 2013

TRAINING

2014 Construction Quality
Management for Contractors

OSHA 500/501/502 Authorized
Trainer

USACE Site Safety and Health
Officer

Prior USN Explosive Ordnance
Disposal (EOD) Technician/Diver

Qualified UXO experience IAW
DDESB TP 18 (Experience with
UXO operations on land or
underwater)

HDR Federal Contracts/
Subcontractor Safety and Health
Program Coordinator

CO Radiation Safety Officer (RSO)

HAZWOPER Trainer/Competent
Emergency Responder

American Heart Association (AHA)
and American Safety and Health
Institute (ASHI) CPR/AED/First Aid
Qualified Instructor

INDUSTRY TENURE

11 years

HDR TENURE

Mr. Sciarro also has more than eight years of combined Explosive Ordnance Disposal (EOD) and Unexploded Ordnance (UXO) experience. He provides technical UXO EHS support in the development of project logistics. Mr. Sciarro has led multiple teams for a variety of different scopes of UXO related work, including site visual surveys, intrusive investigations, preparing demolition systems, and using and/or storing explosive materials in accordance with DDESB TP-18. Mr. Sciarro is experienced with the excavation, storage, and disposal of UXO, MEC, MD, DMM and/or all other military range related material or constituents. He has planned, conducted, and supervised UXO operations on land and in water for UXO remediation efforts such as clearances and UXO support operations.

EXPERIENCE HIGHLIGHTS

As a Health and Safety Specialist, Mr. Sciarro provides leadership while implementing and directing safety performance with the ultimate goal of reducing accidents and illness at work.

- Develops, reviews, and implements company Environment, Health, and Safety programs and documentation to ensure proper internal functioning to achieve project and HDR desired results.
- Liaisons with other EHS management concerning all HDR EHS policy and regulatory matters
- Liaisons with Project Management, employees, and client representatives concerning HDR EHS related issues.
- Assists in job safety analysis and project process safety with supervisors
- Monitors work activities with emphasis towards Environment, Health, and Safety concerns
- UXO Military Munitions Response Program (MMRP) Safety and Health Specialist
- Outstanding Safety and Quality Control record on all previously accomplished projects

5 years

HDR OFFICE LOCATION
Englewood, CO.

RELEVANT EXPERIENCE

Port of Seattle, Naval Supply Depot, Time Critical Removal Action (TCRA), Seattle, WA (2011–2012). Site Safety and Health Officer/ UXO Dive Program Manager. Developed the initial work plan with specific regards to USACE protocols for underwater UXO dive operations. Coordinated with USACE Dive Safety Inspectors for initial approval of SCUBA operations to be conducted for UXO MMRP projects. Assisted in the development of the TCRA Explosive Safety Submission approval from the DDESB.

Supervised all functions enumerated with UXO diving operations for underwater reconnaissance, anomaly reacquisition, mag/dig, removal and disposal operations. Conducted daily Site Safety and Health Officer (SSHO) briefings and coordinated daily objectives with contractor UXO Dive team, SUXOS and UXOQC. Conducted daily coordination of dive team safe separation distances and operational diving protocols to be used within various underwater MRA's. Conducted inspections of accumulated MPPEH, MD, MEC, and Range Debris underwater through the use of Remotely Operated Vehicles. Positively identified underwater DMM and assisted in the management and Disposal of DMM. Implemented Daily/Weekly Quality Control Reports (DQCR's).

CSE Phase I Investigation, Eglin AFB/SSHO (Underwater) Legacy Ranges, FL (2011). Site Safety and Health Officer/ UXO Dive Program Manager. Performed all functions enumerated for managing UXO diving for underwater visual survey operations. Conducted daily Site Safety and Health Officer (SSHO) briefings and coordinated daily objectives with UXO Dive Officer, SUXOS and UXOQC. Conducted daily coordination of team compositions for operational priorities, as well as inspections of accumulated MPPEH, MD, MEC, and Range Debris. Positively identified underwater UXO and assisted in the management of MEC. Developed daily and weekly quality control status reports. Implemented Daily/Weekly Quality Control Reports (DQCR's). Implemented safe methods and procedures for detection, identification, evaluation, render safe, and disposal of surface and underwater conventional, explosive ordnance. Performed all functions enumerated for UXO Tech II as an escort, for anomaly reacquisition's, and avoidance. Conducted inspections of positively identified UXO, MPPEH, DMM, MD, and or MC. Performed anomaly avoidance for geological survey activities and was responsible for safely executing these operations in accordance with the approved Work Plans, Site Safety and Health Plan, Accident Prevention Plan.

CSE Phase I Investigation, Eglin AFB/SSHO (Underwater) Legacy Ranges, FL (2010). Site Safety and Health Officer. Implemented all aspects of the approved project site specific APP/SSHP. Ensured personnel have current medical clearance and up-to-date training onsite; coordinate with, and identify personnel for whom special Personal Protective Equipment (PPE), exposure monitoring, or work restrictions may be required; conduct and document daily site safety inspections prior to the start of each shift; provide an ongoing review of the assigned protection level needs as project work is performed. Implemented upgrade/downgrades in protection levels as appropriate; ensure that field personnel follow any defined decontamination procedures; and halt site operations, if necessary, in the event of an emergency or to correct any unsafe work practices; conduct project site-

specific training and daily safety briefings; assist with any investigations required for all accidents, incidents and “near misses”; conduct visitor orientation and maintain the onsite visitor log; review and approve the APP/SSHP by signature prior to starting any field work; and assume any other duties as directed by the PM.

Former Lowry Bombing and Gunnery Range (FLBGR) Air to Ground Gunnery Range, Aurora, CO (2012–2013). UXO Technician II/Site Safety and Health Officer. Ensured personnel have current medical clearance and up-to-date training onsite; coordinate with, and identify personnel for whom special Personal Protective Equipment (PPE), exposure monitoring, or work restrictions may be required; conduct and document daily site safety inspections prior to the start of each shift; provide an ongoing review of the assigned protection level needs as project work is performed.

Implemented upgrade/downgrades in protection levels as appropriate; ensure that field personnel follow any defined decontamination procedures; and halt site operations, if necessary, in the event of an emergency or to correct any unsafe work practices; conduct project site-specific training and daily safety briefings; assist with any investigations required for all accidents, incidents and “near misses”; conduct visitor orientation and maintain the onsite visitor log; review and approve the APP/SSHP by signature prior to starting any field work; and assume any other duties as directed by the PM.

CSE Phase I, Gulfport AGS, MS (2010). UXO Technician II/Site Safety and Health Officer. Performed all functions enumerated for UXO Tech II as an escort, for anomaly reacquisition's, and avoidance. Conducted daily UXO site safety and team briefs as the on Site Safety and Health Officer for field Geo activities. Performed Visual UXO surveys. Monitor work activities with emphasis towards Environment, Health, and Safety concerns. Conducted daily inspections of team composition for daily operational objectives. Positively identified all encountered UXO, DMM, MD, MEC, SA, and MPPEH. Implemented Daily/Weekly Quality Control Reports (DQCR's). Conducted inspections of positively identified UXO, MPPEH, DMM, MD, and or MC. Performed anomaly avoidance for geological survey activities and was responsible for safely executing these operations in accordance with the approved Work Plans, Site Safety and Health Plan, Accident Prevention Plan.

Phase I PA, Joint Base Ft. Dix, McGuire, Lakehurst, NJ (2010). UXO Technician II/Site Safety and Health Officer. Performed all functions enumerated for UXO Tech II escort personnel. Performed Visual UXO surveys. Conducted initial physical onsite survey to summarize LIDAR data collected on previous airborne investigations. Conducted daily onsite safety briefs as the Site Safety and Health Officer for field crew. Conducted daily inspections of team composition and daily operational procedures. Positively identified all encountered UXO, DMM, MD, MEC, SA, and MPPEH. Implemented Daily/Weekly Quality Control Reports (DQCR's).

PA, McGuire AFB, NJ (2009). UXO Technician II/Site Safety and Health Officer. Performed all functions enumerated for UXO Tech II escort personnel. Performed Visual UXO surveys. Conducted daily UXO site safety and team briefs as the on Site Safety and Health Officer for field Geo activities. Monitor work activities with emphasis towards Environment, Health, and Safety concerns. Conducted daily inspections of team composition for daily operational objectives. Positively identified all

encountered UXO, DMM, MD, MEC, SA, and MPPEH and assisted in the management MEC including developing schedule, daily/weekly status reports and assisting with emergency response protocols.

Phase I PA, Minot AFB, ND (2009). UXO Technician II/Site Safety and Health Officer. Performed all functions enumerated for UXO Tech II escort personnel. Conducted daily UXO site safety and team briefs as the on Site Safety and Health Officer for field Geo activities. Performed Visual UXO surveys. Monitor work activities with emphasis towards Environment, Health, and Safety concerns. Conducted daily inspections of team composition for daily operational objectives. Positively identified all encountered UXO, DMM, MD, MEC, SA, and MPPEH and assisted in the management MEC including developing schedule, daily/weekly status reports and assisting with emergency response protocols. Implemented Daily/ Weekly Quality Control Reports (DQCR's).

CSE Phase II, Moody AFB, GA (2009). UXO Technician II. Performed all functions enumerated for UXO Tech II escort for field personnel. Performed Visual UXO surveys. Conducted daily UXO site safety and team briefs as the on Site Safety and Health Officer for field Geo activities. Monitor work activities with emphasis towards Environment, Health, and Safety concerns. Conducted daily inspections of team composition for daily operational objectives. Positively identified all encountered UXO, DMM, MD, MEC, SA, and MPPEH and assisted in the management MEC including developing schedule, daily/weekly status reports and assisting with emergency response protocols.

Phase I PA, Scott AFB, IL (2009). UXO Tech III/SSHO. Performed all functions enumerated for UXO Tech II escort for field personnel. Conducted daily Site Safety duties and commenced briefings as the Site Safety and Health Officer. Performed Visual UXO surveys. Conducted daily inspections of team composition and daily operational procedures. Positively identified all encountered UXO, DMM, MD, MEC, SA, and MPPEH. Implemented Daily/ Weekly Quality Control Reports (DQCR's).

PIKA International/ Aerotek, Remedial Investigation/Mag and Dig, Ft. McClellan, AL (2008). UXO Technician II. Performed all functions enumerated for UXO Tech II, to include anomaly reacquisitions, Intrusive Mag and Dig operations. Conducted team inspections for positive identification of UXO, MPPEH, DMM, MD, and or MC. Assisted in the excavation and management for disposal of unexploded ordnance.

Pratt and Whitney (Rocketdyne) Solid and Liquid Rocket Propellant Manufacturing/ Testing Plant San Jose, CA (2005–2007). UXO Tech II/Explosives Safety Specialist II/EHS Field Advisor. Developed and implemented company environmental, health, and safety procedures and newly developed high hazard response programs. Consulted with EHS management daily concerning any EHS policy matters and/ or concerns. Liaison with subcontract superintendents and on-site client representatives concerning all EHS related issues. Coordinated and participated in safety meetings. Issued and reviewed all controlled work permits. Assisted in JSA worksheet process with supervisors. Monitored work activities with emphasis towards Environment, Health, and Safety concerns. Managed and trained employees to respond to hazardous waste environments including explosive munitions or explosive compound removal. Conducted Safety reports and ensured EH&S division is compliant with all local, state and federal

agencies. Provided regulatory training to all Veolia and subcontracted high-hazard division employees. Acted as a team leader for responses to explosive and hazardous substance spills or emergencies and/or implemented clean-up and decontamination operations.

United States Navy Electricians Mate “EM2” “EOD” “DV” (1996–2003).

NAVY E.O.D. Assistant (MU3 97-99):

- Implemented safe methods/procedures for detection, identification, evaluation, render safe, and disposal of surface, underwater conventional and nuclear explosive ordnance

NAVY E.O.D. Technician Diver (MU3 2000-2003):

- Improvised methods and tactics on identifying and stabilizing underwater hazards
- Qualified on instruction to dive Heo2/N2o2 mixed gas re-breathers at 300 feet
- Qualified SCUBA 190 feet regulator or full face communication AGA masks
- Qualified Surface Supplied Air Rigs (Military or Civilian style apparatus)
- Qualified maintenance man for SCUBA, Re-Breathers and Surface Supplied Air

Explosives/HAZMAT Driver:

- Conducted vehicular transport operations according to D.O.T./ E.P.A./ DoD operational standards

NAVY E.O.D Marine Mammal (Dolphin) Handler/Trainer:

- Monitored daily operational health and training of marine mammals as a primary handler of three Atlantic/Pacific bottle nose dolphins for military underwater operations. Located, tracked, and investigated unknown anomalies for neutralization or disposal using the natural sonar abilities of Navy Marine Mammals.

Columbia Southern University

By Authority of the Board of Trustees and on recommendation
of the Faculty hereby confers upon

Daniel John Sciarro

the degree

Bachelor of Science
Occupational Safety and Health

Magna Cum Laude

With all rights, privileges and honors therunto appertaining.
In Testimony Whereof, we have affixed our signatures and
the Seal of the University

this thirty-first day of January, two thousand thirteen.

Robert Mayes, Jr.
President



James E. David
Chairman of the Board of Trustees



Naval School Explosive Ordnance Disposal

This is to certify that

EM3 Daniel J. Sciarro, USN

has successfully completed the

Basic EOD Course

Navy (CIN A-431-0011)

Class 01010N

*In witness thereof, this certificate has been signed and
given under my hand at*

Naval School Explosive Ordnance Disposal, Eglin AFB, Florida

This 13th day of September in the Year of Our Lord, Two Thousand One

[Signature]
Commanding Officer

Stephen Coffee

Industrial Hygienist III

Mr. Coffee is a Certified in Industrial Hygiene with over twenty-five years of experience managing or consulting in occupational safety and health to private industries and government agencies. His skills and abilities include:

- Evaluating the work environment for recognizable health and safety hazards that adversely impact the work environment and employee health.
- Developing solutions in a coordinated effort with clients to protect the health and welfare of all personnel while working within the client resource means.
- Conducting gap analysis workplace evaluations of the client's programs and working with the client to develop and implement policies and programs to advance their health and safety programs.
- Training employees in a variety of health and safety topics.
- Preparing concise and detailed reports in Microsoft Word, Excel, and PowerPoint as well as WordPerfect.

EDUCATION

Bachelor of Science, Industrial Hygiene (Environmental Health), Colorado State University, 1985

REGISTRATIONS

Certified Industrial Hygienist, American Board of Industrial Hygiene, Colorado, No. CIH 6541
CP Issued: 11/23/1994, Expires: 06/01/2016

EPA AHERA Accredited Asbestos Building Inspector, Issued: 07/31/2013

EPA AHERA Accredited Project Designer, Colorado, No. PD14042
Issued: 02/12/2014, Expires: 02/12/2015

EPA Certified Lead-Based Paint Inspector, No. I13045L, Issued: 06/14/2013

EPA Certified Lead-Based Paint Risk Assessor, No. RA13096L
Issued: 11/01/2013, Expires: 11/01/2016

HAZWOPER, Colorado, No. 1410135121480
Issued: 10/13/2014, Expires: 10/13/2015

PROFESSIONAL MEMBERSHIPS

American Industrial Hygiene Association, Rocky Mountain Section, Member, 2006-Present

INDUSTRY TENURE

28 years

HDR TENURE

6 years

OFFICE LOCATION

Englewood, CO

RELEVANT EXPERIENCE

Defense Supply Center Richmond, Virginia (DSCR), Environmental Compliance Evaluation, 8/2014. Environmental Assessor for the Environmental Compliance Evaluation (ECE). Responsible for conducting and reporting of environmental assessments for the DSCR ECE. The ECE assessment encompassed 13 different protocols outlined in TEAM Guide in addition to applicable local and state regulations. Assessments were accelerated, using a state-of-the-art Assessment Manager computer program specifically developed for the completion of compliance assessments. Contract Value - \$80,000

Defense Supply Center Richmond, Virginia (DSCR), Industrial Hygiene Survey Evaluation, 2/2013. Lead Industrial Hygienist. Conducted a thorough industrial hygiene evaluation for the ozone depleting substance recovery operations and compressed gas cylinder refurbishing operation at Warehouse 3. The evaluation consisted of measuring employee exposure to chemical vapors, dusts, and metals, performing employee noise dosimetry and collecting sound level measurements, and testing the breathing air for supplied air respirators to meet Grade D standards. Contract Value - \$20,000

Defense Supply Center Richmond, Virginia (DSCR), Environmental Compliance Evaluation, 11/2013. Environmental Assessor for the Environmental Compliance Evaluation (ECE). Responsible for conducting and reporting of environmental assessments for the DSCR ECE. The ECE assessment encompassed 13 different protocols outlined in TEAM Guide in addition to applicable local and state regulations. Assessments were accelerated, using a state-of-the-art Assessment Manager computer program specifically developed for the completion of compliance assessments. Contract Value - \$80,000

U.S. Army National Guard; Environmental Program Assessment

System (EPAS), Nevada, 1/2014-12/2014. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 7 ARNG facilities within the state of Nevada. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Missouri, 1/2014-12/2014. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 5 ARNG facilities within the state of Missouri. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Connecticut, 1/2014-12/2014. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 4 ARNG facilities within the state of Connecticut. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Utah, 1/2014-12/2014. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 6 ARNG facilities within the state of Utah. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Alabama, 1/2013-12/2013. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 6 ARNG facilities within the state of Alabama. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment

System (EPAS), New Jersey, 1/2013-12/2013. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 10 ARNG facilities within the state of New Jersey. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Indiana, 1/2013-12/2013. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at ARNG facilities at Camp Atterbury within the state of Indiana. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Massachusetts, 1/2013-12/2013. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 10 ARNG facilities within the state of Massachusetts. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

Defense Supply Center Columbus, Ohio (DSCC), Environmental, Safety, Occupational Health (ESOH) support, 1/2012-12/2013. Lead Industrial Hygienist. Evaluated the operations throughout DSCC to identify occupational health concerns that require a detailed survey. The industrial hygiene surveys are documented in an Industrial Hygiene Implementation Plan (IHIP) along with a schedule for conducting the surveys. Initiated the implementation of the IHIP by evaluating employee exposure to noise and various chemicals related to the activities at DSCC. Results of the surveys are provided in detailed reports. Identified job tasks that present a risk of injury to employees and prepared detailed Job Hazard Analyses to provide control measures to protect employees Value - \$150,000.

Nellis Air Force Base, Nevada: Internal Environmental Safety and Occupational Health Compliance and Management Program (ESOH CAMP), 1/2012-12/2012. Industrial Hygienist. Conducted an occupational health compliance assessment. Tasks included, but were not limited to, conducting daily assessment of activities and operations, entering findings into a standardized database, conducting daily briefings of preliminary findings to PACAF representatives, and preparing a final report and outbrief presentation. Value - \$60,000

Defense Logistics Agency Installation Support for Distribution; Safety,

and Occupation Health (ESOH) Program Assessment, 01/2014-12/2014.

Lead Safety Assessor. Responsibilities include conducting field audits; researching federal regulations; assigning risk assessment codes; and developing corrective actions. Evaluated program performance and site regulatory compliance, and documented the results in executive summary reports. Results were entered into Enterprise Safety Applications Management System (ESAMS) to track closure of noncompliant issues. Performed assessments at three (3) DLA Distribution Centers located in Pennsylvania, Italy, and Germany. ESOH Program Assessment assesses compliance with Federal OSHA regulations and internal safety and occupational health programs. Contract Value - \$1,500,000

Defense Logistics Agency Installation Support for Distribution, Environmental Compliance Evaluation, 01/2014-12/2014.

Environmental Assessor providing support to the environmental office for Installation Support for Distribution. Responsible for conducting assessments and preparing reports of environmental assessments results. The environmental assessment encompassed 13 different environmental protocols in addition to applicable local and state regulations. Environmental compliance assessments were conducted at 5 DLA Distribution Centers located in Alabama, Texas, Georgia, and Virginia. Contract Value - \$1,500,000

Defense Logistics Agency Installation Support for Distribution; Environmental, Safety, and Occupational Health (ESOH) Program Assessment, 1/2012-12/2012. Lead Safety Assessor. Responsibilities include conducting field audits; researching federal regulations; determining root causes; and developing corrective actions at distribution locations recently acquired by DLA Distribution from Land and Maritime. Performed assessments at two DLA Distribution locations in the United States. ESOH Program Assessment assesses compliance with Federal OSHA regulations and internal safety and occupational health programs. Also completed an Industrial Hygiene Implementation Plan (IHIP) for DLA Distribution Red River. Evaluated the distribution operations to identify occupational health concerns that require a detailed industrial hygiene survey, which are documented in the IHIP with a schedule for conducting the surveys. Provided technical oversight in the initial implementation of the IHIP. – Value \$1,000,000

Defense Supply Center Richmond, Virginia (DSCR), Environmental, Safety, and Occupational Health (ESOH) Program Assessment, 1/2012-12/2012.

Lead Safety Assessor. Responsibilities include conducting field audits; researching federal regulations; determining root causes; and developing corrective actions. Provided detailed reports documenting the results of the field audits and evaluating the program performance, and included a Corrective Action Plan for the location. ESOH Program Assessment assesses compliance with Federal OSHA regulations and internal safety and occupational health programs. Contract Value - \$50,000

Defense Supply Center Richmond, Virginia (DSCR), Environmental Compliance Evaluation, 1/2012-12/2012.

Environmental Assessor for the Environmental Compliance Evaluation (ECE). Responsible for conducting and reporting of environmental assessments for the DSCR ECE. The ECE assessment encompassed 13 different protocols outlined in TEAM Guide in addition to applicable local and state regulations. Assessments were accelerated, using a state-of-the-art Assessment Manager computer

program specifically developed for the completion of compliance assessments. Contract Value - \$80,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Arizona, 1/2012-12/2012. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 5 ARNG facilities within the state of Arizona. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$185,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Texas, 1/2012-12/2012. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 12 ARNG facilities within the state of Texas. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$210,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Illinois, 1/2012-12/2012. Lead Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 6 ARNG facilities within the state of Illinois. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

Defense Logistics Agency Disposition Services; Safety and Occupational Health (SOH) Program Assessment, 3/2011-10/2011. Lead Safety Assessor. Responsibilities include conducting field audits; researching federal regulations; determining root causes; and developing corrective actions. Provided detailed reports documenting the results of the field audits and evaluating the program performance, and included a Corrective Action Plan for each site. Performed assessments at 6 DLA Disposition Service locations in North Carolina, Texas, Virginia, and California. SOH Program Assessment assesses compliance with Federal OSHA regulations and internal safety and occupational health programs. Contract Value - \$54,000

Defense Logistics Agency Installation Support for Distribution; Environmental, Safety, and Occupation Health (ESOH) Program Assessment, 12/2010-10/2011. Lead Safety Assessor. Responsibilities include conducting field audits; researching federal regulations; determining root causes; and developing corrective actions. Provided detailed reports documenting the results of the field audits and evaluating the program performance, and included a Corrective Action Plan for each site. Performed assessments at 16 DLA Distribution locations in the United

States, Japan, Korea, Guam, and Europe. Field audits were also completed for 6 Mapping Support offices in the United States, Japan, Korea, and Europe. ESOH Program Assessment assesses compliance with Federal OSHA regulations and internal safety and occupational health programs. Contract Value - \$1,500,000

Defense Logistics Agency Installation Support in Richmond; Noise Mapping Survey, 10/2011. Lead Industrial Hygienist. Responsibilities include identification of equipment and activities generating excess noise; measuring the noise levels; determining safe distances from high noise areas; and preparing a report to document the noise measurements for activities and equipment included in the survey. The noise measurements are evaluated for compliance with Federal OSHA regulations and internal safety and occupational health programs. Contract Value - \$280,000

Defense Supply Center Richmond, Virginia (DSCR), Environmental Compliance Evaluation, 9/2009-11/2011. As Environmental Assessor for the Environmental Compliance Evaluation (ECE), This included conducting and reporting of environmental assessments for the DSCR ECE. The ECE assessment encompassed 13 different protocols outlined in TEAM Guide in addition to applicable local and state regulations. Assessments were accelerated, using a state-of-the-art Assessment Manager computer program specifically developed for the completion of compliance assessments. Contract Value - \$92,000

Defense Supply Center Richmond, Virginia (DSCR): Environmental Planning at DSCR, 9/2009-11/2011. As Task Manager for the safety tasks related to this multi-tasked contract, Mr. Coffee assisted DSCR with evaluation, development, and implementation of their Lockout/Tagout Program, Fall Protection Program, Ergonomics Program, Job Hazard Analysis Program, and Machine Safeguarding Program. Mr. Coffee lead a team of experts to evaluate the status of current DSCR programs in these areas, to develop updated or new programs where necessary, to provide training as needed, and to assist in implementation of program elements. Mr. Coffee developed and oversaw the completion of over 30 machine specific LOTO procedures, over 60 JHA's, and training in the areas of LOTO, Fall Protection, and Ergonomic Evaluations. Contract Value - \$870,000

National Oceanic and Atmospheric Administration (NOAA), FY 2009 NOAA Environmental Compliance and Safety Assessment System (NECSAS) Support, 5/2008-9/2010. Project Manager. Assists NOAA in implementing their NOAA Environmental Compliance and Safety Assessment System (NECSAS). This includes organizing, scheduling, conducting and reporting of environmental, health and safety assessments in Missouri, Oklahoma, Michigan, Tennessee, North Carolina, South Carolina, and Maryland. NECSAS Assessments encompassed 13 different environmental protocols outlined in TEAM Guide, 50 different health and safety protocols outlined in the USSH Guide in addition to applicable local and state regulations and Environmental Management System (EMS) Audits. Assessments were accelerated, using a state-of-the-art Assessment Manager computer program specifically developed for the NECSAS Program with 11 facilities assessed and a draft report produced in a one-week time frame. Managed, conducted, and/or drafted reports for Health, Safety and Environment (HS&E) assessments. Contract Value - \$300,000.

National Oceanic and Atmospheric Administration (NOAA), FY 2010

NOAA Environmental Compliance and Safety Assessment System (NECSAS) Support, 5/2010- 9/2011. Project Manager. Assists NOAA in implementing their NOAA Environmental Compliance and Safety Assessment System (NECSAS). This includes organizing, scheduling, conducting and reporting of environmental, health and safety assessments in Florida, Hawaii, Louisiana, Mississippi, Connecticut, New Jersey, Massachusetts, and Rhode Island. NECSAS Assessments encompassed 13 different environmental protocols outlined in TEAM Guide, 50 different health and safety protocols outlined in the USSH Guide in addition to applicable local and state regulations and Environmental Management System (EMS) Audits. Assessments were accelerated, using a state-of-the-art Assessment Manager computer program specifically developed for the NECSAS Program, with 17 facilities assessed and a draft report produced in a one-week time frame. Managed, conducted, and/or drafted reports for Health, Safety and Environment (HS&E) assessments. Contract Value - \$300,000.

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Florida, 2/2009-2/2010. Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 4 ARNG facilities and Camp Blanding within the state of Florida. Facilities assessed included armories, wheeled and tracked vehicle maintenance shops, aircraft maintenance shops, and major training sites. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$180,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Maine, 3/2009-3/2010. Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments ARNG facilities at Camp Keyes within the state of Maine. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$153,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Michigan, 3/2009-3/2010. Environmental Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 4 ARNG facilities and Fort Custer Training Center within the state of Michigan. Facilities assessed included armories, wheeled and tracked vehicle maintenance shops, aircraft maintenance shops, and major training sites. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$176,000

U.S. Army National Guard; Environmental Program Assessment System (EPAS), Mississippi, 3/2010-3/2011. Lead Environmental Assessor. Responsibilities include conducting field audits; researching

Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 7 ARNG facilities within the state of Mississippi. Facilities assessed included armories, wheeled and tracked vehicle maintenance shops, and aircraft maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$170,000

U.S. Army National Guard; Environmental Program Assessment

System (EPAS), Ohio, 9/2010-9/2011. Lead Environmental Assessor.

Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 3 ARNG facilities and Camp Perry within the state of Ohio. Facilities assessed included armories, wheeled and tracked vehicle maintenance shops, aircraft maintenance shops, and major training sites. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$160,000

U.S. Army National Guard; Environmental Program Assessment

System (EPAS), Puerto Rico, 4/2010-4/2011. Lead Environmental

Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 7 ARNG facilities within the US Territory of Puerto Rico. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$170,000

U.S. Army National Guard; Environmental Program Assessment

System (EPAS), Washington, 9/2010-9/2011. Lead Environmental

Assessor. Responsibilities include conducting field audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at 6 ARNG facilities within the state of Washington. Facilities assessed included armories and wheeled and tracked vehicle maintenance shops. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$178,000

U.S. Army Reserve; Environmental Program Assessment System (EPAS), 81st Regional Sustainment Command, 2008-2009.

Environmental Assessor. Responsibilities include conducting environmental compliance audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at approximately 42 USAR reserve centers located in the states of Alabama, Florida, Georgia, Mississippi, North Carolina, and Tennessee. Reserve center activities and operations include administrative buildings, wheeled and tracked vehicle maintenance shops, aircraft maintenance shops, marine vessel maintenance shops, warehouses, and

local training sites. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$1,266,614

U.S. Army Reserve; Environmental Program Assessment System (EPAS), 99th Regional Sustainment Command, 2009-Present. Lead Environmental Assessor. Responsibilities include conducting environmental compliance audits; researching Federal, state, and local regulations; determining root causes; and developing corrective actions. Performed assessments at approximately 54 USAR reserve centers located in the states of Delaware, Maryland, Massachusetts, New York, Pennsylvania, Rhode Island, Virginia, and West Virginia. Reserve center activities and operations include administrative buildings, wheeled and tracked vehicle maintenance shops, aircraft maintenance shops, warehouses, and local training sites. EPAS assesses compliance with the following environmental regulations: RCRA Subparts C, D, and I; CWA; CAA; EPCRA; NEPA; NHPA; CERCLA/SARA; SDWA; TSCA; FIFRA; and other Federal, state, and local regulations. Contract Value - \$1,532,410

Ceradyne, Inc.; Environmental, Safety, and Occupational Health (ESOH) program assessment, 3/2012-4/2012. Occupational Safety and Health lead assessor. Conducted an evaluation of the safety and health programs at a graphite products manufacturer related to a real estate transaction. Assessed the manufacturer's activities and programs at locations in Ohio and New York for regulatory compliance. Value \$50,000

United States Postal Service (USPS); Noise Assessment Evaluation, 2/2013-8/2013. Lead Industrial Hygienist. Set up the study to evaluate noise exposure to USPS employees working at the Mail Processing Annex (MPA) and the Network Distribution Center (NDC). Provided technical oversight to HDR employees conducting the noise assessment. The assessment included noise dosimetry to measure employee noise exposure and collecting area noise measurements to identify operations with elevated noise levels. Contract Value - \$10,000.

NON-HDR EXPERIENCE

Bioenvironmental Engineering Flight at Maxwell Air Force Base in Montgomery, Alabama, 9/2006-11/2006. Industrial Hygiene and Safety. Provided comprehensive industrial hygiene support to Bioenvironmental Engineering Flight at Maxwell Air Force Base in Montgomery, Alabama. Reviewed previous case files to evaluate the operation and determine survey requirements. Conducted personal exposure monitoring for numerous operations including paint spraying, abrasive blasting, various types of welding, and pesticide application. Conducted personal noise dosimetry for numerous operations involving exposure to potentially high noise levels while servicing aircraft. Performed numerous ventilation surveys to evaluate the efficiency of paint booths, abrasive blasting booths, and local exhaust ventilation systems. Contract Value \$100,000

Environmental Protection Agency; Drum Top Crusher Study, 2004-2005. Industrial Hygiene and Safety. Participated in a study sponsored by the Environmental Protection Agency to evaluate the performances of different drum top crushing devices to process fluorescent lamps and capture the mercury emissions. Supported a work group to develop and

implement an industrial hygiene approach for evaluating worker exposure to mercury and general environmental mercury releases. Reported the results of the study in a comprehensive report that documented all the air sample results, wipe sample results and the results of a mass balance study. The overall performance of the devices was reported based on the efficiency to capture and retain mercury to control operator exposure to mercury vapors. Contract Value \$150,000

Evaluation of Mobile Laboratory Prototypes for the Department of Homeland Security, 3/2006-8/2006. Project Health and Safety Officer.

Project Health and Safety Officer. Functioned as the Project Health and Safety Officer for a field evaluation of mobile laboratory prototypes for the Department of Homeland Security. The prototypes are designed to quickly and efficiently identify chemical warfare agents and toxic industrial chemicals that could be released as an act of terror. Reviewed and provided comments on the Chemical Hygiene Plans submitted by each prototype manufacturer. Developed and managed the project health and safety plan that encompassed all Booz Allen Hamilton employees as well as prototype manufacturer employees. Provide incident response and reporting for each occurring incident during the course of the laboratory prototype evaluation. Contract Value \$50,000

Occupational Safety and Health Audits at Environmental Protection Agency (EPA), 2000-2005. Audit Team Health and Safety. Conducted

occupational safety and health audits at Environmental Protection Agency (EPA) regional offices and laboratories to assess regulatory and policy compliance and provide opportunities to enhance their safety and health programs. Audits started with thorough walkthroughs of all facilities to observe building and equipment conditions and active operations. Programs and records maintained by the facility were reviewed to determine accuracy and completeness. Concise reports were prepared to identify findings based on corresponding general industry regulatory standards, consensus standards, and EPA guidelines. At the conclusion of the audit, program strengths and deficiencies were communicated to EPA officials and recommendations were provided to support and further enhance their safety and health programs. Contract \$500,000

TRAINING

ENVIRON. REG COMPLIANCE, 1996

40 HOUR HAZWOPER, 1997

MINING SAFETY MSHA(F), 2012





American Safety & Health Institute
1450 Westec Drive
Eugene, OR 97402
800-447-3177

Friday, August 14, 2015
Darren Harbeck

Dear Darren

Congratulations on successfully completing your American Safety & Health Institute Basic First Aid/CPR and AED for Adult/Child/Infant class. In an effort to be more environmentally friendly your ASHI Approved Training Center has chosen to issue your certification card electronically.

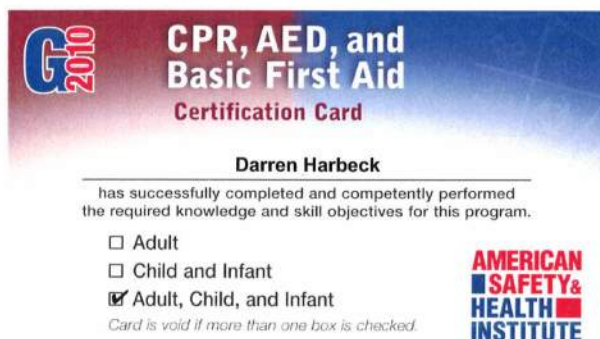
The digital certification card below is identical to a printed version of the card and documents that a properly authorized ASHI Instructor evaluated your knowledge and hands on skills in accordance with the program standard. You may duplicate this page as needed to provide proof of your training.

Go online to access your ASHI Passport and take advantage of the additional training resources available to you:

- Digital download of Student Handbook
- LearningLinks™ Refresher Scenarios
- Mobile Application Downloads
- E-mail Renewal Notification
- Rate Your Program Survey

Register now at www.hsi.com/passport/. Use the registration code 2662 to register.

HDR Inc
8404 Indianhills Dr
Omaha, NE 68114



ASHI-Approved Certification Card

Daniel Sciarro	
Authorized Instructor (Print Name)	
286834	
Registry No.	
05/07/2015	05/07/2017
Class Completion Date	Expiration Date
907-644-2044	161504
Training Center Phone No.	Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content conforms to the 2010 AHA Guidelines for CPR and ECC, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion date. More frequent reinforcement of skills is recommended.



**American
Red Cross**

Phil Werner

has successfully completed requirements for

Adult First Aid/CPR/AED: valid 2 Years

Date Completed: 07/31/2015

conducted by: American Red Cross

Instructor: Nathan Sean Rudolph



ID: 0XAZLK
Scan code or visit:
redcross.org/confirm

Attachment E

Material Safety Data Sheets/Safety Data Sheets

Insect Repellent	D-E-1
Fire Extinguisher	D-E-11
Alconox	D-E-17

This page intentionally left blank.

WPC Brands, Inc.
P. O. Box 4406
Bridgeton, MO 63044-0406

Material Safety Data Sheet

Complies with OSHA's Hazard Communication Standard, 29 CFR 1910.1200

Hazardous Material Identification System – (HMIS)

HEALTH – 2	REACTIVITY – 0
FLAMMABILITY – 3	PERSONAL – None

I Trade Name: Repel Insect Repellent Sportsmen Max Formula 40% DEET			
Product Type: Aerosol Insect repellent			
Product Item Number: 33801-2		Formula Code Number: 21-0996	
EPA Registration Number	Manufacturer		Emergency Telephone Numbers
305-46	Chemsico Division of United Industries Corporation 8494 Chapin Industrial Drive St. Louis, MO 63114		For Chemical Emergency: 1-800-633-2873 For Information: 1-888-880-1181 Prepared by: C. A. Duckworth Date Prepared: October 18, 2010
II Hazards Ingredient/Identity Information		III Physical and Chemical Characteristics	
Chemical DEET (N,N-diethyl-m-toluamide) CAS# 134-62-3 Ethanol CAS #64-17-5/ 977021-81-0 Hydrocarbon Propellant CAS #75-28-5/74-98-6	% 40.00 20.0 10.0	OSHA PEL NA 1000 ppm NA	ACGIH TLV NA 1000 ppm NA
Appearance & Odor: Light mist spray with an alcohol odor Boiling Point: NA Vapor Pressure: NA Specific Gravity: 0.88 at 72° F (H ₂ O = 1) Vapor Density: 1.6 % Volatile (by vol.): >90% Solubility in Water: NA Evaporation Rate: Approximately 1 (Butyl Acetate = 1)		Stability: Stable Polymerization: Will not occur Conditions to Avoid: None Incompatible Materials: May soften or damage some synthetics such as rayon. May damage leather. Hazardous Decomposition or Byproducts: None	
IV Fire and Explosive Hazards Data		V Reactivity Data	
Flash Point: NA Flame Extension: 18" (Level 3 Aerosol) Autoignition Temperature: N/A Fire Extinguishing Media: Carbon dioxide, Foam, Dry chemical Decomposition Temperature: NA Special Fire-Fighting Procedures: For Small Fires: Use Carbon dioxide or dry chemical extinguisher. For Large Fires: Use copious amounts of water. Unusual Fire and Explosion Hazards: Also see Section VII		Stability: Stable Polymerization: Will not occur Conditions to Avoid: None Incompatible Materials: May soften or damage some synthetics such as rayon. May damage leather. Hazardous Decomposition or Byproducts: None	
VI Health Hazard Data		VII Precautions for Safe Handling and Use	
Ingestion: Harmful if swallowed. First Aid: Contact a Poison Control Center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a Poison Control Center or doctor. Do not give anything by mouth to an unconscious person. If in eyes: Causes substantial but temporary eye injury. Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes then continue rinsing eye. Special Notes: Use of this product may cause skin reactions in rare cases. If you suspect a reaction to this product discontinue use. Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Contact a Poison Control Center or doctor. Have the product container with you when calling or going for treatment. Health conditions Aggravated by Exposure: None known Ingredients listed by NTP, OSHA, or IARC as Carcinogens or Potential Carcinogens: None		Steps to be Taken in Case Material is Released or Spilled: Flammable material. Remove all possible ignition sources. Soak up with absorbent material. Wash small quantities away with soapy water. Waste Disposal: Do not puncture or incinerate. If empty: Place in trash or offer for recycling. If partially filled: Call your local solid waste disposal agency for disposal instructions. Handling & Storage Precautions: Keep away from heat, sparks, or open flame. Exposure to temperatures higher than 130°F may cause bursting.	
VIII Control Measures		IX Transportation Data	
Read and follow label directions. They are your best guide to using this product effectively, and give necessary safety precautions to protect your health.		DOT: Consumer Commodity, ORM-D, UN-1950 IMDG: UN-1950, Aerosols, 2.1 IATA: UN-1950, Aerosols, Flammable, 2.1	

The information and statements herein are believed to be reliable but are not to be construed as warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.

MATERIAL SAFETY DATA SHEET

Page 1 of 4

MSDS # 127549001

OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II

Date Issued: 19Apr2007

Supersedes: 21Dec2004

US MANUFACTURER:

S.C. Johnson & Son, Inc.
Phone: (800) 725-6737
Racine, Wisconsin 53403-2236
Emergency Phone: (866) 231-5406
International Emergency Phone:
(952) 852-4647

CANADIAN MANUFACTURER:

S.C. Johnson and Son, Limited
Phone: (800) 725-6737
1 Webster Street
Brantford, Ontario N3T 5R1
Transportation Emergency:
CANUTEC (collect) (613) 996-6666
Poison Control: (866) 231-5406

HAZARD RATING	HMIS	HAZARD	NFPA	DISTRIBUTED IN CANADA BY:
4-Very High	2	Health	2	S.C. Johnson and Son, Limited
3-High	4	Flammability	4	Phone: (800) 725-6737
2-Moderate	0	Reactivity	0	1 Webster Street
1-Slight		Special		Brantford, Ontario N3T 5R1
0-Insignificant				

SECTION 1 - PRODUCT IDENTIFICATION

PRODUCT NAME..... OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II
REASON FOR CHANGE..... Section 2. Section 3. Section 4. Section 7. Section 8. Section 11. Section 13.
PRODUCT USE..... Insect repellent

SECTION 2 - INGREDIENT INFORMATION

INGREDIENT	WEIGHT%	EXPOSURE LIMIT/TOXICITY
Butane (CAS# 106-97-8).....	1-5	800 ppm ACGIH/OSHA TWA
Propane (CAS# 74-98-6).....	1-5	1000 ppm OSHA PEL , 2500 ppm ACGIH TWA
Isobutane (CAS# 75-28-5).....	1-5	NOT ESTABLISHED
Water (CAS# 7732-18-5).....	1-5	NOT ESTABLISHED
Deet (CAS# 134-62-3).....	30	NOT ESTABLISHED LD50: 1950 mg/kg (oral-rat) ; 3,180 mg/kg (dermal-rabbit)
Ethyl alcohol (CAS# 64-17-5).....	50-60	1000 ppm ACGIH/OSHA TWA LD50: 7,060 mg/kg (oral-rat)

SECTION 3 - HEALTH HAZARDS IDENTIFICATION (Also See Section 11)

ROUTE(S) OF ENTRY..... Eye contact. Skin contact. Ingestion. Inhalation.
EFFECTS OF ACUTE EXPOSURE:
EYE..... May cause: Severe eye irritation.
SKIN..... May cause skin reactions in rare cases.
INHALATION..... Prolonged or repeated contact may cause: Central nervous system depression.
INGESTION..... May cause: Abdominal discomfort. Central nervous system depression.
MEDICAL CONDITIONS..... None known.
GENERALLY RECOGNIZED AS BEING AGGRAVATED BY EXPOSURE

SECTION 4 - FIRST AID MEASURES

EYE CONTACT..... Flush immediately with plenty of water for at least 15 to 20 minutes. If irritation persists, get medical attention.

MATERIAL SAFETY DATA SHEET

Page 2 of 4

MSDS # 127549001

OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II

Date Issued: 19Apr2007

Supersedes: 21Dec2004

----- SECTION 4 - FIRST AID MEASURES (continued) -----

SKIN CONTACT..... Wash contaminated area with water and soap. If irritation develops, get medical attention.
INHALATION..... Remove to fresh air. If breathing is affected, get medical attention.
INGESTION..... Do not induce vomiting! Get medical attention immediately. Immediately drink 1-2 glasses of water. Do not administer anything by mouth to an unconscious person.

----- SECTION 5 - FIRE AND EXPLOSION INFORMATION -----

FLASH POINT..... < 20°F (< -7°C) (TCC) (propellant)
FLAMMABLE LIMITS..... Not available.
AUTOIGNITION..... Not available.
TEMPERATURE
EXTINGUISHING MEDIA... Foam. CO2. Dry chemical. Water fog.
SPECIAL FIREFIGHTING... Fight fire from maximum distance or protected area. Cool and use
PROCEDURES caution when approaching or handling fire-exposed containers. Fire fighters should wear self-contained breathing apparatus and protective clothing.
UNUSUAL FIRE AND..... Aerosol product - Containers may rocket or explode in heat of
EXPLOSION HAZARDS fire.

----- SECTION 6 - PREVENTIVE RELEASE MEASURES -----

STEPS TO BE TAKEN IN... Eliminate all ignition sources. Dike large spills. Absorb with
CASE MATERIAL IS oil-dri or similar inert material. Sweep or scrape up and
RELEASED OR SPILLED containerize.

----- SECTION 7 - HANDLING AND STORAGE -----

PRECAUTIONARY..... WARNING: CAUSES EYE IRRITATION. May be harmful if swallowed.
INFORMATION Avoid contact with eyes and lips. FLAMMABLE: Keep away from heat, sparks and flame. CONTENTS UNDER PRESSURE. Do not puncture or incinerate. Exposure to temperatures above 120 F may cause bursting. KEEP OUT OF REACH OF CHILDREN.
OTHER HANDLING AND..... Store in a cool, dry place with adequate ventilation. Wash
STORAGE CONDITIONS thoroughly after handling. Observe good personal hygiene practices.

----- SECTION 8 - SPECIAL PROTECTION INFORMATION -----

RESPIRATORY PROTECTION. No special requirements under normal use conditions. If mists/vapors are not adequately controlled by ventilation, use appropriate respiratory protection to prevent overexposure.
VENTILATION..... General room ventilation adequate.
PROTECTIVE GLOVES..... No special requirements under normal use conditions.
EYE PROTECTION..... No special requirements under normal use conditions.
OTHER PROTECTIVE..... No special requirements.
MEASURES

----- SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES -----

COLOR..... Clear

MATERIAL SAFETY DATA SHEET

Page 3 of 4

MSDS # 127549001

OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II

Date Issued: 19Apr2007

Supersedes: 21Dec2004

----- SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES (continued) -----

PRODUCT STATE.....	Dispensed as a spray mist.
ODOR.....	Characteristic
pH.....	Not applicable.
ODOR THRESHOLD.....	Not available.
SOLUBILITY IN WATER....	Dispersible
SPECIFIC GRAVITY.....	0.84
(H2O=1)	
VAPOR DENSITY (AIR=1)..	Not available.
EVAPORATION RATE (BUTYL	Not available.
ACETATE=1)	
VAPOR PRESSURE (mm HG)..	Not available.
BOILING POINT.....	Not available.
FREEZING POINT.....	Not available.
COEFFICIENT OF.....	Not available.
WATER/OIL	
PERCENT VOLATILE BY....	Not available.
VOLUME (%)	
VOLATILE ORGANIC.....	Not available.
COMPOUND (VOC)	
THEORETICAL VOC.....	Not available.
(LB/GAL)	

----- SECTION 10 - STABILITY AND REACTIVITY -----

STABILITY.....	Stable
STABILITY - CONDITIONS.	Excessive heat.
TO AVOID	
INCOMPATIBILITY.....	Avoid contact with: Rubber. Plastic. Strong oxidizing materials
	(e.g. liquid chlorine).
HAZARDOUS DECOMPOSITION	When exposed to fire: Produces normal products of combustion.
PRODUCTS	
HAZARDOUS.....	Will not occur.
POLYMERIZATION	
HAZARDOUS.....	Not applicable.
POLYMERIZATION -	
CONDITIONS TO AVOID	

----- SECTION 11 - TOXICOLOGY INFORMATION (Also See Section 3) -----

LD50 (ACUTE ORAL TOX)...	Greater than 2000 mg/kg (rats).
LD50 (ACUTE DERMAL TOX)	Estimated to be greater than 2000 mg/kg. (rabbit)
LC50 (ACUTE INHALATION.	> 2.0 mg/L (rat)
TOX)	
EFFECTS OF CHRONIC.....	None known.
EXPOSURE	
SENSITIZATION.....	None known.
CARCINOGENICITY.....	None known.
REPRODUCTIVE TOXICITY..	None known.
TERATOGENICITY.....	None known.
MUTAGENICITY.....	None known.

MATERIAL SAFETY DATA SHEET

Page 4 of 4

MSDS # 127549001

OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II

Date Issued: 19Apr2007

Supersedes: 21Dec2004

----- SECTION 12 - ECOLOGICAL INFORMATION -----

ENVIRONMENTAL DATA..... Not available.

----- SECTION 13 - DISPOSAL CONSIDERATIONS -----

WASTE DISPOSAL..... PESTICIDAL WASTE - Observe all applicable Federal/ Provincial/
INFORMATION State regulations and Local/ Municipal ordinances regarding disposal of pesticide wastes. If possible, recycle empty aerosol can to nearest steel recycling center. Use up package or give to someone who can.

----- SECTION 14 - TRANSPORTATION INFORMATION -----

US DOT INFORMATION..... Please refer to the Bill of Lading/receiving documents for up-to-date shipping information.
CANADIAN SHIPPING NAME. OFF!® DEEP WOODS® SPORTSMEN INSECT REPELLENT II
TDG CLASSIFICATION..... Not applicable.
PIN/NIP..... Not applicable.
PACKING GROUP..... Not applicable.
EXEMPTION NAME..... Consumer commodity

----- SECTION 15 - REGULATORY INFORMATION -----

WHMIS CLASSIFICATION... Not applicable.

All ingredients of this product are listed or are excluded from listing on the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

All ingredients in this product comply with the New Substances Notification requirements under the Canadian Environmental Protection Act (CEPA).

This product is not subject to the reporting requirements under California's Proposition 65.

----- SECTION 16 - OTHER INFORMATION -----

ADDITIONAL INFORMATION. NFPA 30B Level 2 Aerosol.
EPA REGISTRATION #..... 4822-397

----- PREPARATION INFORMATION -----

PREPARED BY..... Manufacturer's Technical Support Department. Refer to page 1 (Manufacturer) for contact information.

This document has been prepared using data from sources considered technically reliable. It does not constitute a warranty, express or implied, as to the accuracy of the information contained herein. Actual conditions of use and handling are beyond seller's control. User is responsible to evaluate all available information when using product for any particular use and to comply with all Federal, State, Provincial and Local laws and regulations.

PRINT DATE: 07Jun2007



261 Cahaba Valley Parkway - Pelham, AL 35124-1146
Tel: 1.800.637.6047 / 205.733.0333
Fax: 1.800.521.6896 / 205.733.8930
www.rainbowtech.net
Woman-Owned Business Enterprise - Founded 1971

Safety Data Sheet (SDS)

SECTION 1 - MANUFACTURER INFORMATION

MANUFACTURER/DISTRIBUTOR: Rainbow Technology Corporation
(800) 637-6047
CONTACT PERSON: Larry Joa Steeley, Jr.
EMERGENCY PHONE # (24 HRS.): Chem-Tel, Inc.
(800) 255-3924
TRADE NAME: Jungle Formula Insect Repellent
PRODUCT NUMBER: 4501
CHEMICAL NAME: Proprietary
CHEMICAL FAMILY: Proprietary
FORMULA: Proprietary
ISSUE DATE: April 22, 2013
REPLACES SDS DATED: September 7, 2010

SECTION 2 - HAZARDOUS INGREDIENTS AND OTHER COMPONENTS

CHEMICAL/COMMON NAME	CAS-NUMBER	Wt. %	EINECS#
DEET (N,N Diethyl-m-toluamide)	000134-62-3	25	205-149-7
MGK* 264 (N-Octyl Bicycloheptene Dicarboximide)	000113-48-4	5	204-029-1
MGK* Repellent 326 (Di-n-Propyl Isocinchomeronate)	000136-45-8	2.5	205-245-9
Isopropyl Alcohol	000067-63-0	40	200-661-7
Liquefied Petroleum Gas	068476-85-7	20-25	270-703-7

Note: Ingredients not identified are proprietary or nonhazardous. Values are not product specifications.

SECTION 3 - HAZARDS IDENTIFICATION

HMS CODES: FIRE: 4 HEALTH: 1 REACTIVITY: 1

EMERGENCY OVERVIEW

IMMEDIATE CONCERNS: WARNING. EXTREMELY FLAMMABLE. Causes Substantial but temporary eye injury. Contents Under Pressure. Keep Away from heat and open flame. Do not expose to Temperatures above 130°F. May cause respiratory tract irritation. May be harmful if swallowed. ALWAYS Wear Safety Glasses and appropriate personal protective equipment when handling this product. Avoid breathing vapors and spray mists of this product. DO NOT puncture or incinerate container.

POTENTIAL HEALTH EFFECTS

EYES: Causes substantial but temporary eye injury. SKIN: Can cause skin irritation. CHRONIC: Not established.
INGESTION: Can cause stomach irritation, resulting in nausea, cramps and vomiting. Can cause nervous system such as fatigue, dizziness, headaches, lack of coordination, tremors and unconsciousness.
INHALATION: Excessive inhalation can cause nasal and respiratory irritation, nausea and nervous system disorders, such as fatigue, dizziness, headaches, lack of coordination, tremors and unconsciousness.

SECTION 4 - FIRST AID MEASURES

EYES: Remove contact lenses and immediately flush with large amounts of water for at least 15 minutes. If irritation persists, get medical attention.
SKIN: Remove contaminated clothing and wash affected areas with large amounts of soap and water. If irritation persists, get medical attention. Wash clothing separately before reuse.
INGESTION: If swallowed call a physician or poison control center and seek medical attention immediately. DO NOT induce vomiting. Never give anything by mouth to an unconscious person.
INHALATION: Remove affected person to fresh air. If breathing has stopped, administer artificial respiration and seek medical attention immediately. NOTES TO PHYSICIAN: None

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE CLASS: This aerosol is classified as EXTREMELY FLAMMABLE by the flame extension test method described in 16 CFR 1500.45.
EXTINGUISHING MEDIA: Foam, carbon dioxide or dry chemical.
HAZARDOUS COMBUSTION PRODUCTS: Under fire conditions this product will support combustion and may decompose to give off toxic gases such as carbon monoxide, carbon dioxide and nitrogen oxides.
EXPLOSION HAZARDS: Contents under pressure. Exposure to temperatures above 130°F can cause bursting.
FIRE FIGHTING PROCEDURES: Treat as an oil fire. Use a full-faced self-contained breathing apparatus along with full protective gear. Keep nearby containers and equipment cool with a water stream.

Safety Data Sheet (SDS)

SECTION 6 – ACCIDENTIAL RELEASE MEASURES

33SMALL SPILL: Shut off ignition sources. Stop release, if possible without risk. Dike or contain release, if possible, and if immediate response can prevent further damage or danger. Isolate and control access to the release area. Take actions to reduce vapors. Absorb with appropriate absorbent. Clean spill area of residues and absorbent.

LARGE SPILL: Shut off ignition sources. Stop release, if possible without risk. Dike or contain release, if possible, and if immediate response can prevent damage or danger. Isolate and control access to the release area. Take action to reduce vapors. Collect product into drums, etc. via drains, pumps, etc. Absorb with appropriate absorbent. Clean spill area of residues and absorbent.

SECTION 7 – HANDLING AND STORAGE

GENERAL PROCEDURES: Do not use near heat, open flame or any ignition source.

STORAGE: Store containers upright and closed. Store in areas that are cool, dry and well-ventilated. Exposure to temperatures at or above 130°F may cause bursting. Keep away from heat, ignition sources and strong oxidizers. Emptied containers may retain product residues.

HANDLING: Contents under pressure do not puncture or incinerate. Do not use near heat or open flame. Do not contaminate water, feed or food by storage, handling or disposal. Read and observe all precautions and instructions on the label.

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE GUIDELINES:

		OSHA PEL		ACGIH TLV	
		ppm	mg/m ³	ppm	mg/m ³
Isopropyl Alcohol	TWA	400	980	400	983
	STEL			500	1230
Liquefied Petroleum Gas	TWA	1000	1800	1000	1800

There no established exposure limits for DEET (N,N Diethyl-m-toluamide); MGK® 264 (N-Octyl Bicycloheptene Dicarboximide) or MGK® Repellent 326 (Di-n-Propyl Isocinchomeronate)

PERSONAL PROTECTIVE EQUIPMENT:

EYES AND FACE: Wear OSHA-approved safety glasses, goggles or face shield

SKIN: Not applicable. Product for use on skin.

RESPIRATORY: Mechanical ventilation should be used when handling this product in enclosed spaces. Local exhaust ventilation may be necessary. Avoid breathing vapors or mists of this product. If necessary, use a NIOSH approved organic vapor respirator to avoid breathing sprays or mists of this product.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: Liquefied gases and liquid.

ODOR: Odor of Isopropanol and DEET

APPEARANCE: Clear colorless liquid.

PERCENT VOLATILE: Less than 70%

VAPOR DENSITY: Heavier

SOLUBILITY IN WATER: Insoluble

SPECIFIC GRAVITY: 0.889

COMMENTS: Specific Gravity is for the aerosol contents less the compressed gas propellant

SECTION 10 – STABILITY AND REACTIVITY

STABLE: Yes

HAZARDOUS POLYMERIZATION: No

CONDITIONS TO AVOID: Not compatible with strong acids or bases. Not compatible with strong oxidizers

SECTION 11 – TOXICOLOGICAL AND ECOLOGICAL INFORMATION

ACUTE: ORAL LD50: 3.87 gm/kg

EYE EFFECTS: Produced conjunctival irritation in 6/6 albino rabbit eyes. No conjunctival irritation was observed in 2/6 animals by 4 days, in 5/6 animals by 7 days and 6/6 animals by 15 days. Corneal opacity was noted for 6/6 animals. No corneal opacity was observed for 2/6 animals by 72 hours, for 4/6 animals by 7 days, for 5/6 animals by 8 days and for 6/6 animals by 15 days. No iritis was observed during the study.

SKIN EFFECTS: Produced a primary skin irritation index of 0.17 in albino rabbits.

SENSITIZATION: When applied dermally to albino guinea pigs, this product appears to be a dermal sensitizer.

COMMENTS: None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as being carcinogens.

SECTION 12 – DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: We encourage you to use this product completely. If you cannot use it all up, give it to someone who can use it. Otherwise unused product may be disposed of by securely wrapping container in several layers of newspaper and discard in trash.

RCRA/EPA WASTE INFORMATION: None of the ingredients in this product are RCRA/CERCLA Hazardous Waste.

Safety Data Sheet (SDS)

SECTION 13 – TRANSPORT INFORMATION

DOT Shipping Name: Aerosols, Limited Quantity
Hazards Class: Class 2.1
UN/ID Number: UN1950

SECTION 14 – REGULATORY INFORMATION

UNITED STATES

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)

311/312 HAZARD CATEGORIES: FIRE: YES PRESSURE GENERATING: YES REACTIVITY: NO ACUTE: YES

313 REPORTABLE INGREDIENTS:

COMPONENT	CAS #	MAX%
Di-n-propyl isocinchomeronate	000136-45-8	2.50
Isopropyl Alcohol	000067-63-0	40.00

302/304 EMERGENCY PLANNING

EMERGENCY PLAN: There are no Sara Title III Section 302 extremely hazardous substances present in this formulation (40 CFR 355).

There are no components that are subject to emergency requirements under CERCLA Section 103(a)(40 CFR 302.4) in this formulation.

TSCA (TOXIC SUBSTANCE CONTROL ACT)

TSCA STATUS: All chemical substances found in this product comply with the Toxic Substances Control ACT inventory reporting requirements.

The information provided herein was believed to be accurate at the time of preparation and prepared from a compilation of sources believed to be reliable, but it is the responsibility of the user to investigate and understand other pertinent sources of information, to comply with all laws and procedures applicable to the safe handling and use of this product, and to determine the suitability of the product for its intended use. It is a violation of Federal law to use this product in a manner inconsistent with its labeling.



MATERIAL SAFETY DATA SHEET

FORAY

Product Code: 2001-2-015 ANa

Issue Date: 12-15-2013

1. Product and Company Identification

Material name	FORAY
Version #	01
Revision date	12-15-2013
CAS #	Mixture
Product Code	2001-2-015 ANa
Product use	Fire extinguishing agent
Manufacturer / Importer / Supplier	
Name	Tyco Fire Protection Products
Address	One Stanton Street Marinette, WI 54143-2542
Phone	715-735-7411
Internet	http://www.ansul.com
Emergency Phone Number	CHEMTREC 800-424-9300 or 703-527-3887

2. Hazards Identification

Emergency overview	WARNING
	Irritating to eyes and skin.
OSHA regulatory status	This product is considered hazardous under 29 CFR 1910.1200 (Hazard Communication).
Potential health effects	
Routes of exposure	Eye contact. Skin contact. Inhalation. Ingestion.
Eyes	Avoid contact with eyes. Contact with eyes may cause irritation.
Skin	Avoid contact with the skin. May cause skin irritation.
Inhalation	Inhalation of dusts may cause respiratory irritation.
Ingestion	Not a likely route of entry.
Target organs	Eyes. Respiratory system. Skin.
Signs and symptoms	Irritation of eyes and mucous membranes.

3. Composition / Information on Ingredients

	CAS #	Percent
Hazardous components		
CALCIUM CARBONATE	471-34-1	1 - 2.5
Non-hazardous components		
Pigment Yellow 14	5468-75-7	0 - 0.1
Silicone fluid	63148-57-2	0.1 - 1
FULLERS EARTH	8031-18-3	2.5 - 10
Ammonium Sulfate	7783-20-2	10 - 20
Ammonium Phosphate	7722-76-1	60 - 80

4. First Aid Measures

First aid procedures	
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation persists after washing.

Skin contact	Wash off with warm water and soap. Get medical attention if irritation develops and persists.
Inhalation	Move to fresh air. Get medical attention, if needed.
Ingestion	Rinse mouth. Do not induce vomiting without advice from poison control center. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.
Notes to physician	Symptoms may be delayed.
General advice	If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance.

5. Fire Fighting Measures

Flammable properties	No unusual fire or explosion hazards noted.
Extinguishing media	This product is not flammable. Use extinguishing agent suitable for type of surrounding fire.
Suitable extinguishing media	
Protection of firefighters	None known.
Specific hazards arising from the chemical	
Hazardous combustion products	Carbon monoxide and carbon dioxide.

6. Accidental Release Measures

Personal precautions	Local authorities should be advised if significant spillages cannot be contained. Avoid inhalation of dust from the spilled material. Wear a dust mask if dust is generated above exposure limits.
Environmental precautions	Prevent further leakage or spillage if safe to do so. Do not contaminate water.
Methods for containment	If sweeping of a contaminated area is necessary use a dust suppressant agent which does not react with the product. Prevent entry into waterways, sewer, basements or confined areas.
Methods for cleaning up	Should not be released into the environment. Sweep up or vacuum up spillage and collect in suitable container for disposal. Collect dust using a vacuum cleaner equipped with HEPA filter. Avoid dust formation. Following product recovery, flush area with water.
Other information	Clean up in accordance with all applicable regulations.

7. Handling and Storage

Handling	Keep formation of airborne dusts to a minimum. Do not breathe dust. Avoid contact with eyes. Do not use in areas without adequate ventilation. Wear personal protective equipment. Wash thoroughly after handling.
Storage	Keep container tightly closed. Guard against dust accumulation of this material. Use care in handling/storage.

8. Exposure Controls / Personal Protection

Occupational exposure limits

U.S. - OSHA

Components

CALCIUM CARBONATE (471-34-1)

Type

PEL

TWA

Value

5.0000 mg/m3

15.0000 mg/m3

5.0000 mg/m3

15.0000 mg/m3

Form

Respirable fraction.

Total dust.

Respirable fraction.

Total dust.

Engineering controls	Ensure adequate ventilation, especially in confined areas.
Personal protective equipment	
Eye / face protection	Do not get in eyes. Chemical goggles are recommended.
Skin protection	No special protective equipment required.
Respiratory protection	When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
General hygiene considerations	Do not get in eyes.

9. Physical & Chemical Properties

Appearance	
Form	Powder.
Color	Yellow.
Odor	Odorless.
Physical state	Solid.
pH	Not available.
Melting point	Not available.
Freezing point	Not available.
Boiling point	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability limits in air, upper, % by volume	Not available.
Flammability limits in air, lower, % by volume	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Specific gravity	Not available.
Relative density	Not available.
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
VOC	Not available.

10. Chemical Stability & Reactivity Information

Chemical stability	Material is stable under normal conditions.
Incompatible materials	Strong acids.
Hazardous decomposition products	Carbon oxides.

11. Toxicological Information

Toxicological information	The toxicity of this product has not been tested.

Toxicological data

Components

Test Results

CALCIUM CARBONATE (471-34-1)

Acute Oral LD50 Rat: 6450 mg/kg

Local effects

Components of the product may be absorbed into the body through the skin. Contact may irritate or burn eyes.

Chronic effects

Hazardous by OSHA criteria. Prolonged inhalation may be harmful.

Carcinogenicity

This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

12. Ecological Information

Ecotoxicological data

Components

Test Results

CALCIUM CARBONATE (471-34-1)

LC50 Western mosquitofish (*Gambusia affinis*): > 56000 mg/l
96.00 Hours

Ammonium Sulfate (7783-20-2)

EC50 Water flea (*Ceriodaphnia dubia*): 52 - 67 mg/l 48.00
hours

LC50 Pink salmon (*Oncorhynchus gorbuscha*): 0.068 mg/l
96.00 hours

Material name: FORAY

1540 Version #: 01 Revision date: 12-15-2013

MSDS US

3 / 5

Ecotoxicity	This material is not expected to be harmful to aquatic life.
Environmental effects	An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Persistence and degradability	Not available.

13. Disposal Considerations

Disposal instructions	This product, in its present state, when discarded or disposed of, is not a hazardous waste according to Federal regulations (40 CFR 261.4 (b)(4)). Under RCRA, it is the responsibility of the user of the product to determine, at the time of disposal, whether the product meets RCRA criteria for hazardous waste. Dispose of waste material according to Local, State, Federal, and Provincial Environmental Regulations.
Waste from residues / unused products	Dispose of in accordance with local regulations.

14. Transport Information

DOT

Not regulated as dangerous goods.

15. Regulatory Information

US federal regulations	This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200. All components are on the U.S. EPA TSCA Inventory List.

CERCLA/SARA Hazardous Substances - Not applicable.

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: De minimis concentration

Ammonium Phosphate (CAS 7722-76-1)	1.0 %
Ammonium Sulfate (CAS 7783-20-2)	1.0 %

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: Listed substance

Ammonium Phosphate (CAS 7722-76-1)	Listed.
Ammonium Sulfate (CAS 7783-20-2)	Listed.

CERCLA (Superfund) reportable quantity

None

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Acute Health - Yes Chronic Health - Yes Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

Section 302 extremely hazardous substance

No

Section 311 hazardous chemical

No

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

Material name: FORAY

1640 Version #: 01 Revision date: 12-15-2013

MSDS US

4 / 5

State regulations This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

US - Pennsylvania RTK - Hazardous Substances: Listed substance

Ammonium Sulfate (CAS 7783-20-2)

Listed.

CALCIUM CARBONATE (CAS 471-34-1)

Listed.

16. Other Information

Further information

HMIS® is a registered trade and service mark of the NPCA.

HMIS® ratings

Health: 1*

Flammability: 0

Physical hazard: 0

NFPA ratings

Health: 1

Flammability: 0

Instability: 0

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Issue date

12-15-2013

This page intentionally left blank.

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX**1 Identification of the Substance/mixture and of the Company/Undertaking****1.1 Product identifier**Trade name: **ALCONOX**

Application of the substance / the preparation: Cleaning material/ Detergent

1.2 Relevant identified uses of the substance or mixture and uses advised against:

No additional information available.

1.3 Details of the supplier of the Safety Data Sheet**Manufacturer/Supplier:**

Alconox, Inc.
30 Glenn St., Suite 309
White Plains, NY 10603
Phone: 914-948-4040



Further information obtainable from: Product Safety Department

1.4 Emergency telephone number:

ChemTel Inc.: (800)255-3924, +1 (813)248-0585

2 Hazards Identification**2.1 Classification of the substance or mixture Classification according to Regulation (EC) No 1272/2008:***Eye Irrit. 2B; H320: Causes eye irritation.***Information concerning particular hazards for human and environment:**

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to the latest editions of the EU-lists, and extended by company and literature data

2.2 Label elements**Labelling according to Regulation (EC) No 1272/2008:**

The product is classified and labelled according to the CLP regulation.

Hazard pictograms:**Signal word:** Warning**Hazard-determining components of labelling:**

Sodium Alkylbenzene Sulfonate

Hazard statements:

H320: Causes eye irritation.

Precautionary statements:

P280 Wear protective gloves/protective clothing/eye protection/face protection.

P264: Wash thoroughly after handling.

P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P337+P313: If eye irritation persists: Get medical advice/attention.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

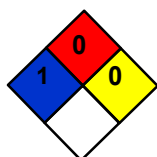
Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

Other Hazard description:**WHMIS-classification and symbols:**

D2B - Toxic material causing other toxic effects

**NFPA ratings (scale 0 - 4)**

Health = 1
Fire = 0
Reactivity = 0

HMIS-ratings (scale 0 - 4)

HEALTH	1		Health = 1
FIRE	0		Fire = 0
REACTIVITY	0		Reactivity = 0

2.3 Other hazards**Results of PBT and vPvB assessment**

PBT: Not applicable.

vPvB: Not applicable.

3 Composition/Information on Ingredients

3.2 Chemical characterization: Mixture

Description: Hazardous ingredients of mixture listed below.

Identifying Nos.	Description	Wt. %
CAS: 68081-81-2	Sodium Alkylbenzene Sulfonate	10 - 25%
CAS: 497-19-8	Sodium Carbonate	5-15%
CAS: 7722-88-5	Tetrasodium pyrophosphate	5-15%
CAS: N/A	Proprietary (non-classified)	40-60%

Additional information: For the wording of the listed risk phrases refer to section 16.

4 First Aid Measures

4.1 Description of first aid measures**General information:**

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and SDS to health professional with contaminated individual.

After inhalation:

Supply fresh air; consult doctor in case of complaints.

After skin contact:

Immediately wash with water and soap and rinse thoroughly. If skin irritation continues, consult a doctor.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

After eye contact:

Remove contact lenses if worn. Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor.

After swallowing:

Rinse out mouth and then drink plenty of water. Do not induce vomiting; call for medical help immediately.

4.2 Most important symptoms and effects, both acute and delayed:

No additional information available.

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information available.

5 Firefighting Measures

5.1 Extinguishing media:**Suitable extinguishing agents:**

CO2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

5.2 Special hazards arising from the substance or mixture:

No additional information available.

5.3 Advice for firefighters:**Protective equipment:**

Wear self-contained respiratory protective device.

Wear fully protective suit.

6 Accidental Release Measures

6.1 Personal precautions, protective equipment and emergency procedures:

Product forms slippery surface when combined with water.

6.2 Environmental precautions:

Do not allow product to reach sewage system or any water course.

6.3 Methods and material for containment and cleaning up:

Pick up mechanically.

Clean the affected area carefully; suitable cleaners are: Warm water

6.4 Reference to other sections:

See Section 7 for information on safe handling.

See Section 8 for information on personal protection equipment.

See Section 13 for disposal information

7 Handling and Storage

7.1 Precautions for safe handling:

Ensure good ventilation/exhaustion at the workplace.

Keep receptacles tightly sealed.

Prevent formation of dust.

Information about fire - and explosion protection: No special measures required.

7.2 Conditions for safe storage, including any incompatibilities:**Storage:**

Requirements to be met by storerooms and receptacles: No special requirements.

Information about storage in one common storage facility: None required.

Further information about storage conditions: Protect from humidity and water.

7.3 Specific end use(s): No additional information available.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

8 Exposure Controls/Personal Protection

8.1 Control parameters

Ingredients with limit values that require monitoring at the workplace: Not required.

Additional information: The lists valid during the making were used as basis.

8.2 Exposure controls:

Personal protective equipment:

General protective and hygienic measures:

- Keep away from foodstuffs, beverages and feed.
- Immediately remove all soiled and contaminated clothing.
- Wash hands before breaks and at the end of work.
- Avoid contact with the skin.
- Avoid contact with the eyes and skin.

Respiratory protection:

- Not required under normal conditions of use.
- In case of brief exposure or low pollution use respiratory filter device.
- In case of intensive or longer exposure use self-contained respiratory protective device.

Protection of hands:



Protective gloves

The glove material has to be impermeable and resistant to the product. Selection of the glove material should be based on the penetration time, rates of diffusion and the degradation of the glove material.

Material of gloves:

The selection of a suitable gloves does not only depend on the material, but also on the quality, and varies from manufacturer to manufacturer.

Penetration time of glove material:

The exact break through time has to be determined by the manufacturer of the protective gloves. DO NOT exceed the breakthrough time set by the Manufacturer.

For long term contact, gloves made of the following materials are considered suitable:

- Butyl rubber, BR
- Nitrile rubber, NBR
- Natural rubber (NR)
- Neoprene gloves

Eye protection:



Safety glasses

Body protection: Protective work clothing

9 Physical and Chemical Properties

9.1 Information on basic physical and chemical properties:

General Information:

Appearance:

Form:	Powder
Color:	White
Odor:	Odorless
Odor threshold:	Not determined.
pH-value (10 g/l) at 20°C:	9.5 (NA for Powderform)

Change in condition:

Melting point/Melting range:	Not determined.
Boiling point/Boiling range:	Not determined.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

Flash point:	Not applicable.
Flammability (solid, gaseous):	Not determined.
Ignition temperature:	Not determined.
Decomposition temperature:	Not determined.
Self-igniting:	Product is not selfigniting.
Danger of explosion:	Product does not present an explosion hazard.
Explosion limits:	
Lower:	Not determined.
Upper:	Not determined.
Vapor pressure:	Not applicable.
Density at 20°C:	1,1 g/cm ³
Relative density:	Not determined.
Vapor density:	Not applicable.
Evaporation rate:	Not applicable.
Solubility in / Miscibility with water:	Soluble.
Segregation coefficient (n-octanol/water):	Not determined.
Viscosity:	
Dynamic:	Not applicable.
Kinematic:	Not applicable.
Solvent content:	
Organic solvents:	0.0 %
Solids content:	100 %
9.2 Other information:	No additional information available.

10 Stability and Reactivity

- 10.1 Reactivity:**
- 10.2 Chemical stability:**
- Thermal decomposition / conditions to be avoided:**
 No decomposition if used according to specifications.
- 10.3 Possibility of hazardous reactions:**
- Reacts with acids.
 Reacts with strong alkali.
 Reacts with strong oxidizing agents.
- 10.4 Conditions to avoid:**
- No additional information available.
- 10.5 Incompatible materials:**
- No additional information available.
- 10.6 Hazardous decomposition products:**
- Carbon monoxide and carbon dioxide
 Phosphorus compounds
 Sulphur oxides (SO_x)

11 Toxicological Information

- 11.1 Information on toxicological effects:**
- Toxicity data:** No additional information available.
- Primary irritant effect:**
- On the skin:** Irritating to skin and mucous membranes.
 On the eye: Strong irritant with the danger of severe eye injury.
 Sensitization: No sensitizing effects known.

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

Additional toxicological information:

The product shows the following dangers according to the calculation method of the General EU Classification Guidelines for Preparations as issued in the latest version: Irritant.

Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.

12 Ecological Information

12.1 Toxicity:

Aquatic toxicity: No additional information available.

12.2 Persistence and degradability: No additional information available.**12.3 Bioaccumulative potential:** Not worth-mentioning accumulating in organisms.**12.4 Mobility in soil:** No additional information available.**Ecotoxicological effects:**

Remark: Harmful to fish

Additional ecological information:**General notes:**

Water hazard class 2 (German Regulation) (Self-assessment): hazardous for water.

Do not allow product to reach ground water, water course or sewage system.

Danger to drinking water if even small quantities leak into the ground.

12.5 Results of PBT and vPvB assessment:

PBT: Not applicable.

vPvB: Not applicable.

12.6 Other adverse effects: No additional information available.

13 Disposal Considerations

13.1 Waste treatment methods:**Recommendation:**

Smaller quantities can be disposed of with household waste.

Small amounts may be diluted with plenty of water and washed away. Dispose of bigger amounts in accordance with Local Authority requirements.

The surfactant used in this product complies with the biodegradability criteria as laid down in Regulation (EC) No. 648/2004 on detergents. Data to support this assertion are held at the disposal of the competent authorities of the Member States and will be made available to them, at their direct request or at the request of a detergent manufacturer.

Uncleaned packaging:

Recommendation: Disposal must be made according to official regulations.

Recommended cleansing agents: Water, together with cleansing agents, if necessary.

14 Transport Information

14.1 UN-Number:

DOT, ADR, ADN, IMDG, IATA:

Not Regulated

14.2 UN proper shipping name:

DOT, ADR, IMDG, IATA:

Not Regulated

14.3 Transport hazard class(es):

DOT, ADR, IMDG, IATA:

Class:

Not Regulated

Label:

-

14.4 Packing group:

DOT, ADR, IMDG, IATA:

Not Regulated

Safety Data Sheet

according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

14.5 Environmental hazards:**Marine pollutant:** No**14.6 Special precautions for user:** Not applicable.**14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code:** Not applicable.**UN "Model Regulation":** Not Regulated

15 Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:**United States (USA):****SARA:****Section 355 (extremely hazardous substances):** None of the ingredient is listed.**Section 313 (Specific toxic chemical listings):** None of the ingredient is listed.**TSCA (Toxic Substances Control Act):** All ingredients are listed.**Proposition 65 (California):****Chemicals known to cause cancer:** None of the ingredient is listed.**Chemicals known to cause reproductive toxicity for females:** None of the ingredient is listed.**Chemicals known to cause reproductive toxicity for males:** None of the ingredient is listed.**Chemicals known to cause developmental toxicity:** None of the ingredient is listed.**Carcinogenic Categories:****EPA (Environmental Protection Agency):** None of the ingredient is listed.**TLV (Threshold Limit Value established by ACGIH):** None of the ingredient is listed.**NIOSH-Ca (National Institute for Occupational Safety and Health):** None of the ingredient is listed.**OSHA-Ca (Occupational Safety & Health Administration):** None of the ingredient is listed.**Canada:****Canadian Domestic Substances List (DSL):** All ingredients are listed.**Canadian Ingredient Disclosure list (limit 0.1%):** None of the ingredient is listed.**Canadian Ingredient Disclosure list (limit 1%):**

497-19-8	Sodium Carbonate
7722-88-5	Tetrasodium pyrophosphate
151-21-3	Sodium dodecylsulphate

15.2 Chemical safety assessment: A Chemical Safety Assessment has not been carried out.

16 Other Information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Relevant phrases:

H320: Causes eye irritation.

Safety Data Sheet
according to 1907/2006/EC (REACH), 1272/2008/EC (CLP), and
GHS

Effective date: 11/20/2014

Revision: 05/12/2015

ALCONOX

Abbreviations and Acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
IMDG: International Maritime Code for Dangerous Goods.
DOT: US Department of Transportation.
IATA: International Air Transport Association.
GHS: Globally Harmonized System of Classification and Labelling of Chemicals.
ACGIH: American Conference of Governmental Industrial Hygienists.
NFPA: National Fire Protection Association (USA).
HMIS: Hazardous Materials Identification System (USA).
WHMIS: Workplace Hazardous Materials Information System (Canada).
VOC: Volatile Organic Compounds (USA, EU).
LC50: Lethal concentration, 50 percent.
LD50: Lethal dose, 50 percent.

SDS Created by:

Global Safety Management, Inc.
10006 Cross Creek Blvd
Tampa, FL, 33647
Tel: 1-844-GSM-INFO (1-844-476-4636)
Website: www.GSMSDS.com

Appendix E

Unexploded Ordnance Personnel Qualifications Certification Letter

Certification Letter	E-1
SUXOS Qualifications	E-2
UXOSO/UXOQCS Qualifications	E-13

This page intentionally left blank.



August 20, 2015

Ms. Kimberly Gross
Project Manager
USACE - Baltimore District
10 South Howard Street
Baltimore, MD 21201

RE: Personnel Qualifications
Contract No. W912QR-13-D-0001, Task Order 0001
Radford Army Ammunition Plant, Virginia

Dear Ms. Gross:

I certify that the personnel listed below meet or exceed the qualifications for the functions they will perform (per Technical Paper 18).

Don Ebersole, SUXOS
Darren Harbeck, UXOSO/UXOQCS

Additionally, the personnel meet Bering Sea Eccotech's contractual requirements. If you have any questions please contact me via email or call (757) 604-1173.

Regards,

A handwritten signature in black ink, appearing to read "SS", is shown within a rectangular box.

Sarah Skrobialowski
Project Manager
sskrobialowski@bsenv.com

Enclosure: Resume and Certifications of above listed personnel

UXO QUALITY CONTROL SUPERVISOR



DONALD E. EBERSOLE

USACE NUMBER: 440

DATE COMPLETED BASIC EOD SCHOOL: MAY 1975

OTHER PERTINANT INFORMATION: 40 HOUR HAZARDOUS WASTE COURSE, MAY 1993; 8 HOUR HAZARDOUS WASTE SUPERVISOR, MAY 1993; CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS, FEB 2013; FIRST AID / CPR, JUN 2015; CURRENT BI-ANNUAL PHYSICAL, AUG 2015; 8 HOUR HAZARDOUS WASTE REFRESHER COURSE, NOV 2014

MILITARY EOD ASSIGNMENTS:

MAY 75-APR 76	EOD Specialist, 438 Supply Squadron (EOD), McGuire AFB, NJ Member of EOD Response Team.
MAY 76-MAY 77	EOD Specialist, 5071 Air Base Group (EOD), King Salmon Airport, AK Member of 2 Man Response Team.
JUN 77-JUN 82	EOD Supervisor, 56 Equipment Maintenance Squadron (EOD), MacDill AFB, FL. Planned and supervised operations of EOD team during range clearance operations at Avon Park Bombing and Gunnery Range, FL; Branch Explosive/Ground Safety NCO; Squadron Exercise Evaluator (QC).
JUL 82-MAY 85	EOD Supervisor, 43 Munitions Maintenance Squadron (EOD), Anderson AFB, Guam. Supervised EOD response team on WW II ordnance RSP and Disposal Operations. Supervised Joint Service Disposal Operations. Squadron Explosive/Ground Safety NCO; Squadron Exercise Evaluator (QC).
JUN 85- JUL 91	EOD Supervisor/ Senior EOD Supervisor, 2701 Explosive Ordnance Disposal (EOD) Squadron, Hill AFB, UT. Planned, budgeted, and managed subsurface clearance of rail garrison test facility at Vandenberg AFB, CA. Range Safety Officer on numerous explosive operations and tests with government contractors; Range Safety Officer on numerous range clearance operations at the Utah Test and Training Range, UT; Exercise Evaluator (QC) Team Spirit 87; Squadron Explosive/ Ground Safety NCO. RETIRED

CIVILIAN UXO EXPERIENCE:

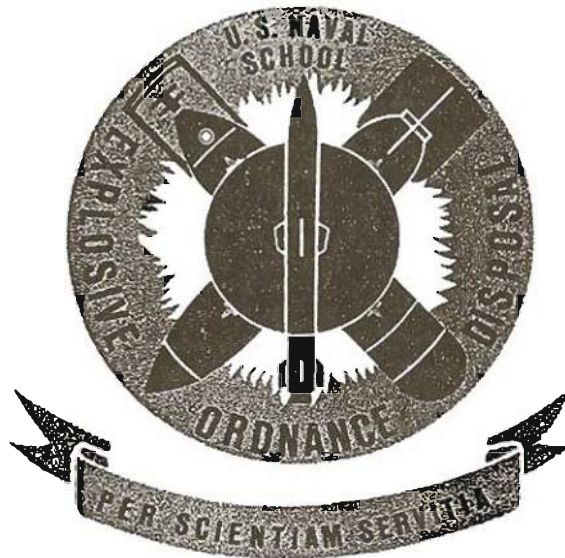
NOV 92-APR 93	UXO Supervisor, Environmental Chemical Corporation, former Camp Elliot, CA. UXO Team Leader.
APR 93-OCT 93	UXO Supervisor, Wyle Laboratories, Idaho National Engineering Laboratory, ID. UXO Team Leader and DOE Licensed Blastman.
NOV 93-DEC 93	Site Safety and Health Officer, Wyle Laboratories Idaho National Engineering Laboratory, ID. Site safety for soil remediation project.
MAR 94-MAY 94	UXO Supervisor, Wyle Laboratories, Water Island, St. Thomas, US Virgin Islands. UXO Team Leader.
JUN 94-DEC 94	UXO Supervisor, Wyle Laboratories, Idaho National Engineering Laboratory ID. UXO Team Leader and DOE Licensed Blastman.

MAY 95-MAY 95	UXO Supervisor, Wyle Laboratories, Culebra Island, Puerto Rico. UXO Team Leader.
JUL 95-SEP 95	UXO Supervisor, Wyle Laboratories Garfield Flats Drop Test Area, NV. UXO Team Leader.
OCT 95-DEC 95	UXO Specialist/Supervisor, UXB International Inc, HI. UXO Dig Team Member, UXO Supervisor of Backhoe Digging Operations at the Model Cleanup Project, Kahoolawe Island.
JAN 96-APR 96	UXO Supervisor, Wyle Laboratories Chino Hills, CA. UXO Team Leader at the Areojet Ordnance Facility.
MAY 96-MAY 96	UXO Specialist, MTA Inc, Pueblo Army Depot, CO. UXO Team Member on Archaeologists escort duty.
JUN 96-JUN 96	UXO Supervisor, Scientech, Inc, Umatilla Army Depot, OR. UXO Team Leader.
JUL 96-AUG 96	Senior UXO Supervisor, Scientech, Inc, Umatilla Army Depot, OR. Senior UXO on site.
AUG 96-AUG 96	UXO Supervisor, Mta, Inc, Pueblo Army Depot, CO. UXO Team Leader of Down Hole Monitoring Team.
SEP 96-NOV 96	UXO Supervisor/ Senior UXO Supervisor, Scientech, Inc, Idaho National Engineering Laboratory, ID. UXO Team Leader of ordnance assessment team. Promoted to senior UXO Supervisor of the same project.
JAN 97-FEB 97	Senior UXO Supervisor, Scientech, Inc, Idaho National Engineering And Environmental Laboratory, ID. Responsible for research of documents for preliminary scoping track 2 summary report for Operable Unit 10-03 at the Idaho National Engineering And Environmental Laboratory.
MAR 97	Senior UXO Supervisor, Scientech, Inc. Business marketing of UXO Division.
APR 97	UXO Supervisor, Scientech, Inc, Picatinny Arsenal, NJ. Responsible for safe conduct of escorted HAZMAT personnel.
MAY 97-SEP 97	Health and Safety Office/EOD Technical Oversight, Lockheed Martin-Idaho Technologies Corporation, Idaho National Engineering and Environmental Laboratory, ID. Responsible for removal action Plan Compliance and The Health And Safety Compliance of UXO Field Teams.
FEB 98-APR 98	Senior UXO Supervisor, Scientech, Inc, Fort Wingate Depot Activity, NM and Nellis AFB, NV. Responsible for writing documents that controlled UXO operations.
MAY 98-SEP 98	Senior UXO/ Project Manager, Scientech, Inc, FT Wingate Army Depot Activity, NM. Responsible for all UXO activities for Bldg. 503 demolition. Responsible for ensuring compliance with all required Corps of Engineers and federal regulations during this time.
OCT 98-JAN 99	Senior UXO Supervisor, Scientech, Inc, Nellis Range, Indian Springs, NV. Responsible for certifying range debris as ordnance free for recycling.
JAN 99-JUL 99	Senior UXO Supervisor, Scientech, Inc, Ft Wingate, NM. Responsible for searching and certifying debris as ordnance free during landfill removal project.
AUG 99	UXO Technician, UXB International, Marshall Islands. Responsible for EOD support for all ordnance related incidents on Kwajalein Atoll and surrounding Atolls.
OCT 99-JAN 00	UXO Technician, UXB International, Marshall Islands. Responsible for EOD support for all ordnance related incidents on Kwajalein Atoll and surrounding Atolls.
JAN 00-APR 00	Independent 3rd Party QA, REST Corp, Melrose Range, NM and Goldwater Range, AZ. Responsible for certifying range residue as ordnance free for recycling.

MAY 00	UXO Technician, MTA Inc, Badlands Bombing Range, ND. Responsible for UXO Avoidance and Soil Sampling.
AUG 00	UXO Technician, UXB International Umatilla Army Depot, OR. Responsible for UXO Avoidance and Soil Sampling.
SEP 00	UXO Supervisor, UXB International, Defense Depot Ogden, UT. Responsible for directing team operations during site setup of CWM recovery site.
OCT 04-NOV 04	Senior UXO Supervisor, BSE/REST Corp, Savannah Army Depot, IL. Responsible for Site Operations during soil sifting operation.
NOV 04-FEB 05	Senior UXO Supervisor, BSE/REST Corp, Utah Test And Training Range, UT. Responsible for team operations during range residue recycling operations.
FEB 05-MAY 05	Site Superintendent, BSE/REST Corp, Avon Park Bombing Range, FL. Responsible for operations during sub-surface survey completed for the US Navy.
MAY 05-JAN 06	Site Superintendent, BSE/REST Corp, NAS Fallon, NV. Responsible for inspection and certification of target debris for shipment to Hawthorne Army Depot.
FEB 06-APR 06	Site Superintendent, BSE/REST Corp, Camp Keller Firing Range, MS. Responsible for sub-surface clearance operations conducted.
APR 06	Independent 3rd Party QA, REST Corp, Pinecastle Range, FL. Responsible for oversight during range residue recycling being conducted.
MAY 06-JUN 06	Senior UXO Supervisor, BSE/REST Corp, Ft. Richardson, AK. Responsible for escorting CRREL personnel throughout the Eagle River Flats Impact Area.
JUL 06-AUG 06	Independent 3rd Party QA, REST Corp, Boardman, OR. Responsible for certifying range residue as ordnance free for recycling at the Naval Weapons System Training Facility.
SEP 06	Senior UXO Supervisor, BSE/REST Corp, Ft. Richardson, AK. Responsible for escorting CRREL personnel throughout the Eagle River Flats Impact Area.
OCT 06-DEC 06	UXO Tech III, BSE/REST Corp, Fallon NAS, NV. Responsible for clearance operations at various sites around Lone Rock, B20 Range.
DEC 06-JAN 07	Site Superintendent, BSE/REST Corp, Palmdale AAF, CA. Responsible for all sift operations.
JAN 07-MAR 07	Independent 3rd Party QA, REST Corp, Boardman, OR. Responsible for certifying range residue as ordnance free for recycling at the Naval Weapons System Training Facility.
APR 07-JUN 07	Independent 3rd Party QA, REST Corp, Camp Pendleton, CA. Responsible for certifying range residue as ordnance free for recycling at AFA 17 Operations.
JUL 07-FEB 08	Independent 3rd Party QA, REST Corp, NAS Fallon, NV. Responsible for certifying range residue as ordnance free for recycling at various ranges.
MAR 08-DEC 08	Independent 3rd Party QA, REST Corp, Camp Pendleton, CA. Responsible for certifying range residue as ordnance free for recycling at AFA 17 Operations.
JAN 09-MAR 09	Independent 3rd Party QA, REST Corp, NAF El Centro, CA. Responsible for certifying range residue as ordnance free for recycling.
APR 09-JUN13	UXO Quality Control Manager, Bering Sea Eccotech, Various Locations. Responsible for ensuring compliance with requirements of existing contracts and SOP'S.
JUN13-SEP 13	UXO Quality Control Manager/SUXOS, Bering Sea Eccotech, NSA Panama City, FL. Responsible for ensuring compliance with requirements of existing contracts and SOP's for various locations. Supervised Geophysical surveying to identify anomalies, and Surface and Sub Surface Range Clearance of the land sector to allow movement of the LCAC across the affected property, the affected

	property within the Non-Magnetic Testing Areas and the Tidal Wetlands area at NSA Panama City, FL.
SEP 13-MAY 14	UXO Quality Control Manager, Bering Sea Eccotech, Various Locations. Responsible for ensuring compliance with requirements of existing contracts and SOP'S.
MAY 14-NOV 14	UXO Quality Control Manager/SUXOS, Bering Sea Eccotech, Waikane Impact Area Remedial Action, Oahu, HI. Supervised Vegetation Removal, Geophysical surveying to identify anomalies, and Surface and Sub Surface Range Clearance of the land in the Impact area.
NOV 14-JAN 15	UXO Quality Control Manager, Bering Sea Eccotech, responsible for ensuring compliance with requirements of existing contracts and SOP'S
JAN 15-MAY 15	UXO Quality Control Manager/SUXO, Bering Sea Eccotech, Pohakuloa Training Area, HI. Supervised Surface Clearance Operations and Construction Support Operations in the Impact Area for the installation of the Urban Close Air Support Target and Aviation Bulls-eye Range project.
JUN 15	UXO Quality Control Manager, Bering Sea Eccotech. Conducted site Quality Control Staff Assistance Visit to BSEn operations at Pinecastle Bombing Range, Ocala, FL
JUL 15	UXO Quality Control Manager/SUXO, Bering Sea Eccotech, Supervised Surface and Subsurface Range Clearance Operations at Douglas Border Patrol Station, Douglas, AZ.
AUG 15-Present	UXO Quality Control Manager/SUXO, Bering Sea Eccotech, Waikane Impact Area Remedial Action, Oahu, HI. Responsible for document approval and all actions preparing for upcoming mobilization to Waikane Valley.

Naval School Explosive Ordnance Disposal



This certifies that

SERGEANT DONALD E. FRERSON, 184-44-0303, USAP

having successfully completed
the prescribed course of study for

EXPLOSIVE DISPOSAL SPECIALIST - 5A7N46430 - PDS: CLO 16wk/3da

is awarded this
Certificate

this 16TH day of MAY A.D. 1975


D. L. SCHAEFER, CDR, USN
COMMANDING OFFICER

U. S. Army

Missile & Munitions School

Redstone Arsenal, Alabama



Certificate

Sgt DONALD E. EBERSOLE

has successfully completed a course of 2 weeks duration

in

EXPLOSIVE ORDNANCE DISPOSAL, (ARMY) 4E-F3/431-55D20

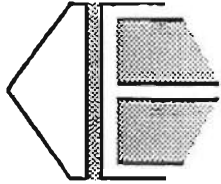
at the

U. S. Army Missile And Munitions Center And School

12 December 1974

ERROL E. HAYES, JR.
Colonel, Ordnance Corps
Commandant





**IESMC Industrial/Environmental
Safety Management Consulting**

Certifies that

DONALD E EBERSOLE

has been awarded this certificate for successfully completing

40 Hour Hazardous Waste Site Worker Training

in accordance with 29 CFR 1910.120

Conducted on 05-24-93

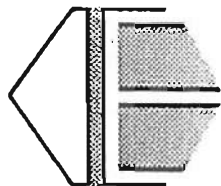
SS#:184-44-0303

CERT# 5934005

5-24-93

Date


James C. Meldrum, Founder



**IESMC Industrial/Environmental
Safety Management Consulting**

Certifies that

DONALD EBERSOLE

*has been awarded this certificate for successfully completing
8 Hour Supervisory Hazardous Waste Activities*

in accordance with 29 CFR 1910.120

Conducted on MAY 25, 1993

SS#184-44-0303

5-25-93

Date

James C. Meldrum

James C. Meldrum, Founder

Certificate of Completion

This certifies that

Donald Ebersole

Has Successfully completed

8 Hour HAZWOPER Supervisor Refresher Training

This certification alone does NOT indicate INITIAL 8 Hour OSHA Supervisor Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120

And all State OSHA/EPA Regulations as well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs

Julius P. Griggs
Instructor #892

141128534285

Certificate Number

11/28/2014

Issue Date



UNLIMITED, Inc.

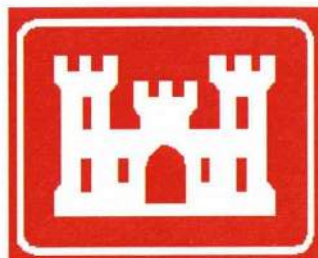
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-869-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training
Want to be sure this certificate is valid? Visit safetyunlimited.com/verification



USACE LEARNING CENTER
HUNTSVILLE, ALABAMA



CERTIFICATE

Donald Ebersole

SW9-01-13-00049

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

Las Vegas, Nevada

Location

February 1 & 2, 2013

Training Date(s)

SW9 - NAVFAC Southwest

Instructional District/ NAVFAC

Michael Haliburton PMP, PE

CQM-C Manager

Walter F. Buchanan, P.E.

Facilitator/Instructor

walter.buchanan1@gmail.com

Email

619-791-9502

Telephone

Facilitator/Instructor Signature

Chief, USACE Learning Center

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: <https://www.myuln.net>



PHYSICIAN'S WRITTEN OPINION MEDICAL CLEARANCE

Employee Name: DONALD EBERSOLE

Date: 9 AUG 2013

TYPE OF EXAM:

PRE-EMPLOYMENT ☐ RECURRING ☒ OTHER ☐

Note: Due to the nature of duty, clearance results of this exam will remain valid for two years unless otherwise indicated by the attending physician.

DATE OF BIRTH 9/7/1953 SOCIAL SECURITY NUMBER 184-44-0303

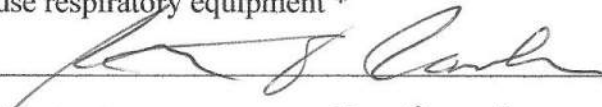
The individual named above has:

- 1) Undergone a physical examination per OSHA (29 CFR 1910.120 (f)) and has been found medically:

(☒) qualified for hazardous site work
(☐) not qualified for hazardous site work*

- 2) Undergone a physical examination per OSHA (29 CFR 1910.134 (e)) and has been found medically:

(☒) qualified to use respiratory equipment
(☐) not qualified to use respiratory equipment *

Physician's Signature: 

Printed Name of Physician: Steven J. Saul MD

Address: 2306 HIGHWAY 77 PANAMA CITY, FL 32405

Phone Number: (850) 763-9744

Physician's State License Number: ME 44362 / Florida

Copies of test results are maintained and available at: Bay Walk-In Clinic 2306 Hwy 77 Panama City, FL 32405

Address

Bay Walk-In Clinic
2306 Hwy 77
Panama City, FL 32405

OSHA 1910.120 states that persons should not be assigned to tasks requiring the use of respiratory equipment unless it has been determined that they are physically able to perform the work and use the equipment safely.

*The physician should append his report detailing the reason for this opinion.

Darren L. Harbeck

UXO - Technician III

Mr. Harbeck has more than 21 years of experience in Unexploded Ordnance (UXO) and Explosive Ordnance Disposal (EOD) operations. As a Senior UXO Supervisor (SUXOS) he supervises all field operations of a UXO project that include site mobilization and demobilization, site setup, coordination with subcontractors, ensures compliance with all project planning documentation, ensures implementation of the QC/QA program, supervises geophysical and UXO teams, manages explosives delivered and stored on project site, safely manages on-site disposal of munitions and explosives of concern (MEC) items, and ensures all procedures for processing munitions potentially presenting explosive hazards (MPPEH) are adhered to. Mr. Harbeck has expertly supervised surface and subsurface ordnance removal operations at various military and Formerly Used Defense Sites (FUDS) in the United States. He has managed the coordination, administrative, and operational components of UXO location and recovery teams performing clearance and disposal operations on a multitude of vintage and current ordnance items in wide ranging environments.

EDUCATION

Naval Explosive Ordnance Disposal School 05/13/1995

REGISTRATIONS

OSHA 40HR HAZWOPER
OSHA 8HR HAZWOPER Refresher
OSHA 8HR Supervisor Training
OSHA 30HR Construction Safety
50HR Site Safety Officer
USACE Construction Quality Management
Excavation Competent Person Training
Confined Space: Entry Supervisor (ENT & ATT)
Red Cross First Aid & CPR

INDUSTRY TENURE

21 years

HDR TENURE

3 years

OFFICE LOCATION

Englewood, CO

AWARDS

2013 HDR Pathfinder Award of Excellence, for Production & Performance.

RELEVANT EXPERIENCE

Eglin AFB, SR 123 Multi-lane Reconstruction Project

FDOT, Eglin AFB, Florida, 05/2014 – Present. Description/Role: Senior UXO Supervisor. Oversight of all field operations for approximately 10 personnel. Duties include implementation of all planning documentation, field procedure development, staffing, quality control, cost control, Explosive Safety Submission implementation, safely manage on-site disposal of MEC, supervise the processing of all MMPEH, and document and ship all MDAS (material documented as safe) for demilitarization. Removal Action consisting of construction support, anomaly avoidance, visual surveys, technology assisted surface removal, mag and dig/map and dig of 140 acres.

Eglin AFB, MBBA Culvert Restoration, Mid Bay Bridge Authority, Ft. Walton Beach Florida 05/2014-05/2014. Description/Role: UXO Technician III. Executed anomaly avoidance for five culvert excavations and replacements.

Air-To-Ground Gunnery Range Removal Action, USACE-Omaha, Aurora, Colorado 10/2012-01/2014. Description/Role: Senior UXO Supervisor. Oversight of all field operations for approximately 30 personnel. Duties included the implementation of all planning documentation, field procedure development, explosives licensing/permitting, staffing, quality control, public participation, cost control, Explosive Safety Submission implementation, safely manage on-site disposal of MEC, supervised the processing of all MMPEH, documented and shipped all MDAS for demilitarization, audit all field generated paperwork, write Daily/Weekly Site Reports. Removal Action consisting of visual surveys, technology assisted surface removal, mag and dig/map and dig of 411 acres. To date the project has removed over 5756 lbs. of munitions debris and 20 MEC disposal events.

Tennessee Pass Range Complex, Former Camp Hale, RI/FS, USACE-Omaha, Camp Hale, CO 06/2012–10/2012. Description/Role: UXO Technician III, Served as a Team leader for a 7 person UXO team during intrusive operations, escorted a 3

person team during visual surveys, and removal/disposal of MEC/MD.

NON-HDR EXPERIENCE

Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 05/2005–02/2012. Description/Role: Alternate Senior UXO Supervisor/UXO Tech III, UXO Tech II. Supervised all site activities to include team operations, satisfactory completion of all grids, demolition operations, incoming shipments of explosives, weekly explosives inventories, inspect all Munitions Debris for energetic materials, audit all field generated paperwork, and write Daily/Weekly Site Reports when performing as the Alternate SUXOS. Perform as Site Safety Officer in Primary's absence. Review all Project Procedures, Work Plan, Site Safety and Health Plan, Explosive Safety Submission, State and Federal Regulations to ensure site compliance. Performed as a Team Leader for a 7 person UXO Team during surface and subsurface clearance operations.

Buckley AFB CSE Phase II, USACE-Omaha, Aurora, Colorado 10/2009–09/2010. Description/Role: Alternate Senior UXO Supervisor/UXO Technician III. Supervised all site activities to include team operations, satisfactory completion of all grids, demolition operations, incoming shipments of explosives, weekly explosives inventories, inspect all Munitions Debris for energetic materials, audit all field generated paperwork, and write Daily/Weekly Site Reports when performing as the Alternate SUXOS. Served as UXO Team Leader of Comprehensive Site Evaluation Phase II, including lead remediation and removal of firing berm. Investigation and removal/disposal of MEC and MD.

Schofield Barracks Active Range Complex, USACE, Zapata, Schofield Barracks, Hawaii 10/2004–04/2005. Description/Role: UXO Technician II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD.

Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 05/1999 – 10/2004. Description/Role: UXO Tech II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Activities conducted also included OB/OD pit excavations, sift plant operations, anomaly avoidance, MC sampling, construction support, and visual surface sweeps. Removal Action activities occurred on 12 OAC's including mortar, rocket, bombing, and gunnery targets.

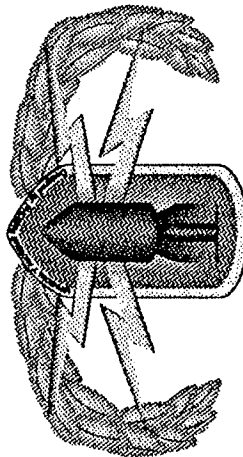
Balboa Range, Panama, USACE-Huntsville, Panama 01/1999 – 05/1999. Description/Role: UXO Technician II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Removal Action activities were in support of the planned construction to widen the panama canal.

Former Lowry Bombing and Gunnery Range, USACE-Omaha, Aurora, Colorado 07/1998 – 01/1999. Description/Role: UXO Tech II performed MMRP Removal Action activities including the detection, identification, removal, and disposal of MEC/MD. Activities conducted also included OB/OD pit excavations, sift plant operations, anomaly avoidance, construction support, and visual surface sweeps. Removal Action activities occurred on 12 OAC's including mortar, rocket, bombing, and gunnery targets.

Military EOD Assignments, Fort Carson, Colorado, United States Army, 94th EOD 07/1995 – 08/1998. Description/Role: EOD Sergeant, Served as an EOD team member, unit armor, and Training NCO.



Naval School Explosive Ordnance Disposal



Certificate of Completion

Presented to

SPC Darren L. Harbeck, USA

For having successfully completed the prescribed course of study for

EXPLOSIVE ORDNANCE DISPOSAL

PHASE 1 & 11 - SURFACE

on this, the Thirteenth day of June 1995.



Commanding Officer

CPR J. R. Lake USN



United States Army
Headquarters, 52D Ordnance Group (EOD)
Fort Gillem, Georgia



This is to certify that:

SPC Darren L. Harbeck, 336-68-2043

having completed 40 hours of instruction and demonstrated knowledge of the
Hazardous Materials Incident Command System and the environmental regulations
regarding military ordnance and explosive waste, is hereby designated a

Specialist Employee for Ordnance and Explosive Waste

IAW 29 CFR 1910.120(q)(5)

19 July 1996

Date

EDWARD L. WOODFORD, CHMM
Primary Instructor



Certificate of Completion

This certifies that

Darren Harbeck

Has Successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA and EPA Regulations As Well

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) issued by Safety Unlimited, Inc. (Accreditation # 044)

Julius P. Griggs

Julius P. Griggs
Instructor #892

150219579010

Certificate Number

2/19/2015

Issue Date



UNLIMITED, Inc.

OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley, CA 93063
888 309-SAFE (7233) or 805 306-8027 866-869-7097 (fax)
www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training
Want to be sure this certificate is valid? Visit safetyunlimited.com/verification

This certificate is awarded to

Darren Harbeck

for the successful completion of the course

8-Hour HAZWOPER Supervisor Training

Hours: 8 hours 0 min Credits: 0

Completion Date: 5/6/2010




Montague S. Yeckie, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



This certificate is awarded to

Darren Harbeck

for the successful completion of the course

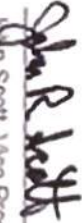
OSHA 30 Hour Construction Safety

Hours: 30 hours 0 min Credits: 0

Completion Date: 5/6/2010




Monique S. Vocke, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



This certificate is awarded to

Darren Harbeck

for the successful completion of the course

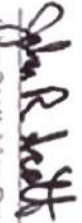
Site Safety Officer

Hours: 50 hours 0 min Credits: 0

Completion Date: 5/7/2010




Monique S. Vocke, Sr. Director, HR Centralized Services
Human Resources Department


John Scott, Vice President
Environmental Health & Safety



CERTIFICATE

Darren Harbeck

NWO-70-12-00050

has completed the Corps of Engineers and Naval Facility Engineering Command Training Course

CONSTRUCTION QUALITY MANAGEMENT FOR CONTRACTORS - #784

Denver, CO	10 April 2012	NWO - Omaha District	Louis Richardson
Location	Training Date(s)	Instructional District/ NAVFAC	CQM-C Manager
Peter L. Sturdivant	peter.l.sturdivant@usace.army.mil	719-333-2975	Facilitator/Instructor Signature
Facilitator/Instructor	Email	Telephone	

Peter L. Sturdivant

THIS CERTIFICATE EXPIRES FIVE YEARS FROM DATE OF ISSUE
CQM-C Recertification online course: <https://www.myuln.net>

Director, USACE Learning Center



American Safety & Health Institute
1450 Westec Drive
Eugene, OR 97402
800-447-3177

Friday, August 14, 2015
Darren Harbeck

Dear Darren

Congratulations on successfully completing your American Safety & Health Institute Basic First Aid/CPR and AED for Adult/Child/Infant class. In an effort to be more environmentally friendly your ASHI Approved Training Center has chosen to issue your certification card electronically.

The digital certification card below is identical to a printed version of the card and documents that a properly authorized ASHI Instructor evaluated your knowledge and hands on skills in accordance with the program standard. You may duplicate this page as needed to provide proof of your training.

Go online to access your ASHI Passport and take advantage of the additional training resources available to you:

- Digital download of Student Handbook
- LearningLinks™ Refresher Scenarios
- Mobile Application Downloads
- E-mail Renewal Notification
- Rate Your Program Survey

Register now at www.hsi.com/passport/. Use the registration code 2662 to register.

HDR Inc
8404 Indianhills Dr
Omaha, NE 68114



Darren Harbeck

has successfully completed and competently performed
the required knowledge and skill objectives for this program.

- ☐ Adult
☐ Child and Infant
☒ Adult, Child, and Infant

Card is void if more than one box is checked.



ASHI-Approved Certification Card

Daniel Sciarro

Authorized Instructor (Print Name)

286834

Registry No.

05/07/2015

Class Completion Date

907-644-2044

Training Center Phone No.

05/07/2017

Expiration Date

161504

Training Center I.D.

This card certifies the holder has demonstrated the required knowledge and skill objectives to a currently authorized ASHI Instructor. Certification does not guarantee future performance, or imply licensure or credentialing. Course content conforms to the 2010 AHA Guidelines for CPR and ECC, and other evidence-based treatment recommendations. Certification period may not exceed 24 months from class completion date. More frequent reinforcement of skills is recommended.