FINAL
WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA
MRS-R01, RANGE II; MRS-R02, RANGE III; MRS-R03, RANGE IV; MRS-R09, MACHINE GUN /RIFLE RANGE
(U.S. ARMY CORPS OF ENGINEERS, CHARLESTON DISTRICT)

CONTRACT NO. W912DY-10-D-0023
TASK ORDER NO. 0018

Prepared for

U.S. Army Corps of Engineers
U.S. Army Engineering and Support Center, Huntsville

Prepared by:

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Suite 400
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July 2015

Approved by:
Corporate Quality Management Representative _____ 7/15/15
Neil Feist Date

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REMEDIAL INVESTIGATION/FEASIBILITY STUDY
MILITARY MUNITIONS RESPONSE SITES
FORMER CONWAY BOMBING AND GUNNERY RANGE
MRS-R01, RANGE II; MRS-R02, RANGE III; MRS-R03, RANGE IV;
MRS-R09, MACHINE GUN /RIFLE RANGE
HORRY COUNTY, SOUTH CAROLINA

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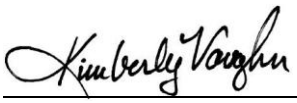

07/15/15

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LIST OF ACRONYMS AND ABBREVIATIONS

3PIP	three phase inspection process
AAB	Army Air Base
AAF	Army Air Field
ADD	average daily dose
ADE	average daily exposure
AHA	activity hazard analysis
APP	Accident Prevention Plan
AR	Army Regulation
ARAR	applicable or relevant and appropriate requirement
ASR	Archives Search Report
ATF	Bureau of Alcohol, Tobacco, Firearms and Explosives
ATFP	Alcohol, Tobacco and Firearms Publication
AUF	area use factor
BDC	Bomb Data Center
BERA	baseline environmental risk assessment
BGEPA	Bald and Golden Eagle Protection Act
BGR	Bombing and Gunnery Range
bgs	below ground surface
BIP	blown-in-place
BW	body weight
°C	degrees Celsius
cal	caliber
CAR	corrective action request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CO	Contracting Officer
COC	contaminant of concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
CWM	chemical warfare materiel
DA	Department of the Army
DD	Decision Document
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
DFW	definable feature of work
DGM	digital geophysical mapping

DID	Data Item Description
DMM	discarded military munitions
DoD	Department of Defense
DOT	Department of Transportation
DQCR	Daily Quality Control Report
DQO	data quality objective
Eco-SSL	ecological soil screening level
EE/CA	Engineering Evaluation/Cost Analysis
EIS	Environmental Impact Statement
EM	Engineer Manual
EOD	explosive ordnance disposal
EODT	EOD Technology, Inc.
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPP	Environmental Protection Plan
ER	engineer regulation
ERA	ecological risk assessment
ERM	Environmental Resources Management
ESA	Endangered Species Act
ESL	ecological screening level
ESP	Explosives Site Plan
EZ	exclusion zone
FAR	Federal Acquisition Regulation
FIR	food ingestion rate
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet/foot
FUDS	Formerly Used Defense Site
FY	fiscal year
GIP	geophysical investigation plan
GIS	geographical information system
GPS	Global Positioning System
HA	hazard assessment
HAZMAT	hazardous material
HAZWOPER	Hazardous Waste Operations and Emergency Response
HGL	HydroGeoLogic, Inc.
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient

HVAR	high velocity aircraft rocket
IAW	in accordance with
IC	institutional control
IDW	investigation derived waste
IGD	interim guidance document
IRIS	Integrated Risk Information System
IS	incremental sampling
ISM	incremental sampling methodology
ISO	industry standard object
ITRC	Interstate Technology & Regulatory Council
IVS	instrument verification strip
lb	pound
LD_{50}	median lethal dose
LOAEL	lowest observed adverse effect level
MC	munitions constituent
MCL	maximum contaminant level
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
MG	machine gun
MGFD	munition with greatest fragmentation distance
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MIS	multi-incremental sample
mL	milliliter
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MR	munitions response
MRS	munitions response site
MRSPP	munitions response site priority protocol
MSD	minimum separation distance
NAS	National Academy of Sciences
NDAI	No DoD Action Indicated
NEW	net explosive weight
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPS	National Park Service

OE	ordnance and explosives
OESS	Ordnance and Explosives Safety Specialist
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
%	percent
PA	Preliminary Assessment
PDCA	Plan-Do-Check-Act
PDT	project delivery team
PEL	permissible exposure limit
PM	Project Manager
PMP	Project Management Plan
PP	Proposed Plan
PPE	personal protective equipment
PWS	performance work statement
QA	quality assurance
QAPP	Quality Assurance Project Plan
QASP	Quality Assurance Surveillance Plan
QC	quality control
QCP	Quality Control Plan
QMS	Quality Management System
RAB	restoration advisory board
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RCWM	Recovered Chemical Warfare Materiel
RI	Remedial Investigation
RME	reasonable maximum exposure
ROE	right-of-entry
RR	rifle range
RRD	range related debris
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SCDAH	South Carolina Department of Archives and History
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Environment and Natural Resources
SDSFIE	Spatial Data Standards for Facilities, Infrastructure and Environment
SI	Site Investigation
SIR	soil ingestion rate
SLERA	screening level ecological risk assessment

SLV	screening level value
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SU	sampling unit
SUF	seasonal use factor
SUXOS	Senior Unexploded Ordnance Supervisor
TBD	to be determined
TCLP	toxicity characteristic leaching procedure
TCRA	Time Critical Removal Action
TCT-St. Louis	Twin City Testing – St. Louis
TM	technical manual
TNT	2,4,6-trinitrotoluene
TO	task order
TP	Technical Paper
TPP	technical project planning
TRV	toxicity reference value
TSERAWG	Tri-Services Environmental Risk Assessment Work Group
UCL	upper confidence level
UF	uncertainty factor
UFP	Uniform Federal Policy
USABTAG	U.S. Army Biological Technical Assistance Group
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAESCH	U.S. Army Engineering and Support Center, Huntsville
U.S.C.	U.S. Code
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VOC	volatile organic compound
VSP	Visual Sampling Plan
WERS	Worldwide Environmental Remediation Services
WP	Work Plan
WWII	World War II

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FINAL
WORK PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA

1.0 INTRODUCTION

1.0.1 This Work Plan (WP) has been prepared by HydroGeoLogic, Inc. (HGL) for the U.S. Army Engineering Support Center, Huntsville (USAESCH) under Worldwide Environmental Remediation Services (WERS) Contract No. W912DY-10-D-0023, Task Order (TO) No. 0018, for a Remedial Investigation (RI)/Feasibility Study (FS) at the Former Conway Bombing and Gunnery Range (BGR) in Horry County, South Carolina. The WP was prepared to meet the performance objectives required by the TO performance work statement (PWS) dated April 11, 2013 (Appendix A). This WP details the technical approach for completion of TO component activities and provides procedures to conduct an RI/FS for the following four munitions response sites (MRSs):

- MRS-R01, Range II (Formerly Used Defense Site [FUDS] Project No. I04SC002501R01)
- MRS-R02, Range III (FUDS Project No. I04SC002501R02)
- MRS-R03, Range IV (FUDS Project No. I04SC002501R03)
- MRS-R09, Machine Gun (MG)/Rifle Range (RR) (FUDS Project No. I04SC002501R09)

1.0.2 Figure B.1 shows the location of the four MRSs at the Former Conway BGR.

1.1 PROJECT AUTHORIZATION

1.1.1 The RI/FS at the Former Conway BGR MRSs will be executed in accordance with (IAW) the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent applicable, the National Oil and Hazardous Pollution Contingency Plan (40 Code of Federal Regulations [CFR], Part 300). The RI/FS is being implemented under the Military Munitions Response Program (MMRP), which was created by the fiscal year (FY) 2002 National Defense Authorization Act by modifying the Defense Environmental Restoration Programs (DERP) to address munitions and explosives of concern (MEC) and munitions constituents (MCs) contamination on inactive, nonoperational military ranges. All applicable U.S. Department of Defense (DoD), Department of the Army (DA), and U.S. Army Corps of Engineers (USACE) regulations and guidance will be followed.

1.1.2 The Army is the lead agency responsible for the RI/FS at the Former Conway BGR. RI/FS activities will be conducted with regulatory coordination, as appropriate, with the U.S. Environmental Protection Agency (EPA), Region 4, and the South Carolina Department of Environment and Natural Resources (SCDNR).

1.2 PURPOSE AND SCOPE

1.2.1 An RI of the Former Conway BGR was conducted by EOD Technology, Inc. (EODT) in 2012. However, due to limitations on the Rights-of-Entry (ROEs), only a limited amount of the fieldwork could be performed. The EODT RI presented the following summary of results and recommendations for MRS-R01 (Range II), MRS-R02 (Range III), MRS-R03 (Range IV), and MRS-R09 (MG/RR):

Table 1.1
EODT RI Summary of Results and Recommendations

MRS	Potential MEC Hazards	MEC Hazard Assessment (HA) Level (Current/Future)	MC Risk	Recommendation	Conclusions
MRS-R01 (Range II)	Unlikely	Not assessed	No MC release has occurred	Further investigation	MEC nature and extent not quantified
MRS-R02 (Range III)	Yes	1/1	No MC release has occurred	Further investigation	The area was well delineated during previous investigations. Potential MEC hazards present
MRS-R03 (Range IV)	Unlikely	1/1	No MC release has occurred	Further investigation	Explosive safety hazard not present
MRS-R09 (MG/RR)	Yes	1/1	Not assessed	Further investigation	Potential MEC hazards present, based on previous investigations. No ROE obtained during RI

Source: EODT, 2012

1.2.2 As a result of the EODT recommendations, the purpose of this RI is to (1) collect and analyze the data necessary to determine the nature and extent of MEC and MC contamination at the four MRSs at the Former Conway BGR and (2) conduct a baseline risk assessment to quantify risk and explosives safety concerns to human health and the environment. The purpose of the FS is to ensure that appropriate remedial alternatives are developed and evaluated and that an appropriate remedy is selected. For the MMRP, the FS is the mechanism in the remedial process used to develop, screen, and conduct a detailed evaluation of alternative munitions response options that will result in timely and appropriate decisions for protecting human health, safety, and the environment. Following the FS process, a Proposed Plan (PP) will be prepared for each MRS. The PPs will detail the potential remedies evaluated

and provide the rationale for the selection of the recommended alternative to the public. Finally, a Decision Document (DD) will be prepared for each MRS. The DDs will document the acceptance of the selected remedies. The USAESCH PWS for this TO is provided in Appendix A.

1.2.3 MEC is composed of: 1) unexploded ordnance (UXO); 2) Discarded Military Munitions (DMM); or 3) MC in high enough concentrations to pose an explosive hazard (USACE, 2008). The scope of this RI will focus on determining the nature and extent of UXO at the former Conway BGR because the history of these four MRSs, as explained in Section 1.6, does not suggest the presence of DMM. Although MC has been found, it is has not been present in concentrations high enough to pose an explosive hazard. Therefore, all references to MEC in this RI/FS WP refer to UXO.

1.2.4 This WP presents the primary practices and procedures that will be used to obtain the following field data during the RI/FS project:

- Physical characteristics of the property;
- Characteristics/classification of soils, sediment, and groundwater;
- Characteristics of the MEC/MC (quantities, concentrations, toxicity, persistence, mobility, depth, nature and extent, etc.);
- Actual and potential pathways through environmental media;
- Actual and potential exposure routes; and
- Other factors such as sensitive populations that pertain to the characterization of the site or support the analysis of potential remedial action alternatives.

1.2.5 To guide the collection of field data and meet project objectives, the project delivery team (PDT), USACE, HGL, and South Carolina Department of Health and Environmental Control (SCDHEC) developed data quality objectives (DQOs) for MEC and MC to define the types of decisions that will be made, identify the intended use of the data, and design the requisite field data collection program. A detailed discussion on the MEC and material potentially presenting an explosive hazard (MPPEH) DQOs is featured in Section 4.5 of the Technical Project Planning (TPP) Memorandum (Appendix H).

1.3 WORK PLAN ORGANIZATION

1.3.1 This WP is prepared consistent with Data Item Description (DID) WERS-001.01 and is organized as noted below. Tables are presented within the relevant chapter. Figures are presented in Appendix B.

- Section 1.0 – Introduction
- Section 2.0 – Technical Management Plan
- Section 3.0 – Field Investigation Plan

- Section 4.0 – Quality Control Plan (QCP)
- Section 5.0 – Explosives Management Plan
- Section 6.0 – Environmental Protection Plan (EPP)
- Section 7.0 – Property Management Plan
- Section 8.0 – Interim Holding Facility Siting Plan for Recovered Chemical Warfare Materiel (RCWM) Projects
- Section 9.0 – Physical Security Plan for RCWM Projects
- Section 10.0 – References
- Appendices:
    - Appendix A PWS
    - Appendix B Site Maps
    - Appendix C Points of Contact
    - Appendix D Accident Prevention Plan (APP)
    - Appendix E Quality Assurance Project Plan (QAPP)
    - Appendix F Forms
    - Appendix G HGL Personnel Qualifications Certification Letter
    - Appendix H TPP Technical Memorandum and DQO Worksheets
    - Appendix I Standard Operating Procedures (SOPs)
    - Appendix J Explosives Site Plan (ESP)
    - Appendix K Geophysical Investigation Plan (GIP)

1.4 LOCATION

1.4.1 Former Conway BGR Location

1.4.1.1 The Former Conway BGR historically consisted of 55,854 acres in Horry County, South Carolina, immediately southeast of Conway, South Carolina. There are nine MRSs included within Conway BGR; however, only four are being addressed by this TO. Figure B.1 shows the regional location of the Former Conway BGR and the location of the four subject MRSs.

1.4.2 MRS-R01, Range II

1.4.2.1 MRS-R01, Range II, is located in the northwest section of the Former Conway BGR. The MRS is composed of approximately 649 acres. Figure B.2 illustrates the location of MRS-R01.

1.4.3 MRS-R02, Range III

1.4.3.1 MRS-R02, Range III, is located in the southern section of the Former Conway BGR. The MRS is composed of approximately 1,961 acres. MRS-R02 overlaps the northern boundary of MRS-R09. Figure B.3 illustrates the location of MRS-R02.

1.4.4 MRS-R03, Range IV

1.4.4.1 MRS-R03, Range IV, is located in the eastern section of the Former Conway BGR. The MRS is composed of approximately 886 acres. Figure B.4 illustrates the location of MRS-R03.

1.4.5 MRS-R09, MG/RR

1.4.5.1 MRS-R09, is located in the southern section of the Former Conway BGR. The MRS is composed of approximately 2,503 acres. MRS-R09 overlaps the southern boundary of MRS-R02. Figure B.5 illustrated the location of MRS-R09.

1.5 CONWAY BGR SITE DESCRIPTION

1.5.1 Topography

1.5.1.1 The Former Conway BGR lies within the Lower Atlantic Coastal Plain physiographic province, and elevations range from nearly sea level to about 40 feet (ft) above sea level with slopes generally to the southeast. Generally, the area is wooded with thick underbrush and pine trees, but contains sporadic wetlands, creeks, and Carolina bays/swamps.

1.5.2 Climate

1.5.2.1 The Conway BGR, located in the Atlantic Coastal Region, has a humid subtropical climate. Climate statistics are as follows (EODT, 2012).

- Average annual temperature: 63.5°F
- Average winter temperature: 47°F
- Average summer temperature: 79°F
- Total annual precipitation: approximately 51 inches (approximately 60 percent [%] of the rain falling between April and September)
- Wettest month of the year: July (followed by August and June)
- Snowfall: no measureable amount
- Average relative humidity in mid-afternoon: approximately 60%
- Sunshine: about 65% in summer and 60% in winter
- Prevailing winds direction: South-Southwest
- Highest average wind speed: 10 miles per hour (summer)

1.5.2.2 Based on these climate statistics, there is minimal to no potential for MEC movement from frost heave at the MRSs.

1.5.3 Natural Resources

1.5.3.1 Natural resources associated with Horry County and the Former Conway BGR, such as threatened and endangered species, wetlands, water resources, and sensitive environments, are addressed under Section 6.0, EPP, of this WP.

1.5.4 Cultural Resources

1.5.4.1 Cultural resources are addressed under Section 6.0, EPP, of this WP.

1.6 HISTORY

1.6.1 Conway BGR History

1.6.1.1 Prior to 1940, the Conway BGR area was primarily privately owned and used for timber harvesting and farming. Research has provided no evidence that munitions or explosives were used on the site prior to War Department acquisition (EODT, 2012). From June 1940 to December 1941, the Army Air Corps conducted aerial photographing and charting of the local area. In 1941, the 112th Observation Squadron established support operations for a BGR in the Myrtle Beach area and later provided coastal defense of the area. Live fire training was conducted, including aerial bombing and direct-fire training using rockets, small arms, and small artillery (37 millimeter [mm]) (EODT, 2012).

1.6.1.2 From 1942 through 1947, several Army Air Fields (AAFs) and Army Air Bases (AABs) utilized the Former Conway BGR for various types of airplanes and practice ordnances. In March 1942, 112th Observation Squadron was replaced by a detachment from Savannah AAB. The Myrtle Beach municipal airport became the Myrtle Beach General BGR in March 1942. The range, which was renamed Myrtle Beach AAF on 8 November 1943, was composed of approximately 100,000 acres of land. The AAF consisted of a cantonment area in Myrtle Beach, air to ground gunnery ranges in the Myrtle Beach area, a BGR in the Conway area (Conway BGR), a BGR in the Georgetown area, and crash target boats at Murrells Inlets (EODT, 2012).

1.6.1.3 During World War II (WWII), Myrtle Beach AAF conducted flight, air to ground gunnery, and bombing training for Army Air Corps and Army Air Forces pilots. The principal plane used at Myrtle Beach AAF was the Douglas A-26 Invader; however, other types include the North American B-25 Mitchell, North American P-51 Mustang, Northrop P-61 Black Widow, and Republic P-47 Thunderbolt. Other airfields/bases utilized the Myrtle Beach AAF, including Columbia AAB, Greenville AAB, Florence AAF, Morris Field, and Charleston AAB (USACE, 1995). The Myrtle Beach AAF closed in November 1947.

1.6.1.4 Table 1.2 presents a listing of airplanes used at the Former Conway BGR and associated tactical weapons and ordnance.

Table 1.2
Airplane Use at Conway BGR During WWII

Airplane	Type	Tactical Weapons*	Practice Ordnance
Douglas A-26 Invader	Attack bomber	Up to10 0.50 caliber (cal) machine guns	0.50 cal ball
		4,000-pound (lb) internal bomb load	3-, 20-, 23-, and 100-lb practice bombs
		2,000 lb under-wing bomb load	
North American B-25 Mitchell	Medium bomber	Up to 14 0.50 cal machine guns	0.50 cal ball
		75mm gun	75mm rounds
		2,000-lb torpedo	
		4,000-lb internal bomb load	3-, 20-, 23-, and 100-lb practice bombs
North America P-51 Mustang	Fighter/attack bomber	Six 0.50 cal machine guns	0.50 cal ball
		Two 500-lb or 1,000-lb bombs	3-, 20-, 23-, and 100-lb practice bombs
Northrop P-61 Black Widow	Night fighter	Four 20mm cannons	20 mm ball
		Up to 6,400 lbs under-wing bomb load	3-, 20-, 23-, and 100-lb practice bombs
Republic P-47 Thunderbolt	Fighter	Eight 0.50 cal machine guns	0.50 cal ball
			3-, 20-, 23-, and 100-lb practice bombs
		Up to 2,500 lbs of external bombs or rockets	
			2.25-, 4.5-, and 5-inch practice rockets

*Exact amount of tactical weaponry is dependent on airplane model
Source: EODT, 2012

1.6.1.5 On February 4, 1948, Conway BGR was declared surplus to U.S. Government needs. On June 22, 1948, 19,246 acres of land owned by the U.S. Government in fee was transferred to the War Assets Administration and eventually sold. By October 1948, leases on 34,685 acres had been terminated and the land returned to International Paper Company (EODT, 2012). The Conway BGR areas have been developed into recreational, commercial, and/or residential areas with plans for additional development.

1.6.2 MRS-R01, Range II

1.6.2.1 The historical usage of MRS-R01, Range II, was practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing (EODT, 2012). Figure B.6 illustrates the historical use areas within the MRS. Figure B.6a illustrates further details on the historical investigations currently available to USACE for evaluation.

1.6.3 MRS-R02, Range III

1.6.3.1 The historical usage of MRS-R02, Range III, was high-and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing (EODT, 2012). Historical evidence at this MRS indicates that 100-lb practice bombs and 2.25-inch rockets were used (USACE, 1995). Figure B.7 illustrates the historical use areas within the MRS. Figure B.7a illustrates further details on the historical investigations currently available to USACE for evaluation.

1.6.3.2 Recent MEC finds in MRS-R02 have included 37-mm projectiles and 2.36-inch rockets. These items have been recovered in a portion of MRS-R02 adjacent to MRS-R09 to the north. Those types of munitions would probably not have been used on MRS-R02, which is a bombing range. Those munitions were most likely overshoots from MRS-R09, which used ground fired munitions (EODT, 2012).

1.6.4 MRS-R03, Range IV

1.6.4.1 The historical usage of MRS-R03, Range IV, was for practice bombing, including medium-altitude bombing (EODT, 2012). This site was identified in a 2003 Engineering Evaluation/Cost Analysis (EE/CA) (Parsons, 2003) and further investigated during the 2012 RI. Figure B.8 illustrates the historical use areas within the MRS. Figure B.8a illustrates further details on the historical investigations currently available to USACE for evaluation.

1.6.5 MRS-R09, MG/RR

1.6.5.1 Historical documentation indicates that activities at MRS-09, MG/RR, were limited to firing bomber turrets and MGs in a ground-mounted mode. The historical use of the range was reported as exclusively for small arms training activities, such as basic rifle marksmanship training. Private cleanups near MRS-R09 have recovered MEC items ranging from 37-mm projectiles to 2.36-inch rockets. Due to lack of ROEs for this MRS, it was not characterized for MEC or MC during the 2012 RI (EODT, 2012). Figure B.9 illustrates the historical use areas within the MRS. Figure B.9a illustrates further details on the historical investigations currently available to USACE for evaluation.

1.7 PREVIOUS INVESTIGATIONS

1.7.1 Former Conway BGR

1.7.1.1 The following investigations of the Former Conway BGR, which occurred between 1991-1995, were the preliminary investigations leading to the establishment of the MRSs at the installation:

- 1991: A Preliminary Assessment (PA) of ordnance contamination at the former Conway BGR was prepared USACE by Twin City Testing – St. Louis (TCT-St. Louis). The assessment, titled "Final Archives Report" consisted of three volumes: "Final Report," "Conclusion and Recommendations," and "Records Compilation." The PA concluded that MEC contamination potentially existed at the former Conway BGR, specifically at Ranges II, III, and IV. A high priority confirmation study at these ranges using visual and geophysical surveys was recommended (EODT, 2012).
- 1991: The U.S. Department of Transportation (DOT) and South Carolina Department of Highways and Public Transportation prepared a Final Environmental Impact Statement (EIS) for a proposed bypass, which crossed through the former Conway BGR. The EIS acknowledged the site was once used as a bombing range and that it is possible for MEC to exist in the area. (EODT, 2012)

- 1994: A PA was performed by the USACE - Charleston District under the DERP/FUDS program. At that time, the "Findings and Determination of Eligibility," dated 4 January 1994, concluded that the 55,854 acre site located in Horry County, South Carolina had been formerly used by the Army Air Corps. A MEC site investigation (SI) was recommended (EODT, 2012).
- 1995: A SI and archives search of the former Conway BGR was conducted by USACE, Rock Island District. The final report outlined the nature and degree of MEC recovered from the former ranges, as well as estimated depth at which ordnance may be present (by area), and probable end usage of the land. The Archives Search Report (ASR) concluded that the presence of ordnance is "confirmed" in Area A and Area C based on verifiable historical evidence and direct witness of ordnance items. The presence of ordnance was "potential" in Areas B, D, E, A-1, B-1, C-1, D-1, and E-1 based on inference from records and indirect witness accounts. Areas F and G were not considered to have any MEC based on a lack of "confirmed" or "potential" ordnance evidence. No historical recorded evidence was located to suggest the presence of Chemical Warfare Materiel (CWM) or radiological waste at the site (EODT, 2012).

1.7.2 MRS-R01, Range II

1.7.2.1 The list below provides a summary of previous investigations at MRS-R01, Range II:

- 1991: A PA was prepared by TCT-St. Louis. The PA concluded that MEC contamination potentially existed at MRS-R01, Range II.
- 1991: When TCT-St-Louis conducted the SI, a practice rocket and 0.50-cal bullets were found within Range II. Between 1991 and the 2003 EE/CA, golf course management reported encountered with munitions debris (MD) (Parsons, 2003).
- 1995: USACE Rock Island District conducted a SI and ASR. The ASR established MRS-R01 and recommended further investigation. The ASR confirmed that MPPEH was present at MRS-R01, Range II (USACE, 1995).
- 2003: The EE/CA investigated MRS-R01, Range II, and identified the potential presence of MEC in Area A, which was a 425-acre circular area established at the center of MRS-R01, Range II. No risk due to MEC presence was identified in Area A-1 (a buffer created around the centrally located Area A). The EE/CA recommended clearance to depth only for planned construction sites within Area A (the 425-acre circular area). The EE/CA also recommended surface clearance elsewhere (in the buffer area) and institutional controls (ICs) throughout the MRS (Parsons, 2003). During the EE/CA, MD identified included a 100-lb practice bomb and small arms ammunition debris.
- 2005/2006: Final Sampling Report (Removal Action), Areas A and A-1. EODT performed a geophysical sampling subsurface investigation for Sun Star, LLC. The investigation covered 439 acres at the Wild Wing Plantation (including the Avocet, Wood Stork, and Hummingbird golf courses, as well as the clubhouse). No MEC

items were identified, but MD items found included the following: 100-lb practice bomb pieces (Wood Stork #2); 100-lb practice bomb (tail fin only) (Avocet #4); bomb rack, 20 lbs (Wood Stork #5); expended .50-cal cartridge (Wood Stork #15); bomb lugs (Wood Stork Hole # 16); expended .50-cal cartridge (Avocet # 3). The Final Sampling Report recommended 70 acres for subsurface clearance. Geophysical surveys were performed on 50 of the 439 acres investigated and a preliminary report was issued in 2005 summarizing the results. Additional surface clearance and construction support followed, which was summarized in the Interim Final Report issued in 2006 covering the UXO Clearance in Area A. EODT performed a removal on 70 acres of the Wild Wing Company LLC property located in Area A.

- 2012: The RI report prepared by EODT concluded that the potential for MEC hazard was "Unlikely" and that no MC contamination was present. However, the RI report states that MEC had not been delineated and recommended further investigation. The refusal of ROEs impacted the RI field activities that could be conducted (EODT, 2012).

1.7.2.2 Figure B.6 illustrates the areas within the MRS-R01, Range II that have been characterized previously and the locations of recovered MD.

1.7.3 MRS-R02, Range III

1.7.3.1 The list below is a summary of previous investigations at MRS-R02, Range III:

- 1991: A PA was prepared by TCT-St. Louis. The PA concluded that MEC contamination potentially existed at MRS-R01, Range III.
- 1995: USACE Rock Island District conducted an SI and ASR. The ASR established nine MRSs and recommended further investigation. USACE conducted a site visit in 1997 and confirmed the presence of MEC at Range III, and located .50-cal shell casings, bullets, fragments of 4-lb incendiary bombs, and a practice 2.5-inch rocket.
- 1997: During site visit at the former Conway BGR in Range III (Area B) several 0.50 cal shell casings, bullets, and fragments of 4 lb incendiary bombs were noted at the ground surface. A practice 2.5-inch rocket was also discovered along the edge of the access dirt road. Aerial photographs depicting site conditions in the early 1950s were reviewed as part of an archival records search to identify specific areas or locations where evidence of MEC can be more adequately assessed during the EE/CA investigation. The photographs were included in Appendix E of the "Final EE/CA Report" (Parsons Engineering Science, Inc., 2003).
- 2002: A Time Critical Removal Action (TCRA) was performed in 2002 on 45 acres of MRS-R02, Range III. Construction support was provided during the property owner's construction activities on all 45 acres (EODT, 2012). MEC items identified included the following: MK II 1.1-inch projectile; M38A2 100-lb sand-filled practice bombs; M48 practice 20-lb fragmentation bomb; practice 5-inch high velocity aircraft rocket (HVAR) warhead; M54 4-lb incendiary bomb; M69 6-lb incendiary bomb; fuzes, including M16 fuze burster, M16 igniter, and AN-M16 white phosphorus

igniter; and M57 250-lb general purpose old style bomb. During the TCRA, the large number of 4-lb incendiary bombs encountered brought about concerns of potential presence of cadmium (Cd) in the site soils. Over the seven month period, 16 soil samples were collected and analyzed. Cadmium was not detected in the soil samples, but was detected in the metal alloy of the incendiary bombs at 51.1 milligrams per kilogram (mg/kg). The Toxicity Characteristic Leaching Procedure (TCLP) result of 0.0553 milligrams per liter (mg/L) for cadmium was well below the EPA regulatory level of 1.0 mg/L. The results of air samples analyzed for cadmium during the investigation were below the Occupational Safety Health Administration (OSHA) Permissible Exposure Limit (PEL) of 0.005 milligrams per cubic meter (mg/m^3). Therefore, cadmium was not a concern during the remainder of the removal action. The detailed laboratory analysis results were provided in Appendix E of the "Final Removal Report TCRA" (Parsons Engineering Science, Inc., 2002).

- 2003: An EE/CA was performed and confirmed the presence of MEC only at Area B. The EE/CA report recommended clearance to depth and ICs for Area B; clearance to depth only at planned construction sites within buffer surrounding Area B (Area B-1); and surface clearance elsewhere along with ICs (Parsons, 2003). During the EE/CA, the following MEC/MD items were recovered: 4-lb incendiary bombs; 2.25-inch rockets; 20-lb fragmentation bombs; a 100-lb practice bomb, and small arms ammunition.
- 2005: Environmental Resources Management (ERM) conducted a removal action for International Paper Realty Company (property owner). The removal action covered 231 acres in Range III. A 100% geophysical survey was performed. ERM's removal summary listed MEC items, including M54, 4 lb incendiary bombs, 2.25" Sub-Caliber Aircraft Rocket, 5" HVAR, M38A1 100 lb sand-filled practice bombs, and cluster support, with a total count of 254 items. However, the exact MEC identification and count by types are unknown.
- 2005: Clearance was performed by Kestrel (with others) covering 456 acres (Parcels A and B). MEC contamination was confirmed. Soil sampling was conducted for explosives. No MC contamination was identified.
- 2006: MCs investigation of soil and surface water was conducted at the Goodson site, located within Range III. A total of 16 samples (including one duplicate sample and one background sample) were analyzed for explosives and metals associated with munitions use. Of these constituents, only lead (PB), zinc (Zn), cadmium (Cd), and mercury (Hg) were identified as potential constituents from munitions used at the former Conway BGR. No explosives were detected. The metals detected (lead, zinc, cadmium, and mercury) were related to MC potentially present. However, based on a limited background investigation and the potential for these constituents to be present as a result of natural or anthropogenic sources, additional sampling was recommended to confirm the presence or absence of MCs at Range III (Parsons, 2006).
- 2006: A Phase I ordnance removal was conducted for D.R. Horton on 114 acres immediately east of and outside the Area B-1 safety zone, which was established

during the EE/CA. MD found included a 100-lb practice bomb; a 5-inch ZUNI rocket warhead; and 2.75-inch rocket.

- 2007: Removal was conducted for Landbank, LLC, on 336 acres (Tracts 15, 16A, and 16B) within the buffer safety zone. Digital geophysical mapping (DGM) was conducted.
- 2010: An investigation was performed for Horry County Schools on approximately 40 acres prior to development. 371 targets identified using geophysical techniques were investigated, and there were only cultural debris items found; no MEC or MPPEH related items were discovered.
- 2012: An RI confirmed the presence of MEC and concluded that no MC contamination was present. The report also states that MEC had not been delineated and that further investigation should be performed.

1.7.3.2 Figure B.7 illustrates the areas within the MRS-R02 that have been characterized previously and the locations of recovered MEC/MD.

1.7.4 MRS-R03, Range IV

1.7.4.1 The list below is a summary of previous investigations at MRS-R03, Range IV:

- 1991: A PA was prepared by TCT-St. Louis. The PA concluded that MEC contamination potentially existed at MRS-R03, Range IV.
- 1995 USACE Rock Island District conducted an SI and ASR. The ASR established MRS-R03 and recommended further investigation.
- 2003: The EE/CA identified the potential presence of MEC in both Area C and Area C-1, as they were designated at that time, in Range IV. The EE/CA recommended clearance to depth only at planned construction sites, and surface clearance elsewhere for both areas. MD identified included the following: 4-lb incendiary bombs; 20-lb fragmentation bombs; and 100-lb practice bombs (Parsons, 2003).
- 2004-2005: USA Environmental conducted a geophysical survey and removals for Centex Homes in the Barefoot Resort area. The report, “Final Report Conway BGR, South Carolina Phase IV Investigations, Centex Homes” (USAE, 2006b), indicated no MEC items were encountered.
- 2006: Arcadis performed soil and groundwater sampling for Centex Homes prior to the development of the Barefoot Golf Course. No explosives detected. Volatile organic compounds (VOCs) and some metals were detected (Arcadis, 2006).
- 2012: RI report concluded that the potential for a MEC hazard was “Unlikely” and that no MC contamination was present. Although a MEC hazard was not anticipated for this MRS, further investigation was recommended (EODT, 2012).

1.7.4.2 Figure B.8 illustrates the areas within the MRS-R02 that have been characterized previously and the locations of recovered MEC/MD.

1.7.5 MRS-R09, MG/RR

1.7.5.1 The list below is a summary of previous investigations at MRS-R09:

- 2003: EE/CA recommended a No DoD Action Indicated (NDAI) determination for this MRS (Parsons, 2003).
- 2012: RI concluded there was a potential presence of MEC that was unable to be investigated because of ROE refusal. The RI did not assess MC contamination and recommended further investigation (EODT, 2012).

1.7.5.2 Figure B.9 illustrates the areas within the MRS-R09 that have been characterized previously.

1.8 LAND USE

1.8.1 The Former Conway BGR is currently owned by private as well as public groups. The International Paper Realty Corporation and the SCDNR are the largest land owners. The developed portions of the Former Conway BGR are used for recreational (golf courses), residential, and commercial purposes. The undeveloped portions are used primarily for hunting and timber harvesting. The future land use is projected to remain similar to the current usage. Additional residential development is planned.

1.9 INVESTIGATION AREAS

1.9.1 Based on historical information, previous investigations conducted at each MRS, and PDT input, the investigation areas of three MRSs (R01, R02, and R03) have been expanded for this RI/FS. The investigation areas have been expanded from the historical MRS boundaries to include potential source areas located outside of the original MRS boundaries. Investigation boundaries were also modified to exclude areas previously characterized. Table 1.3 presents the historical MRS acreages as well as the expanded areas to be investigated during this RI/FS.

Table 1.3
Investigation Areas

MRS	Historical MRS Acreage	RI/FS Expanded Investigation Acreage
MRS-R01, Range II	649	1,561
MRS-R02, Range III*	1,961	4,153 [(1)]
MRS-R03, Range IV	886	1,170
MRS-R09, MG/RR	2,503	1,755[(1)(2)]

[(1)] For the munitions response operations, MRS-R02 and MRS-R09 will be grouped by one boundary since the areas have overlapping acreage and share the same munitions with the greatest fragmentation distance (MGFD). The combined acreage of MRS-R02 and MRS-R09 is 5,908 acres.
[(2)]The historical MRS-R09 boundary, encompassing 2,503 acres, was not expanded for the RI/FS. For the purposes of MRS distinction in the RI/FS, the overlapping portion of MRS-R09 (approximately 748 acres) that lies within MRS-R02's expanded investigation area will be evaluated as part of MRS-R02. The remaining MRS acreage to be investigated as MRS-R09 during the RI/FS is 1,755 acres.

1.10 INITIAL SUMMARY OF MEC EXPLOSIVE SAFETY HAZARDS

1.10.0 Table 1.4 presents a summary of recovered MEC and MD by MRS. The locations of the MEC/MD finds are presented in Figures B.6 through B.8 by MRS. No MEC/MD has been recovered to date in MRS-R09; though the 2012 RI reports that there is the potential presence of MEC at MRS-R09 from the use of the adjacent MRS-02.

Table 1.4
Munitions-Related Items Recovered by MRS

Munitions-Related Items Recovered	MRS-R01 (Range II) [1]	MRS-R02 (Range III) [2]	MRS-R03 (Range IV) [2]	MRS-R09 (MG/RR)
M57 250-lb general purpose bomb		X[3]		
M38A1 100-lb practice bomb	X			
M38A2 100-lb practice bomb	X	X	X	
Bomb, Practice, MK I, 50-lb	X			
M48 20-lb fragmentation bomb		X	X	
M69 6-lb incendiary bomb		X		
M 54, 4-lb incendiary bombs		X	X	
5-inch HVAR warhead		X		
5-inch Zuni rocket		X[3]		
2.25-inch Sub-Caliber Aircraft Rocket		X		
2.5-inch rocket		X		
Mk4, 2.75-inch rocket		X[3]	X	
M63, 37 mm projectile		X		
MK II 1.1-inch projectile		X		
M16, Smoke Grenade		X		
M110, A1 Bomb Fuzes		X		
Bomb Rack 20 lbs	X			
0.50-cal cartridge	X	X		
Bomb lugs	X			
Miscellaneous Ordnance (fuze components, 28 gauge shotgun shell primer, M16 Fuze Burster, M16 Igniter, AN-M16 White Phosphorus Igniter, Fuze M38/28 GA Shot Shell)		X		
M1A1 Spotting Charge			X	

Source:
[1] 2005: EODT, Final Sampling Report
[2] 2012: EODT RI(3) 2006: Ordnance Removal, D.L. Horton

1.10.1 Munition with the Greatest Fragmentation Distance

1.10.1.1 Based on the findings of previous investigations, the item with the largest fragmentation distance was selected for each MRS. The MGFDs are illustrated in Table 1.5.

Table 1.5
Munitions with the Greatest Fragmentation Distance by MRS

MRS	MGFD
MRS-R01, Range II	100-lb M38A2 Practice Bomb (1)
MRS-R02, Range III	250-lb M57 Bomb (TNT Filled)
MRS-R03, Range IV	20-lb M41 Frag Bomb (Composition B)
MRS-R09, MG/RR	250-lb M57 Bomb (TNT Filled)

1.10.2 Chemical Warfare Materiel

1.10.2.1 CWM is not expected to be recovered during this RI at the four MRSs. However, during the RI, if HGL identifies or suspects the presence of any unknown liquid-filled munitions, all personnel will immediately withdraw upwind from the work area and notify the UXO Safety Officer (UXOSO), Senior UXO Supervisor (SUXOS), and Ordnance and Explosives (OE) Safety Specialist (OESS). The OESS will notify the USAESCH Project Manager (PM). HGL shall secure the area and provide two personnel located upwind of the suspect item(s) to secure the site until relieved by DA emergency response personnel.

1.11 PRELIMINARY CONCEPTUAL SITE MODEL

1.11.1 The conceptual site model (CSM) for the RI/FS is based on site-specific details for each MRS. These details includes location, history, physical characteristics, current and future land use, and potentially complete exposure pathways and scenarios to be considered for the human health and ecological risk evaluations. Additionally, the CSM includes a munitions summary and exposure profile, and a summary of the historical MC and hazardous and toxic waste data.

1.11.2 The CSM for MEC and MC provides the basis for the technical approach for each MRS and sampling plan. As information is obtained during the RI/FS process, the CSM will be updated and refined. The preliminary CSM for MEC and MC is discussed in Section 3.15 and illustrated on Figures B.10 and B.11, respectively. Further discussion of the human health and ecological risk assessment (ERA) for MC, and the MEC HA, is provided in Sections 3.15 through 3.16, respectively.

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2.0 TECHNICAL MANAGEMENT PLAN

2.0.1 This Technical Management Plan section details the organization, structure, roles, and functions of the project management team, and the approach, methods, and procedures that will be used for management of the RI/FS at the Former Conway BGR. HGL has the primary responsibility for the execution of all aspects of the RI, including team integration, engineering, data and geographical information system (GIS) management, cost control, program safety, quality control (QC), community relations, and subcontractor selection and management. HGL will coordinate all activities with the USAESCH, USACE, EPA and SCDNR. The HGL PM is responsible for executing the project in a timely and cost-effective manner. This will be accomplished by continually tracking project status. The SUXOS is responsible for oversight of RI field activities and will provide a summary of field problems and progress to the PM. A summary of the field activities completed will be reported to the USAESCH PM on a weekly basis while fieldwork is being conducted.

2.1 PROJECT ORGANIZATION

2.1.0 The PDT for the RI/FS at the Former Conway BGR consists of USAESCH, USACE (Savannah and Wilmington Districts), HGL, and SCDHEC. Several other organizations are indirectly involved on this project, and individuals may serve as stakeholders during this project. These organizations include local county and municipal governments, and major landowners. An organizational chart depicting the various organizations and key personnel involved in the execution of the Conway RI/FS is presented in Figure B.12. The roles of each organization are described below.

2.1.1 U.S. Army Engineer Support Center-Huntsville

2.1.1.1 USAESCH has the primary responsibility for administration of this TO. Roles and responsibilities for USAESCH are summarized as follows:

- Provides overall guidance to the HGL when necessary or requested for purposes of PWS clarification;
- Provides review and comment and coordination of all U.S. Government comments on HGL-prepared Project Management Plan (PMP) and Quality Assurance (QA) Surveillance Plan (QASP), reports, and other project documents;
- Responsible for monitoring, assessing, recording, and reporting on the technical performance of the HGL;
- Responsible for monitoring HGL's performance in the areas of contract compliance and contract administration, and contractual and technical administration of the project;
- Coordinates all activities with the various USACE technical supporting elements, as appropriate;

- Reviews payment requests and, in consultation with the other key personnel of the PDT, makes recommendations for payment action based on completion of designated milestones;
- Approves all payment milestones and HGL invoices;
- Works with the HGL to identify and correct any deficiencies prior to those deficiencies adversely affecting the project; and
- Attends and/or participates in all project-related meetings/calls.

2.1.2 U.S. Army Corps of Engineers

2.1.2.1 USACE has the Project Management function for the Former Conway BGR RI/FS project. Roles and responsibilities are summarized as follows:

- Provides support to USAESCH, including interface with local key Stakeholders;
- Responsible for providing technical review of and commenting on HGL-prepared PMP and QASP, reports, and other project documents; and
- Attends and/or participates in project related meetings/calls, as necessary.

2.1.3 HydroGeoLogic, Inc.

2.1.3.1 HGL is the prime contractor to USAESCH for this TO. HGL has the primary responsibility for the execution of all aspects of the RI/FS IAW the PWS (Appendix A). RI/FS activities include team integration, engineering, data and GIS management, cost control, program safety, QC, community relations, and subcontractor selection and management. HGL will coordinate all activities with USAESCH, USACE, EPA, and SCDNR.

2.1.4 Federal, State, and Local Agencies

2.1.4.1 The roles of federal, state, and local agencies and other stakeholders include participation in the TPP process and courtesy review of project plans and documents. All regulatory participation will be coordinated by USAESCH.

2.2 PROJECT PERSONNEL

2.2.1 The following sections describe the roles and responsibilities of the HGL project team personnel shown on the organization chart, Figure B.12. Descriptions of the responsibilities of the key HGL project team members are presented in Table 2.1. All project personnel will meet the training and experience requirements for their assigned positions. The project support staff includes administrative personnel, contract administrators, risk assessors, technical editors, and information management specialists. A list of contact information for project personnel is provided in Appendix C.

Table 2.1
Key Personnel Responsibility and Authority Matrix

Assigned Name/Role	Responsibility	Reports To	Coordinates With
Janardan Patel WERS Program Manager	Mr. Patel will maintain overall accountability for the successful execution of the TO and HGL's performance. He will provide technical support as needed to the project, and his primary functions will include reviewing schedules, cost performance and status reports, and QC efforts.	Principal-in-Charge	Technical Director and PM
Kimberly Vaughn PM	Ms. Vaughn will have overall management responsibility for this RI/FS project, including progress reporting and invoicing; QC efforts; schedule compliance; and budget control. She will serve as the primary interface on programmatic issues and be responsible for the successful execution of the TO, including all technical, subcontracting, and customer-related issues, and for the quality of the work product. She will assign project and corporate resources as necessary to meet performance objectives, direct all HGL project personnel and manage the HGL administrative aspects of the project, serve as the primary point of contact for USACE, and report problems or discrepancies with contract requirements to the HGL contracts officer and USACE.	Program Manager	Program Manager, PDT, Resource Leads, and Subcontractors
Tim Deignan Senior Geophysicist	Mr. Deignan will design the geophysical investigation methodologies to ensure use of a sound technical approach that meets performance objectives, provide oversight of all aspects of the project geophysical team, and provide technical review and/or preparation of planning documents. He will also lead geophysical investigation teams, assisted by the on-site Project Geophysicist.	PM	Field DGM staff, Resource Leads, and PM
Manok Synakorn Senior Scientist/ Engineer	Mr. Synakorn will assists in the preparation of technical plans and share responsibility for the quality of the work product. He will also execute sampling field activities and/or provide oversight of drilling subcontractors during field investigations, and report problems or discrepancies with WP requirements to the PM or SUXOS.	PM	Field Technicians, Resource Leads, and PM
Joel Sanders SUXOS	Mr. Sanders will serve as the HGL field operations lead and supervise the execution of field activities, implementation of WP requirements, and excavation, accountability, removal, and disposal of MEC. He will certify MPPEH, range related debris (RRD), and MD prior to off-site disposal, perform periodic inspections of HGL compliance with DoD, DA, and USACE explosives management and safety requirements, and conduct or support HGL and QASP surveillance activities.	PM	Field Technicians, Resource Leads, and PM

Table 2.1 (continued)
Key Personnel Responsibility and Authority Matrix

Assigned Name/Role	Responsibility	Reports To	Coordinates With
Oscar Honne UXOSO	Mr. Honne will ensure proper execution of the APP/Site Safety and Health Plan (SSHP) by HGL and subcontractors performing on-site work, document health and safety procedures, issues, and requirements, and perform periodic inspections of HGL compliance with DoD, DA, and USACE explosives management and safety requirements. He will also conduct or support HGL and QASP surveillance activities, and communicate with the SUXOS, PM, and, if needed, certified industrial hygienist to address any health and safety concerns or issues.	Corporate Health and Safety Officer and PM	All Field Personnel, Resource Leads, and PM
Westleon Rogers UXO QC Supervisor (UXOQCS)	Mr. Rogers will implement QC for the HGL team and subcontractors performing on-site work, certify MPPEH, RRD, and MD prior to off-site disposal, and confirm HGL QC documentation to ensure accuracy, compliance, and acceptance. Mr. Rogers will also conduct or support HGL and QASP surveillance activities, and communicate with the SUXOS and PM to address any concerns or issues.	Corporate QA Manager and PM	All Field Personnel, Resource Leads, and PM
To Be Determined (TBD) Regulatory Specialist	This individual will actively participate in the development of field methodologies and provide technical writing support on WPs, including the Field Sampling Plan (FSP) and QAPP.	PM	Resource Leads and PM
Ken Rapuano Senior Chemist	Mr. Rapuano will be responsible for providing guidance on analytical methodologies to the PM, field personnel, and laboratories; QA/QC of field activities; and sample and data management. He will also be responsible for QA Project Plans (QAPPs) and QC SOPs. As the corporate chemical QC coordinator, he will ensures that samples are collected, lab testing is conducted, and data is processed IAW the Uniform Federal Policy (UFP)-QAPP and USACE requirements.	PM	Resource Leads and PM
Cindy Crane Risk Assessor	Ms. Crane will prepare the risk assessment portions of the WP, provide input on data requirements during the TPP processes, and prepare and review any necessary MEC HAs or MC risk assessments performed based on data gathered.	PM	Resource Leads and PM

2.3 PROJECT COMMUNICATIONS AND REPORTING

2.3.1 Communications

2.3.1.1 Communications for this project will generally flow along the lines established by the project organization chart shown on Figure B.12. Communications between HGL and the USAESCH and/or USACE will primarily be directed through the respective PMs or the

Contracting Officer (CO) at USAESCH. Communications directly between HGL and other government entities associated with this project will occur only when directed by USAESCH. All project personnel will meet and talk on a frequent basis via online meetings, emails, and conference calls. Technical personnel will be encouraged to work directly with their counterparts to resolve technical issues. Significant conversations, meetings, or other communications will be documented and shared among all team members.

2.3.2 Reporting

2.3.2.1 Reporting will comply with the requirements contained in the PWS. Upon the initiation of fieldwork, HGL will prepare weekly status reports consistent with DID WERS-016.02, Periodic Status Reports. Weekly reports will be developed and submitted to the USAESCH in electronic versions for the duration of fieldwork. In addition to weekly status reports, the PM will submit daily reports during the field activities. The daily reports to be provided will include the Daily Quality Control Report (DQCR) and the Site Daily Production Report to be prepared with input from the SUXOS and UXOQCS. Templates for these daily reports are included in Appendix F. These daily reports will be provided electronically to the PDT for the duration of the fieldwork. The HGL PM is responsible for issuing the following documents throughout the project:

- Daily and Weekly field activities reports;
- Meeting Minutes (submitted within 10 working days after a meeting);
- Records of Telephone Conversations (submitted with the monthly status reports); and
- Monthly Status Reports (IAW DID WERS-016.01).

2.4 DELIVERABLES

2.4.1 Project deliverables will meet the schedule requirements of the project and will be prepared in the format indicated in the PWS. HGL will submit all deliverables to USAESCH and other reviewers IAW Paragraph 4.2 of the PWS. Deliverables will receive internal HGL reviews prior to submittal to other organizations. USAESCH and USACE will review draft documents and provide comments to HGL IAW the project schedule. The following deliverables are required under the PWS:

- Meeting Minutes from Kickoff Phone Conference
- Proposed Schedule
- Pre-TPP Meeting Materials
- CSM
- Draft and Final TPP Memorandum
- Draft, Draft Final, and Final Community Relations Plan
- Draft and Final Pre-Public Meeting Materials
- Draft, Draft Final, and Final PMP/QASP
- Draft, Draft Final, and Final RI/FS Report
- Draft, Draft Final, and Final PP
- PP Meeting Transcripts

- Draft, Draft Final, and Final DD
- Final Administrative Record
- Final GIS Files on Compact Disc

2.4.2 All deliverables will be prepared IAW applicable USACE DID format and requirements. Detailed descriptions of each project deliverable and submittal requirement are featured in the PMP.

2.5 PROJECT SCHEDULE

2.5.1 HGL uses Microsoft Project to compile and track scheduled project activities. Figure B.13 presents the schedule for the Former Conway BGR RI/FS project. The HGL PM will monitor and report all tracking information to the USAESCH PM as described in Section 2.6.

2.6 PERIODIC REPORTING

2.6.1 HGL will prepare monthly progress reports, when not actively conducting field operations, IAW DID WERS-016.01, Periodic Status Reports. These will summarize project progress and detail task-specific information associated with the reporting period, clarify status of current work, and state plans for future work. This report also will identify whether the current work is on schedule and, if necessary, describe actions required to return it to schedule.

2.6.2 When actively conducting field operations, HGL will prepare weekly status reports consistent with DID WERS-016.02, Periodic Status Reports, upon the initiation of fieldwork. Weekly reports will be developed and submitted to the USAESCH for the duration of fieldwork.

2.7 COSTING AND BILLING

2.7.1 Costing

2.7.1.1 HGL's project delivery system, DELTEK®, is designed to facilitate control of costs and schedules based on real-time budget, cost, and schedule data. The HGL PM reviews this information on a regular basis to anticipate and prevent cost overruns and schedule delays. By frequently reviewing actual costs and performance progress in comparison with budgets and schedules, potential costs and/or schedule variances can be identified early and corrective action implemented. This reporting is for internal use, and billing is based on completing milestones for the planning and documentation phases of the project. Fieldwork is a mix of firm fixed price and fixed unit price tasks under the TO.

2.7.2 Billing

2.7.2.1 HGL uses the DELTEK® to manage financial information for its clients. Subcontractor invoices and employee work records are input daily to maintain a real-time snapshot of the

project's budget. HGL PMs are well versed in the data analysis functions of DELTEK® for management and billing activities.

2.8 PROJECT PUBLIC RELATIONS SUPPORT

2.8.1 HGL will participate in stakeholder meetings to execute the TPP process, five restoration advisory board (RAB) meetings, and two public meetings to discuss project progress and present findings. The HGL project team's participation will include delivery of presentations, plus development and production of TPP worksheets and handout materials, including fact sheets, for public meetings. HGL will develop a Community Relations Plan that will describe the approach for informing the community about the project and supporting public meetings as needed.

2.9 SUBCONTRACTOR MANAGEMENT

2.9.1 HGL's Quality Management Program provides for subcontractor site evaluations, supplier ratings, and inspections by HGL, as appropriate. HGL's Quality Management Program also ensures that subcontractors are aware of contract requirements.

2.10 FIELD OPERATIONS MANAGEMENT

2.10.1 The HGL PM and SUXOS will oversee all aspects of the field operations. Field staff (including subcontractors) will communicate daily with the HGL SUXOS. The SUXOS will address any unexpected issues or concerns that arise during field operations. Thus, the SUXOS will be aware of any changes in site conditions or planned modifications to field procedures. The HGL PM will involve the USAESCH PM as necessary, but at a minimum will inform the USAESCH PM of any changes in site conditions or planned modifications to field procedures for consideration and concurrence by USAESCH.

2.11 DATA MANAGEMENT

2.11.1 HGL will manage the existing GIS data and maintain new GIS data IAW DID WERS-007.01, Engineer Manual (EM) 200-1-2, and other applicable interim guidance documents (IGDs) to develop the CSM and monitor project progress. HGL will compile GIS data created during the remedial actions, EE/CA, and previous RI/FS and develop a comprehensive geodatabase including vector-based site-specific data such as color aerial imagery, transportation feature centerlines, place names, wetlands, flood hazard zones, soil types, and buildings. HGL maintains current ESRI software and will manage the geodatabase in the ArcGIS 10.x environment. HGL will integrate new environmental data into the geodatabase as necessary, including geophysical surveying data, sampling locations, intrusive results, locations of sensitive habitats and potential receptors, and rights-of-entry data received from USACE.

2.11.2 HGL will create two separate geodatabases, including respective pre- and post-project response action geospatial data analyses. The pre-RI geodatabase will be built from existing GIS data, and it will be delivered prior to the TPP meetings and documented in the WP. As the project is executed, the post-RI geodatabase will serve as the comprehensive project

geodatabase, incorporating entities impacted by RI/FS activities and potential impacts of future response action activities (if applicable). Map layers will be developed in conformance with the Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE) for installation mapping and geospatial data; data will be projected in the local Universal Transverse Mercator coordinate system.

2.11.3 The establishment of this system will allow the GIS data to be queried, retrieved, and disseminated via password to the USACE, HGL team members, and stakeholders authorized by the USACE. At project conclusion, the geodatabase will be submitted to the USACE. Information about archaeological and culturally sensitive areas and property owner information will not be included in the geodatabase.

3.0 FIELD INVESTIGATION PLAN

3.1 INTRODUCTION

3.1.1 The Field Investigation Plan defines procedures for the execution of the technical approach during RI/FS field activities at four MRSs: MRS-R01, Range II; MRS-R02, Range III; MRS-R03, Range IV; and MRS-R09, MG/RR. The technical approach for each MRS was developed after a review of the MRS-specific information, located in Sections 1.4 through 1.9 of this WP.

3.1.2 The field investigation will focus on a surface and subsurface investigation to characterize the nature and extent of MEC and MC at the four MRSs. MEC is composed of: 1) UXO; 2) DMM; or 3) MC (e.g., TNT, RDX) in high enough concentrations to pose an explosive hazard (USACE, 2008). Since the history of the site does not support DMM and MC in explosive concentrations has not been found during previous investigations, the RI will focus on determining the nature and extent of UXO at the former Conway BGR. References to MEC in this WP refer to UXO.

3.1.3 The Field Investigation Plan will present a discussion of the following tasks to be performed during the field effort, which include the following:

- Mobilization and site preparation;
- Boundary and location surveys;
- Brush clearance;
- Visual and instrument-aided surface sweeps over areas where DGM will be performed;
- Establishment of DGM transects and performance of DGM survey using anomaly avoidance techniques;
- Establishment of “mag-and-dig” transects within the known target areas;
- Reacquisition and intrusive investigation of anomalies;
- Management and disposal of recovered MEC;
- Completion of MRS-specific sampling and analysis to characterize MC concentrations present in site-specific media (surface and subsurface soil, sediment, and groundwater, as site-specific conditions dictate);
- Completion of site restoration activities such as backfilling and leveling;
- Performance of a human health risk assessment (HHRA) and an ERA to evaluate potential risk associated with MC present and evaluation of explosive safety hazards for MEC;
- Establishment and maintenance of a project GIS database;
- Updating of the CSM and the munitions response site priority protocol (MRSPP); and
- Preparation of the RI report.

3.2 DATA QUALITY OBJECTIVES

3.2.1 To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design the requisite data collection program in an effort to characterize the residual hazards/risk remaining at the project site. DQOs are statements defining the quality, quantity, and type of data required (for example, geophysical), the manner in which data may be collected, and the acceptance criteria for that data, to provide an adequate database to support project decisions. DQO worksheets developed during the TPP meeting and DQOs established during the TPP process are included in Appendix H. However, this WP further refines the DQOs and presents MRS-specific DQOs in Tables 3.1a through 3.1e. Tables 3.1a through 3.1e also provide a crosswalk for each DQO to the development steps from both the EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4*, EPA/240/B-06/001, February 2006, and the USACE *Technical Project Planning Process (TPP)*, EM 200-1-2, August 31, 1998.

3.2.2 The data collected under the DQOs will continuously be evaluated against the appropriate decision rule. The anticipated decision rules are included in Table 3.2. HGL will solicit project team concurrence and input during evaluation of the RI data collected for each MRS against the project DQOs and decision rules. Based on project team concurrence, the appropriate decision rules will be selected as applicable to the RI data collected for the path forward for each MRS.

3.3 ESTABLISHING INVESTIGATION BOUNDARIES

3.3.1 As illustrated in Figures B.2 through B.5, each of the four MRSs has a historical boundary. However, based on evaluation of recent investigations, these boundaries will not be sufficient to adequately characterize the anticipated MEC contamination in the vicinity of MRS-01, MRS-02 and MRS-03. Therefore, the PDT agreed that for the purposes of the RI/FS the areas of investigation for MRS-01, MRS-02, and MRS-03 should be extended beyond the historical MRS boundaries. The expanded investigation area boundaries are also illustrated in Figures B.2 through B.5. The governing boundary for the RI/FS investigation of MRS-09 is the historical MRS boundary.

3.4 MEC AVOIDANCE ACTIVITIES

3.4.1 MEC avoidance procedures will be implemented within the area of investigation boundary where MEC is known or suspected to be present and no previous clearance activities have been completed. Activities requiring anomaly avoidance and/or MEC escort activities include, but are not limited to, boundary marking, vegetation reduction, DGM surveys, placement of transect stakes; environmental and natural resource assessments, sampling of environmental media; and general construction support. MEC avoidance activities will be performed IAW HGL SOP 15.2, Anomaly Avoidance Support (Appendix I).

Table 3.1a
MEC DQO Summary for MRS-R01, Range II

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R01, Range II, because it was used as practice bombing range, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R01, Range II and to determine if further response actions are required to support current and future residential, commercial, and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-01, Range II. As listed in Section 1.7.2, these include a PA, SI, EE/CA, Removal Action and RI. The 2012 RI concluded that MEC had not been delineated and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R01, Range II RI/FS Expanded Investigation Area is 1,561 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.14.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.14 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation area will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

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Table 3.1b
MEC DQO Summary for MRS-R02, Range III

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R02, Range III because it was for high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R02, Range III and to determine if further response actions are required to support current and future residential, commercial and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-02, Range III. There have been numerous investigations of this MRS, as listed in Section 1.7.3, which include: PA, SI, TCRA, EE/CA, removal actions and RI. The 2012 RI confirmed the presence of MEC, concluded that MEC had not been delineated, and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R02, Range III RI/FS Expanded Investigation Area is 4,153 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.15.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.15 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation area will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

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Table 3.1c
MEC DQO Summary for MRS-R03, Range IV

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R03, Range IV, because was for practice bombing, including medium-altitude bombing The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R03, Range IV and to determine if further response actions are required to support current and future residential, commercial, and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-03, Range IV. As listed in Section 1.7.4, these include a PA, SI, EE/CA, Removal Action and RI. The 2012 RI concluded that MEC had not been delineated and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R03, Range IV RI/FS Expanded Investigation Area is composed of 1,170 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.16.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.16 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation areas will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, frag, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

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Table 3.1d
DQO Summary for MRS-R09, MG/RR

Criteria from EPA (1)	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R09, MG/RR because the historical use of the range was exclusively for small arms training activities, such as basic rifle marksmanship training. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R09 to determine if further response actions are required to support current and future residential, commercial, and recreational land use(2)	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous EE/CA and RI investigation conducted at MRS-09, as discussed in Section 1.7.5. The 2012 RI concluded that there was a potential presence of MEC at MRS-R09, however it was unable to be investigated due to ROE refusal. The historical boundary of MRS-R09, encompassing 2,503 acres, was not expanded for the RI. However, the portion of MRS-R09 that overlaps with MRS-R02, approximately 748 acres, will be investigated as a part of MRS-02. The remaining 1,755 acres will be investigated as MRS-09 during the current RI.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.17.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.17 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the MRS will be delineated into “elevated anomaly density” areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA’s *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE’s *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.
(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

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Table 3.1e
MC DQO Summary: MRS-R01, MRS-R02, MRS-R03 and MRS-R09

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	Project Objectives Satisfied	Data User Perspectives	Contaminant or Characteristic of Interest	Media of Interest	Required Locations or Areas	Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method	Analytical Method
MC Characterization	Evaluate and determine nature and extent of MC contamination [2]	Risk, Remedy	MC (as set out in "Analysis" shown in Table 3.5) to include explosives, select metals analyses in soil and sediment and analysis of metals and explosives in groundwater.	Soil, sediment, and groundwater	Incremental sampling methodology (ISM) sampling (explosives) and discrete sampling (metals) will be conducted at locations selected based on historical information, DGM data, and intrusive investigative results. If required, surface water features adjacent to impacted areas will be identified for sediment sampling. Additionally, existing groundwater wells down gradient of impacted MRSs will be sampled, if required.	See RI approach detailed in Table 3.4 and the sampling matrix provided in Table 3.5.	If MC is detected during Phase 1 sampling, results will be compared against site-specific background metals concentrations levels and screening levels to determine if MC contamination is present. Phase 2 sampling and Phase 3 sampling will then be conducted, if required. The screening levels as developed during the TPP process are set out in the Appendix E (QAPP) worksheets. Site-specific background samples will be used to assess metals concentrations. Decision rules regarding MC characterization are provided in Table 3.2a. If there are MC detections at concentrations indicating contamination is present which may constitute a risk to the public or the environment, a risk assessment will be performed.	Approach will include collection of incremental soil samples, discrete surface and shallow subsurface soil samples and may also include sediment and groundwater samples. Samples to be collected and analyzed IAW Section 3.13 and Appendix E of this WP and to meet all quality requirements of the QCP, Section 4.0.	ISM samples will be analyzed for explosives (8330B). Analysis of discrete soil and sediment samples will include select metals (6020A/7471). Analysis of groundwater will include metals (6020A/7471) and explosives. See the additional sampling matrix in Table 3.4 and Table 3.5.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MC is based on the screening levels agreed to by the TPP team as being protective of the identified exposure pathways shown in the CSM. The preliminary remediation objective is to ensure that any identified MC contamination at the site determined to pose an unacceptable risk to human health or the environment is addressed to minimize or mitigate those risks.

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Table 3.2
Decision Rules for MRSs, Former Conway BGR, Horry County, South Carolina

Row No.	Characterization (UXO/MC) and Preliminary Status	Investigation	Decision Rule	Intermediate Status	Decision Rule	Intermediate Status	Decision Rule	Final Status and Recommendation
1	UXO characterization where **UXO contamination** is anticipated	Per Table 3.1, conduct surface sweep in areas to undergo DGM survey and conduct DGM survey (visual inspection of surface and aboveground locations for UXO or MD).	If UXO and MD are located: Modify MRS boundaries to improve boundary accuracy and expand investigations (if needed).	**UXO contamination** is anticipated.	Following completion of geophysical surveys the area will be identified as: 1) an area having elevated anomaly density or the potential to contain UXO, or 2) areas unlikely to contain UXO contamination.	1) Elevated Anomaly Density: Demonstrate that a 90% confidence has been achieved for determining both the potential depth of UXO and the nature (type and density) of UXO.	**UXO Contaminated:** Following intrusive investigation, if UXO or a significant amount of MD is found, the area will be characterized as UXO contaminated.	**UXO Contaminated:** Recommended for evaluation in FS.
						2) **Unlikely to Contain UXO Contamination**: Demonstrate that the investigation approach was capable of locating potential UXO contamination.	**Unlikely to Contain UXO Contamination:** If no MEC or MD are found, the area will be characterized as No Significant UXO Present.	**No Significant UXO Present:** No FS evaluation required, potential for NDAI.
2	UXO characterization where n**o UXO contamination is anticipated**[(1)]	Conduct surface reconnaissance using a Schonstedt magnetometer in non-MEC use areas.	If UXO and MD are located: Modify MRS boundaries to improve boundary accuracy and expand investigations (if needed).	**UXO contamination is anticipated.**	If UXO contamination is anticipated, the decision rules in Row 1 will apply.			
				UXO contamination is not anticipated.	If no UXO or MD is found, the area will be characterized as **no significant UXO present**.	**No significant UXO is present.** Recommended for NDAI.		
3	MC characterization	Conduct sampling as outlined in Table 3.4.	If MC is not detected during Phase 1 sampling or if concentrations are less than screening levels and/or background (as defined in the QAPP, Appendix E), then:	**No MC contamination is present.**				
			If MC are detected during Phase 1 sampling at concentrations exceeding the screening levels and/or background, then:	**MC contamination is present.**	If MC contamination is present, additional evaluations of the nature and extent of MC contamination (soil, sediment, and groundwater sampling) will be performed, and a risk assessment will be conducted to determine if a risk to human health or the environment exists.	**If MC contamination is present and there is a risk to human health or the environment, then additional evaluations of the nature and extent of the MC contamination will be performed.** Recommended for FS.		

(1) Areas where no UXO contamination is anticipated based on historical data or observed site conditions are omitted from the statistical requirements of the PWS.

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3.5 MOBILIZATION AND SITE PREPARATION

3.5.1 Mobilization includes transporting personnel and equipment to the project site. During mobilization, site controls and support facilities will be established. These facilities include a field office within a centrally located area and siting of a Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)-approved magazine. The magazine will be sited IAW the approved ESP. During mobilization, logistics support will be coordinated, field scheduled finalized, and on-site training will occur IAW the APP (Appendix D).

3.5.2 Site preparation activities include boundary marking and location surveys. Existing or newly established temporary Class I, 3rd Order, survey control monuments will be used to provide location survey control for the investigative teams. Additional Global Positioning System (GPS) survey control will be established across the site as needed for data collection.

3.5.3 If surface evidence of MEC is discovered during site preparation activities near the MRS investigation boundary, HGL will consult with the PDT to discuss expanding the investigation boundary.

3.6 VEGETATION CLEARANCE

3.6.1 Brush clearance, which will be performed using anomaly avoidance procedures, may be required for the analog and DGM surveys. Anomaly avoidance will consist of visual and instrument-aided procedures to ensure that no MEC/MPPEH or other debris is on or protruding from the surface such that it may damage the equipment or cause a safety hazard. Areas to be avoided will be clearly marked by personnel conducting anomaly avoidance procedures. In areas determined by the UXO Technician II to be free of surface MEC/MPPEH, vegetation will be cleared to a minimum height of 6 inches above the ground surface and be limited to cutting of brush, vines, small trees, and tree limbs that would directly impede access for the geophysical survey personnel. Cut vegetation will be moved from the anticipated instrument path so as not to impede data collection or create a safety hazard.

3.6.2 Brush clearing will be accomplished by a two-person brush clearing team consisting of a UXO Technician II and a heavy equipment operator using a tracked loader with a mulching head or brush-hog attachment. Brush clearing personnel will don appropriate personal protective equipment (PPE) during brush clearing activities. Any surface recovered MEC/MPPEH will be managed and disposed of IAW the ESP.

3.6.3 Vegetation removal will be coordinated with the individual landowners and the PDT. Additional coordination may be required to ensure that operations do not disturb endangered species. HGL is aware that some property owners may have concerns that transect paths cut through wooded areas may promote trespassing. When transect pathway clearance is required, pathways will be limited to the width of the anticipated tow vehicle (such as the amphibious vehicle proposed).

3.7 SURFACE METAL REMOVAL

3.7.1 Prior to performing a DGM survey, UXO technicians will perform a visual and detector-aided surface sweep. Recovered MEC/MPPEH and MD will be managed and disposed of IAW Section 3.11 of this WP. If during the surface sweep additional evidence is found that suggests that the area impacted by historical operations of the MRS may be larger or smaller, then MRS boundaries may be modified to improve boundary accuracy.

3.8 GEOPHYSICAL INVESTIGATION

3.8.1 Overview

3.8.1.1 The design of the geophysical approach of the RI/FS (transect spacing) was based on an analysis of historical data on range use (Section 1.6), range size and shape, and the types of munitions recovered from each MRS (Table 1.3). The analysis of this data resulted in the identification of potential MEC use areas, specifically target areas and other areas of high anomaly density.

3.8.1.2 The geophysical investigation of the four MRSs will use a combination of DGM transects and grids. DGM transects will be used to define areas of evaluated concentrations of anomalies. DGM transect investigations will include the following types of transects:

- Towed-array transects (golf course and residential areas);
- Wetland towed-array transects (These will used for wetland areas and surface water features that are 1.5 ft deep or shallower, such as retention ponds or golf course water hazards; DGM data will not be collected where the water is deeper than 1.5 ft);
- Person-portable single sensor overland transects (land-based transects for areas near permanent structures or in wooded areas); and
- Mag-and-dig transects within known target areas.

3.8.1.3 Following the transect investigations, anomaly density maps will be generated and locations for DGM grids will identified. DGM grids will be installed in high-density anomaly areas to characterize the nature, density, and extent of MEC and MD. DGM grids will also be used in areas of relatively low anomaly concentrations to confirm the absence of MEC/MD. A buffer area outside of the expected MEC areas will be characterized using a grid sampling approach to confirm that MEC is not present outside the boundary of the investigation area.

3.8.1.4 It is expected that ROEs will not be granted for all land parcels present within these MRSs; therefore, investigation activities will be limited to areas where ROEs have been granted by landowners. If landowners are agreeable, specific transect anomalies may be evaluated instead of installing and intrusively investigated full coverage grids.

3.8.1.5 DGM data will be collected within wetland/pond areas that are 1.5 ft deep or shallower. This data will only be used to determine anomaly density. There will be no

intrusive investigation of DGM anomalies found in the wetland/pond areas. However, an intrusive investigation will be performed on DGM anomalies that border a water feature.

3.8.2 Transect Delineation

3.8.2.1 The Visual Sampling Plan (VSP) software was used to select the optimum transect spacing for the geophysical investigation of the four MRSs. VSP is a useful tool for determining transect coverage in a quantitative manner. After geophysical data are collected along the transects, the results can provide quantifiable determination and confidence that a postulated target area may or may not be present. Analysis of the data can provide estimates of the number of anomalies that will ultimately require investigation and the size of area to be remediated.

3.8.2.2 The VSP module "Transect Spacing Needed to Locate a UXO Target Area" was used to quantitatively validate the transect spacing and orientation that is necessary to detect target areas with 90% confidence. Table 3.3 illustrates the linear miles of transect coverage and the transect spacing by MRS. All transects will be spaced 500 ft apart. Figures B.14 through B.17 illustrate the planned transects for each of the MRSs.

Table 3.3
Transect Delineation by MRS

MRS	Transects
MRS-R01 (Figure B.14)	• 8,445 ft (1.60 miles) of residential area transects • 78,081 ft (14.79 miles) of golf course transects • 55,981 ft (10.60 miles) of overland transects • 25,318 ft (4.80 miles) of wetland/ponds transect investigations
MRS-R02 (Figure B.15)	• 78,357 ft (16.29 miles) of overland transects • 17,363 ft (4.31 miles) of wetland/ponds transects • 13,061 ft (2.47 miles) of mag-and-dig transects within the known target areas
MRS-R03 (Figure B.16)	• 4,989 ft (0.94 miles) of residential area transects • 13,419 ft (2.54 miles) golf course transects • 18,544 ft (4.45 miles) overland transects • 45,718 ft or (8.66 miles) wetland/ponds • 39,429 ft (7.47 miles) of mag-and-dig transects within the known target areas
MRS-R09 (Figure B.17)	• 231 ft (0.04 miles) of residential transects • 36,024 ft (6.82 miles) of overland transects • 4,874 ft (0.92 miles) of wetlands transects

3.8.3 Grid Selection

3.8.3.1 Following the DGM survey of the transects, anomaly density maps will be developed to locate survey grids within high-, medium- and low-anomaly density areas. These grids will undergo an additional DGM survey and an intrusive investigation of anomalies to better define the nature of MEC and MD within each MRS. If MEC is discovered at the outer boundary of an MRS, HGL will coordinate with the PDT to determine an acceptable approach for expanding the characterization to evaluate the MRS boundary.

3.8.3.2 Grid locations will be distributed throughout the investigation area. The grids may be of various sizes depending on the anomaly density of the "target" areas, but will average 2,500 square ft (50 by 50 ft). These grids will be mapped using DGM to identify potential MEC and MD items. Representative targets will be intrusively investigated by UXO-qualified technicians IAW Section 3.9 below. Once a munitions contaminated area has been identified, the boundaries of the area will be validated with intrusive transect segments, as necessary. The intrusive transect segment will assist in accurately defining the extent of the munitions contaminated area.

3.8.3.3 Grid locations will also be distributed throughout areas less likely to contain munitions to confirm the absence of MEC and MD. These grids will be mapped using DGM to identify potential MEC and MD items as discussed above. Grid coverage will be selected based on the UXO Estimator software and ensure a 90% confidence that the residual UXO density will be less than 0.1, 0.5, or 1 UXO item per acre, depending on site-specific land use. If munitions are found during the grid investigation in presumed "no MEC present" areas, additional characterization (DGM transects, DGM grids, intrusive transect segments) may be required to verify the extent of residual MEC.

3.8.4 Geophysical Investigation Plan

3.8.4.1 A comprehensive discussion of the geophysical equipment, procedures, and QC processes that will be utilized during the RI/FS is provided as Appendix K. The GIP also discusses how geophysical data will be incorporated into the RI report.

3.9 INTRUSIVE INVESTIGATION

3.9.1 An intrusive investigation will be performed of all subsurface anomalies identified along mag-and-dig transects and within full coverage DGM grids. The anomaly selection criteria will be proposed in the instrument verification strip (IVS) report and will ensure that both MEC and MD (for example, frag) are accounted for in the selection process. In addition, HGL will intrusively investigate specific geophysical anomalies representative of MEC and MD that are identified along terrestrial transects to refine the boundaries of features of interest.

3.9.2 A qualified MEC dig team will be deployed to investigate the identified anomalies. The MEC dig team, under the direct supervision of the SUXOS, will conduct intrusive investigation of the identified anomalies. If MPPEH is found during anomaly investigation, it will be evaluated as described in Section 3.10.

3.9.3 The following procedures will be followed during the intrusive investigations:

- The field teams will intrusively investigate anomalies specified on the dig sheet within the DGM grids and towed-array transects. All contacts along mag-and-dig transects will be investigated. Anomalies will be excavated IAW this WP and HGL's intrusive investigation SOPs (Appendix I) to positively identify each item.

- Targets selected for identification will initially be investigated by hand using hand tools. If the anomaly cannot be uncovered within 2 ft of the ground surface, the UXO team will note the location of the anomaly for subsequent excavation with mechanized equipment IAW the procedures in the approved ESP.
- If the subsurface contact proves to be non-MEC, it will be removed and the hole rechecked with a handheld magnetic locator. If the hole is "clean," the UXO technician will move on to the next contact. If the contact is a suspect MEC item, it will be marked with a pin flag for disposal as required. An area with a 1-meter radius around the identified anomaly will be checked to ensure that the primary anomaly was not masking additional anomalies and to ensure that all anomalies have been investigated.
- All anomalies identified as MEC will be left in place until their condition and identification is assessed by qualified UXO personnel to determine ultimate disposition. Digital photographs of all MEC will be taken for reporting purposes. Dig sheets and photographs will be linked to the project GIS. QC checks of the cleared designated anomaly locations will be completed by the UXOQCS.
- Areas or excavations that present discolored soils, burned material, leaking munitions, or disposal pits will be marked and logged. The SUXOS will notify the HGL PM and installation personnel as soon as practical upon such a discovery. The HGL PM will notify the USAESCH PM and supplemental project personnel, if necessary.
- After the removal of the anomaly or the blown-in-place (BIP) disposal of the MEC, the excavation will be backfilled and restored as closely as possible to its original condition IAW the contract specifications.
- The SUXOS will maintain a detailed record of recovered items, including amounts of MEC, proper nomenclature and condition, location, depth, and disposition. The record will include the classification of the item and the mark/model number of the item. The locations of large area (saturated response) anomalies will be identified and the sources characterized, if possible.
- Investigative results will be recorded electronically or on hardcopy forms. Electronic dig sheets will be annotated, as appropriate, and all columns completed.
- Excavations will be backfilled and the ground surface restored as near as practical to its original condition.

3.10 MEC PROCEDURES

3.10.1 Personnel Qualifications

3.10.1.1 Site personnel will be trained and meet the medical monitoring requirements outlined in the APP (Appendix D). These include the requirements of Hazardous Waste Operations and Emergency Response (HAZWOPER) regulations under 29 CFR 1910.120/29 and CFR 1926.65. MEC operations personnel will be qualified and certified IAW terms outlined by the

U.S. Department of Labor's Employment Standards Administration Wage Hour Division for UXO personnel and DoD Explosives Safety Board (DDESB) Technical Paper (TP) 18, *Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel* (DDESB, 2004). A personnel qualifications letter is provided in Appendix G.

3.10.2 Exclusion Zones

3.10.2.1 Exclusion zones (EZs) will be established IAW the DDESB-approved ESP (Appendix J). Access to an EZ will be controlled with entry control points. While an EZ is in effect, access will be limited to essential personnel and authorized visitors. Any occupied building or public roadways in the minimum separation distance (MSD) area during MEC-related operations will be evacuated and/or blocked to prevent non-essential personnel from entering during the conduct of MEC operations. Nonessential personnel will not be allowed back into the EZ until all MEC operations within that zone are complete. Once MEC operations within the zone have been concluded, the SUXOS will open the area to normal activities.

3.10.3 Engineering Controls

3.10.3.1 MEC items will be disposed of on an individual basis. If required, engineering controls IAW the approved version of the ESP will be implemented.

3.11 MEC AND MPPEH MANAGEMENT

3.11.1 General

3.11.1.1 MPPEH will be processed and disposed IAW EM 395-1-97 as well as DoD Instruction Number 4140.62, November 25, 2008, *Material Potentially Presenting an Explosive Hazard*. Additionally, site personnel will adhere to HGL SOP 15.03, MPPEH Inspection, Management, and Processing (See Appendix I), which establishes overall practices for HGL UXO-qualified personnel inspecting, processing, safeguarding, and managing MPPEH during MEC activities.

3.11.1.2 All MPPEH will be assessed and its explosives safety status determined and documented before transferring it within the DoD or released from DoD control. Before it is released to the public, MPPEH will be documented by authorized and technically qualified personnel as material documented as safe (MDAS) after a 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective.

3.11.2 Acceptable-to-Move Determination

3.11.2.1 The SUXOS and UXOSO will then make an acceptable-to-move determination. The MEC item will be classified as either unacceptable-to-move or acceptable-to-move and demilitarized as follows:

- MEC that is unacceptable-to-move will be BIP.

- MEC found acceptable-to-move by the SUXOS and UXOSO may be moved within the boundary of the area of investigation for detonation. In such cases, the responsible SUXOS and UXOSO must agree with the risk determination and document this decision in writing before moving the MEC item.

3.11.3 DD Form 1348-1A

3.11.3.1 The SUXOS will certify and the USACE OESS will verify that the debris is free of explosive hazards. If the OESS is not on site, the UXOQCS will sign as the verifier. DD Form 1348-1A will be used as certification/verification documentation. All DD 1348-1A forms will clearly show the typed or printed names of the contractor's SUXOS and UXOQCS, as well as the organization, signature, and home and field office telephone numbers for the persons certifying and verifying the debris as free of explosive hazards. The form will state the following if only MD is being processed:

> This certifies and verifies that the munitions debris listed has been 100% properly inspected and to the best of our knowledge and belief, is free of explosive hazards.

3.11.3.2 If RRD is being processed with MD, the form will state the following:

> This certifies that the material listed has been 100% properly inspected and, to the best of our knowledge and belief are free of explosive hazards, engine fluids, and illuminating dials and other visible liquid hazardous, toxic, and radioactive waste materials.

3.11.3.3 The SUXOS will ensure that a DD Form 1348-1A is completed for each container prior to transfer. The form will contain the following information:

- Location where material was obtained,
- Basic material content (type of metal, such as steel or mixed),
- Estimated weight,
- The unique identification number of each container, and
- Seal identification number.

3.11.3.4 All MDAS will be disposed of at a recycler where it will be processed through a smelter, shredder, or furnace prior to resale or release IAW all governing regulations. If it is discovered during the material transfer and shipping process that a seal has been broken and the chain of custody of the material cannot be verified, the material in question will be subject to reinspection following the established MPPEH process. Copies of all MDAS certification and chain of custody documentation will be provided to HGL for inclusion in the RI report.

3.11.3.5 All material will be accounted for in the daily and weekly reports.

3.11.4 Chain of Custody

3.11.4.1 MPPEH chain of custody and final disposition procedures for certified and verified material will be followed IAW EM 385-1-97, Chapter I, Section 11.

3.11.5 Explosives Storage

3.11.5.1 No MEC storage is anticipated. MEC will be destroyed daily or guarded until destroyed.

3.11.5.2 Donor explosives may be stored at an explosive magazine or explosives may be delivered on an as-needed basis as described in the ESP. Total control of explosives will be maintained while the explosives are on site. All vehicles transporting explosives will be properly inspected, equipped, and placarded before loading explosives, and DD Form 626, Motor Vehicle Inspection, will be completed.

3.11.6 On-Site MEC Disposal

3.11.6.1 Explosive operations will follow the procedures outlined in Technical Manual (TM) 60A-1-1-31, *Explosive Ordnance Disposal (EOD) Procedures*; EM 385-1-97, *Explosives Safety and Health Requirements Manual* (USACE, 2008a); and the HGL SOPs (Appendix I). Disposition of MEC will be accomplished by UXO personnel qualified IAW DDESB TP 18 (DDESB, 2004). Demolition operations will be performed daily, or items will be properly guarded until such operations can be conducted. Demolition operations will be performed within the MRS. The use of BIP demolition, collection points, and consolidated shots will be performed as described in the ESP.

3.11.6.2 The UXOSO will be responsible for determining whether minimum safe conditions to conduct demolition operations are met. The SUXOS and UXOQC/UXOSO, in coordination with USACE, will discuss all occurrences where 24-hour security needs to be provided for MEC items awaiting disposal. Team personnel will provide perimeter security during demolition operations.

3.12 SITE RESTORATION AND DEMOBILIZATION

3.12.1 Upon completion of the QC check for each investigated anomaly, the excavation will be backfilled with soil and the ground will be restored to near-grade conditions. Full demobilization will occur when the project is completed and appropriate QA/QC checks have been performed.

3.13 MUNITIONS CONSTITUENTS INVESTIGATION APPROACH

3.13.0.1 Although site-specific data has been collected previously at the Former Conway BGR, additional sampling is required to generate a defensible RI/FS. Soil, sediment, and, if needed, groundwater samples will be collected at biased locations selected within each MRS for laboratory analysis. The biased locations will be either relatively small SUs or discrete samples collected within areas of the MRSs that are judged most likely to have MC

contamination based on MEC/MD presence. The biased locations will not necessarily represent the entire MRS; however, the data will support a decision regarding the presence or absence of MC contamination within the areas of the MRS most likely to contain contamination (see Phase 1 in paragraph 3.13.0.3). Additional investigation may be required to define nature and extent, if contamination is confirmed to be present (see Phase 2 in paragraph 3.13.0.3). Analytes will include explosives and selected MC metals (lead and zinc) (see Table 3.4).

3.13.0.2 Based on existing site conditions, historical site activities, and previous investigation data and results, HGL and the PDT have determined that a combination of an ISM sampling strategy and biased discrete sampling is appropriate for characterizing MC during the RI. ISM samples will only be collected for analysis of explosives. Discrete samples will be collected for metals analysis. Soil sample locations will be biased toward areas of MEC/MD presence, based on historical information, DGM analysis, and intrusive investigative results. Additional details associated with the execution of the MC sampling approach are presented below.

3.13.0.3 Activities will be conducted to identify the presence or absence of soil, sediment, or groundwater contamination, to delineate the nature and extent of existing MC contamination, and to evaluate migration pathways and/or pathways for the potential discharge of chemical constituents into the surface water or groundwater. Field sampling activities will be conducted in coordination with MEC field activities in three phases with six separate stages:

Phase 1

- Stage 1 – geophysical surveys to evaluate site conditions and identify the presence and extent of surface and subsurface MEC/MD;
- Stage 2 – MEC characterization, identification, and disposal activities; and
- Stage 3 – ISM surface soil sampling for explosives, and discrete soil sampling, will be collected in located biased toward areas of MEC/MD presence, to define the nature and extent of MC soil contamination. Sampling will be conducted in each MRS. Additionally, a site-specific background data set will be collected for each MRS, for both discrete soil samples and ISM surface soil samples. Background samples will be discrete surface soil samples, collected in locations outside the potential influence of DoD-related impacts to the MRS, and analyzed for select metals (lead and zinc).

Phase 2

- Stage 4 – dependent upon Phase 1 MC soil sampling results, additional ISM surface soil sampling, additional discrete surface, and/or subsurface soil sampling will be performed at sample locations where a release of MC has been verified to define the nature and extend of MC soil contamination; and
- Stage 5 – sediment sampling from surface water bodies adjacent to potential source areas to characterize the impact on the local drainage, if necessary. Background

sediment samples will be collected at upstream or up gradient locations, if sediment sampling is deemed necessary.

Phase 3

- Stage 6 – dependent upon Phase 1 and Phase 2 MC sample results, groundwater sampling of existing wells to characterize the potential nature and extent of groundwater MC contamination, if necessary.

3.13.0.4 HGL has designed this phased approach for sampling to adequately characterize the nature and extent of MC contaminants, provide the necessary data for a risk-based evaluation, and serve as a basis for future response decisions. A summary of the MC sampling strategy to be used at each of the MRSs is presented in Table 3.4. A summary of the overall sampling rationale is shown in the sampling matrix presented in Table 3.5. Figures B.18 through B.21 in Appendix B show proposed Phase 1 sampling locations. SOPs in Appendix I describe the ISM as well as the discrete surface and shallow depth soil sampling procedures that will be followed. Additional details associated with the execution of the MC sampling approach are presented below.

Table 3.4
RI MC Sampling Approach for Each MRS

MRS Sampling Approach: ISM, Discrete Soil, Sediment, and Groundwater Sampling
Phase 1:
• Select ten 100- by 100-ft ISM sampling unit (SU) parcels based on results of the geophysical survey.
• Subdivide each SU into at least 32 uniform (incremental sample) grid cells.
• Randomly select a single increment sampling point in an initial grid cell (center of grid) and collect increments from the same relative location within each of the other grid cells.
• Ten discrete samples will be collected within each MRS. (One discrete sample will be collected from each of the 10 SUs)
• ISM soil samples will be analyzed for explosives (8330B).
• Discrete samples will be analyzed for metals (6020A – lead and zinc).
Phase 2:
• If Phase 1 sample results require, collect up to an additional five ISM soil samples and/or discrete surface and/or shallow subsurface soil samples (<2 ft below ground surface [bgs]) from within the general area sampled during Phase 1 at locations selected based on PDT input.
• Analyze Phase 2 discrete soil samples for explosives (8330B) and select metals (6020A – lead and zinc).
• If Phase 1 sample results require, select up to 20 sediment sampling locations from selected surface water locations (creeks, ponds, swamps/bays, etc.) adjacent to potential source areas based on sample results and PDT input.
• Upstream or up gradient background sampling locations will also be identified and sampled for sediment.
• Analyze sediment samples for explosives (8330B) and select metals (6020A/7471B – lead and zinc).
Phase 3:
• If Phases 1 and 2 sample results require, collect up to three groundwater samples from existing downgradient wells for explosives (8330B) and select metals (6020A/7471 – lead and zinc).
MRS Background Soil Sampling:
From each MRS, ten discrete background samples will be collected for background at locations agreed upon by the PDT. Analyze soil samples for metals (6020A/7471B – lead and zinc).

3.13.1 ISM Sampling Approach

3.13.1.1 During the RI, HGL will use ISM for soil characterization sampling at SUs identified after the completion of the DGM geophysical survey and intrusive activities. HGL is using the ISM sample collection and processing methodology because the process incorporates specific

elements designed to control data variability due to heterogeneity in contaminant distribution. The objective is to obtain a single sample that contains all analytes in exactly the same proportion as in the entire sampled area. This is achieved by collecting a sufficient number of discrete "increments" (typically 30 to 100) in an unbiased manner from throughout a specified area (the SU), combining and processing the increments, and incrementally subsampling the processed material to obtain a representative aliquot for analysis. Properly executed, the method provides unbiased, representative, and reproducible estimates of the mean concentration of analytes in the SU.

3.13.1.2 During the Phase 1 (Stage 3, as described in 3.13.0.3) field activities at the Former Conway BGR, 10 ISM soil samples will be collected for explosives constituents from SUs (100- by 100-ft grids) in each MRS using the methodology outlined in Appendix A of EPA Method 8330B and IGD 09-02 (USACE, 2009b). Additional ISM samples may be collected for explosives constituents during Phase 2 (Stage 4) sampling activities. The SU is a reasonable residential lot size; thus the data will be appropriate for direct comparison to residential risk-based soil screening levels and relevant to the CSM developed for the Former Conway BGR (Figures B.10 and B.11). Additionally, a minimum of 32 increments are planned, which is expected to provide spatial density sufficient to control variability due to the nonuniform distribution of contaminants within the SU, but still be practical for logistical considerations. An environmental scientist and a UXO-qualified technician (to provide escort) will collect soil samples for chemical analysis. In addition, the sampling team will collect QC (for example, field triplicates) and QA samples. Analytical sampling is covered in greater detail in Appendix E.

3.13.1.3 The USACE TPP guidance (USACE, 1998) and guidance provided by the *Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009b) describe a process for systematic planning, which determines the sampling objectives, sampling strategy, and sampling design that govern how the ISM will be adapted and applied. Appendix H summarizes factors considered during the TPP.

3.13.2 Discrete Soil Sampling Approach

3.13.2.1 Ten discrete samples will be collected from each MRS as part of Phase 1 sampling and will be analyzed for select metals only. Additionally, if MC metals are detected and exceed screening criteria in the Phase 1 discrete sample results, then additional discrete soil sampling will be conducted as Phase 2 to confirm the presence of the elevated concentrations of metals and evaluate potential source areas. Phase 2 discrete sampling will include five surface (0 to 0.5 ft bgs) soil samples and/or discrete shallow subsurface (0.5 to 2.0 ft bgs) soil samples collected from at locations within each MRS near Phase 1 sample exceedances, with input from the PDT.

3.13.3 Background Sampling Approach

3.13.3.1 Inorganic constituents (metals) occurring in natural environmental media (surface soil) are regarded as "background" concentrations that are characteristic of uncontaminated conditions to the extent that site activities have not adversely impacted these media. The

background concentrations are typically used during the assessment of site-related contamination (including risk assessments) to ensure that naturally occurring and non-site-related constituents are not unnecessarily carried forward through the assessments. Many metals-bearing compounds occur in nature and cannot readily be distinguished from site-related contamination without knowledge of metals concentrations in the unaffected (background) environmental media.

3.13.3.2 HGL will conduct environmental background sampling during RI field activities at the Former Conway BGR to assess existing site conditions relative to naturally occurring ones. The purpose of the background characterization is to establish statistically valid background database concentrations for metals (lead and zinc) present in the surface soils that can be used during the RI/FS process.

3.13.3.3 Information regarding background metals concentrations present in the surface soils at the Former Conway BGR does not exist; therefore, 10 biased, discrete samples will be collected during Phase 1 from areas similar to but outside MRS boundaries per EPA guidance. Field sampling will be conducted IAW this WP at locations agreed upon by the PDT. HGL will use this data to conduct the screening and evaluation of inorganic soil concentrations detected during the Former Conway BGR RI/FS.

3.13.3.4 Background soil samples will be analyzed for select metals using Method 6020A. A sample matrix outlining the total samples proposed for collection at all of the MRSs, as well as analytical methods and analyses, is presented in Table 3.5. All hand augers, spoons, trowels, sample coring devices, and other reusable sampling equipment used to collect surface and subsurface soil samples will be decontaminated between each sampling location.

3.13.4 Sediment Sampling Approach

3.13.4.1 In addition, if ISM or discrete sample results from Phase 1 sampling activities indicate that detected constituent concentrations exceed relevant criteria, then, in consultation with the PDT, HGL will collect up to 20 supplemental sediment samples per MRS from PDT-identified locations to determine if these source areas have impacted sediments in adjacent surface water bodies. Upstream or up gradient background sampling locations will also be identified and sampled for sediment. Sediment samples would be evaluated for explosives and selected metals (lead and zinc). If sample collection occurs, samples will be collected as specified in Table 3.3 and the QAPP (Appendix E).

3.13.5 Groundwater Sampling Approach

3.13.5.1 If Phases 1 and 2 soil sampling results show MC contamination above the appropriate criteria, groundwater samples would potentially be collected to delineate the nature and extent of existing MC contamination, as well as to evaluate migration pathways and/or pathways for the potential discharge of chemical constituents into groundwater. Existing wells within 1 mile of the MRS boundaries were located and basic information on the wells was obtained utilizing the SCDNR Hydrology Section water well records (SCDNR, 2004). Groundwater sampling may be conducted at up to 3 PDT-selected production/drinking water wells downgradient of

Table 3.5
Sample Matrix

Matrix [A]	Estimated No. Field Samples Required	QC Field Duplicates or Triplicates/ Splits (10%) [B]	Matrix Spikes (5%) (Matrix Spike Duplicates) (5%) [C]	Equipment Rinsate Blanks (Daily)	QA Splits (10%)	Total HGL Samples	Analysis	Analytical Procedure	DQO Level	Holding Time	Preservation Requirements	Sample Containers
Incremental Soil Sampling (Phase 1 MRS)	**40**	4	0 (4)	0	4	**48**	Multi-Increment Explosives (including PETN and Nitroglycerin)	8330B	Definitive	After drying phase is complete: 14 days for extraction/ 40 days for analysis	None	Clear polyethylene bag, containing at least 32 aliquots, total sample weight of approximately 1.5 kilograms.
Discrete Soil Sampling (Phase 1 MRS)	**40**	4	0 (4)	0	4	**48**	Metals (lead and zinc,)	6020A/7471B	Definitive	180 days	None	(1) 8-ounce wide-mouth glass with Teflon-lined cap
Incremental Soil Sampling (Phase 2 MRS)	**20**	2	0 (2)	0	2	**24**	Multi-Increment Explosives (including PETN and Nitroglycerin)	8330B	Definitive	After drying phase is complete: 14 days for extraction/40 days for analysis	None	Clear polyethylene bag, containing at least 32 aliquots, total sample weight of approximately 1.5 kilograms.
Discrete Soil Sampling (Phase 2 MRS)	**20**	2	0 (2)	0	2	**24**	Metals (lead and zinc)	6020A/7471B	Definitive	180 days	None	(1) 8-ounce wide-mouth glass with Teflon-lined cap
Sediment Sampling (Phase 2 MRS)	**80**	8	0 (8)	0	8	**96**	Explosives (including PETN and Nitroglycerin)	8330B	Definitive	14 days for extraction/ 40 days for analysis	Cool to ≤6°C	(1) 8-ounce wide-mouth glass with Teflon lined cap
	80	8	0 (8)	0	8	**96**	Select Metals (lead and zinc)	6020A/7471B	Definitive	180 days	Cool to ≤6°C	(1) 8-ounce wide-mouth glass with Teflon-lined cap
Groundwater Sampling (Phase 3 Existing Wells)	**12**	2	0 (2)	1	2	**14**	Select Metals (lead and zinc)	6020A/7471	Definitive	180 days	Cool to ≤6°C pH <2	(1) 1-liter polyethylene preserved with nitric acid to pH <2
	12	2	0 (2)	0	2	**14**	Explosives	8330B	Definitive	7 days for extraction/ 40 days for analysis	Cool ≤6°C	125-mL polyethylene bottle

(A) The sample matrix is a representation of samples to be collected per sample phase at all MRSs. Refer to Table 3.4 for a more detailed discussion of samples to be collected at each MRS.
(B) For IS, triplicate QC sampling is conducted at a rate of 10%. One ISM SU collected in triplicate equates to three field samples. Per Method 8330B, percent relative standard deviation calculations of triplicate samples serve as QA/QC measures (typically, relative standard deviation should be <30%).
(C) Matrix spike/matrix spike duplicate analyses will not require the submission of additional aliquots; a single IS or 8-ounce jar will contain sufficient material to perform any required QC analyses in conjunction with the sample analyses. The number in parentheses indicates the number of matrix spike and matrix spike duplicate analyses that will be requested on chain of custody forms for each matrix.
°C = degrees Celsius
mL = milliliter

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each MRS, assuming that the PDT determines that the wells available are appropriate. It should be noted that there are only a few existing wells within a 1-mile radius to the MRS boundaries, and many of the water levels recorded for the wells that were identified were deeper than 50 ft bgs. Therefore, should MC contamination impact local shallow groundwater, it is unlikely to migrate to or influence nearby existing wells. If Phase 1 and Phase 2 soil sampling indicate that groundwater analysis is necessary, site specific background water samples will be collected from outside the MRSs.

3.13.5.2 The total of samples proposed for collection, as well as analytical methods and analyses, is presented in Table 3.5.

3.13.6 MC Sampling Procedures

3.13.6.0 This section details procedures, techniques, and equipment that will be used during the Former Conway BGR RI field investigation activities to conduct MC soil, sediment, and groundwater sampling activities, if required. Any changes to the proposed approach will be incorporated into the RI WP as an amendment of field change and will be approved by the PDT.

3.13.6.1 Utility Clearance

3.13.6.1.1 Utility maps for the immediate vicinity of the MRS will be reviewed by HGL personnel prior to completion of intrusive excavation and/or soil boring field investigation activities. Before intrusive activities occur at the Former Conway BGR, potential underground utilities present within the MRS area of investigation will be identified by applicable local utility personnel. All excavation activities and reporting will comply with the applicable laws, ordinances, regulations, and requirements of the State of South Carolina and USACE.

3.13.6.2 Soil Boring and Sample Logging

3.13.6.2.1 Soil boring or soil excavation will be conducted with a UXO Technician II or above providing oversight of MEC anomaly avoidance procedures. During soil boring sampling activities, the lithology will be classified using the Unified Soil Classification System. The HGL project geologist will record the lithology and document the information in the field logbook and on a field boring log form (Appendix F). Each log will include a complete description of the characteristics of the material collected, as well as conditions encountered. The following sample characteristics will be included in each log:

- Lithology,
- Particle size (visual estimates),
- Color (Munsell),
- Consistency and texture,
- Relative density,
- Moisture, and
- Other distinctive features.

3.13.6.2.2 Soil sampling will be conducted to determine the presence or absence of contamination in the surface and shallow subsurface soil horizons. Sampling depths, sampling methods, and frequency will be based on observations made during investigation activities. In general, samples may be collected from two strata: surface (0 to <0.5 ft bgs) and shallow subsurface intervals (between 0.5 and 2 ft bgs). Observations, sampling rationale, and details of sample collection will be recorded in the soil boring and sample logs. SOPs for the collection and logging of surface and shallow subsurface soil samples are presented in Appendix I. Each sample location will be surveyed, and the coordinates will be recorded on the soil boring logs.

3.13.6.2.3 Completed field forms and survey data will be provided with the Former Conway BGR RI report. The following Sections describe the methods and equipment that will be used to collect soil samples.

3.13.6.3 Surface Soil Sampling Procedures (Discrete and Incremental)

3.13.6.3.1 Surface soil samples may be collected throughout the MRS locations as part of the RI field activities. Incremental (explosives) and discrete (select metals) samples will be collected from surface soil locations. These samples will be collected and analyzed as specified in Table 3.3 and the QAPP (Appendix E).

3.13.6.3.2 Discrete surface soil samples will be collected from the ground surface to 0.5 ft bgs using decontaminated stainless steel equipment. Shallow subsurface soil samples will be collected from between 0.5 and 2 ft bgs. Before sample collection, all sample locations will be screened by a UXO Technician II or above escort using a Schonstedt geophysical instrument. If detection is made of a subsurface anomaly, the sample will be collected from a nearby point that is cleared by the UXO escort. Soil boring sampling will be conducted using a hand auger or stainless steel sampling spoons and bowls. Samples will be homogenized and placed into appropriate sample containers (for example, glass jars) using sampling equipment and following procedures specified below and in SOP 2.13, *Surface and Shallow Depth Soil Sampling,* presented in Appendix I. QC samples will be collected using the same procedures used for primary environmental samples.

3.13.6.3.3 For ISM samples, surface soil will be collected from the SU locations agreed to by the PDT. The typical SU size is anticipated to be 100 by 100 ft. The size and shape of SUs may be adjusted be based on the evaluation of DGM transect data, reconnaissance transect data, and intrusive investigation data. Additionally, the size of an SU may be adjusted to encompass site features, but the total area will remain the same. The four corners of each SU will be recorded using a GPS unit capable of sub-meter or better accuracy. Each ISM sample collected will be composed of at least 32 increments collected along approximately equally spaced lanes covering each respective SU. Before sample collection, all sample increment locations will be screened by a UXO Technician II or above escort using a Schonstedt geophysical instrument. If detection is made of a subsurface anomaly, the sample will be collected from a nearby point that is cleared by the UXO escort.

3.13.6.3.4 Incremental samples will be collected using a multi-incremental sample (MIS) sampling tool. QC samples will be collected using the same procedures used for primary environmental samples. The collected soil will be placed in clean and certified plastic bags; the total weight of all the increments from each SU (regardless of the total number of sample increments collected) will be at least 1 kilogram but no more than 2 kilograms. When all sample increments have been collected, the bag will be sealed and sent to the analytical laboratory for analysis. The incremental sample preparation conducted by the laboratory includes drying and sieving for all analyses. The procedures are described in SW846 Method 8330B. Processed soil will be ground for explosive analyses. The sampling will be conducted in compliance with the ISM described in SOP 002 Incremental Sampling presented in Appendix I.

3.13.6.3.5 The procedures described below will be followed for collecting soil samples during the RI field investigation:

- Sampling equipment will be thoroughly cleaned and decontaminated before initial use and after each soil sample completion.
- Decontaminated equipment will be air dried before being wrapped in a nonplastic material (for example, aluminum foil or Teflon®) and stored in a manner that reduces the potential for accidental contamination.
- Containers necessary for soil samples are described in QAPP Worksheet #19.

3.13.6.3.6 All soil samples will be assigned a unique sampling identification number based on the location, media, and sample depth, as described in the QAPP (Appendix E). Samples will be packed in coolers immediately upon collection and tracked using a chain of custody. The samples will be forwarded directly to the analytical laboratory in waterproof coolers on wet ice; both sample jars and ice will be packed in separate bags in a manner to minimize cross-contamination and cooler leakage during shipment. Coolers will be sealed and marked with custody seals to prevent tampering.

3.13.6.3.7 Each sample cooler will contain sufficient ice or blue ice® to maintain sample temperature at 4°C ± 2°C. Before shipment the temperatures of the coolant blank will be recorded. Laboratory personnel will repeat this procedure when the samples arrive at the laboratory. Should the temperature exceed 6°C at arrival at the laboratory, or if there is evidence that the samples have been frozen in transit, the laboratory will contact the HGL PM and project chemist. The HGL PM and project chemist will determine whether the requested analyses should continue on the affected samples or whether the analyses should be cancelled and the samples re-collected.

3.13.7 Sediment Sampling Procedures

3.13.7.1 If surface soil results indicate the presence of a potential source, sediment samples may be collected from surface water locations (ponds, creeks, rivers) identified during the completion of the RI field activities to characterize potential migration of MC. These samples will be analyzed as specified in Table 3.3 and the QAPP (Appendix E). Specific descriptions

of equipment and procedures that will be used to sample the sediment at the specified locations are provided below and in SOP 2.15, *Sediment Sampling* (Appendix I).

3.13.7.2 Sediment samples will be collected using either a stainless steel hand auger or a stainless steel trowel. HGL field personnel will determine the exact types of sampling equipment based on site conditions. Field decisions will be based on site-specific conditions, and the rationale for these decisions will be included in the field logbook.

3.13.7.3 Sediment samples for explosives and select metals (lead and zinc) analysis will be placed in a stainless steel bowl and homogenized before placing them into the laboratory-specified sample containers. All sediment samples will be assigned a unique sampling identification number based on the location, media, and sample depth, as described in the QAPP (Appendix E). Samples will be packed in coolers immediately upon collection and tracked using a chain of custody. Procedures for packing, chain of custody, and shipping coolers for sediment samples are described in the QAPP (Appendix E) and SOP 2.15 (Appendix I).

3.13.8 Groundwater Sampling Procedures

3.13.8.1 Groundwater samples may be collected from existing production wells identified during the completion of the RI field activities. If collected, these samples will be analyzed as specified in Table 3.3 and the QAPP (Appendix E). Specific descriptions of equipment and procedures that will be used to sample the groundwater at these locations are provided in SOP 2.32, *Domestic and Public Well Sampling*, presented in Appendix I. All groundwater samples will be assigned a unique sampling identification number based on the location, media, and well identification, as described in the QAPP. Samples will be packed in coolers immediately upon collection and tracked using a chain of custody.

3.14 SAMPLING QUALITY ASSURANCE PROCEDURES

3.14.1 The sampling QC procedures are presented in the QAPP in Appendix E.

3.15 HUMAN HEALTH RISK ASSESSMENT APPROACH

3.15.0.1 The objective of the screening level HHRA is to characterize the adverse health effects associated with potential exposures to environmental contaminants at the MRSs to identify areas that may need further investigation as well as identify those that warrant no further action.

3.15.0.2 To meet this objective, the HHRA will evaluate potential human exposures to constituents of potential concern (COPCs) identified in the environmental media (soil and potentially sediment and groundwater) at each of the MRSs using methods consistent with the EPA risk assessment guidance provided in *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A)* (EPA, 1989). Other pertinent guidance documents will be used as appropriate and include, but are not limited to, the following:

- EPA *Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manuals Part D* (EPA, 2001a), Part E (2004), and Part F (2009a);
- USACE *Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance* (November) (2013a).
- USACE *Risk Assessment Handbook Volume I: Human Health Evaluation* (January 1999); and
- EPA *Regional Screening Level Tables and User's Guide* (November 2013).

3.15.0.3 The HHRA will follow the four-step process of hazard identification, toxicity assessment, exposure assessment, and risk characterization defined by the National Academy of Sciences (1983) and EPA (1989). A qualitative uncertainty analysis discussion will also be included.

3.15.1 Hazard Identification

3.15.1.1 The hazard identification section will summarize the available data that exist for each MRS. Available site data will consist of historical data and the data collected as identified in the RI WP for each specific MRS. Based on historical site data and anticipated RI data collection efforts, the HHRA will focus on potential exposure to surface soil. Shallow subsurface soil, groundwater, and sediment will be evaluated in the HHRA, as appropriate, based on the results of the RI data collection efforts.

3.15.1.2 The soil data for each MRS will be summarized in data tables that will include the frequency of detection, the range of laboratory reporting limits, the range of detected concentrations, and the concentration used for screening. The data tables will follow the format for "Table 2" as presented in EPA *Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manual Part D* (EPA, 2001a).

3.15.1.3 Where the dataset includes multiple valid results for a sampling location due to the collection of field duplicate or triplicate samples, the determinative results for that location will be selected for inclusion in screening and risk assessment. The selection of determinative results will be made on an analyte-specific basis using the following decision rules:

1. When more than one duplicate or replicate at a location has a detected concentration, the highest detection will be treated as one detected concentration at the location.
2. When only one of the duplicate or replicate samples at a location has a detected value, the detected value will be treated as one detected concentration at the location.
3. When all duplicate or replicate samples have nondetect values, the lowest limit of detection will be used as one nondetected concentration at the location.

3.15.1.4 The data will be presented separately for surface soil and subsurface soil. Surface soil is defined as any surface soil sample beginning at ground surface (0 inches) and ending at less than 0.5 ft bgs. Subsurface soil is defined as any soil sample beginning at 0.5 ft or more bgs. Data will also be presented as appropriate for groundwater and sediment.

3.15.1.5 COPCs are defined as the detected analytes potentially related to releases at a site. Analytes not detected in any of the samples collected from a particular medium (for example, surface soil) will be excluded from further evaluation. For datasets with 20 or more samples, a chemical detected at a frequency of less than or equal to 5% will not be identified as a COPC. This frequency of detection criterion will only be used after an evaluation of the spatial distribution of the detections demonstrates that the detections are not associated with potential release or migration areas.

3.15.1.6 The analytical results for metals will be evaluated with respect to site-specific background concentrations collected during the Phase 1 sampling efforts. If a chemical's results are statistically similar to background concentrations, then that chemical will not be identified as a COPC. For those chemicals that appear to represent contamination, the maximum detected concentrations will be compared to risk-based screening levels. The human health screening levels presented for soils are the Regional Screening Levels (RSLs) for residential soil published in the RSL tables jointly developed by EPA Regions 3, 6, and 9, and updated in May 2014 (EPA, 2014). The RSLs for noncarcinogens are concentrations that correspond to an analyte-specific hazard index (HI) of 1; the RSLs for carcinogens are concentrations that correspond to an analyte-specific cancer risk of 10-6. The human health screening levels for groundwater are derived by screening samples against Federal maximum contaminant levels (MCLs), as listed in the most recent EPA RSL Table. In the event that no MCL is available, the regional screening value for tap water should be used.

3.15.1.7 For those chemicals that are identified as potential contaminants based on the background comparison, COPCs in soil for each MRS will be identified using the following methodology:

- The maximum detected concentration of each carcinogenic compound will be compared to the EPA residential soil RSL value (as presented in the references identified above) calculated for an acceptable target cancer risk of 10^{-6}.
- The maximum detected concentration of each noncarcinogenic compound will be compared to the EPA residential soil RSL value (as presented in the references identified above). The EPA residential soil RSL will be adjusted downward by a factor of 10 to address the potential presence of multiple noncarcinogenic compounds that may affect the same target organ, for an acceptable target hazard quotient (HQ) of 0.1. If the maximum detected concentration is greater than any of the noted residential screening values, the chemical will be identified as a COPC for direct contact with soil and retained for quantitative evaluation in the HHRA.
- For ISM results, the detected concentrations also may be compared to screening levels using a 95% upper confidence level (UCL). (See Section 3.15.2.4.5.)

3.15.1.8 The maximum concentrations of the detected metals (lead and zinc) in soil will also be compared to background data to provide an initial determination as to whether metals have been detected at concentrations that correspond to site background concentrations. Metals that appear to reflect background conditions will not be included in any risk quantification.

3.15.1.9 If groundwater and sediment samples are obtained as a part of the RI data collection efforts, then the constituents detected in these media will also be compared to risk-based screening levels pursuant to the methodology presented above. Constituents detected in groundwater will initially be screened in comparison to the EPA RSLs for tap water. These RSLs address potential exposure through ingestion and the inhalation of volatiles from the use of tap water. Sediment data will be compared to the EPA RSLs for soil, which address the potential for exposure through incidental ingestion, dermal contact, and inhalation of volatiles and particulates.

3.15.1.10 COPCs will be identified as constituents detected at concentrations that exceed risk-based screening criteria. A standardized list of COPCs detected at concentrations that exceed the residential RSLs will be developed for each MRS, and this list of COPCs will be carried through for further quantitative evaluation in the HHRA. A justification will be provided for each compound not identified as a COPC. If a detected constituent has no screening criteria, it will be qualitatively evaluated in the HHRA based on information obtained through a review of scientific literature.

3.15.2 Exposure Assessment

3.15.2.0 The exposure assessment will provide a discussion of the type and magnitude of exposures to COPCs at each MRS. The preliminary CSM will be refined to evaluate the potential fate and transport mechanisms of the COPCs and to identify potential human health and ecological exposure pathways including potential receptors and routes of exposure.

3.15.2.1 Conceptual Site Model

3.15.2.1.1 An exposure pathway analysis will be performed through the development of the CSM. The CSM will identify the relationship among sources, release mechanisms, impacted media, exposure routes, exposure points, and receptors potentially affected by constituents present at or released from the MRS locations at the Former Conway BGR.

3.15.2.1.2 There are four elements used to establish a complete exposure pathway:

1. A source and a mechanism of release to the environment,
2. An environmental transport medium,
3. A point of potential contact between a receptor and the environmental medium (referred to as the exposure point), and
4. An exposure route or uptake mechanism.

3.15.2.1.3 The preliminary CSM for MEC and MC at the Former Conway BGR is presented as Figures B.10 and B.11.

3.15.2.2 Potential Migration Pathways

3.15.2.2.1 Based on the preliminary evaluation of potential sources and release mechanisms, the preliminary CSM identified five transport mechanisms for the potential migration of constituents in soil:

- Mechanical redistribution,
- Wind erosion,
- Plant uptake/bioaccumulation,
- Surface water runoff, and
- Leaching/percolation.

3.15.2.2.2 The contaminants of interest at this site do not include volatile constituents, and vaporization is not an applicable transport mechanism. The preliminary evaluation of potential migration pathways as presented in the CSM will be updated based on the data collected during the RI.

3.15.2.3 Potential Receptors and Routes of Exposure

3.15.2.3.1 The preliminary CSM also presents the initial evaluation of potential receptors and exposure routes. The potential receptors are chosen based on the current and future land use at each MRS. Currently, the Former Conway BGR land is used for timber harvesting and for agricultural, residential, and recreational purposes. The land at the four MRSs was converted to private use and is owned by private entities. Portions of all four MRSs have been developed as golf courses and as residential housing. According to the RI report prepared by EODT, the current land use at MRS-R01, Range II, is residential, recreational, and forestry, and the current land use at MRS-R02, Range III, is residential and recreational (EODT, 2012). At both MRS-R03, Range IV, and MRS-R09, MG/RR, the current land use is residential, forestry, hunting, mining, and agricultural. However, there is very little farmland remaining within the BGR. Additional residential development is anticipated in the future. Conway BGR is in South Carolina Game Zone 5, which allows deer hunting with bow and arrow from August 15 through August 31, and deer hunting with gun from September 1 through January 1. Turkey hunting season is April 1 to May 1.

3.15.2.3.2 Based upon the initial evaluation, the following receptors could be present at the Former Conway BGR under the current and potential future land use scenarios:

- Construction Worker,
- Outdoor Worker,
- Maintenance/Utility Worker,
- Trespasser,
- Recreational User/Hunter,
- Indoor Worker, and
- Resident.

3.15.2.3.3 The above receptors are considered to have the potential for exposure to constituents detected in site media through the following exposure routes:

- Inhalation of airborne particulates,
- Incidental ingestion and dermal contact with surface soil,
- Incidental ingestion and dermal contact with subsurface soil,
- Ingestion of vegetation,
- Ingestion of prey animals,
- Incidental ingestion and dermal contact with sediment, and
- Ingestion, inhalation while showering, and dermal contact with groundwater.

3.15.2.3.4 It should be noted that not all exposure routes are applicable to each receptor. Only select routes are applicable to each individual receptor.

3.15.2.3.5 The preliminary evaluation of potential receptors and exposure routes for the Former Conway BRG as presented in the CSM will be updated based upon the data collected during the RI and presented for each MRS in the HHRA. The current and future potential receptors and exposure pathways identified for each MRS will be summarized on tables in the format of "Table 1" as presented in EPA *Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manual Part D* (EPA, 2001a).

3.15.2.4 Quantification of Potential Exposure

3.15.2.4.1 It should be noted that it is currently assumed that a comprehensive baseline HHRA will not need to be conducted. Therefore, if quantification of potential exposure is determined to be necessary, it will only be undertaken upon the agreement and authorization of all parties involved. If the hazard identification step results in the identification of constituents at concentrations above risk-based screening criteria, then, consistent with EPA guidance, the magnitude, frequency, and duration of exposure for each complete exposure pathway identified above will be quantified through the estimation of exposure point concentrations (EPCs) and the calculation of intakes.

3.15.2.4.2 For the purposes of the HHRA, the exposures to each potential receptor will be considered to occur entirely within each MRS. Exposure points, the locations of potential contact between a receptor and a COPC, will be defined within each site based on the media-specific data relevant for potential exposure(s). Furthermore, an evaluation of potential outliers (or areas with elevated concentrations of COPCs) will occur with the results clearly identified in the final report. As a result of the risk assessment, the exposure points may be defined as the data representing the entire site and/or a smaller area based on the media-specific sampling data relevant for that exposure. Exposure units will be identified based on potential source areas and the corresponding potential for receptors to come into contact with the exposure medium. Different exposure units may be identified for different receptors within the same MRS.

3.15.2.4.3 With the exception of exposure units subject to ISM, the EPC for each exposure area will be calculated using an EPA-approved methodology (EPA, 2002b) such as the 95% UCL of the means of the data representing the exposure area. The most recent version of the EPA software ProUCL (current version 5.0.00) or the guidance from the Interstate Technology & Regulatory Council (ITRC) (2012), will be used to perform the statistical analysis as needed for discrete samples (EPA, 2010a).

3.15.2.4.4 The ProUCL version 5.0.00 technical guide (EPA, 2013) indicates that statistics computed for datasets with limited detection frequencies cannot be considered reliable enough to estimate an EPC. For datasets with fewer than four detections, the technical guide suggests use of an ad hoc method (for example, median or mode) to identify the EPC. IAW this recommendation, the median result will be used as the EPC for datasets with limited detection frequencies. For datasets with more than four detected results, ProUCL will be used to calculate the EPC. For nondetect results or results qualified as blank contamination, the limits of detection will be entered into the ProUCL input file, and the result will be identified as a nondetect. If the ProUCL analysis recommends a statistical value that exceeds the maximum detected concentration, the maximum detected concentration will be identified as the EPC.

3.15.2.4.5 A 95% UCL will also be calculated for samples collected using ISM. According to recent guidance from the ITRC (2012), calculation of a 95% UCL for ISM data requires a minimum of three ISM samples, and with ISM data, the 95% UCL will be used as the EPC even if it exceeds the maximum reported concentration. The ProUCL program may also be used with ISM data. Two statistical methods are considered appropriate for calculating the 95% UCL for ISM data, the Student's-t and Chebyshev, and these methods will be used to calculate the 95% UCL for each ISM dataset as needed.

3.15.2.4.6 For each complete exposure pathway and receptor, the average daily dose (ADD) (or average daily exposure [ADE] for inhalation pathways) will be calculated to estimate a potential receptor's daily intake from exposure to the COPCs. According to EPA (1989), the exposure dose should be calculated by averaging it over the period of time for which the potential receptor is assumed to be exposed. For COPCs with potential carcinogenic effects, the lifetime ADD should be calculated to estimate potential exposures over the course of a lifetime (70 years) (EPA, 1989). Consistent with EPA guidance, reasonable maximum exposure (RME) scenarios will be evaluated in the HHRA. The RME scenario represents the maximum upper bound exposure that a receptor could reasonably experience at a site. Most individuals will not be subject to all conditions that comprise the RME scenario. Individuals who do not meet all conditions in the RME scenario have lower potential exposures to constituents and, therefore, lower potential hazards and risks associated with those exposures.

3.15.2.4.7 The exposure parameters that will be used to evaluate the current and future potential receptors and exposure pathways identified for each MRS will be summarized on tables in the format of "Table 4" as presented in EPA *Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manual Part D* (EPA, 2001a). These tables will summarize the values used to calculate the daily intakes for the RME scenarios.

3.15.3 Toxicity Assessment

3.15.3.1 The toxicity assessment section will summarize the available toxicity data for the COPCs identified at each MRS, including reference doses, reference concentrations, cancer slope factors, and inhalation unit risks. The toxicity data will be obtained from EPA-approved sources pursuant to the hierarchy outlined in the Office of Solid Waste and Emergency Response (OSWER) Directive 9285.7-53 (EPA, 2003), including the following:

- Tier 1 – EPA's Integrated Risk Information System (IRIS) (EPA, 2012).
- Tier 2 – EPA's Provisional Peer Reviewed Toxicity Values: The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center develops these values on a chemical-specific basis when requested by EPA's Superfund program.
- Tier 3 – Other Toxicity Values: Tier 3 includes additional EPA and non-EPA sources of toxicity information, such as CalEPA values, the Agency for Toxic Substances and Disease Registry Minimal Risk Levels, and toxicity information presented in the Health Effects Assessment Summary Tables (EPA, 1997a). Priority should be given to those sources of information that are the most current, have a basis that is transparent and publicly available, and have been peer reviewed.

3.15.3.2 If a value cannot be found in any of the sources listed in this OSWER directive, the toxicity value provided in the EPA RSL tables will be used, if available. As noted previously, if a detected constituent has no screening criteria (and thus has no established toxicity data), it will be qualitatively evaluated in the HHRA based on information obtained through a review of scientific literature.

3.15.3.3 Dermal reference doses and cancer slope factors will be estimated from oral values IAW *Risk Assessment Guidance for Superfund Volume 1: Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004). Subchronic exposures (for example, potential exposures associated with the construction worker) will be evaluated using chronic toxicity values.

3.15.3.4 The toxicity information will be summarized on tables in the format of "Table 5" and "Table 6" as presented in EPA *Risk Assessment Guidance for Superfund (RAGS) Volume I, Human Health Evaluation Manual Part D* (EPA, 2001a).

3.15.4 Risk Characterization

3.15.4.1 As noted previously, it is currently assumed that a comprehensive HHRA will not need to be conducted. If all parties agree and authorize the quantification of potential risk associated with the COPCs in site media, then the risk characterization will be a presentation of the calculated risk estimates. Otherwise, the risk characterization will be a qualitative evaluation of potential risk associated with the Former Conway BGR.

3.15.4.2 The quantitative risk characterization will combine the toxicity data identified for each COPC with the exposure data for each potential receptor population to estimate potential

upper-bound (conservative) cancer risk and noncancer HIs for all identified receptors with potentially complete exposure pathways. Cancer risks will be calculated for each COPC within each exposure medium, summed across each exposure medium, and summed across all exposure media for a specific receptor population. The cancer risk calculation will take into account age-dependent adjustment factors for mutagenic chemicals. The cumulative excess lifetime cancer risks from all exposure pathways for a potential receptor will be compared to the EPA acceptable carcinogenic risk range of 1E-06 to 1E-04, using 10^{-6} as a point of departure and with a preference for achieving the more protective end of the risk range.

3.15.4.3 Noncancer risk estimates or HQ, for each COPC will also be summed across each exposure medium and all exposure media to provide a total HI for each receptor. The estimated total HI from multiple exposure pathways for a potential receptor will be compared to the EPA acceptable cumulative HI limit of 1. If the total HI exceeds 1, COPCs will be segregated by critical effects.

3.15.4.4 Those contaminants that contribute substantially to a target organ HI greater than 1 or a cumulative cancer risk greater than the target risk range (1E-06 to 1E-04) will be identified as contaminants of concern (COCs) for further evaluation and/or risk management decisions.

3.15.4.5 Exposure to lead will be evaluated through the EPA Adult Lead Model (EPA, 2009b) and the EPA Integrated Exposure Uptake Biokinetic Model for Lead in Children (EPA, 2010b).

3.15.4.6 The risk characterization will include a discussion of the uncertainty regarding the data and assumptions used in deriving the risk and hazard estimates. The goal of the risk characterization is to provide stakeholders with sufficient information to make informed decisions about which COCs, media, and areas of the MRSs may need to be addressed further. The uncertainty discussion will qualitatively evaluate potential risks associated with background constituents present at concentrations greater than the risk-based screening values.

3.16 ECOLOGICAL RISK ASSESSMENT APPROACH

3.16.0.1 The purpose of the ERA is to determine whether potentially unacceptable risks are posed to ecological receptors due to exposures to residual MC at any of the Former Conway BGR MRSs and, if so, to identify the specific chemical constituent(s) contributing to that risk.

3.16.0.2 As per the *Final U.S. Army Military Munitions Response Program RI/FS Guidance* (USACE, 2009a), the ERA for these sites will be performed based on EPA guidance for conducting ERAs at CERCLA-regulated sites, principally *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Draft* (EPA, 1997b, as implemented by EPA, 1999a). Supplemental ERA guidance from EPA and DoD is also provided in USACE (2010), EPA (1998), EPA (2001a and b), the U.S. Army Biological Technical Assistance Group (USABTAG) (2002), and from the Tri-Services Environmental Risk Assessment Work Group (TSERAWG) (2008).

3.16.0.3 The ERA process under CERCLA consists of eight steps. This process is separable into two tiers: the screening level ERA (SLERA) and the baseline ERA (BERA) (USACE, 2010). The SLERA includes Steps 1 and 2 of the CERCLA process, and the BERA encompasses the remaining steps (Steps 3 through 8). Step 1 includes the (preliminary) problem formulation, which defines the goals, breadth, and focus of the SLERA, and the ecological effects evaluation, which identifies thresholds of potentially adverse ecological effects for the predicted constituents at the sites. Step 2 of the SLERA includes a preliminary exposure estimation for the key ecological receptors identified in the problem formulation, and a risk characterization, which provides a highly conservative evaluation of the potential for risk to those receptors based on the comparison of the estimated exposures to the corresponding toxicity thresholds.

3.16.0.4 The overall objective of the SLERA is to conservatively identify (based on existing site data) those constituents that are at levels in ecologically relevant media sufficient to potentially pose a risk to ecological receptors through one or more complete exposure pathways. Constituents that either lack complete exposure pathways to ecological receptors or are at insufficient concentrations in ecologically relevant media to pose a potential risk are eliminated from further consideration in the ERA process. The remaining constituents are identified as constituents of potential ecological concern (COPECs) for the site in question and are either evaluated further in the BERA or are targeted for remediation or other risk management action.

3.16.0.5 Because the SLERA is a highly conservative screening process and is likely to significantly overestimate the potential for risk, a refined (less conservative) secondary screening evaluation is commonly conducted at the end of the SLERA (USACE, 2010). The purpose of this secondary screening (sometimes referred to as “Step 3a” or the “Refined Risk Estimation”) is to reduce the probability that site constituents that do not pose a potential risk are identified as COPECs and are unnecessarily passed on to the BERA or become drivers in remediation.

3.16.0.6 This WP describes the approach and methods that will be used to perform the SLERA for each of the MRSs at the Former Conway BGR. As necessary, the refinement of the screening of COPECs identified in the initial screening will also be conducted for each of these sites. The following sections detail the approach that will be used to conduct the SLERA at these sites.

3.16.1 Problem Formulation

3.16.1.0 The problem formulation lays the foundation for the subsequent risk assessment process. In the problem formulation, the potentially affected environment is defined and preliminary constituents of concern are identified. The following sections describe the components included in the problem formulation.

3.16.1.1 Ecological Setting and Conceptual Site Models

3.16.1.1.1 The Former Conway BGR lies within the Lower Atlantic Coastal Plain physiographic province. The topography associated with the Former Conway BGR slopes generally to the southeast, and elevations range from nearly sea level to about 40 ft above sea level. Generally, the area is wooded with pine trees and thick underbrush. Within the boundaries of the Former Conway BGR, several Carolina Bays (or swamps) and wetlands exist, as well as several small tributaries within the larger Pee Dee River Basin. Several rivers drain Horry County, including the Pee Dee, Little Pee Dee, and Waccamaw. Additionally, the Intercoastal Waterway is located along the southern edge of the Former Conway BGR, and parallel to the coastline. Portions of the project area are within the 100-year floodplain (Horry County, 2014); however, impacts to the floodplain and stormwater impacts to surface water are not anticipated and are unlikely primarily because excavations will be hand-dug, and on a very limited scale, creating minimal disturbance.

3.16.1.1.2 The ecological setting of each of the MRSs will be described with regard to significant habitats and potential receptors within each habitat type. Emphasis will be placed on ecologically relevant media within each habitat type (surface and near-surface soil, surface water, and sediment) that could act a source of exposure of ecological receptors to MC within that medium. Because no biological reconnaissance or survey of the MRSs has been conducted specifically for the ERA, the ecological site descriptions are based on existing information of the habitats and biological communities of the Former Conway BGR combined with information garnered from open literature and Internet sources. Based on a list provided by the SCDNR, no state or federally listed threatened or endangered species are documented as existing within the Former Conway BGR. However, it does not mean that other state or federally listed species or critical habitats are not present within the area of interest.

3.16.1.1.3 Based on the CSM illustrated in Figure B.11, surface and shallow subsurface soil are the principal media of concern for MC residues at these sites. Ecological receptors will include terrestrial plants, soil invertebrates, and terrestrial wildlife. Plants and soil invertebrates are exposed to MC residues in both the surface (0 to 0.5 ft bgs) and subsurface (0.5 to 2 ft bgs) soils. Evaluated exposures in wildlife receptors will include direct ingestion of soil from the sites and indirect ingestion from consumption of contaminated food items at the sites. Other potential exposure pathways (dermal contact and inhalation of dust or vapors) are considered insignificant for wildlife. The wildlife receptors will include both mammalian and avian species representing three major trophic guilds—herbivores, insectivores, and predators. Where the potential migration of MC to aquatic habitats is evaluated, concentrations within sediment will be assessed with regard to potential risks to relevant wetland species.

3.16.1.2 Data Compilation and Screening

3.16.1.2.1 Data used in the SLERAs for these sites will include soil (to 2 ft in depth), sediment, and shallow groundwater, if applicable and as available. The data will consist of historical data plus the data collected as identified in the RI WP for each specific MRS. Only MC will be included in this evaluation; therefore, the potential constituents at these sites are limited to select metals and explosive residues (and their by-products). These data will be

combined and compiled into medium-specific summary tables that will include (for each detected analyte) the frequency of detection, the range of detected concentrations, the range of reporting limits, and, if sufficient data are available, the 95% UCL of the mean, and the basis of the UCL calculation as determined by the ProUCL version 5.0.00 software package.

3.16.1.2.2 The information presented in the statistical summary tables will be the basis of the preliminary COPEC selection. The preliminary COPECs will be selected from the overall analyte list based on the following criteria:

1. The analyte was detected in at least one sample of an ecologically relevant medium at the site.
2. The analyte is not an identified nutrient (i.e., it is not one of the following: calcium, magnesium, potassium, or sodium).
3. The analyte is present at concentrations statistically greater than background values.
4. The maximum analyte concentration exceeds the corresponding ecologically based screening criteria (for example, EPA ecological soil screening level [Eco-SSLs]).

3.16.1.2.3 Analytes that do not meet any of the above criteria will be eliminated from further consideration as COPECs for the medium in question. All others will be considered preliminary COPECs and retained for evaluation in the SLERA.

3.16.1.3 Assessment and Measurement Endpoints

3.16.1.3.1 PA and measurement endpoints for the MRSs are listed in Table 3.6. Assessment endpoints represent an explicit expression of the actual environmental values to be protected at the site. Measurement endpoints represent quantifiable ecological characteristics that can be measured, interpreted, and related to the valued ecological component(s) chosen as the assessment endpoints. The measurement endpoints were selected based on the expected species/community/habitat patterns across the site, the varying relationship to the COPEC concentrations, and considerations of the potential mechanisms of toxicity. For each measurement endpoint, there is an explicit relationship between it and the assessment endpoint to which it is linked. For the SLERA problem formulation, the assessment and measurement endpoints are considered preliminary, are broadly based, and are primarily targeted at the identification of COPECs that may pose risk to receptor groups (for example, terrestrial plants or insectivorous birds). In the BERA (if conducted), these endpoints would be refined to directly target specific resources that may be at risk.

Table 3.6
Assessment and Measurement Endpoints, SLERA MRSs, Conway BGR, South Carolina

Assessment Endpoint	Measurement Endpoint	Key Ecological Receptor(s)
Growth, reproduction, and survival of terrestrial plant populations	Comparison of MC concentrations in surface and subsurface soil to plant-based soil screening levels	Terrestrial plants (generic)
Growth, reproduction, and survival of soil invertebrate populations	Comparison of MC concentrations in surface and subsurface soil to earthworm-based soil screening levels	Earthworms
Growth, reproduction, and survival of avian wildlife populations	Comparison of MC concentrations in surface and subsurface soil to avian-based soil screening levels	Mourning dove (bird) American woodcock (bird) Red-tailed hawk (bird)
Growth, reproduction, and survival of mammalian wildlife populations	Comparison of MC concentrations in surface and subsurface soil to mammalian-based soil screening levels	Eastern cottontail (mammal) Southern short-tailed shrew (mammal) Long-tailed weasel (mammal)

3.16.1.4 Key Ecological Receptors

3.16.1.4.1 For each of the assessment and measurement endpoint pair, a key ecological receptor or receptor group (for example, terrestrial plants) is identified. Specific receptor species are selected to represent a group of species that fill a specific niche in the ecosystem (for example, the American woodcock to represent avian insectivores). The key receptors for each of the assessment and measurement endpoints in this SLERA are listed in Table 3.4. The criteria for the selection of representative wildlife receptor species include three factors: (1) they are known or suspected to occur in the local ecological communities and are species likely to be exposed to chemical concentrations in the exposure media, (2) they represent functional groups considered to be essential to, or indicative of, the normal functioning of the affected habitat, and (3) they may represent federal or state threatened or endangered species or other protected or valued species in the local ecosystem.

3.16.1.5 Ecological Effects Evaluation

3.16.1.5.1 The ecological effects evaluation entails a review of the ecotoxicological record for each of the COPECs and the identification of ecological screening levels (ESLs) or, if necessary, the development of toxicity reference values (TRVs) for the selected ecological receptors. Effects considered ecologically relevant for wildlife receptors are growth, reproduction, and survival. For plants, a 20% reduction in growth (Efroymson et al., 1997) is considered ecologically relevant.

3.16.1.5.2 Medium-specific ESLs will be derived from the following sources and databases:

- EPA Eco-SSL documents (EPA, 2005a-h, 2006, 2007a-d, and 2008b);
- EPA ESLs (specifically, EPA Regions 4 and 5);

- ESLs developed by National Laboratories (specifically, Oak Ridge National Laboratory, Los Alamos National Laboratory, and Savannah River National Laboratory);
- National Recommended Water Quality Criteria;
- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (Buchman, 2008); and
- Relevant state guidance and standards.

3.16.1.5.3 According to EPA Region 4 guidance (EPA, 2001b - Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment), an alternate Effects Level number should be used in place of Region 4 sediment ESLs for certain contaminants in some circumstances (data reported below the required quantitation limit).

3.16.1.5.4 TRVs will be based on chronic no observed adverse effect level (NOAEL) or equivalent toxicological benchmark values. These will primarily be from accepted secondary literature sources that may include the following:

- EPA Eco-SSL documents (EPA, 2005a through 2005h, 2006, 2007a through 2007d, and 2008),
- Sample et al. (1996),
- U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) (USACHPPM, 2000, 2001a, b, and c, 2002, and 2005), and
- Talmage, et al. (1999).

3.16.1.5.5 If no toxicity values are available for a particular compound, appropriate surrogate chemical chronic NOAELs will be used to develop TRVs. Surrogate chemicals will be selected based on structural chemistry.

3.16.1.5.6 When chronic NOAELs are not available, other endpoints, such as lowest observed adverse effect levels (LOAELs), may be used with appropriate and accepted uncertainty factors (UFs) applied. UFs will include 0.1 for LOAEL-to-NOAEL or subchronic-to-chronic exposure and 0.01 for median lethal dose (LD_{50})-to-chronic NOAEL. It should be noted that from an ecological standpoint, basing the TRV on a NOAEL may be overly conservative because exceedance of a NOAEL does not necessarily imply an adverse effect to the receptor.

3.16.2 Exposure Estimation

3.16.2.1 The exposure estimation is the process of estimating the magnitude of potential exposures of the selected ecological receptors to COPECs present at the site in question. This includes the identification of EPCs of the COPECs in each relevant medium that are appropriate to the level of risk assessment being conducted. For the SLERA, the initial screening will be based on maximum measured concentrations. If sufficient data are available to calculate 95% UCLs (at least eight data points as per EPA, 2010c), these values will be

used as the EPCs for the refined (less conservative) evaluation of potential risk for discrete samples. For ISM results, the detected concentrations also may be compared to screening levels using a 95% UCL (see Section 3.15.2.2.5).

3.16.2.2 For plants and soil invertebrates, exposures will be based directly on the EPC of the medium to which they are most exposed. This EPC will be the maximum measured concentration in either the surface soil (0 to 0.5 ft bgs) or subsurface soil (0.5 to 2 ft bgs).

3.16.2.3 For wildlife receptors (birds and mammals), species-specific exposure will be estimated through dietary exposure models. In these species, the principal mechanism of exposure is ingestion, which includes the direct ingestion of the COPECs in incidentally ingested soil from the site and the indirect ingestion of the COPECs within the tissues of food items from the site. Although wildlife may also be exposed to site COPECs through dermal contact with soil or through the inhalation of dust or vapors, these are considered minor pathways with respect to the ingestion pathways and will not be explicitly evaluated.

3.16.2.4 Exposure of wildlife receptor species through ingestion is quantified as an ADD, which is in units of milligrams of the COPEC per kilogram (fresh) of body weight per day (mg/kg-day). The general equation used to calculate the receptor's ADD is as follows:

$$ADD_i = AUF_i \cdot SUF_i \left(\frac{SIR_i \cdot C_s + \sum_{j=1}^{n} \left(Fr_{ij} \cdot FIR_{ij} \cdot C_j \right)}{BW_i} \right)$$

Where:

ADD_i = Average daily dose (ADD) for wildlife receptor species i (mg/kg-day)

AUF_i = Area use factor (AUF) for wildlife receptor species i (unitless)

SUF_i = Seasonal use factor (SUF) for wildlife receptor species i (unitless)

SIR_i = Daily incidental soil ingestion rate (SIR) wildlife receptor species i (kilogram / dry weight / day [kg dw/day])

C_s = Concentration of COPEC in soil (mg/kg dw)

Fr_{ij} = Fraction of diet of wildlife receptor species i composed of food item j (unitless)

FIR_{ij} = Daily food ingestion rate (FIR) of wildlife receptor species i (kg dw/day)

C_j = Concentration of COPEC in food item j (mg/kg dw)

n = The number of food items in the diet of wildlife receptor species i

BW = Body weight (kg fresh weight)

3.16.2.5 For the SLERA, both the AUF and SUF will initially be set to 1.0, meaning that the receptor is present and active throughout the year and its foraging activities are entirely restricted to the site. If it is found in the analysis of uncertainties that more realistic assumptions of area or seasonal use will significantly reduce the predicted risk for a particular receptor species, these factors may be altered accordingly in the refined assessment.

3.16.2.6 A preliminary list of terrestrial wildlife receptors and associated exposure factors for the SLERA is presented in Table 3.7. Values for the FIR, SIR, and BW for the wildlife receptors species are derived from literature sources where available (for example, EPA, 1993). In some cases, these factors are estimated from body weight based on allometric equations. Allometric equations are generally of the following form:

$$FIR = a \cdot BW^{b}$$

Where:

FIR = FIR of the wildlife receptor (kg dw/day)

BW = BW of wildlife receptor species (kg)

a and b = Empirically derived regression parameters from the literature specific to a particular taxon or trophic level

3.16.2.7 The dietary exposure model allows for multiple dietary items. For the SLERA, however, each receptor will be limited to a single food item based on the nominal trophic level of the species (see Table 3.7). Therefore, Fr_{ij} in the dietary exposure model will be 1.0 (100%) in all cases. Mixed diets may be evaluated in the refined evaluation of risk if this restrictive assumption is found to be producing unrealistic estimates of potential risk.

3.16.2.8 Because biotic tissues will not be directly sampled at any of the MRSs, the COPEC concentrations in the food items (C_j) will be estimated from medium-specific concentrations using biota transfer models from the literature. These models may be simple linear models that incorporate a bioaccumulation factor or a similar media-to-biota transfer factor, or they may be empirically derived nonlinear models, typically based on a log-log regression model (for example, Sample et al., 1998a, b). Sources of transfer factors in the literature are varied and include Baes et al. (1984), Bechtel Jacobs Company (1998), EPA (1999b and 2005a), and Talmage et al. (1999). For organic compounds, the transfer factors may be estimated from the octanol-water partition coefficient (log K_{ow}). Equations for these estimations are from sources such as EPA (1999b and 2005a), Travis and Arms (1988), and Garten and Trabalka (1983).

Table 3.7
Exposure Factors for Terrestrial Wildlife Receptors
Munitions Response Sites, Conway BGR, South Carolina

Common Name	Scientific Name	Trophic Level[1]	BW[2] (kg)	FIR[3] (kg[dw]/day)	SIR[4] (percent of FIR)	Home Range[5] (acres)
Mourning dove	*Zenaida macroura*	Herbivore	0.115	0.0219	13.9	28.3
American woodcock	*Scolopax minor*	Insectivore	0.176	0.0377	16.4	11.1
Red-tailed hawk	*Buteo jamaicensis*	Carnivore	1.03	0.0364	5.7	941
Eastern cottontail	*Sylvilagus floridanus*	Herbivore	1.11	0.0944	6.3	7.23
Southern short-tailed shrew	*Blarina carolinensis*	Insectivore	0.0050	0.00105	3.0	0.963
Long-tailed weasel	*Mustela frenata*	Carnivore	0.0865	0.0111	4.3	6.68

[1]In the SLERA, trophic level will determine the diet of the receptor: herbivore = diet of plant material; insectivore = diet of earthworms; carnivore = diet of small mammals. Mixed diets will not be evaluated at the screening level.
[2]BWs are from Dunning (1993) and Silva and Downing (1995).
[3]FIRs are based on data for equivalent species used by EPA to derive Eco-SSLs (EPA, 2005a) or, in the case of the eastern cottontail, on the allometric equation for mammalian herbivores presented in EPA (1993).
[4]SIRs are based on data for equivalent species used by EPA to derive Eco-SSLs (EPA, 2005a) or, in the case of the eastern cottontail, on data presented in EPA (1993) for jackrabbits.
[5]Home ranges for American woodcock, red-tailed hawk, eastern cottontail, and southern short-tailed shrew from data in EPA (1993). Home range for the mourning dove and long-tailed weasel are based on allometric equations from Schoener (1968) and Jetz et al. (2004), respectively.

3.16.3 Risk Characterization

3.16.3.1 The risk characterization integrates the results of the exposure assessment and effects characterization into an estimation of the potential for adverse effects to site-specific ecological receptors. The risk characterization is the culmination of the preceding steps of the ERA and includes three principal components: (1) risk estimation, (2) risk description, and (3) uncertainty analysis. In the risk estimation, the potential for risk to the ecological receptors will be quantitatively estimated using the HQ method. In this method, the estimated exposure (as determined in the exposure assessment) is compared to the TRV (as determined in the effect characterization) using the following equation:

$$HQ = \frac{EPC \text{ or } ADD}{SLV \text{ or } TRV}$$

Where:

HQ = hazard quotient (unitless)
EPC = exposure point concentration (mg/kg or mg/L)
ADD = average daily dose (mg/kg-day)
SLV = screening level value
TRV = toxicity reference value (same units as the numerator)

3.16.3.2 When the HQ is less than or equal to 1, the estimated potential exposure is less than or equal to the TRV, indicating with a high degree of confidence that a potential risk does not

exist and that the COPEC can be eliminated from further consideration as a risk driver for that receptor or pathway. Compounds having an HQ greater than 1 indicate that a potential for risk may exist and that further evaluation is necessary before a final conclusion can be reached regarding the potential for risk. In the risk description component, all of the exposure and risk estimates are synthesized and qualitatively interpreted. A weight-of-evidence evaluation may be included in this step to incorporate other lines of information in support of the conclusion of the risk description. Finally, in the uncertainty analysis, sources of uncertainty in the risk assessment process will be described, and the probable effect of underlying assumptions on the predicted potential for risk will be addressed.

3.16.4 Refined Risk Estimation

3.16.4.1 Because highly conservative assumptions and models will be used in the initial estimation of potential ecological risks, it is likely that the actual risk posed by site COPECs will be overestimated in the SLERA. For this reason, COPECs with HQs exceeding unity will be reevaluated based on less conservative assumptions of exposure and effects that are more likely to reflect actual site conditions and the receptor's natural history. Among the factors that will be refined in this process are the assumed EPC (using a conservative estimate of the mean rather than the maximum), more realistic diets and FIRs (relative to body size), more realistic area and SUFs, and comparisons to background concentrations and background risk. In addition, any COPEC that was detected in 5% or fewer of the samples from a particular medium will be evaluated to determine whether the detections are indicative of a hot spot. If that is not the case, the COPEC will be eliminated from further consideration in the risk assessment process. The results of this reexamination will be used in the formulation of final recommendations for additional assessment at the sites.

3.17 MEC HAZARD ASSESSMENT

3.17.1 HGL will complete the MEC HA IAW the guidance provided in the MEC HA IGD (EPA, 2008a). The MEC HA will be used to evaluate the potential for explosive safety hazards as a result of residual MEC presence that may be accessible to receptors. This interim guidance was developed by the Technical Working Group for Hazard Assessment, which included representatives from DoD, the U.S. Department of the Interior, EPA, and various states and tribes. DoD has encouraged the trial use of the method for a 2-year period (DoD, 2009). If MEC contamination is identified at the site, the MEC HA will be completed and documented in the RI report to provide a qualitative assessment of the potential acute explosive hazards associated with MEC. The MEC HA will incorporate site-specific conditions that affect the likelihood that a MEC accident will occur.

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4.0 QUALITY CONTROL PLAN

4.0.1 The following subsections define the general QC processes and procedures that will be used during the RI/FS at the Former Conway BGR. Additional details about the QC procedures as they apply to the soil sampling to be conducted at the RI/FS sites are contained in the project UFP-QAPP (Appendix E). The GIP (Appendix K) provides specific details of the QC program for the analog and DGM phases of the project.

4.1 STANDARD QUALITY CONTROL PROCESSES

4.1.1 It is HGL's policy to apply sound and cost-effective quality principles to all of its activities. The quality policies established within this WP and its procedures are applicable to all participating project personnel and subcontractors. The plan is applicable to all site activities affecting quality including, investigations, handling of hazardous materials, and data management. Regardless of subcontractor or teaming agreements, HGL is solely responsible for the control of quality and for providing services and deliverables that conform to contractual requirements.

4.1.2 All work will be performed within the framework of HGL's corporate Industry Standard Object (ISO) 9001-compliant quality management system (QMS). HGL's QMS is consistent with the Plan-Do-Check-Act (PDCA) quality principles of Engineer Regulation (ER) 1119-1-12. This approach to quality embraces a continual process of quality improvement based on four phases: Plan – design and document the work to be performed to meet customer requirements and provide high quality products and services; Do – execute the work in a manner consistent with the plan; Check – conduct assessments (for example, management reviews, audits) to verify that plans and procedures are achieving goals; and Act – implement and institutionalize improvements from lessons-learned, reviews and audit findings, including implementation of best practices, personnel training, and other mechanisms. QC is performed in all phases of the work, including inspections during fieldwork, in-process reviews of data and analyses, and independent technical reviews of all work products and written deliverables.

4.1.3 In addition to the PDCA philosophy, specific procedures are developed to identify and implement quality requirements to ensure that overall project activities are accomplished using an acceptable level of internal controls and review procedures. The purpose of such controls is to eliminate conflicts, errors, and omissions and to ensure the technical accuracy of all deliverables. To provide these results, HGL will implement the three-phase QC process (three phase inspection process [3PIP]) during execution of the Former Conway BGR RI/FS.

4.2 THREE-PHASE INSPECTION PROCESS

4.2.1 Preparatory Phase

4.2.1.1 The preparatory phase will be completed before beginning each Definable Feature of Work (DFW). A meeting will be scheduled in advance of the work activity, if necessary, to ensure that there is sufficient time for any necessary corrective actions. The following will be completed during this phase:

- Review specifications, references, and plans;
- Check field equipment to ensure that it is appropriate for intended use and has been tested, submitted, and approved;
- Assign responsibilities and ensure that field staff have necessary knowledge, training, expertise, and information to perform jobs;
- Verify arrangements for support services;
- Inspect work area to verify that required preliminary work has been completed;
- Review appropriate activity hazard analyses (AHAs); and
- Ensure that applicable process and procedures have been approved by the contracts officer.

4.2.1.2 WP and operating procedures will be reviewed by the UXOQCS during this phase to ensure that they describe the prequalifying requirements or conditions, equipment, materials, methodology, and QC provisions. Discrepancies between existing conditions and approved plans and procedures will be resolved or corrective actions will be taken for unsatisfactory and nonconforming conditions identified during a preparatory phase inspection. This will be verified by the UXOQCS or his designee before approval to begin work is granted.

4.2.1.3 The UXOSO will review the APP (Appendix D) and the appropriate AHAs to ensure that applicable safety requirements have been achieved. Preparation phase inspection results will be documented using the Preparatory Phase Checklist and will be summarized in the DQCR. The personnel qualifications checklist will be used to ensure that personnel meet or exceed the training standards outlined by DoD, USACE, and OSHA, including applicable hazardous waste operator training. HGL forms and checklists associated with the completion of the preparatory phase activities are presented in Appendix F.

4.2.2 Initial Phase

4.2.2.1 This phase will be performed when the fieldwork has been initiated for a given DFW. The purpose of this phase will be to accomplish the following:

- Inspect the work in progress for compliance with QC requirements;
- Verify adequacy of QC controls to ensure full contract compliance;
- Establish an acceptable level of workmanship;
- Verify that documentation related to field activities is complete;
- Verify that required PPE and other safety procedures are in compliance with the QC specifications contained in the APP and AHA; and
- Resolve differences of interpretation that may affect the quality of work.

4.2.2.2 Additional preparatory and initial phases may be conducted on the same work being performed if (1) the quality of ongoing work is unacceptable, (2) there are changes in the on-site production supervision or work crew, (3) work is resumed after a substantial period of inactivity (2 weeks or more), or (4) other problems develop.

4.2.2.3 The UXOQCS will be responsible for ensuring that all discrepancies between site practices and approved plan specifications are identified, documented, and resolved. Corrective actions for unsatisfactory conditions or practices will be verified by the UXOQCS or his designee before granting approval to proceed. Initial phase results will be documented on the Initial Phase Checklist and summarized in the DQCR. A copy of HGL Form 15.11, Initial Phase Checklist, is included in Appendix F.

4.2.3 Follow-up Phase

4.2.3.1 This phase will be conducted for each DFW until it has been completed. The purpose of this phase is to ensure compliance with contract requirements and will include the following:

- Verify that the work has been completed in compliance with contract requirements and applicable standards;
- Ensure that the quality of workmanship was maintained and achieved;
- Validate all fieldwork to ensure that no data gaps exist and schedule additional field activities to address any existing data gaps;
- Verify that analytical work was performed by the approved laboratory; and
- Verify that safety inspections were performed.

4.2.3.2 The UXOQCS is responsible for on-site monitoring of the practices and operations taking place, and for verifying continued compliance with the specifications and requirements of the contract, approved project plans, and procedures. The UXOQCS will oversee and observe activities as specified in the initial inspection and will verify that corrective actions for unsatisfactory or nonconforming conditions have been taken before granting approval to continue work. Final follow-up phase checks will be conducted and all deficiencies corrected before starting additional features of work. Final follow-up checks will be documented and summarized in the DQCR.

4.3 DEFINABLE FEATURES OF WORK

4.3.1 HGL will ensure that the three-phase QC system is implemented for each DFW. The phases are intended to ensure that DFWs are completed IAW PWS requirements and applicable standards. A DFW is an activity that is separate and distinct from other activities, has separate control requirements, and may be identified by different trades and disciplines. The following DFWs have been identified for the project:

- Project Planning and Submittals
- IVS Construction, DGM, and Report
- Transect Construction/Vegetation Clearance/Anomaly Avoidance and Surface Metal Removal
- Transect DGM
- Sampling Grid Locations/Technical Memorandums
- Grid Construction/Vegetation Clearance/Anomaly Avoidance and Surface Metal Removal
- Blind Seeding/Anomaly Avoidance
- Grid DGM
- Anomaly Resolution
- MC Sampling
- Mag-and-Dig Operations Along Transects
- Information Management

4.3.2 Although every member of the HGL team is responsible for quality workmanship, the UXOQCS for the project has the overall responsibility for the quality of the fieldwork and for ensuring that the three-phase QC system is implemented in the field. The HGL PM has the responsibility for the quality of the deliverables developed for the project. The general quality requirements associated with each DFW are defined in Table 4.1.

4.4 PROJECT AUDITS

4.4.1 Performance will be evaluated using audits to ensure that the quality standards and contract objectives are achieved. The HGL QA/QC Manager, UXOQCS, QC Geophysicist and/or Project Geophysicist will perform a minimum of three independent audits of specific DFW during project execution. The audits may involve evaluation of the completeness and accuracy of logbooks, visual assessment of field procedures, completeness and representativeness of intrusive results, DGM data collection, processing and target selection, vehicle inspection records, and the MS Access database. All audits will be documented on the appropriate hardcopy form and become part of the project record.

4.4.2 Corrective actions will be implemented when non-conformances or deficiencies are identified during an audit. The audit process involves identifying, documenting, and reporting non-conformances or deficiencies, initiating corrective actions through appropriate channels, and conducting compliance reviews.

Table 4.1
Definable Features of Work

DFW (Manager*)	Task/Inspection Point	Requirement	QC Action	Frequency
Project Planning and Submittals (HGL PM)	Draft, draft final, and final deliverables	Compliance with PWS, applicable DIDs, and WP and final acceptance of all documents	Conduct internal review of documents prior to submittal	Prior to submission of each deliverable
	Comment resolution			
IVS Construction, DGM and Report (Project Geophysicist)	Monuments or control points	Accuracy and usability of preexisting civil survey data achieves metrics in GIP (Appendix K)	Verify civil survey data	Once during initial project activities
	Background survey and installation of IVS items	IVS design approved by client during TPP process; background survey indicates "clean" area	Internal review of background survey and IVS construction	Once, during activity
	Initial QC tests for DGM sensors and peripheral equipment	DGM Data achieves quality metrics in GIP (Appendix K)	Verify DGM data and document in database	Daily during activity
	Final processed DGM data and IVS report	Acceptance of final processed data and IVS report by client	Verify DGM data and document in database; internal review of report prior to submittal	Daily during activity; once prior to submittal of IVS report
Transect Construction/ Vegetation Clearance/ Anomaly Avoidance and Surface Metal Removal (UXOQCS, Project Geophysicist, UXOSO)	Upload of transects from GIS to field team GPSs	Proper coordinate system and accurate location of transects	Conduct internal review (plot transects on approved site base map)	Once, during activity
	GPS accuracy	Achieves metrics in GIP (Appendix K)	Verify GPS functionality and accuracy at known control point and document in database	Daily during activity
	Height of vegetation; presence of non-metallic debris that impedes follow-on activities; presence of moveable surface metal	Vegetation and surface metal removals acceptable for follow-on activities	Verify Vegetation Clearance, Anomaly Avoidance, Surface Removal occurred IAW SOP	Before start of Transect DGM and at intervals determined by preparatory and initial checks

Table 4.1 (continued)
Definable Features of Work

DFW (Manager)	Task/Inspection Point	Requirement	QC Action	Frequency
Transect DGM (Project Geophysicist, QC Geophysicist)	Daily QC tests	DGM data achieves quality metrics in GIP (Appendix K)	Verify DGM data and document in database	Daily during activity
	Final processed DGM data	Acceptance of final processed data by client	Verify DGM data and document in database	Daily during activity
	Target selection	All targets selected IAW criteria specified in IVS Report	Verify target selections and document in database	Daily during activity
Grid Locations/Technical Memorandums (Project Geophysicist)	HGL review of memorandum	Compliance with sampling requirements in PWS and grid locations accepted by client	Conduct internal review of technical memorandums prior to submittal	Before submission of memorandums
	Comment resolution			
Grid Construction/ Vegetation Clearance/ Anomaly Avoidance and Surface Metal Removal (UXOQCS, Project Geophysicist, UXOSO)	Upload of grid locations from GIS to field team GPSs	Proper coordinate system and accurate location of grids	Conduct internal review (plot grid locations on approved site base map)	Once, during activity
	GPS accuracy	Achieves metrics in GIP (Appendix K)	Verify GPS functionality and accuracy at known control point and document in database	Daily during activity
	Height of vegetation, presence of non-metallic debris that impedes follow-on activities, presence of moveable surface metal	Vegetation and surface metal removals acceptable for follow-on activities	Verify Vegetation Clearance, Anomaly Avoidance, Surface Removal occurred IAW SOP	Before start of Grid DGM and at intervals determined by preparatory and initial checks
Blind Seeding/Anomaly Avoidance (Project Geophysicist, QC Geophysicist)	Blind seed grid identification's, coordinates, and burial characteristics	Emplace seed items per requirements in WP and GIP (Appendix K)	Verify seed items are placed at the required rate, size, and depth and document blind seed information in secure database with firewall	Before start of Grid DGM and at intervals determined by preparatory and initial checks

Table 4.1 (continued)
Definable Features of Work

DFW (Manager)	Task/Inspection Point	Requirement	QC Action	Frequency
Grid DGM (Project Geophysicist, QC Geophysicist, UXOQCS)	Daily QC tests	DGM achieves quality metrics in GIP (Appendix K)	Verify DGM data and document in database	Daily during activity
	Final processed DGM data	Acceptance of final processed data by client	Verify DGM data and document in database	Daily during activity
	Target selection	All targets selected IAW criteria specified in IVS Report; QC Geophysicist documents blind seed items are present on target list and verifies dynamic signal and position metrics in GIP achieved (Appendix K)	Verify target selections and document in database	Daily during activity
	Dig package	Dig package accepted by HGL UXOQCS and client	Conduct internal review of dig package for each grid	Before submittal of dig package for each grid
Anomaly Resolution (Project Geophysicist, UXOQCS, QC Geophysicist)	Daily QC tests	All sensors and equipment used achieve quality metrics for specific activity in GIP (Appendix K)	Verify results for sensors and equipment and document in database	Daily during activity
	Anomaly reacquire	Achieve metrics in GIP (Appendix K)	Verify results and document in database	Daily during activity and at intervals determined by preparatory and initial checks
	Identification and removal of subsurface metal	Subsurface removal performed IAW WP	Conduct visual observation of intrusive activities by UXOQCS	Daily during activity and at intervals determined by preparatory and initial checks
	Blind seeds	All blind seeds successfully recovered in field; QC Geophysicist verifies position offset achieves metric in GIP (Appendix K)	Verify recovery, offset, unique identification and document in secure database	Daily during activity
	Completed dig sheets	Inspection and acceptance of completed dig sheets by UXOQCS prior to submittal to HGL GIS; review of database by Project Geophysicist for completeness and accuracy	Verify intrusive results in field for completeness and accuracy (UXOQCS)and after upload to GIS and database (Project Geophysicist)	Daily during activity (weekly checks by Project Geophysicist) and at intervals determined by preparatory and initial checks

Table 4.1 (continued)
Definable Features of Work

DFW (Manager)	Task/Inspection Point	Requirement	QC Action	Frequency
Anomaly Resolution (Project Geophysicist, UXOQCS, QC Geophysicist) (continued)	Geophysical feedback and hole check results	Geophysical feedback process and hole checks performed IAW GIP (Appendix K)	Compare geophysical anomaly characteristics with intrusive results for representativeness; verify hole checks achieve criteria in GIP (Appendix K) and document in database	Weekly during activity and at intervals determined by preparatory and initial checks
Mag-and-Flag Operations Along Transects (UXOQCS, Project Geophysicist, QC Geophysicist)	Upload of transect segments from GIS to field team GPSs	Proper coordinate system and accurate location of transects	Conduct internal review (plot proposed and actual transects an approved site base map)	Daily during activity
	GPS accuracy	Achieves metrics in GIP (Appendix K)	Verify GPS functionality and accuracy at known control point and document in database	Daily during activity
	Identification and excavation of surface and subsurface metal	Work conforms to SOP for Mag-and-Flag (15.04)	Perform visual observation of activities by team leader and/or UXOQCS	Daily during activity and at intervals determined by preparatory and initial checks
	Completed dig sheets	Inspection and acceptance of completed dig sheets by UXOQCS prior to submittal to HGL GIS; review of database by Project Geophysicist for completeness and accuracy	Verify intrusive results in field for completeness and accuracy (UXOQCS) and after upload to GIS and database (Project Geophysicist)	Daily during activity (weekly checks by Project Geophysicist) and at intervals determined by preparatory and initial checks
	Resurvey percentage of transects	Resurvey portion of transects by independent QC per requirements in GIP (Appendix K)	Verify results of resurvey and document in database	Daily during activity
Information Management** (Managed by each technical discipline)	Civil Survey data DGM data Intrusive results GIS Data transfer	Compliance with PWS, applicable DIDs, WP, and GIP (Appendix K)	Verify all data and information meet requirements	Weekly during project and at intervals determined by preparatory and initial checks

*The Manager for each defined role is responsible for the requirements of the QC actions and the related documentation.
**Additional details about the QC procedures and personnel responsibilities for MC sampling contained in the project UFP-QAPP (Appendix E).

4.5 DOCUMENTATION

4.5.0.1 Project documents including the WP, SSHP, field guidelines, and SOPs will be maintained and made available to all project members where the work is being performed. All documents will be available in both a hardcopy version and in electronic form.

4.5.0.2 Individual field logbooks will be assigned to the UXOQCS, UXOSO, and Site Geophysicist, and they will be used to document details of field activities during QC and safety monitoring.

4.5.0.3 At a minimum, the following tasks will be completed before the commencement of project field operations:

- **Training**—The UXOSO and UXOQCS will ensure that initial site-specific training is performed for all field personnel prior to the startup of field activities, and that all safety control measures have been established. Training will be accomplished using only approved training materials. The UXOSO and UXOQCS will ensure that all personnel certifications are filed on site for review.
- **Records**—The UXOSO and UXOQCS will ensure the following:
  - Completion of all required documentation,
  - Compliance with the project's WP, QCP, and APP/SSHP, and
  - Review and submission of all job status reports and documentation.

4.5.0.4 On a daily basis the following tasks will always be completed:

- **Morning Briefing**—The UXOSO and UXOQCS will ensure that daily safety and operational briefings are conducted with the project team.
- **Communications**—
  - Positive communications with site personnel will be maintained throughout the workday.
  - At a minimum, communication checks will be conducted each morning before starting work. Additional checks will be performed as necessary throughout the workday to monitor progress, safety, and QC.
  - Teams will not start operations until satisfactory checks have been achieved.

4.5.1 Telephone Conversation Records

4.5.1.1 HGL will document project-related telephone conversations with the client and other project personnel that result in direction or decisions pertinent to the project.

4.5.2 Meeting Minutes

4.5.2.1 HGL will document all project meetings with the client and other project-related personnel. These meeting minutes will be typed and distributed to all meeting participants.

4.5.3 Daily Field Activity Records

4.5.3.1 All field activities affecting QC will be performed IAW documented procedures identified in the WP or applicable guidance. During field activities, records of daily events will be documented. The information to be recorded could include the following:

- Date and weather conditions,
- Personnel and equipment on site,
- Scope and results of on-site meetings (for example, planning, health and safety, and QA/QC),
- Scope and results of field QA/QC activities,
- Scope and results of safety and health activities,
- Details regarding any accidents or incidents, and
- Details regarding any field changes to the scope of work.

4.5.4 Daily Quality Control Reports

4.5.4.1 DQCRs will be prepared using the standard form included in Appendix F. The information in the DQCRs could include the following:

- Weather,
- Contractor/subcontractor areas of responsibility,
- Test and/or control activities performed with results, and
- Material, supplies, and equipment received.

4.5.4.2 HGL will be responsible for preparing and submitting the DQCR. Electronic copies will be emailed to the PM and to other parties upon request. At a minimum, one DQCR report will be prepared and submitted for every day of work. DQCRs and QC logs are official/public documents of record. Each DQCR will be assigned and tracked by a unique number composed of the project identification number and the date expressed as dd/mm/yyyy.

4.5.5 Safety Log

4.5.5.1 Safety logs (tailgate briefing forms) will be maintained in the project files for inclusion in the final report. HGL will prepare a log including, as a minimum, the following information:

- Preparer (name and signature),
- Date,
- Weather conditions and discussions of any incidents, accidents, or significant site events that may impact safety or require work stoppages, and
- Signatures of all project personnel and visitors acknowledging that they participated in a safety briefing.

4.5.5.2 Documentation of health and safety and tailgate meetings will be contained in a standard form that is included in Appendix F.

4.6 EXPLOSIVES INSPECTION

4.6.1 The UXOQCS will document explosives inspections as required by the Explosives Management Plan.

4.7 QUALITY MANAGEMENT

4.7.1.1 QC failures will be documented with a nonconformance and/or project variance report, HGL will employ root cause analysis to identify the underlying cause(s) and take effective corrective action to alleviate those causes. Root cause analysis is a methodical approach to solve quality problems in a multi-step process and includes the following steps:

1. Identify the problem,
2. Identify possible root causes,
3. Identify patterns and causal relationships in the failed process/product to determine the most likely root cause,
4. Identify potential solutions,
5. Select and implement a solution,
6. Evaluate the effect of the implemented solution, and
7. Standardize the implemented corrective actions.

4.7.1.2 Factors considered in the analysis will include, but not be limited to, the following:

- Staff qualifications and training,
- SOPs,
- Limits, capabilities, and integrity of equipment, and
- Adequacy of QC measures in place.

4.7.1.3 Cause-effect diagrams will be used to identify and evaluate possible causes in a systematic manner. The root cause will be determined by tracing the problem back to its source and identifying the point in the process at which the quality failure occurred and why it occurred.

4.8 CORRECTIVE ACTION PROGRAM

4.8.1 All items and/or processes not meeting established requirements will be identified and documented. All personnel discovering a situation that is not consistent with established requirements are to immediately notify their supervisor. The corrective action request (CAR) process allows the identification of nonconforming conditions and a vehicle to address the concern as well as prevent its recurrence. Through this process, lessons learned are also incorporated into the program.

4.8.2 Potential remedies may include the following:

- Supplemental training,
- Replacement or modification of equipment in use,
- Acquisition of supplemental equipment,
- Revision/modification of existing procedures,
- Implementation of new procedures, and
- Changes in QC procedures.

4.8.3 Work that occurred up to the point of the process or product failure will be accepted. Once corrective actions are in place, rework (if required to meet project objectives) will be performed from the point of the system failure forward.

4.8.4 Upon confirming that an event or item is not in compliance with requirements, a USAESCH Form 948 or a CAR may be initiated. Any project member can initiate a CAR, and it must be forwarded immediately to the QC Manager, who will maintain a CAR log for tracking CAR status. The PM and QC Manager will be responsible for identifying the individuals who will be assigned the responsibility of completing the CAR. A copy if the nonconformance report/CAR form is shown in Appendix F.

4.9 LESSONS LEARNED AND CONTINOUS IMPROVEMENT

4.9.1 The project is designed to identify nonconforming conditions. As required by this program, actions are taken to correct non-conformances and to prevent their recurrence. These conditions will be assessed to determine if they are systematic or unique occurrences. After informal review and discussion by the project team, those conditions that might aid other projects will be written up as lessons learned, describing the original condition and results, changes made, and the resultant improvements. Lessons learned will be discussed in the final project report.

4.9.2 All personnel are encouraged to continually review their processes and suggest changes that improve the process, provide benefits, or improve project efficiency, safety, and quality. These suggestions can be either formally submitted (written memo to project leadership) or informally through verbal discussions at project meetings.

4.10 CONTRACT SUBMITTALS

4.10.1 All field data and documents will be reviewed/verified for technical completeness and accuracy by the appropriate HGL technical/project management prior to transmitting deliverables to USAESCH. Notes recorded from formal and informal meetings through the duration of the project will be cross-checked to ensure that applicable comments were addressed.

4.11 EMPLOYEE PROCESS TRAINING PLAN

4.11.1 All personnel will have the experience and training necessary for their assigned tasks. Personnel will meet the training requirements identified in the accompanying WP. Prior to beginning fieldwork or new phases of work, the QC Manager or his/her designee(s) will review work processes with project personnel to ensure that they are adequately trained/refreshed in phase work requirements, standards, and procedures. New project personnel and subcontractors must review the WP and receive site-specific training.

4.11.2 All visitors to the site will be required to sign in with the UXOSO and receive the health and safety briefing. All visitors, regardless of their qualifications, must be escorted by project personnel.

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5.0 EXPLOSIVES MANAGEMENT PLAN

5.0.1 This plan, consistent with DID WERS-002.01, Explosives Management Plan, outlines the procedures that will be used to perform MEC identification and disposal operations at the project site. HGL will acquire all required federal and state permits. Copies of explosives licenses or permits will be posted and available for inspection on each project site location where explosives materials are used. The procedures are IAW the following:

- Federal Acquisition Regulation (FAR) 45.5, Management of Government Property in the Possession of Contractors,
- Alcohol, Tobacco and Firearms Publication (ATFP) 5400.7, ATF's Federal Explosives Laws and Regulations,
- DoD 6055.09-M, DoD Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requirements,
- Army Regulation (AR) 190-11, Physical Security of Arms, Ammunition, and Explosives,
- DOT Regulations, and
- HGL SOP 15.00, Explosives Accountability and Management (Appendix I).

5.1 LICENSES/PERMITS

5.1.1 HGL holds an ATF Type 20 Manufacturer of Explosives license to purchase and use explosives (Figure B.26) on HGL project sites. The original license is posted at the HGL Munitions Response Team's office in Huntsville, Alabama. A copy of this license will be posted at each HGL project site where explosive materials are stored and used, and will be available for federal, state, or local inspection. Accountability and use of the explosives will remain with HGL unless custody is transferred to the U.S. Government or other agency with a current ATF explosive license. HGL will have a South Carolina-licensed blaster on site or use an explosives vendor with a licensed blaster during demolition operations.

5.2 ACQUISITION

5.2.1 Acquisition Source and Method of Delivery

5.2.1.1 HGL will use on-call explosives delivery or site a magazine, whichever is deemed most efficient for the project. Demolition explosives will be shipped and delivered to the project site by Austin Powder, or other authorized commercial explosives dealer. The explosive dealer will be responsible for all permits and documentation required by federal, state, and local regulations for shipment and transportation of explosives. Demolition explosives will be stored on site IAW the DDESB-approved ESP. Prior to delivery of the demolition explosives HGL will confirm shipment data including the type, class, and net explosive weight (NEW).

5.2.1.2 Transportation of demolition explosives will be conducted IAW DOT regulations. HGL will maintain accountability/records for demolition explosives. If the explosives delivered cannot be stored/used on the same day on which they are delivered due to unforeseen circumstances (for example, electrical storms), HGL will return the explosives to the explosives dealer. The SUXOS will be authorized to request and receive explosives from the commercial explosive dealer.

5.2.2 Listing of Proposed Explosives

5.2.2.1 Hazard Classification/Division 1.4 explosives will be used whenever possible because they are safer to handle, easier and less expensive to ship and store, and more readily available. The demolition explosive materials anticipated for use on this project are shown in Table 5.1.

Table 5.1
List of Proposed Explosives

Nomenclature	Description	Quantity	Hazard/ Classification Division	Compatibility Group	NEW (lbs)
Perforators	32 grams	100	1.4	S	7.1
Detonating Cord	80 grain/ft	1,000 ft	1.1	D	11.4
Detonators, Nonel®	40' Lead	60	1.4	B	9.8
Booster, PETN	¾ lb	49	1.1	D	46.7
Binary liquid explosives	HELIX	20 lbs	Flammable 3 Oxidizer 5.1	N/A	10
Total NEW					85.0

5.3 INITIAL RECEIPT OF EXPLOSIVES

5.3.0 Only those HGL employees listed on the Explosives Authorization List may sign for receipt of explosives from an explosives dealer. Upon the day of receipt of explosive materials at a project site the SUXOS will check the lot number or manufacturer's marks and nomenclature/description of each type of explosive item against the explosives dealer delivery manifest and record this information on the HGL Manufacturer of Explosives Record of Acquisition and the Magazine Data Card–Daily Summary of Magazine Transactions forms (Appendix F).

5.3.1 Receipt of Explosives

5.3.1.1 The original acquisition receipt documents and explosives usage inventory will be maintained on file by the SUXOS. The Magazine Data Card—Daily Summary of Magazine Transactions will be kept current and updated upon each explosive materials acquisition receipt/delivery, issue, return, and inventory At the completion of the project, all original explosive materials records will be sent to HGL's Huntsville office, where they will be maintained for a period of 5 years. Copies of these records will be included in the final report.

5.3.2 Reconciling Discrepancies

5.3.2.1 The SUXOS will first inventory explosives received by verifying the explosive material's lot number/manufacturer's marks, nomenclature/description, and quantity. The SUXOS will reconcile the delivery shipping documentation with the requested amounts ordered and received. Any shortages or overages will be reported to the HGL PM, who will contact the explosive materials distributor and reconcile any differences. HGL will then notify the explosives dealer, and when required the ATF, to reconcile any discrepancies.

5.4 EXPLOSIVES STORAGE MAGAZINE

5.4.1 Establishment of Storage Facilities

5.4.1.1 Explosives storage facilities will be established IAW the DDESB-approved ESP, HGL SOP 15.0, *Explosives Management and Accountability* (Appendix I), and HGL SOP 15.02, *Explosive Storage and Security Inspections* (Appendix I). Strict physical security and safeguarding of explosive materials will be strictly maintained at all times when explosive materials are stored, being delivered, or used. HGL will store the demolition explosive material on site in two Type 2 ATF-approved explosive storage magazines. HGL will comply with ATF as well as other federal and local storage and compatibility criteria and procedures when siting explosives storage magazines, which include the following:

- Use portable, approved ATF Type 2 explosive storage magazines,
- Maintain the magazine(s) to comply with the explosive safety quantity distance requirements IAW ATFP 5400.7 and DoD 6055.9-M, and
- Install sufficient magazines or a type of magazine with an attached, separate detonator magazine to comply with explosive compatibility requirements (for example, bulk explosives, initiating explosives).

5.4.2 Physical Security of Storage Facilities

5.4.2.1 A chain-link fence will be installed, which will be IAW DoD 5100.76-M and EM 385-1-97. Explosive storage magazine facilities will be inspected every 7 days to coincide with the weekly inventory by the SUXOS and the UXOQCS/UXOSO to ensure the integrity of the enclosure. The SUXOS and UXOQCS will enforce access control and security of all explosives materials used on site.

5.5 TRANSPORTATION

5.5.0 Transportation of explosive materials will comply with federal (DOT 49 CFR, Parts 171-173, and DoD), state, and local regulations. The transporter of the demolition explosives will transport explosives on-site using the least populated and safest route. Blasting caps and high explosives will be transported in an ATF-approved Type 3 day-box mounted in the bed of a pickup truck.

5.5.1 Vehicle Safety Requirements

5.5.1.0 When transportation of explosives by vehicles is required, the procedures outlined in Sections 5.5.1.1 through 5.5.1.2 will be implemented.

5.5.1.1 Transport Checklist

5.5.1.1.1 Explosives will be transported in closed vehicles whenever possible. The load will be braced and covered with a fire-resistant tarpaulin or in an appropriate shipping container. Minimum requirements for vehicles transporting explosives or UXO/MEC are listed below:

- The vehicles will be inspected using the Motor Vehicle Inspection-Hazardous Material Checklist, HGL Munitions Response (MR) Form 15.06, and properly placarded per DOT 49 CFR requirements.
- The vehicles will be equipped with a first aid kit, two 10-BC fire extinguishers, and a means of communication with the UXOSO.
- Vehicles engines will be off when loading or unloading explosives.
- Wheels will be chocked during loading and unloading to prevent movement.
- At no time will any bare explosive come into contact with spark-producing metal. Vehicle cargo beds will have wooden or plastic liners, dunnage, or sand bags to protect the explosives from contacting the metal bed and fittings.
- Explosives may be transported in vehicles with plastic bed liners if the explosives are in an authorized original shipping container.

5.5.1.2 General Precautions

5.5.1.2.1 When transportation of explosives requires travel on public highways, the SUXOS and UXOSO will coordinate jointly to provide the UXO team with a safe transportation route plan. Every effort will be made to take a route with the least public exposure. For transportation of demolition material, HGL will comply with the following:

- Initiating explosives, such as blasting caps, will remain separated from other explosives at all times. Blasting caps may be transported in the same vehicle as long as they are in a separate container conforming to Institute of Makers of Explosives requirements and secured away from other explosive items.
- An Institute of Makers of Explosives 122 box will be used to transport blasting caps, and the high explosives will be placed in an ATF Type 3 day-box. The two containers will be placed in the bed of a vehicle, and blocked and braced separately using sand bags or other suitable means to keep the containers from shifting. If the load in being transported in an open vehicle, the load will be covered with a tarp.
- Compatibility requirements will always be observed.

- Only UXO-qualified personnel who have been "cleared" by the ATF will have access and authority to issue explosive materials. The receiving party will sign the receipt documents for accountability.
- Vehicle operators transporting explosives will be a UXO-qualified HGL employee, ATF "cleared," and possess a valid driver's license and a commercial Class-C driver's license with a hazardous material (HAZMAT) endorsement when transporting HAZMAT on public roads.
- Vehicle operators will comply with posted speed limits, but will not exceed a safe and reasonable speed for road/field conditions. Vehicles transporting explosives off-road will not exceed a speed of 25 miles per hour.
- Personnel will not ride in the cargo compartment of a vehicle transporting explosives.

5.6 RECEIPT PROCEDURES

5.6.0 The SUXOS will strictly control access to all explosives. All issues, turn-ins, and inventories of explosives will be properly documented and verified, through physical count, by the SUXOS and UXOQCS.

5.6.1 Records Management and Accountability

5.6.1.1 Upon receipt, the type, quantity, and lot number of each explosive item will be checked against the manifest and recorded on the Magazine Data Card–Daily Summary of Magazine Transactions. A copy of the original receipt documents and an inventory will be maintained on site by the site supervisor. The Magazine Data Card–Daily Summary of Magazine Transactions will remain in the magazine with the explosive items and be annotated and updated upon each issue, receipt, and inventory.

5.6.1.2 ATF requires HGL to maintain explosive records for commercial purchases for a period of 5 years. Original copies of all explosive material purchases, receipts, issuances, inventories, and usage transaction records will be maintained on site by the SUXOS IAW 27 CFR 555.13, and will be available for inspection by authorized agencies. Explosive items will be tracked by their respective manufacturer's marks of identification or lot number until the items are expended or transferred to government control, or are returned to the original ATF-licensed explosives dealer. Upon completion of project field operations, all original explosives records will be sent to HGL's office in Huntsville, Alabama, for archiving throughout the life of HGL's explosives license. Copies of all records will be maintained on site by the SUXOS and be available for inspection by authorized agencies. Explosive items will be tracked using the lot number until the item is expended or transferred to government control and accountability.

5.6.2 Authorized Individuals

5.6.2.1 Only HGL employees who have undergone a successful ATF background check IAW 18 U.S. Code (U.S.C.) Section 843(h), and 27 CFR 555.33 and 555.45(c), will be authorized to purchase explosive materials and have direct physical contact with them for the purposes of

storage, transportation, and use. Every HGL employee required to handle, transport, or store explosives must clearly understand their responsibilities for properly safeguarding and securing explosive materials.

5.6.2.2 HGL is required to provide commercial explosive dealers with documentation of individuals authorized to request and sign for receipt of explosive materials. Only those listed on the HGL Explosives Authorization List will be authorized to purchase and accept receipt of explosive materials. For this project the primary authorized individual to receive and issue explosives is the SUXOS, and the alternate authorized individual will be the UXOQCS.

5.6.3 Certification

5.6.3.1 The SUXOS and UXO Technician III team leader performing demolition operations will sign and date the Explosives Usage Record (Appendix F) certifying that the explosives were used for their intended purpose.

5.6.4 Procedures for Reconciling Receipt Documents

5.6.4.1 The SUXOS will reconcile the delivery shipping documentation with the requested amounts ordered and received. Any shortages or overages will be reported to the HGL PM, who will contact the explosives supplier to reconcile any differences.

5.7 INVENTORY

5.7.1 When explosives are first received on site and once every 7 days thereafter the SUXOS and the UXOQCS will perform a true and accurate physical inventory of all explosive materials stored on site. All items will be properly inventoried. The SUXOS will strictly control access to all explosives and will review all requests for explosives for the site.

5.8 MAGAZINE INSPECTION

5.8.0.1 The SUXOS and the UXOQCS will be responsible for the inspections and security of the explosives storage magazines.

5.8.1 Project Startup Inspection

5.8.1.1 Prior to establishing an explosives storage magazine and receiving explosive materials, a security survey inspection will be conducted by the SUXOS and UXOQCS using the Explosive Storage and Security Survey Checklist. The result of this survey will be documented using the Explosive Storage Magazine Inspection Checklist and in the daily report prepared by the SUXOS.

5.8.2 Weekly Inspections

5.8.2.1 Weekly physical inspections will commence upon initial acquisition of explosive materials. The Explosive Storage Magazine Inspection Checklist will be used for conducting and documenting weekly explosive storage inspections. Upon completion of this inspection,

the checklist will be signed by the individual conducting the inspection. The SUXOS will also sign the inspection checklist upon completion of his review of this form. This inspection checklist will be maintained with the site's project files. This inspection includes, but is not limited to, the following:

- Explosive storage magazine(s) grounding systems,
- Placards and signage,
- Fire hazards,
- Posting of fire/chemical hazards and safety information,
- Explosive compatibility,
- NEW limits,
- Explosive material container labeling and packing,
- Housekeeping,
- Explosive storage magazine integrity,
- Fencing security,
- Evidence of forced entry, sabotage, tampering or vandalism,
- Vegetation,
- Magazine lock and key accountability,
- Abnormal odors and temperatures, and
- Emergency point of contact information displayed.

5.8.3 Grounding Inspection

5.8.3.1 A local qualified electrician will be contracted to ensure that the grounding of the lightning protection system for the explosive storage magazine meets the criteria of the National Electrical Code and National Fire Protection Association 780 as directed by DoD Manual 6055.09-M, *DoD Ammunition and Explosives Safety Standards*, Volume 2, Enclosure 4.

5.9 REPORTING LOST OR STOLEN EXPLOSIVE MATERIALS

5.9.1 If it is confirmed that MEC or explosive materials are missing, the SUXOS will immediately notify the HGL PM and each agency identified below in the following order:

1. Local law enforcement authorities,
2. Local ATF office,
3. HGL UXO Operations Manager or UXO Safety Managers,
4. USACE CO (immediately by telephone and in writing within 24 hours of the discovery), and
5. ATF U.S. Bomb Data Center (BDC) (within 24 hours of discovery using ATF E-Form 5400.5, Report of Loss or Theft—Explosive Material and the emergency contact information in Table 5.2).

Table 5.2
Emergency Contact Information

Personnel	Telephone Number	Hours
HGL SUXOS, Joel Sanders	(919) 236-3304	All hours
HGL PM, Kimberly Vaughn	(512) 658-6828	All hours
Local Law Enforcement	911	All hours
ATF BDC	(800) 461-8841	Mon-Fri, 8:00 a.m.–5:00 p.m.
	(888) 283-2662	After hours
	(866) 927-4570	Fax
UXO Operations Manager, Neil Feist	(256) 970-2103	Mon-Fri, 7:30 a.m.–4:30 p.m.
	(256) 714-5808	After hours
USAESCH PM, Chris Cochrane	(256) 895-1696	Mon-Fri, 8:00 a.m.–5:00 p.m.
USAESCH Chief of OE Safety, Wayne H. Galloway	(256) 895-1582	Mon-Fri, 8:00 a.m.–5:00 p.m.

5.9.2 After all required notifications have been made, the completed Report of Theft or Loss–Explosive Material (ATF E-From 5400.5) will be faxed to the U.S. BDC, (toll free) 1-866-927-4570.

~ WARNING ~

FAILURE TO REPORT THE THEFT OR LOSS OF ANY EXPLOSIVE MATERIALS MISSING FROM STOCK WITHIN 24 HOURS OF DISCOVERY TO THE APPROPRIATE FEDERAL AND LOCAL AUTHORITIES IS A FELONY OFFENSE.

5.10 PROCEDURES FOR RETURN TO STORAGE OF EXPLOSIVES NOT EXPENDED

5.10.1 The UXOSO or UXOQCS will return unexpended explosives to storage at the end of explosives operations and record the transaction as a return on the appropriate magazine data cards.

5.10.2 Each explosive item will be counted. All containers will be opened and counted, and any discrepancies will be noted. The original receipt document will be adjusted to reflect the returned material and will be signed by the individual returning the explosives and a second authorized HGL UXO technician.

5.11 PROCEDURES FOR DISPOSAL OF REMAINING EXPLOSIVES

5.11.1 ATF requires accurate accounting of all explosive materials purchased and used; therefore, when work is completed or temporarily suspended at a project site, all unused explosives will be either disposed of by detonation or returned to the ATF-licensed dealer from which the explosives were purchased.

5.12 FORMS

5.12.1 HGL will use internal forms for explosives receipt, issue, and inventory, and for vehicle inspections. Explosives accountability forms are located in Appendix F.

6.0 ENVIRONMENTAL PROTECTION PLAN

6.0.1 This EPP describes the approach, methods, and operational procedures that will be employed to protect the natural environment during performance of all RI field tasks. The EPP has been developed to document site-specific environmental conditions in and adjacent to the MRSs at the Former Conway BGR. The EPP addresses the potential impacts that the proposed actions may have on the surrounding environment and suggests measures to be implemented during the proposed actions to protect identified environmentally sensitive areas.

6.1 PLAN OBJECTIVES

6.1.1 The plan also identifies environmental management controls that will prevent and/or decrease the environmental impact in and around the project location. The objectives of this plan are to

- Define methods and procedures to minimize the polluting of air, water, and land resources;
- Protect identified, environmentally sensitive cultural and/or historical resources; and
- Execute RI field activities in the project work area IAW all applicable federal, state, and local regulations.

6.2 POLLUTION MINIMIZATION METHODS

6.2.1 Based on the nature of the site work to be conducted, HGL anticipates little, if any, environmental impact to land, air, or water. No stormwater impacts are anticipated. Hand-dug excavations will be on a very limited scale, not requiring runoff controls. Other than during the possible disposal of a UXO item by detonation, noise is not anticipated to be a concern. If HGL personnel recognize an increase in pollution potential, the work will be stopped temporarily, and the HGL and the USAESCH PMs will evaluate and, if necessary, take the appropriate steps to mitigate the situation. If necessary, this WP will be modified.

6.3 IDENTIFICATION AND LOCATION OF KNOWN NATURAL RESOURCES

6.3.0.1 HGL was not scoped to complete an environmental survey prior to conducting operations at the project site. A discussion of the existing environmental conditions and natural resources believed to be present at the Former Conway BGR location is presented in the following sections.

6.3.1 Federally or State Threatened or Endangered Plant and Animal Species

6.3.1.1 Current information regarding endangered, threatened, and protected species was compiled for Horry County, South Carolina, using the U.S. Fish and Wildlife Service (USFWS) Endangered Species Act (ESA) list for Horry County as provided by the USFWS South Carolina Field Office (USFWS, 2014a) and the SCDNR list of species potentially occurring in Horry County (SCDNR, 2014). The information provided included 12 vertebrate animal species (4 birds, 5 reptiles, 1 mammal, and 2 fish) and 7 invertebrate animal species

that potentially occur in habitats within Horry County similar to those at the Former Conway BGR. Marine species (for example, the Finback whale) listed as threatened or endangered and potentially occurring in Horry County are not discussed.

6.3.1.2 The species listed below occur within Horry County and have a status of Threatened (LT) or Endangered (LE) with protection under the ESA, or are state protected as Threatened (ST) or Endangered (SE). The Bald eagle is federally protected under the Bald and Golden Eagle Protection Act (BGEPA).

- Bald eagle (*Haliaeetus leucocephalus*) – BGEPA
- Wood stork (*Mycteria americana*) – LE, SE
- Red-cockaded woodpecker (*Picoides borealis*) – LE, SE
- Least tern (*Sterna antillarum*) – ST
- Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii*) – SE

6.3.1.3 The species of plants listed below occur within Horry County with the status of LE under the ESA.

- American chaffseed (*Schwalbea americana*) – LE
- Canby's dropwort (*Oxypolis canbyi*) – LE
- Pondberry (*Lindera melissifolia*) – LE

6.3.1.4 The federal- and state-listed threatened or endangered species potentially occurring within the project area are presented in Table 6.1. HGL will ensure that the project team is versed in identifying and avoiding these species. Due to the nature of the work during the RI/FS, no listed threatened or endangered species are anticipated to be adversely impacted by the field effort. If any threatened or endangered species are observed, care will be taken to not disturb them or their immediate habitat.

6.3.2 Wetlands

6.3.2.1 Wetlands are saturated areas where water is present all or for varying periods of time during the year. Wetlands provide habitat for waterfowl, fish, other terrestrial and aquatic animals, and a wide variety of plant life. Wetlands also provide resting and feeding places on migration routes, as well as food, shelter, breeding areas, and nurseries for many species. Wetlands protection is mandated by Executive Order 11990.

6.3.2.2 The topography associated with the Former Conway BGR slopes generally to the southeast, and elevations range from nearly sea level to about 40 ft above sea level. Generally, the area is wooded with pine trees and thick underbrush. The USFWS National Wetlands Inventory shows that there are many wetlands within the boundaries of the investigation areas and MRSs, as shown in Figures B.22 through B.25 of Appendix B. The wetland types identified by the National Wetlands Inventory as within the site include freshwater forested/shrub wetlands, freshwater ponds, and freshwater emergent wetlands (USFWS, 2014b). HGL team will make every attempt to avoid disturbing wetlands within the project area.

Table 6.1
Federal- and State-Listed Species Potentially Within the Former Conway BGR, Horry County, South Carolina

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Habitat Present on Site
Bald Eagle	*Haliaeetus leucocephalus*	BGEPA		Areas near shallow, slow moving water with abundant fish and waterfowl. Preferred sites have suitable perch and roost sites with minimal disturbance. Nests in tall trees along coasts or on the banks of rivers and lakes.	Yes
Wood stork	*Mycteria americana*	LE	SE	Freshwater and estuarine wetlands, primarily nesting in cypress or mangrove swamps. Feed in freshwater marshes, narrow tidal creeks, or flooded tidal pools.	Yes
Red-cockaded woodpecker	*Picoides borealis*	LE	SE	Open, park-like mature pine woodlands and savannahs with large old pines for nesting and foraging habitat.	Yes

Table 6.1 (continued)
Federal- and State-Listed Species Potentially Within the Former Conway BGR, Horry County, South Carolina

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Habitat Present on Site
Least tern	*Sterna antillarum*		ST	Seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers. Rests and loafs on sandy beaches, mudflats, and salt-pond dikes. Interior populations nest mainly on riverine sandbars or salt flats that become exposed during periods of low water.	Potentially
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*		SE	Roosts are typically near water in dilapidated buildings, tree cavities, sometimes under tree bark and bridges. Hibernating (late winter to early spring) bats are found in caves, wells, and similar habitats.	Yes
American chaffseed	*Schwalbea americana*	LE		Sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. Generally found in early successional habitats such as open, moist pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, bog borders, and other open grass-sedge systems.	Yes

Table 6.1 (continued)
Federal- and State-Listed Species Potentially Within the Former Conway BGR, Horry County, South Carolina

Common Name	Scientific Name	Federal Status	State Status	Preferred Habitat	Habitat Present on Site
Canby's dropwort *(Oxypolis canbyi)* **Canby's dropwort**	*Oxypolis canbyi*	LE		Pond cypress savannahs, the shallows and edges of cypress/pond pine ponds, sloughs, and wet pine savannas.	Yes
Pondberry	*Lindera melissifolia*	LE		Pond margins, swampy depressions, sandy sinks, seasonally flooded wetlands, along the margins of limestone sinks and shallow depressions, pinelands, and recently burned open areas.	Yes

6.3.3 Sensitive Environments

6.3.3.1 The project area is not located within a national wildlife refuge, national forest, state park, or protected area (USFWS, 2014c; USFWS, 2014d; National Park Service [NPS], 2014a; U.S. Forest Service, 2014). Additionally, there is no federally designated critical habitat for any threatened or endangered species within the Former Conway BGR (USFWS, 2014c). Sensitive environments are not anticipated to be impacted by the RI/FS effort and will be avoided if encountered.

6.3.4 Coastal Zones

6.3.4.1 The Former Conway BGR lies within the Lower Atlantic Coastal Plain physiographic province. South Carolina's coastal zone includes "all lands and waters in the counties which contain any one or more of the critical areas (coastal waters, tidelands, beaches, and primary oceanfront sand dunes)" (NOAA, 2014b). Coastal zones do not occur within the project vicinity, and there are no Marine Protected Areas (NOAA, 2014c) or National Estuarine Research Reserves (NOAA, 2014d) within the site. Therefore, there is no need to locate or avoid this resource.

6.3.5 Cultural and Archaeological Resources

6.3.5.1 There are no sites listed on the National Register of Historic Places or with the American Battlefield Protection Program within the investigation areas or MRS boundaries (NPS, 2014a; NPS, 2014b). HGL searched the websites of the South Carolina State Historic Preservation Office and the South Carolina Department of Archives and History (SCDAH) and identified no significant historic structures or areas within the investigation areas or MRS boundaries (SCDAH, 2014). Should any artifacts or remains be encountered during field activities, no HGL personnel or subcontractor will remove or disturb them and their presence will be reported to the USAESCH PM. Avoidance of impact to archeological or cultural resources is a primary concern, and HGL will take every precaution to protect these important resources.

6.3.6 Water Resources

6.3.6.1 Water resources and floodplain protection is mandated by Executive Order 11988. The topography associated with the Former Conway BGR slopes generally to the southeast. Within the boundaries of the Former Conway BGR, several Carolina Bays (or swamps) and wetlands exist, as well as several small tributaries within the larger Pee Dee River Basin. Several rivers drain Horry County, including the Pee Dee, Little Pee Dee, and Waccamaw. Additionally, the Intercoastal Waterway is located along the southern edge of the Former Conway BGR and runs parallel to the coastline. Portions of the project area are within the 100-year floodplain (Horry County, 2014); however, impacts to the floodplain and stormwater impacts to surface water are not anticipated and are unlikely primarily because excavations will be hand-dug, and on a very limited scale, creating minimal disturbance.

6.3.6.2 The primary aquifer associated with the Former Conway BGR and Horry County is the Black Creek aquifer, which is on average 250 ft thick and flows in a southeasterly direction. Wells in the Black Creek aquifer typically yield 200 to 400 gallons per minute, and the aquifer is composed of thin- to thick-bedded sand and clay deposited in marginal marine or delta plain environments. Groundwater levels in Horry County can range from 23 ft above to 64 ft below mean sea level (SCDNR, 2004). Groundwater will not be disturbed by project field activities; however, existing wells near the MRSs may be sampled as part of Phase 3 sampling activities.

6.3.7 Tree and Shrub Removal

6.3.7.1 Limited vegetation removal will be necessary at the MRSs to aid in survey and clearance activities. The vegetation to be removed may include immature trees (less than 4 inches in diameter), low-lying tree branches, brush, and field grasses. All items will be cut to a level that allows clearance activities to be conducted, but allows regrowth of the vegetation with time. Trees that are 4 inches in diameter or greater, measured at chest height, will not be cut unless specifically authorized by USAESCH. Similarly, brush less than 3 inches in diameter will only be cut in direct coordination with USAESCH.

6.3.8 Existing Waste Disposal Sites

6.3.8.1 There are no known existing waste disposal sites within the project area. However, discarded glass and metal could represent a safety hazard to field team members. In the event a waste site is identified, field crews will avoid all such sites and notify the site manager if they are discovered. Site avoidance may consist of adjusting the survey area boundaries or working around existing waste disposal sites within the clearance area.

6.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT COMPLIANCE

6.4.1 CERCLA response actions are exempted by law from the requirement to obtain federal, state, or local permits related to any activities conducted completely on site. It is the policy of the EPA (and the DA) to ensure that all activities conducted on site are protective of human health and the environment; however, this does not eliminate the requirement to meet (or waive) the substantive provisions of permitting regulations that are applicable or relevant and appropriate requirements (ARARs). The primary laws and regulations that may apply to actions planned for this project are listed below:

- 40 CFR 264, Resource Conservation and Recovery Act (RCRA): Subpart M (Military Munitions Rule)
- 40 CFR 264, RCRA: Subpart X
- 40 CFR 264.601: Environmental Performance Standard
- 33USC 1251, et seq.: Clean Water Act
- 33 USC 403: Rivers and Harbors Act of 1899

- 16 USC 1536(a)(2) and (c); 16 USC 1538(a)(1); 50 CFR 402.01 and .04: ESA of 1973
- 16 USC 703, et seq. and 50 CFR 20-21: Migratory Bird Treaty Act
- 16 USC 460: National Historic Preservation Act of 1966
- 16 USC 470: Archeological Resources Protection Act
- Executive Order 11990: Protection of Wetlands

This list is subject to modification if additional ARARs are encountered and discussed. The evaluation of the ARARs is an iterative process to be performed throughout the life of the project.

6.5 PROTECTION OF NATURAL RESOURCES

6.5.1 Field activities outlined in this WP will be conducted in a manner to minimize impacts to the natural resources listed in Section 6.3. For the geophysical activities, transects and grids will be placed in a manner that avoids any sensitive areas. This goal will be achieved by prior knowledge of any sensitive natural resources at the MRSs and placement of the preliminary transects and grids to avoid these areas. In general, the small size of the transects and grids relative to the whole investigation area will help ensure that impacts will affect a very small overall investigation area. In addition, the amount of brush cutting in transects and grids will be kept to the minimum amount necessary to conduct the geophysical surveys.

6.6 SITE-SPECIFIC MITIGATION MEASURES

6.6.1 Trees and Shrubs

6.6.1.1 Because of the limited vegetation removal activities planned in the MRSs, no tree or shrub restoration is planned after clearance activities are completed.

6.6.2 Waste Disposal

6.6.2.0 All waste generated will be properly characterized and disposed of IAW all applicable regulations and through approved channels. It is expected that only uncontaminated trash will be generated as a result of this project.

6.6.2.1 Nonhazardous Wastes

6.6.2.1.1 Environmental sampling may generate several waste streams requiring disposal. Investigation derived waste (IDW) may include PPE, solid waste, and decontamination water. In addition, scrap metal may be generated as a result of the investigation of metallic geophysical anomalies. Based on the nature of the site and existing data, it is expected that only nonhazardous IDW will be generated during the field sampling event. Nonhazardous IDW such as decontamination fluids from the washing and rinsing of sampling equipment will be collected and properly disposed of. It is expected that solid IDW (for example, rubber

gloves and other plastics) will be collected separately in trash bags and disposed of as municipal solid waste.

6.6.2.2 Hazardous Wastes

6.6.2.2.1 HGL does not anticipate generating contaminated or hazardous wastes during the execution of the project; however, if hazardous wastes are generated they will be disposed of IAW with the procedures described in the following sections.

6.6.2.3 Packaging, Labeling, Storage, and Disposal

6.6.2.3.1 All hazardous materials will be stored in authorized containers and labeled IAW applicable regulations. Any waste generated by HGL will be collected, stored, and labeled IAW applicable regulations.

6.6.2.4 Manifesting and Transporting Wastes

6.6.2.4.1 HGL does not anticipate that there will be any hazardous wastes that will need to be manifested or transported. However, in the unlikely event that hazardous materials and wastes are generated, they will be manifested and transported IAW applicable DOT and EPA regulations.

6.6.2.5 Compliance with DOT Shipping Regulations

6.6.2.5.1 Transportation of all wastes and materials will be conducted IAW applicable DOT regulations, including use of labels, use of placards, and documentation of transportation.

6.6.3 Security of Hazardous Materials

6.6.3.1 HGL personnel will provide security to control the work area. All hazardous materials associated with the project (primarily explosives) will be secured as discussed in Section 5.0 of this WP.

6.6.4 Burning Activities

6.6.4.1 No burning activities are planned for this project.

6.6.5 Dust and Emission Control

6.6.5.1 EPA has established National Ambient Air Quality Standards pursuant to Sections 109 and 301(a) of the Clean Air Act. These standards, expressed in micrograms per cubic meter, establish safe concentration levels for each criteria pollutant. Standards have been set for six pollutants: particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and lead. The proposed project would result in a minimal amount of air pollution in the form of smoke and fugitive dust emissions. Smoke and fugitive dust emissions may result from support vehicles including trucks; however, impact from these operations should not be significant and should not have any long-term environmental impact on air quality.

6.6.5.2 If necessary, areas requiring dust control will be watered down. Prevailing wind directions will be determined before the start of daily fieldwork, and will be considered in planning fieldwork.

6.6.6 Noise Control and Prevention

6.6.6.1 It is expected that mechanical equipment (that is, trucks) will be the one primary source of noise on this project. HGL will control the noise emissions from this equipment by ensuring that the mufflers on the trucks are functioning. Given the distance to any populated structures, it is unlikely that the equipment will create a nuisance noise effect. The OSHA PEL for noise is 85 decibels (29 CFR 1910.95). It is considered highly unlikely that this noise level would be reached.

6.6.7 Spill Control and Prevention

6.6.7.1 Spill Potential

6.6.7.1.1 Due to the nature of the operations, the potential for a spill of pollutants during operations is low. The highest probability for a spill will occur during refueling operations of equipment such as gas and oil tanks on chain saws. In the event of a spill during one of these refueling operations, the largest quantity of pollutant that could be lost is likely less than 1 gallon of gasoline or oil. HGL plans to conduct all fueling and repair of vehicles off site. This practice will reduce the need to store large amounts of liquids on site. HGL anticipates that unleaded gasoline, diesel fuel, and motor oil will be the only liquids with hazardous constituents that may be stored on site in quantities greater than 5 gallons. If it becomes necessary to store the liquids with hazardous constituents in a storage tank, the tank will be placed within an approved secondary containment of adequate size to contain a spill (that is, 110% of storage container size).

6.6.7.2 Spill Control Measures

6.6.7.2.1 All containers of liquid containing petroleum products or other chemicals with potentially hazardous chemical constituents will be carefully managed and kept closed. The containers will be stored away from the main operations to decrease the chances of container damage and chances of spoilage.

6.6.7.2.2 Vehicles will be maintained in good operating condition and left running only when necessary. As indicated earlier all vehicles will be fueled, maintained, and serviced at an off-site location. No routine cleaning or washing of vehicles or equipment will be permitted on site.

6.6.7.2.3 Safety cans or other approved portable service containers of flammable liquids having a flash point at or below 73°F will be clearly marked. Drums, barrels, and flammable-liquid containers will be tightly capped.

6.6.7.2.4 When refueling heavy equipment and/or small power tools, the following measures will be taken to minimize the potential for and impact from any spills:

- Spill pans will be placed on the ground under the fill cap to catch any spills.
- The operator will not leave the fueling operation and will continually monitor the activity and be present throughout the time it takes to complete the operation.
- When the equipment is full, the fuel flow will be suspended and the nozzle will be carefully removed from the equipment to ensure that there are no drips from the nozzle.

6.6.7.3 Spill Response

6.6.7.3.1 Any spills originating from small containers (for example, gasoline cans) will be contained by use of absorbent materials. HGL will arrange for spill kits to be present on site for the immediate cleanup of any petroleum products that may be inadvertently spilled. Should fuel or oil be spilled onto the ground, the following measures will be taken:

- The spill area will be isolated and contained.
- The appropriate emergency response agencies will immediately be notified. A spill of over 1 gallon is required to be reported to the USAESCH on-site representative. If human health or the environment is threatened, the National Response Center and the state will be notified as soon as possible.
- The liquid and affected soils will be removed and placed into plastic bags. The bags will then be placed into DOT-approved containers for disposal at a permitted facility.
- Each of the DOT-approved containers will be labeled to identify the contents.

6.6.8 Storage Areas and Temporary Facilities

6.6.8.1 HGL anticipates establishing a temporary office trailer, storage facility, and portable toilets to support operations required during this project. Upon project completion, HGL will remove all temporary facilities, portable toilets, and associated debris from the site.

6.6.9 Access Routes

6.6.9.1 HGL will use the existing road network and county community roads outside the facility to gain access to the MRSs. No environmental impact is anticipated from the use of existing roads because they are currently in use by the general public.

6.6.10 Control of Water Run-on and Runoff

6.6.10.1 HGL will conduct work associated with this site investigation in a manner that prevents the discharge of pollutants into adjacent waterways within and outside of the project area. No excavation or major soil disturbance activities will be conducted during the project tasks. Therefore, no sediment or erosion control measures will be required.

6.6.11 Decontamination and Disposal of Equipment

6.6.11.1 Nondisposable PPE and equipment will be decontaminated prior to reuse as indicated in the WP. The disposition of disposable PPE and disposable equipment is addressed in the QAPP (Appendix E).

6.6.12 Minimizing Areas of Disturbance

6.6.12.1 All activities associated with this project will be conducted in a manner that will minimize impacts to land resources within and outside the project boundaries. Areas affected by the project will be restored, as practical, to their original condition. Ruts and excavation holes will be backfilled with the native materials removed. No additional fill material will be brought on site. The area of soil that will be disturbed is not anticipated to be above the threshold that requires an erosion and sediment control plan.

7.0 PROPERTY MANAGEMENT PLAN

7.0.1 A Property Management Plan is required if HGL is provided U.S. Government-furnished equipment or U.S. Government-furnished property; however, issuance of such items is not anticipated for completion of this project.

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8.0 INTERIM HOLDING FACILITY SITING PLAN FOR RCWM PROJECTS

8.0.1 An Interim Holding Facility Siting Plan is not applicable.

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9.0 PHYSICAL SECURITY PLAN FOR RCWM PROJECTS

9.0.1 CWM is not anticipated at the site. However, if during site operations HGL personnel encounter a suspected toxic chemical munition or CWM, they will immediately withdraw upwind, outside of the MSD of the ordnance, and notify the USACE Safety Specialist. HGL will secure the site with a UXO technician until the arrival of an emergency response team.

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APPENDIX A

PERFORMANCE WORK STATEMENT

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ORDER FOR SUPPLIES OR SERVICES

PAGE 1 OF 59

1. CONTRACT/PURCH. ORDER/ AGREEMENT NO.	2. DELIVERY ORDER/ CALL NO.	3. DATE OF ORDER/CALL (YYYYMMMDD)	4. REQ./ PURCH. REQUEST NO.	5. PRIORITY
W912DY-10-D-0023	0018	2013 Aug 19	W31RYO32194490	

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than 6)	CODE	8. DELIVERY FOB
US ARMY ENGINEERING & SUPPORT CENTER CEHNC-CT 4820 UNIVERSITY SQUARE HUNTSVILLE AL 35816-1822	W912DY	SEE ITEM 6		[X] DESTINATION [ ] OTHER (See Schedule if other)

9. CONTRACTOR	CODE	FACILITY	10. DELIVER TO FOB POINT BY (Date) (YYYYMMMDD)	11. MARK IF BUSINESS IS
NAME AND ADDRESS HYDROGEOLOGIC, INC. PETER S. HUYAKORN 11107 SUNSET HILLS RD STE 400 RESTON VA 20190-5309	0UFZ2		SEE SCHEDULE 12. DISCOUNT TERMS Net 30 Days	[ ] SMALL [ ] SMALL DISADVANTAGED [ ] WOMEN-OWNED

13. MAIL INVOICES TO THE ADDRESS IN BLOCK
See Item 15

14. SHIP TO	CODE	15. PAYMENT WILL BE MADE BY	CODE	
SEE SCHEDULE SEE SCHEDULE SEE SCHEDULE AA	W912DY	US ARMY ENG & SUP CENTER - FINANCE OFFIC US ARMY CORPS OF ENGRS FINANCE CTR 5722 INTEGRITY DRIVE MILLINGTON TN 38054-5005	964145	**MARK ALL PACKAGES AND PAPERS WITH IDENTIFICATION NUMBERS IN BLOCKS 1 AND 2.**

16. TYPE OF ORDER			
	DELIVERY/ CALL	X	This delivery order/call is issued on another Government agency or in accordance with and subject to terms and conditions of above numbered contract.
	PURCHASE		Reference your quote dated Furnish the following on terms specified herein. REF:

ACCEPTANCE. THE CONTRACTOR HEREBY ACCEPTS THE OFFER REPRESENTED BY THE NUMBERED PURCHASE ORDER AS IT MAY PREVIOUSLY HAVE BEEN OR IS NOW MODIFIED, SUBJECT TO ALL OF THE TERMS AND CONDITIONS SET FORTH, AND AGREES TO PERFORM THE SAME.

HydroGeoLogic, Inc.	Trudy L Kearney	Trudy Kearney Director, Business Operations	8/19/13
NAME OF CONTRACTOR	SIGNATURE	TYPED NAME AND TITLE	DATE SIGNED (YYYYMMMDD)

[ ] If this box is marked, supplier must sign Acceptance and return the following number of copies:

17. ACCOUNTING AND APPROPRIATION DATA/ LOCAL USE
See Schedule

18. ITEM NO.	19. SCHEDULE OF SUPPLIES/ SERVICES	20. QUANTITY ORDERED/ ACCEPTED*	21. UNIT	22. UNIT PRICE	23. AMOUNT
	SEE SCHEDULE				

* If quantity accepted by the Government is same as quantity ordered, indicate by X. If different, enter actual quantity accepted below quantity ordered and encircle.

24. UNITED STATES OF AMERICA
TEL: Jason Polk
EMAIL:
BY: Contracting Officer
POLK.JASON.S.104 8504244 8/19/2013
CONTRACTING / ORDERING OFFICER

25. TOTAL	$2,225,511.24
26. DIFFERENCES	

27a. QUANTITY IN COLUMN 20 HAS BEEN
[ ] INSPECTED [ ] RECEIVED [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS NOTED

b. SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE	c. DATE (YYYYMMMDD)	d. PRINTED NAME AND TITLE OF AUTHORIZED GOVERNMENT REPRESENTATIVE

e. MAILING ADDRESS OF AUTHORIZED GOVERNMENT REPRESENTATIVE	28. SHIP NO.	29. DO VOUCHER NO.	30. INITIALS	
	[ ] PARTIAL [ ] FINAL	32. PAID BY	33. AMOUNT VERIFIED CORRECT FOR	
f. TELEPHONE NUMBER / g. E-MAIL ADDRESS				
36. I certify this account is correct and proper for payment.	31. PAYMENT		34. CHECK NUMBER	
a. DATE (YYYYMMMDD) / b. SIGNATURE AND TITLE OF CERTIFYING OFFICER	[ ] COMPLETE [ ] PARTIAL [ ] FINAL		35. BILL OF LADING NO.	

37. RECEIVED AT	38. RECEIVED BY	39. DATE RECEIVED (YYYYMMMDD)	40. TOTAL CONTAINERS	41. S/R ACCOUNT NO.	42. S/R VOUCHER NO.

DD Form 1155, DEC 2001 PREVIOUS EDITION IS OBSOLETE.

ORDER FOR SUPPLIES OR SERVICES

PAGE 1 OF 59

1. CONTRACT/PURCH. ORDER/ AGREEMENT NO.	2. DELIVERY ORDER/ CALL NO.	3. DATE OF ORDER/CALL (YYYYMMMDD)	4. REQ./ PURCH. REQUEST NO.	5. PRIORITY
W912DY-10-D-0023	0018	2013 Aug 19	W31RYO32194490	

6. ISSUED BY CODE W912DY
US ARMY ENGINEERING & SUPPORT CENTER
CEHNC-CT
4820 UNIVERSITY SQUARE
HUNTSVILLE AL 35816-1822

7. ADMINISTERED BY *(if other than 6)* CODE
SEE ITEM 6

8. DELIVERY FOB
[X] DESTINATION
[ ] OTHER
(See Schedule if other)

9. CONTRACTOR CODE 0UFZ2 FACILITY
NAME AND ADDRESS
HYDROGEOLOGIC, INC.
PETER S. HUYAKORN
11107 SUNSET HILLS RD STE 400
RESTON VA 20190-5309

10. DELIVER TO FOB POINT BY (Date) *(YYYYMMMDD)*
SEE SCHEDULE

11. MARK IF BUSINESS IS
[ ] SMALL
[ ] SMALL DISADVANTAGED
[ ] WOMEN-OWNED

12. DISCOUNT TERMS
Net 30 Days

13. MAIL INVOICES TO THE ADDRESS IN BLOCK
See Item 15

14. SHIP TO CODE W912DY
SEE SCHEDULE
SEE SCHEDULE
SEE SCHEDULE AA

15. PAYMENT WILL BE MADE BY CODE 964145
US ARMY ENG & SUP CENTER - FINANCE OFFIC
US ARMY CORPS OF ENGRS FINANCE CTR
5722 INTEGRITY DRIVE
MILLINGTON TN 38054-5005

MARK ALL PACKAGES AND PAPERS WITH IDENTIFICATION NUMBERS IN BLOCKS 1 AND 2.

16. TYPE OF ORDER
DELIVERY/ CALL [X] This delivery order/call is issued on another Government agency or in accordance with and subject to terms and conditions of above numbered contract.
PURCHASE [ ] Reference your quote dated
Furnish the following on terms specified herein. REF:

ACCEPTANCE. THE CONTRACTOR HEREBY ACCEPTS THE OFFER REPRESENTED BY THE NUMBERED PURCHASE ORDER AS IT MAY PREVIOUSLY HAVE BEEN OR IS NOW MODIFIED, SUBJECT TO ALL OF THE TERMS AND CONDITIONS SET FORTH, AND AGREES TO PERFORM THE SAME.

NAME OF CONTRACTOR | SIGNATURE | TYPED NAME AND TITLE | DATE SIGNED (YYYYMMMDD)

[ ] If this box is marked, supplier must sign Acceptance and return the following number of copies:

17. ACCOUNTING AND APPROPRIATION DATA/ LOCAL USE
See Schedule

18. ITEM NO.	19. SCHEDULE OF SUPPLIES/ SERVICES	20. QUANTITY ORDERED/ ACCEPTED*	21. UNIT	22. UNIT PRICE	23. AMOUNT
	SEE SCHEDULE				

* *If quantity accepted by the Government is same as quantity ordered, indicate by X. If different, enter actual quantity accepted below quantity ordered and encircle.*

24. UNITED STATES OF AMERICA
TEL:
EMAIL:
BY: CONTRACTING / ORDERING OFFICER

25. TOTAL $2,225,511.24
26. DIFFERENCES

27a. QUANTITY IN COLUMN 20 HAS BEEN
[ ] INSPECTED [ ] RECEIVED [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT EXCEPT AS NOTED

b. SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE | c. DATE (YYYYMMMDD) | d. PRINTED NAME AND TITLE OF AUTHORIZED GOVERNMENT REPRESENTATIVE

e. MAILING ADDRESS OF AUTHORIZED GOVERNMENT REPRESENTATIVE

f. TELEPHONE NUMBER | g. E-MAIL ADDRESS

28. SHIP NO. | 29. DO VOUCHER NO. | 30. INITIALS

[ ] PARTIAL [ ] FINAL

31. PAYMENT
[ ] COMPLETE [ ] PARTIAL [ ] FINAL

32. PAID BY

33. AMOUNT VERIFIED CORRECT FOR

34. CHECK NUMBER

35. BILL OF LADING NO.

36. I certify this account is correct and proper for payment.
a. DATE (YYYYMMMDD) | b. SIGNATURE AND TITLE OF CERTIFYING OFFICER

37. RECEIVED AT	38. RECEIVED BY	39. DATE RECEIVED (YYYYMMMDD)	40. TOTAL CONTAINERS	41. S/R ACCOUNT NO.	42. S/R VOUCHER NO.

DD Form 1155, DEC 2001 PREVIOUS EDITION IS OBSOLETE.

Section A - Solicitation/Contract Form

AWARD NARRATIVE

Task Order 0018, which contains Firm Fixed-Price (FFP), Cost-Plus-Fixed-Fee (CPFF) and Fixed Unit Priced (FUP) Tasks, is being issued to HGL, Inc. for the Remedial Investigation/Feasibility Study (RI/FS) Former Conway Bombing and Gunnery Range, South Carolina in accordance with the Performance Work Statement entitled "Remedial Investigation/Feasibility Study (RI/FS) Former Conway Bombing and Gunnery Range, South Carolina, dated April 11, 2013.

The Period of Performance for this Task Order is 36 months from date of award.

The Terms and Conditions of the basic contract, W912DY-10-D-0023 takes precedence in the case of any ambiguity or conflict.

US Department of Labor Wage Determination Number 2005-2393, Revision 14 dated 19 June 2013, shall be used with this project task order.

The following Task Listing reflects funding allocation:

Former Conway Bombing and Gunnery Range						
Task, Title, Type		Qty	Unit	Unit Price	Not to exceed Quantity(ies)	Total
1, Technical Project Planning (TPP),	FFP	1.0	LS	$59,227.00		$59,227.00
1a, Additional meeting, Optional	FUP	1.0	Ea	$18,541.03	Up to 2	
2, RI/FS Work Plan, PMP, UFP-QAPP, & QASP	FFP	1.0	LS	$82,553.34		$82,553.34
2a, ~~Optional,~~ Explosives Site Plan,	FFP	1.0	LS	$13,102.75		$13,120.75
3, GeoSpatial Data,	FFP	1.0	LS	$29,868.52		$29,868.52
3a, Additional GIS per month, Optional	FUP	1.0	EA	$829.68	Up to 2	
4, RI/FS Field Activities,	FFP	1.0	LS	$1,768,143.30		$1,768,143.30
FUPs are optional & shall be awarded FFP CLINS when funded						
Civil Survey, per acre,	FUP	1.0	Ea	$2,851.06	Up to 10	
Light Vegetation Removal, per acre,	FUP	1.0	Ea	$2,170.17	Up to 10	
Medium Vegetation Removal, per acre,	FUP	1.0	Ea	$2,387.19	Up to 10	
Heavy Vegetation Removal, per acre,	FUP	1.0	Ea	$2,625.91	Up to 10	
Density Transects per acre - Light Brush,	FUP	1.0	Ea	$1,156.51	Up to 10	
Density Transects per acre - Medium Brush,	FUP	1.0	Ea	$1,272.17	Up to 10	
Density Transects per acre - Heavy Brush,	FUP	1.0	Ea	$1,399.38	Up to 10	
DGM Transect geophysics per acre,	FUP	1.0	Ea	$3,307.80	Up to 10	
Analog Transect geophysics per acre,	FUP	1.0	Ea	$6,626.30	Up to 10	
DGM Grids geophysics per acre,	FUP	1.0	Ea	$9,834.96	Up to 10	
Analog Grids geophysics per acre,	FUP	1.0	Ea	$10,953.25	Up to 10	
Five additional demolition shots,	FUP	1.0	Ea	$20,474.89	Up to 5	

Former Conway Bombing and Gunnery Range					
Task, Title, Type	Qty	Unit	Unit Price	Not to exceed Quantity(ies)	Total
Intrusive Investigation – One dig-team per day, FUP	1.0	Ea	$2,112.00	Up to 5	
Intrusive Investigation – One dig-team per week, FUP	1.0	Ea	$10,341.08	Up to 5	
Sampling and analysis, Soil, ten plus QC/QA, MS/MSD, FUP	1.0	Ea	$7,641.61	Up to 3	
Sampling and analysis, Water, ten plus QC/QA, MS/MSD, FUP	1.0	Ea	$8,122.55	Up to 3	
Sampling and analysis, Sediment, ten plus QC/QA, MS/MSD, FUP	1.0	Ea	$7,823.71	Up to 3	
Sampling and analysis, Groundwater sample, FUP	1.0	Ea	$1,235.32	Up to 3	
Sampling and analysis, Groundwater, plus QC/QA, MS/MSD, FUP	1.0	Ea	$1,101.09	Up to 3	
Sampling and analysis, Groundwater sample using Push Probe, FUP	1.0	Ea	$4,370.71	Up to 3	
Incremental Sampling Unit(DU) (100'x100'), FUP	1.0	Ea	$2,274.05	Up to 3	
Pre & Post Detonation per set, FUP	1.0	Ea	$1,987.68	Up to 3	
Installation of monitoring well, base price per well, FUP	1.0	Ea	$12,360.70	Up to 5	
Installation of monitoring well, price per additional foot, FUP	1.0	Ea	$154.51	Up to 20	
Subsurface Sampling, per 2' - 4' boring. FUP	1.0	Ea	$1,804.78	Up to 3	
Program/Project Management, per week, in office. FUP	1.0	Ea	$1,973.83	Up to 4	
Program/Project Management, per week, in field. FUP	1.0	Ea	$11,159.31	Up to 4	
Site Management (SUXOS, UXOQC, UXOSO), per week. FUP	1.0	Ea	$9,680.27	Up to 4	
4a, Evacuations CPFF	1.0	LS	$10,663.27		$10,663.27
5, Remedial Investigation Report, FFP	1.0	LS	$85,513.04		$85,513.04
6, Feasibility Study and Report, FFP	1.0	LS	$29,951.21		$29,951.21
7, Proposed Plan, FFP	1.0	LS	$20,395.15		$20,395.15
8, Decision Document, FFP (8a-8d shall be priced)					

Former Conway Bombing and Gunnery Range					
Task, Title, Type	Qty	Unit	Unit Price	Not to exceed Quantity(ies)	Total
8a, MRS-R01- Range II, FUDS No.SC002501R01. FFP	1.0	LS	$14,138.71		$14,138.71
8b, MRS-R02- Range III, FUDS No.SC002501R02. FFP	1.0	LS	$14,138.71		$14,138.71
8c, MRS-R03-Range IV, FUDS No.I04SC002501R03. FFP	1.0	LS	$14,138.71		$14,138.71
8d, MRS-R09-MG/Rifle Range, FUDS No.I04SC002501R09. FFP	1.0	LS	$14,138.71		$14,138.71
9, Community Relations Support, FFP	1.0	LS	$41,980.53		$41,980.53
9a, Additional meeting, Optional FUP	1.0	Ea	$14,829.63	Up to 2	
10, Community Relations Plan, FFP	1.0	LS	$12,233.55		$12,233.55
11, Administrative Record, FFP	1.0	LS	$15,306.74		$15,306.74
				Total	**$2,225,511.24**

The following Payment Milestone Schedule is acceptable for use on this project Task Order

Task No.	Task Element	Milestone*
1	TPP	TPP Meeting 1, Acceptance of Final TPP Memo TPP Meeting 2, Acceptance of TPP-2 Memo TPP Meeting 3, Acceptance of TPP-3 Memo
2	RI/FS WP, PMP, UPF-QAPP & QASP	Approval of Final Work Plan
2a	Explosives Site Plan	Government Acceptance of Final Siting Plan
3	GeoSpatial Data	Government Acceptance of GIS Set-up (Pre CSM) Final acceptance of GIS
4	RI/FS Field Activities	Monthly Invoicing during Field activities
4a	Evacuations	Government Acceptance
5	Remedial Investigation Report	Government Acceptance of Final RI Report
6	Feasibility Study Report	Government Acceptance of Final FS Reports
7	Proposed Plan	Government Acceptance of Final Proposed Plans
8	Decision Document for 4 MRSs	Government Acceptance of Final Decision Documents
9	Community Relations Support	After each public meeting and acceptance of meeting report Government Acceptance of Website Setup Monthly Web Maintenance
10	Community Relations Plan	Government Acceptance of Final CRP
11	Administrative Record	Acceptance of Admin Record at Project Closeout

*Milestones will be considered met or completed when the required QC documentation has been submitted, QA completed and the submittal and/or product is accepted.

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Section B - Supplies or Services and Prices

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0001		1	Lump Sum	$59,227.00	$59,227.00
	Task 1, TPP FFP The contractor shall implement the four-phase TPP process in accordance with the PWS. FOB: Destination MILSTRIP: W31RYO32194490 PURCHASE REQUEST NUMBER: W31RYO32194490				
				MAX NET AMT	$59,227.00
	ACRN AA CIN: W31RYO321944900001				$59,227.00

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0002		1	Lump Sum	$82,553.34	$82,553.34

Task 2, RI/FS WP, PMP, UFP, QAPP QASP
FFP
The contractor shall prepare, submit and gain acceptance of a WP, PMP, MC UFP-QAPP and QASP that are detailed and comprehensive plans covering all aspects of site characterization, risk assessment and methodology, and project execution. UFP-QAPP is only required for environmental sampling in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

MAX NET AMT		$82,553.34
ACRN AA CIN: W31RYO321944900001		$82,553.34

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0003		1	Lump Sum	$13,120.75	$13,120.75
EXERCISED OPTION	Task 2a Explosives Site Plan				

FFP
The contractor shall prepare, submit and gain acceptance of an Explosives Site Plan (ESP) in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

MAX NET AMT		$13,120.75
ACRN AA CIN: W31RYO321944900001		$13,120.75

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0004		1	Lump Sum	$29,868.52	$29,868.52
	Task 3 GeoSpatial Data FFP The contractor shall utilize a geographic information system (GIS) in the development of the Conceptual Site Model (CSM) and maintain and manage all project and geospatial data in accordance with the PWS. FOB: Destination PURCHASE REQUEST NUMBER: W31RYO32194490				
				MAX NET AMT	$29,868.52
	ACRN AA CIN: W31RYO321944900001				$29,868.52

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0005		1	Lump Sum	$1,768,143.30	$1,768,143.30

Task 4 RI/FS Field Activities
FFP
The contractor shall conduct a remedial investigation in accordance with CERCLA, as amended, characterizing the nature and extent of MEC at the MRSs (MRS-R01- Range II – FUDS Project No. I04SC002501R01, MRS-R02 - Range III-FUDS Project No. I04SC002501R02, MRS-R03 - Range IV-FUDS Project No.I04SC002501R03, and MRS-R09 - MG/Rifle Range-FUDS Project No.I04SC002501R09) meeting the project DQOs as defined during the TPP process. For the purpose of this investigation, the current Goodson property shall be excluded.This task shall include all field activities necessary to execute this task. For MC contamination, collect sufficient data that meets the project DQOs as defined during the TPP process, of known quality and quantity to determine the nature and extent of munitions constituents (MC) to support and perform a human health and ecological baseline risk assessment in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

	MAX NET AMT	$1,768,143.30
ACRN AA CIN: W31RYO321944900001		$1,768,143.30

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0006		UNDEFINED	Lump Sum	UNDEFINED	$10,663.27

Task 4a Evacuations

CPFF

The contractor shall provide support for evacuation of residences displaced due to intrusive investigation exclusion zones in accordance with the PWS. CPFF: The Fixed Fee Pool of $776.54 under this task is Completion Form in accordance with Federal Acquisition Regulation (FAR) 16.306(d)(1). FUNDING AND PAYMENT: a) For purposes of payment of cost, inclusive of fee, the total amount allotted by the Government for this CLIN is $10,663.27 for Task 4a, which covers the following estimated Period of Performance for 36 months after notice to proceed.

The total amount of $776.54 to be obligated under this CLIN is designated for payment of the Fixed Fee. b) The Contractor shall submit separated monthly invoices to the Contracting Officer Representative for work performed under this CLIN detailing Cost and Fee as separate lines. Fee is to be invoiced as a percentage of the work completed since the last invoice times the fee pool less 15% for retention. c) Final payment of retention will be withheld until satisfactory completion and acceptance of the final documentation as outlined in the Performance Work Statement (PWS). The Contractor, operating as an independent contractor and not as an agent of the Government, shall provide all labor, materials, facilities, and equipment and perform all work identified in each individual task order and in accordance with the PWS found in Section C.

FOB: Destination

PURCHASE REQUEST NUMBER: W31RYO32194490

MAX COST	$9,886.73
FIXED FEE	$776.54
TOTAL MAX COST + FEE	$10,663.27
ACRN AA	$10,663.27

CIN: W31RYO321944900001

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0007		1	Lump Sum	$85,513.04	$85,513.04

Task 5 Remedial Investigation Report
FFP
The contractor shall prepare, submit and gain acceptance of a RI report in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

	MAX NET AMT	$85,513.04
ACRN AA CIN: W31RYO321944900001		$85,513.04

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0008		1	Lump Sum	$29,951.21	$29,951.21

Task 6 Feasibility Study and Report
FFP
The contractor shall conduct a feasibility study and prepare, submit and gain acceptance of a FS report in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

	MAX NET AMT	$29,951.21
ACRN AA CIN: W31RYO321944900001		$29,951.21

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0009		1	Lump Sum	$20,395.15	$20,395.15
	Task 7 Proposed Plan FFP The contractor shall prepare, submit and gain acceptance of Proposed Plans (PP) in accordance with he PWS. FOB: Destination PURCHASE REQUEST NUMBER: W31RYO32194490				
				MAX NET AMT	$20,395.15
	ACRN AA CIN: W31RYO321944900001				$20,395.15

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0010		1	Lump Sum	$56,554.84	$56,554.84

Task 8 Decision Document
FFP
The contractor shall prepare, submit and obtain acceptance of DDs for each delineated MRS resulting from the RI in accordance with the PWS.
Task 8a – MRS-R01 - RANGE II – FUDS Project No. I04SC002501R01 - $14,138.71

Task 8b – MRS-R02 - RANGE III – FUDS Project No. I04SC002501R02 - $14,138.71

Task 8c – MRS-R03 - RANGE IV - FUDS Project No.I04SC002501R03 - $14,138.71

Task 8d – MRS-R09 - MG/RIFLE Range - FUDS Project No.I04SC002501R09 - $14,138.71

FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

	MAX NET AMT	$56,554.84
ACRN AA CIN: W31RYO321944900001		$56,554.84

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0011		1	Lump Sum	$41,980.53	$41,980.53

Task 9 Community Relations Support
FFP
The contractor shall Successfully complete public meetings and support the Charleston District with community relations in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

MAX NET AMT		$41,980.53
ACRN AA CIN: W31RYO321944900001		$41,980.53

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0012		1	Lump Sum	$12,233.55	$12,233.55

Task 10 Community Relations Plan
FFP
The contractor shall update, submit and gain acceptance of a CRP in accordance with the PWS.
FOB: Destination
PURCHASE REQUEST NUMBER: W31RYO32194490

MAX NET AMT		$12,233.55
ACRN AA CIN: W31RYO321944900001		$12,233.55

ITEM NO	SUPPLIES/SERVICES	MAX QUANTITY	UNIT	UNIT PRICE	MAX AMOUNT
0013		1	Lump Sum	$15,306.74	$15,306.74
	Task 11 Administrative Record FFP The contractor shall update and maintain the Administrative Record for each MRS throughout the period of performance of this Task Order in accordance with the PWS. FOB: Destination PURCHASE REQUEST NUMBER: W31RYO32194490				
				MAX NET AMT	$15,306.74
	ACRN AA CIN: W31RYO321944900001				$15,306.74

Section C - Descriptions and Specifications

REV01 PWS DATE 11 APRIL 2013

PERFORMANCE WORK STATEMENT
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA
11 April 2013 REV01

1.0 OBJECTIVE:
The objective of this task order is to perform an RI/FS and achieve acceptance of Decision Document(s) in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and Department of Defense, Army, and USACE Regulations and Guidance to include Interim Guidance and Data Item Descriptions (DID) at the referenced Munitions Response Sites.

2.0 BACKGROUND:

2.1 Work under this Performance Work Statement (PWS) falls within the Military Munitions Response Program (MMRP) for MRSs R01, R02, R03, and R09. The Contractor shall perform all work in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP), 40 CFR Part 300. All activities involving work in areas potentially containing explosive hazards shall be conducted in full compliance with United States Army Corps of Engineers (USACE), Department of the Army (DA), and Department of Defense (DoD) regulations.

2.2 Available Site Specific information will be provided with the request for proposal for contractor reviews and to use either a designated Internet site or delivery of recorded data on CD/DVD. This information may include but is not limited to the general site history, previous investigations and other documentation.

3.0 GENERAL REQUIREMENTS:

3.0.1 Contractor Methods: This is a performance based task order. The performance objectives and standards included herein are the basis of the task order requirements. The technical approach and level of effort expended to achieve task order objectives and standards are solely up to the contractor to select and adjust as necessary through the life of the task order. Government recognizes the contractor's right to change the technical approach and level of effort from that proposed with the understanding that the contractor shall still meet all project objectives and gain government Quality Assurance acceptance in order to receive payment. Given the short time available during the pre-award phase to evaluate the site it is possible that after award and refinement of the conceptual site model and data needs that the contractor will wish to adjust the investigation strategy. If after the TPP but before the field work begins an adjustment in the quantities or types field investigations are required to achieve the performance

standard or the Government determines that the performance standard must be adjusted the Government at its discretion may choose to modify the contract with the price adjustment based upon the prorated unit prices proposed in the accepted offer. Once these adjustments are complete the contractor shall be obligated to deliver the required performance standard making adjustments in the field strategy as may be necessary to achieve the standard without a change in price.

3.0.2 Quality monitoring and measurement: The contractor will be evaluated periodically during performance of this task order to ensure compliance with the proposed and accepted performance goals, regulations, guidance and DIDs, and to document that acceptance criteria (AC), delivery schedule, and the overall completion date are being met. This evaluation will be performed according to a Quality Assurance Surveillance Plan (QASP). A programmatic QASP will be provided by the government as a starting point for the contractor prepared Draft QASP per Task 2. The government will finalize the contractor's Draft QASP. This final QASP will be supplied to the contractor and used by the government to evaluate the contractor's performance. Failure to adequately complete any service or submittal to at least a satisfactory level of quality or timeliness may result in a repeat of the work, or a poor performance evaluation, or both.

3.0.3 Performance Requirements. Performance requirements are addressed in each task and summarized in the Performance Requirements Summary (PRS) provided in Attachment A. Performance metrics are provided in Attachment B. If discrepancies or ambiguity exists between the documents, the order of precedence is 1) the Task; 2) Performance Requirements Summary; 3) Performance Metrics.

3.0.4 Task pricing: A pricing schedule is provided in Attachment D which will be used as a basis for negotiation of price increase or decrease due to government changes in the specified performance objectives.

3.1 Task 1, Technical Project Planning (TPP): This is a Firm Fixed Price (FFP) task. Objective: Implement the four-phase TPP process.

Performance Standard: Achieve the objectives of each TPP phase as listed in EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents. Facilitate meetings in a professional and organized manner.

Acceptance Criteria (AC): Acceptance of TPP documents (meeting presentations, agenda, handouts, Conceptual Site Model (CSM) and memorandums) with up to one (1) revision. Meetings held are organized; accomplish requirements of the TPP process; and are conducted in a professional manner. Zero letters of reprimand, grievances, or formal complaints.

Measurement / Monitoring: A TPP checklist for each phase, as provided in the EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents, will be used to measure and document progress; guidance cited will be used to evaluate content of documents for acceptance / non-acceptance. The Government will attend and evaluate organization and facilitation of the meetings, and professional nature of the meetings.

Incentives/Disincentives: Satisfactory or greater Contractor Performance Assessment Reporting System (CPARS) rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: The contractor shall utilize the TPP process to obtain consensus on specific Data Quality Objectives (DQO). The contractor shall present DQOs necessary to achieve the performance standards in task 4.0, which were proposed and accepted at the time of task order award. The Contractor shall plan for meetings to occur as follows: First meeting, pre-Work Plan with resulting DQOs and CSM, and TPP Memorandum; Second meeting, to finalize Work Plan with resulting TPP addendum; Third meeting, verify all data gaps have been filled and finalize Remedial Investigation Report with resulting TPP addendum. The contractor shall organize and coordinate all meetings; identify and involve all stakeholders, upon approval by the Government; and be responsible for the logistics of these meetings to include, but not limited to, providing a facilitator, obtaining meeting location, and sending invitation letters (pending government review and acceptance). The Contractor shall prepare, submit for review and gain acceptance of a TPP memorandum or addendum for each meeting. If a site visit is planned prior to acceptance of a Work Plan, the Contractor shall prepare and submit for acceptance an Abbreviated Accident Prevention Plan (AAPP). The Contractor shall utilize statistical methods (such as Visual Sample Plan (VSP) software) to support the decision making processes used to characterize both MEC as well as munitions constituents (MC).

3.2 Task 2, Remedial Investigation (RI)/Feasibility Study (FS) Work Plan (WP), Project Management Plan (PMP), Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) and QASP: This is a Firm Fixed Price (FFP) task.

Objective: Prepare, submit and gain acceptance of a WP, PMP, MC UFP-QAPP and QASP that are detailed and comprehensive plans covering all aspects of site characterization, risk assessment and methodology, and project execution. UFP-QAPP is only required for environmental sampling.

Performance Standard: Prepare the WP in accordance with DID WERS-001.01 and other applicable DIDs for sub plans, EM 1110-1-4009, EM 385-1-1, EM 385-1-97, Army RI/FS guidance, and other Interim Guidance as appropriate. Prepare the PMP in accordance with DID WERS-18. Prepare the sampling and analysis plan, field sampling, and UFP-QAPP in accordance with EM 1110-1-4009, DID WERS-009.01, Intergovernmental Data Quality Task Force UFP-QAPP Manual, and the State of South Carolina regulatory guidance, as appropriate. Prepare a risk assessment work plan as part of the overall project work plan incorporating implementation of the risk assessment and methodologies per USEPA Risk Assessment Guidance (RAGS), the State of South Carolina regulatory guidance, and USACE EM 200-1-4, Volumes I and II, as appropriate. UFP-QAPP content shall also meet the requirements of DoD Quality Systems Manual for Environmental Laboratories (current version). Draft QASP includes requirements in regulations, guidance, DIDs and the Quality Control Plan included in the WP.

AC: Acceptance of WP, PMP, and UFP-QAPP with two revisions. Draft QASP reflects requirements of the WP and the Quality Control Plan (QCP) with one revision required. One additional revision is acceptable to incorporate EM-CX.

Measurement / Monitoring: Review of WP, PMP, UFP-QAPP and QASP to verify that the minimum acceptable content has been provided and meets applicable guidance.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Incorporate all decisions pursuant to the TPP process. The sampling and analysis plan (SAP) shall include the Contractor's phased approach, address contaminants of interest, sample media (soil/groundwater/sediment/surface water/air), and methods that will be utilized to ensure that data generated are of an acceptable quality for its intended use. The contractor shall discuss quantity, quality and the methods used to verify adherence to the PARCCS parameters for sample collection, handling, laboratory analysis, verification and validation. The Contractor shall provide a discussion on data evaluation and fate and transport analysis. The potential for fate and transport will address all transport pathways, and it should also address future degradation products resulting from biodegradation, photolysis, and chemical reactions.

3.2.1 Optional Task 2a, Explosives Site Plan: This is a Firm Fixed Price (FFP) task. If this optional task is not awarded, an Explosive Site Plan will be provided by the government for inclusion in the WP.

Objective: Prepare, submit and gain acceptance of an Explosives Site Plan (ESP).

Performance Standard: Prepare required submission in accordance with DoD 6055.09-M, EM 385-1-97, Errata Sheet #3, and DID WERS-003.01 as a standalone document for inclusion after acceptance into the WP.

AC: Acceptance of submission with two revisions. One additional revision is acceptable to incorporate EM-CX, USATCES and DDESB comments.

Measurement / Monitoring: Review by Government using guidance cited to determine acceptability.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Once the ESP has been reviewed and acceptance by the Design Center, the document will be reviewed by the CEHNC-EM-CX, USATCES and DDESB. All comments shall be incorporated. Allow eight (8) weeks in the schedule for DDESB approval after submission of final document to the CEHNC-EM-CX.

3.3 Task 3, GeoSpatial Data: This is a Firm Fixed Price/Unit Price task.

Objective: Utilize a geographic information system (GIS) in the development of the Conceptual Site Model (CSM) and maintain and manage all project and geospatial data.

Performance Standard: Manage and maintain project data, and develop CSM in GIS IAW DID WERS-007.01, EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.

AC: Acceptance of CSM and GeoSpatial Data submissions, which also meet quality and formatting requirements.

Measurement / Monitoring: Review by Government using cited to determine acceptability to determine acceptability.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: The GeoSpatial Data shall include:
- A comprehensive CSM
- A pre and post-project response action geospatial data analysis will be performed using a GIS.
- All available existing data that is applicable to the project will be consolidated into the GeoDatabase and analyzed to relay pertinent information to the Project Delivery Team (PDT). If an existing GIS database is available, it will be provided by the government.
- The analysis of data from the GIS shall support all conclusions of the CSM.
- The information attained through the pre-RI analysis will be documented in the work plan.
- The information attained in the post-RI and FS analysis will be documented in the RI and FS reports.
- The pre-RI analysis will encompass social, environmental and/or economic entities that will be or may be impacted by response-action activities.
- The post-RI and FS analysis will detail entities impacted by RI/FS activities and impacts of future response action activities (if applicable).
- The pre and post-RI and FS analyses may detail the fieldwork strategies, areas of concern, survey requirements, environmental concerns, milestones and/or other factors that affect product delivery and future action planning.
- Entities that may be affected by response actions include but are not limited to: landowners, homeowners, rental tenants, schools, utilities, roads, businesses, recreational areas, air traffic, water bodies and/or industries.
- The GeoDatabase shall be a living repository that is refined throughout the life of the project.
- Incorporate layers that overlay on maps of the site that identify physical features, and Material Potentially Presenting Explosive Hazard (MPPEH)/Munitions Debris (MD) found during the investigation. Examples include: streets, anomalies, Munitions and Explosives of Concern (MEC) positively identified, identifiable MD, sampling location, cultural resources, environmental, biological, and socio-economic variables.
- Archeological site locations will not be released to the public without written permission from USACE.
- Perform civil surveys IAW EM 1110-1-4009 and DID WERS-007.01.
- A licensed Professional Land Surveyor in the State of South Carolina shall certify all surveying requirements to include all control points, grid corners, transect points, and boundaries as required by the project.

- Final GIS deliverable shall include all documentation, reports, meeting minutes databases, etc. created developed or modified under this task order in original and PDF format. This deliverable shall meet QA acceptance prior to payment of final invoice.
- Property owner privacy will be preserved. Property owner names shall not be disseminated in any documents.

3.4 Task 4, RI/FS Field Activities: This is a Firm Fixed Price/Unit Price task.

Objective: Conduct a remedial investigation in accordance with CERCLA, as amended, characterizing the nature and extent of MEC at the MRSs (MRS-R01- Range II – FUDS Project No. I04SC002501R01, MRS-R02 - Range III-FUDS Project No. I04SC002501R02, MRS-R03 - Range IV-FUDS Project No.I04SC002501R03, and MRS-R09 - MG/Rifle Range-FUDS Project No.I04SC002501R09**)** meeting the project DQOs as defined during the TPP process. For the purpose of this investigation, the current Goodson property shall be excluded.This task shall include all field activities necessary to execute this task. For MC contamination, collect sufficient data that meets the project DQOs as defined during the TPP process, of known quality and quantity to determine the nature and extent of munitions constituents (MC) to support and perform a human health and ecological baseline risk assessment.

Performance Standard: Field work, data quantity and quality, and analysis of said data (does not include area where Rights-of-entry were not obtained) provides the following results in the RI report:
- Demonstrate that the work was performed in accordance with the applicable laws, regulations, and guidance documents;
- Demonstrate that all areas with elevated anomaly density or with potential to contain MEC have been traversed at the completion of fieldwork and that there is at least 90% chance of detecting these areas.
- Demonstrate that in areas outside of the MEC-contaminated areas there is a 90% confidence there is less than or equal to 0.1 UXO per acre in residential areas, 0.5 UXO per acre in low use areas and 1.0 UXO per acre in areas without intrusive activities.
- Demonstrate that the boundaries of all identified MEC contaminated areas have been delineated to an accuracy of a maximum 250 feet, and demonstrate that at least 90% confidence has been achieved for bounding the potential depth of MEC.
- Demonstrate that data inputs from the RI into the FS will enable remediation cost estimates with an accuracy of +50%/-30%. The work and reporting shall address the surface and sub-surface metallic anomaly density distribution (anomaly/acre) across identified MEC contaminated areas as well as other remediation cost drivers such as vegetation type and density, terrain conditions, soil type, exclusion zone evacuation costs, etc each to a level of accuracy within the range specified herein.
- For areas unlikely to contain a target with elevated anomaly density, but with the potential for MEC/MC contamination (e.g. burial pits) the contractor shall use historical data to narrowed the area and then apply the required confidence level.

Additionally:
- Perform the RI field activities in accordance with the accepted Work Plan and UFP-QAPP.
- Proper disposal of all MEC, UXO, DMM, and MC encountered.

- All Material Potentially Presenting an Explosive Hazard (MPPEH) processed in accordance with Chapter 14 and Errata Sheet No. 2 of EM 1110-1-4009.
- Meet the project DQOs as defined by the TPP process.
- All geophysics shall be IAW DID WERS-004.01. For this task order 1 acre of transects equals 14,520 lf (2.75 miles) of transects 3 feet wide. One acre's worth of grids equals seventeen (17) 2500 sf grids or four (4) 10,000 sf grids.
- -To the maximum extent practicable the contractor should conduct the field investigation by gathering sensor data that is digitally recorded and geo-referenced (geo-referencing need be no more accurate than is needed for the use of the data). Exceptions may include situations where other methods provided data and/or significant cost value in which case the contractor shall provide detailed justification in their proposal describing why the other methods provide a better value. In any case a geo-referenced permanent record of the investigation shall be delivered as part of the RI report (GIS of traverse and items located, digital geophysical data, etc).
- MC analyses shall be performed in accordance with the requirements of the Department of Defense (DoD) Quality Assurance Manual (QAM), WERS-009.01 Munitions Constituents Chemical Data Quality Deliverables, and the approved project specific UFP-QAPP.
- As appropriate, the contractor shall implement statistical methods for its sampling plan.

AC: Conduct the RI in accordance with the accepted/approved WP, PMP, UFP-QAPP, and QASP. QC data submitted meets requirement described in DID WERS-004.01.
- Sampling field work and data meets established criteria within the accepted UFP-QAPP, SAP, and Work Plan.
- No more than 3 CARs/948s for non-critical violations and/or 1 CAR/948 for critical violation. No unresolved Corrective action requests.
- All final data and QC tests/documentation submitted. Government QA acceptance of QC tests/documentation gained.
- No Class "A" Safety accidents, contractor at fault; No Class "B", contractor at Fault, no more than 1 non-explosive Class "C" accident; and <2 non-explosive related Class "D" accidents, IAW AR 385-40.
- Major safety violations, no more than 1 non-explosive related safety violation.
- Minor safety violations, no more than 2 safety violations.
- Zero letters of reprimand, grievances, or formal complaints.

Measurement / Monitoring: Periodic inspection/review of field work and data. Verify compliance with accepted WP, PMP, UFP-QAPP and QASP. Quality control tests/documentation submitted per the QASP for government review. Additionally, statistical confidence will be calculated using the Visual Sampling Plan software, UXO Estimator or some other statistical method. Boundary precision will be determined by evaluation of the sampling footprint as it relates to the reported contaminated/uncontaminated areas in question. Anomaly density profile and other remediation cost driver precision will be verified by QA of methods used.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements:

- Restore all areas to their original condition; all access/excavation/detonation holes shall be backfilled.
- Maintain a detailed accounting of all MEC, UXO, DMM, MC and range-related debris encountered per DID WERS-004.01. This accounting shall include: amounts of MEC, UXO, DMM and MC; nomenclature; location and depth of UXO/DMM; location of MD; and final disposition. The accounting system shall also account for all demolition materials utilized on site. Digital photographs should include all MEC, UXO , DMM, MC and representative photographs on MD &RRD.
- All MEC, UXO, DMM, and MC encountered during this munitions response shall be processed in accordance with the approved work and safety plans.
- Any deviations from the accepted SAP shall be documented in the Daily Quality Control Reports (DQCR) and conveyed to USAESCH personnel immediately.
- The contractor is responsible for subcontracting an independent laboratory to analyze QA samples separate from the contractor's primary laboratory. Additionally, contractor shall validate primary and QA samples. Both laboratories used shall be DOD Environmental Laboratory Accreditation Program (ELAP) certified.

3.4.1 Task 4a, Evacuations: This is a Cost Plus Fixed Fee (CPFF) task.

Objective: Provide support for evacuation of residences displaced due to intrusive investigation exclusion zones.

Performance Standard: Support evacuation of residences in an efficient and timely manner so as not to cause delays in schedule and complains from the residences.

AC: Necessary voluntary evacuations accomplished in a courteous and professional manner with no contract a fault delay to project schedule.

Measurement / Monitoring: Government monitoring of evacuations, receipt of complaints from the public, unsolicited commendations.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating.

Specific Task requirements: The Contractor shall provide printing services and distribution of door hangers for evacuation reminders. The Contractor shall provide logistics for Hospitality Area (HosA), transportation to the HosA and support evacuation requirements; food and drink. The Contractor shall arrange for kenneling as necessary. The Contractor shall provide additional services for evacuation, as required, by the District. The following shall be used for price of evacuation:

- Sleeping Rooms	44 at Government Per Diem
- Hospitality Suite	$175 plus taxes and gratuity per day of evacuations
- Food	$15 per person per day
- Transportation	$50 round trip per car load once per week of fieldwork
- Pet Boarding	$40 per pet per day

3.5 Task 5, Remedial Investigation Report: This task is a Firm Fixed Price (FFP) task.

Objective: Prepare, submit and gain acceptance of a RI report.

Performance Standard: The RI report shall document the results of the RI and previous investigations, and the Contractor shall prepare the report in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04, and the Army RI/FS guidance. The ecological and human health risk assessment shall be performed in accordance with the EPA Risk Assessment Guidance (RAGS) and USACE EM 200-1-4, Volumes I and II, as appropriate.

AC: Acceptance of RI with two revisions. One additional revision is acceptable to incorporate EM-CX.

Measurement / Monitoring: Review of RI against guidance to verify that the minimum acceptable content has been provided.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements:
- Each MRS shall be fully discussed separately and in a sequential manner in the document. Multiple MRS discussions shall not be mingled within the chapters. This will require more chapters than indicated in the guidance and can be addressed as separate volumes in the RI Report. This applies only if one RI Report is required to cover all MRSs if each MRS is required to have a separate report this instruction does not apply.
- Use EPA MEC Hazard Assessment, not Ordnance and Explosives Risk Impact Assessment.
- Incorporate all RI data and data from previous investigations, historical documents, PA/SI into this RI report.
- Recommend changes in delineation of MRS boundaries based on RI findings.
- Prepare, as an appendix to this report, a new or updated Munitions Response Site Prioritization Protocol (MRSPP) for each MRS dependent upon RI findings using the MRSPP worksheets, http://www.lab-data.com/MRSPP/ .

3.6 Task 6, Feasibility Study and Report: This task is a Firm Fixed Price (FFP) task.

Objective: Conduct a feasibility study and prepare, submit and gain acceptance of a FS report.

Performance Standard: The FS report shall document the results of the FS and prepared in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04, and Army RI/FS guidance.

AC: Acceptance of FS with two revisions. One additional revision is acceptable to incorporate EM-CX.

Measurement / Monitoring: Review of FS against guidance to verify that the minimum acceptable content has been provided.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: None.

3.7 Task 7, Proposed Plan: This task is a Firm Fixed Price task.

Objective: Prepare, submit and gain acceptance of Proposed Plans (PP.

Performance Standard: Prepare the PP(s) in accordance with, ER 200-3-1, EP 1110-1-18, EM-CX Interim Guidance 06-04, EPA 540-R-98-031 and CERCLA, as amended.

AC: Acceptance of PP with two revisions. One additional revision is acceptable to incorporate EM-CX.

Measurement / Monitoring: Review of PP against guidance to verify that the minimum acceptable content has been provided.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: After government & regulator review, the revised draft-final version of the Proposed Plan will be subject to a minimum 30-day public review. A public meeting shall be held to present the Proposed Plan to the public. This public meeting falls under Task 9, Community Relations Support.

3.8 Task 8, Decision Document: This task is a Firm Fixed Price task.

Objective: Prepare, submit and obtain acceptance of DDs for each delineated MRS resulting from the RI.

3.8.1 Task 8a – MRS-R01 - RANGE II – FUDS Project No. I04SC002501R01.

3.8.2 Task 8b – MRS-R02 - RANGE III – FUDS Project No. I04SC002501R02.

3.8.3 Task 8c – MRS-R03 - RANGE IV - FUDS Project No.I04SC002501R03.

3.8.4 Task 8d – MRS-R09 - MG/RIFLE Range - FUDS Project No.I04SC002501R09.

Performance Standard: Prepare the DDs in accordance with ER 200-3-1, EP 1110-1-18, Attachment C, herein, EPA 540-R-98-031 and CERCLA, as amended.

AC: Acceptance of DD(s) with two revisions. One additional revision is acceptable to incorporate EM-CX.

Measurement / Monitoring: Review of DD(s) against guidance to verify that the minimum acceptable content has been provided.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: PWS Attachment C provides additional formatting requirements for the DD(s). For formatting of Decision Documents, Attachment C provides additional instructions and requirements above that in the CEHNC-EM-CX Interim Guidance 06-04.

3.9 Task 9, Community Relations Support: This task is a Firm Fixed Price task.

Objective: Successfully complete public meetings and support the Charleston District with community relations.

Performance Standard: Contractor attends and participates in meetings. Meeting materials are accepted by the government as required. Meeting transcripts for PP meeting are accurate and prepared by a professional court reporter.

AC: Acceptance of meeting materials with two revisions and acceptance of PP meeting transcripts in one revision. Meetings held are organized; and professional in nature. Contractor personnel in attendance are thoroughly familiar with the project. Zero letters of reprimand, grievances, or formal complaints.

Measurement / Monitoring: Acceptance of required materials for meetings. Government will attend and evaluate the contractor's attendance, participation and professional demeanor.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating.

Specific Task Requirements: Work shall be executed in accordance with the accepted Community Relations Plan (CRP). The Contractor shall attend and participate in three (3) public meetings. These meetings are different from and in addition to TPP meetings. If additional public meetings are required they will be purchased separately according to the FUP in the attached price spreadsheet, Attachment D. These meetings will be held near the project site; specific location to be determined as part of the CRP development. Support shall include, but is not limited to: preparation and delivery of briefings, graphics, maps, posters, and support of question and answer sessions during public meetings, supply printing services. The Contractor shall also obtain the meeting site, provide sound equipment as needed, perform public notification and prepare any correspondence necessary to meeting the objectives of this task. The government shall approve all correspondence, public notices and all other materials prior to being presented/distributed to the public. These actions are independent of the field activities that involve interaction with the community. The meeting for the Proposed Plan shall be covered under this task. Transcripts of the public meeting for the Proposed Plan shall be included without editing or deleting anything from the official document with the exception of redactions to protect Personally Identifiable Information (PII) if needed and shall be included in the Administrative Record and placed in information repositories. The Contractor shall provide

support as needed for development and maintenance of the USACE FUDS website for the project.

3.10 Task 10, Community Relations Plan: This task is a Firm Fixed Price task.
Objective: Update, submit and gain acceptance of a CRP.

Performance Standard: Prepare the CRP in accordance with EP 200-3-1, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and DENIX website.

AC: Acceptance of CRP with two revisions.

Measurement / Monitoring: Review of CRP against guidance to verify that the minimum acceptable content has been provided.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: This effort shall include, but is not limited to: preparation and delivery of stakeholder surveys, review and presentation of survey findings, completion of stakeholder interviews, determining a list of local, state, and federal representatives for the area, determining proposed locations for public meetings, determining best methods of communicating to the public (radio, television, mail outs, etc). The government shall approve all correspondence, survey content, and all other materials prior to being presented/distributed to the public. These actions are independent of the field activities that involve interaction with the community.

3.11 Task 11, Administrative Record: This task is a Firm Fixed Price task.

Objective: Update and maintain the Administrative Record for each MRS throughout the period of performance of this Task Order.

Performance Standard**:** Prepare in accordance with the guidance in EP 200-3-1, Chapter 4 (Establishing and Maintaining Administrative Records) and Standard Operating Procedure for Formerly Used Defense Sites (FUDS) Records Management, Revision 5, dated January 2008 (or most recent version).

AC: Administrative record will be evaluated against guidance for compliance with requirements, accuracy and completeness of the record, with up to one uncorrected deficiency remaining during the period of performance.

Measurement / Monitoring: The government will visit, at least once, the administrative record's location and check for completeness and compliance with referenced EP; electronic submissions will be evaluated randomly upon receipt as data is entered into the record.

Incentives/Disincentives: Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

Specific Task Requirements: Secure a location such as a public library for a place to house the Administrative Record in the local city or community for each MRS. This task requires close coordination with the Charleston District (CESAC) and USAESCH to secure all required documents to support the Administrative Record. Provide copies of all final documents posted to the Administrative Record on CD/DVD to USAESCH and Charleston District, 2 copies each. These files shall be suitable for placement on the FRMD web site.

4.0 SUBMITTALS:

Even though draft and draft final submittals are requested, the term "draft" shall not reflect upon the quality of the submittal being provided by the Contractor. Submittals shall include all supporting materials including supporting data whether electronic or hardcopy. Submittals not meeting the requirements of referenced guidance or Data Item Descriptions or missing supporting data may be rejected and revised by the contractor at the contractor's own expense.

4.1 The Contractor shall deliver the specified number of copies shown in Table 4.2 of each report listed in Table 4-1 to the following addressees (addresses to be verified by Contractor):

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-CT-E (Janice Jamar)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-OE-DC (Chris Cochrane)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-OE-DC (Chris Cochrane)
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

Commander
U.S. Army Corps of Engineers, Charleston District
Attn: CESAC-PM-I (Shawn A. Boone)
69A Hagood Ave.
Charleston, SC 29403

US Army Engineering & Support Center, Huntsville
Attn: CEHNC-CX-MM
PO Box 1600
Huntsville, AL 35807-4301
4820 University Square
Huntsville, AL 35816-1822

Contractor to obtain and/or verify addresses.

4.2 Submittals and Due Dates.
The Contractor shall submit 1 copy of the entire submittal on a CD with each hard copy of a submittal (Reports, Plans, etc) in accordance with DID WERS-007.01. Hardcopies shall be printed on both sides of the paper whenever possible.

Table 4-1 List of Submittals

Submittal	**Due Date (Calendar Days)**
Meeting minutes for Kickoff phone conf.	7 days after Kickoff phone conference
Proposed Schedule	7 days after kickoff conference call
Pre-TPP Meeting Materials	14 Days prior to TPP meetings
Conceptual Site Model (CSM)	With Pre-TPP materials
AAPP (If required)	7 days prior to site visit
Draft TPP Memorandum	14 days after first TPP meeting
Final TPP Memorandum	7 days after acceptance of comment responses
Draft TPP Memorandum Addendum	7 days after second/third TPP meeting
Final TPP Memorandum Addendum	7 days after acceptance of comment responses
Draft Public Involvement Plan	TBD
Draft-Final Public Involvement Plan	14 days after acceptance of comment responses
Final Public Involvement Plan	7 days after acceptance of comment responses
Pre-Public Meeting Materials	14 Days prior to public meetings
Final Public Meeting Materials	No later than 3 days before meeting
Draft PMP	Within 30 days of contract award
Final PMP	Within 30 calendar days of receipt of COR comments on the draft
Draft Work Plan	21 days after acceptance of TPP memorandum

Draft Final Work Plan	14 days after acceptance of comment responses
Final Work Plan	14 days after acceptance of comment responses and TPP meeting
Draft QASP	Submit with the Draft Final Work Plan
Quality Control Documents	**As required by Regulation, guidance, DIDs, QCP, QASP, or agreed to in project schedule, to include the following**:
Daily QC Report for Environ. Sampling	Daily during Sampling Activities
Analytical Data Submittal for QA Evaluation	30-60 days after completion of fieldwork
Electronic Laboratory Data Submittal	30-60 days after completion of fieldwork
Draft RI Report (GIS on DVD)	60-81 days after completion of field work
Draft Final RI Report	21 days after acceptance of comment responses
Final RI Report	14 days after acceptance of comment responses and TPP meeting
Draft FS Report	21 days after acceptance of the RI Report
Draft Final FS Report	14 days after acceptance of comment responses
Final FS Report	14 days after acceptance of comment responses
Draft Proposed Plan	14 days after acceptance of the FS Report
Draft Final Proposed Plan	14 days after acceptance of comment responses
Final Proposed Plan	14 days after PP public meeting
PP Meeting Transcripts	with final Proposed Plan
Responsiveness Summary	with Decision Document Submittal
Draft Decision Document	14 days after acceptance of Proposed Plan
Draft Final Decision Document	7 days after acceptance of comment responses
Final Decision Document	7 days after acceptance of comment responses
Final Administrative Record (On CD/DVD)	Upon completion of the Record
Final GIS Files on CD	End of Project

4.3 Submittal Quantities

Provide the number of submittals shown in Table 4-2 to the addressees given in Section 4.2. No draft documents shall be released to the regulatory community until reviewed by the government.

Table 4-2 Submittal Guidance

	Draft Documents	Draft Final/Final Documents
KO/COR	1 each	1 each
USAESCH	3	3
CESAC	1	1

4.4 Review Period: The contractor shall include at least a minimum 14 calendar day review period for USAESCH, 21 calendar day review period for the EM-CX and 30 calendar day review period for the regulators.

4.5 Period of Performance: The Completion Date for this Task Order is 36 months after NTP.

5.0 MILESTONE PAYMENTS: (for firm fixed price tasks): Milestones will be considered met or completed when the required QC documentation has been submitted, QA completed and the submittal and/or product is accepted. Any payment vouchers submitted that do not coincide with the final accepted milestones or do not have the appropriate QC documentation will be rejected. All payments will be made utilizing an agreed upon Payment Milestone Schedule. The Contractor shall provide suggested milestones for payment. Milestones for payment shall be shown on the project schedule.

5.1 The following is a list of potential milestones for payment:
- Final Submittals: upon government acceptance, for example: Final WP
- Field Work: for defined units and activities completed and QA review and acceptance, for example: Final QC density data package.
- Meetings: after completion of meetings with government acceptance of meeting minutes, for example: Final PP meeting transcripts.

6.0 REFERENCES:

6.1 Refer to "Base Contract."

6.2 Data Items Descriptions at the following website:

http://www.hnd.usace.army.mil/engr/WERS.aspx .

6.3 **Site Specific References**

Specific references.
- Remedial Investigation Report – Former Conway Bombing and Gunnery Range.
- Feasibility Study Report - Former Conway Bombing and Gunnery Range.
- Proposed Plan - Former Conway Bombing and Gunnery Range

7.0 GENERAL CONDITIONS: See the Base Contract Section C, Section 10 General Conditions and the following addendums:

7.1 This is a performance based task order. The inclusion of unit prices in the proposal shall in no way be construed to mean that the Government is procuring a specified number of units of any given service.

7.2 Government acceptance of the proposed technical approach and/or price does not relieve the Contractor from full responsibility for the viability, productivity, and efficiency of the approach used to meet the performance requirements of the PWS at the price proposed. The task order is for the provision of services that ultimately meet the performance requirements of this task. If the contractor must adjust its technical approach or perform more field work than anticipated in order to achieve the proposed performance goal then the contractor will do so with no change in task order price.

7.3 If the Government at its sole discretion chooses to modify the performance standard the parties to this task order will assess the impact on the estimated amount of field work required to achieve the new performance standards and will negotiate a price adjustment based upon the unit prices providing as price proposal supporting documentation (See Attachment D).

7.4 The Contractor attests that it applied due diligence in the research and development of its proposal has priced reasonable estimates of the site conditions and the associated risks into the price. The Contractor accepts full and sole responsibility for identifying and considering all factors that may affect the cost to execute the work. The act of signing this task order signifies that the Contractor has been given ample opportunity to assess the conditions under which the work will be performed and the Contractor either fully understands those conditions or has factored the risk into the price.

7.5 The Government provided the Contractor with historical documents and documents from previous site activities. The Contractor attests it interpreted the data utilizing an experienced understanding of how the data of this type is collected, analyzed, interpreted, and presented.

8.0 ARMY CONTRACTOR MANPOWER REPORTING:

8.1 Implementation.

8.1.1 The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains a secure Army data collection site where the contractor will report contractor manpower information (including subcontractor manpower information) required for performance of this contract. The contractor shall submit all the information required in the format specified at the following web address: **https://cmra.army.mil/default.aspx**

8.1.2 The Contractors shall fill in the required information on the website, fields are shown below:

- Contract Number
- Delivery Order Number (if applicable)
- Task Order Number (if applicable)
- Requiring Activity Unit Identification Code (UIC)
- Command
- Contractor Contact Information
- Federal Service Code (FSC)
- Direct Labor Hours

- Direct Labor Dollars
- Location Information (where contractor and subcontractors (if applicable) performed the services

8.1.3 Reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 15 October of each calendar year.

8.1.4 If your particular contract crosses fiscal years, 2 entries must be made to capture the data for the contract period; for example if the contract start date is 1 January 2007 and ends 31 December 2007, the data for the period from 1 January 2007 through 30 September 2007 shall be entered not later than 15 October 2007 and the period 1 October 2007 through 31 December 2007 shall be entered not later than 15 January 2008.

Attachment A
Performance Requirements Summary:

A.1 The Contractor shall meet the following performance requirements. Performance requirements are addressed in each task and summarized in the following Performance Requirements Summary. If discrepancies or ambiguity exists between the documents, the order of precedence is 1) the Task; 2) Performance Requirements Summary; 3) Performance Metrics

Table A-1 Performance Requirements Summary

Task Application	Objective	Performance Standard	Minimum Acceptable Criteria	Measurement / Monitoring	Incentive/ Disincentive
Task 1, Technical Project Planning (TPP)	Implement the four-phase TPP process.	Achieve the objectives of each TPP phase as listed in EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents. Facilitate meetings in a professional and organized manner.	Acceptance of TPP documents (meeting presentations, agenda, handouts, Conceptual Site Model (CSM) and memorandums) with up to one (1) revision. Meetings held are organized; accomplish requirements of the TPP process; and be conducted in a professional manner. Zero letters of reprimand, grievances, or formal complaints.	TPP checklist for each phase as provided in the EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents will be used to measure and document successful progress; guidance cited will be used to evaluate content of documents for acceptance / non-acceptance. Government will attend and evaluate organization and facilitation of the meetings, and professional nature of the	Satisfactory or greater Contractor Performance Assessment Reporting System (CPARS) rating/poor CPARS rating and/or re-performance of work at contractor's expense.

				meetings.	
Task 2, Remedial Investigation (RI)/Feasibility Study (FS) Work Plan (WP), Project Management Plan (PMP), Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) and QASP	Prepare, submit and gain acceptance of a WP, PMP, MC UFP-QAPP and QASP that are detailed and comprehensive plans covering all aspects of site characterization, risk assessment and methodology, and project execution. UFP-QAPP is only required for environmental sampling.	Prepare the WP in accordance with DID WERS-001.01 and other applicable DIDs for sub plans, EM 1110-1-4009, EM 385-1-1, EM 385-1-97, Army RI/FS guidance, Interim Guidance (Draft Army Regulation XXX) Chemical Warfare Materiel Responses and Related Activities as appropriate and other Interim Guidance as appropriate. Prepare the PMP in accordance with DID WERS-18. Prepare the sampling and analysis plan, field sampling, and UFP-QAPP in accordance with EM 1110-1-4009, DID WERS-009.01, Intergovernmental Data Quality Task Force UFP-QAPP Manual, and the State of South Carolina regulatory guidance}, as appropriate. Prepare a risk	Acceptance of WP, PMP, UFP-QAPP with two revisions. Draft QASP reflects requirements of the WP and the Quality Control Plan (QCP) with one revision required. One additional revision is acceptable to incorporate EM-CX.	Review of WP, PMP, UFP-QAPP and QASP to verify that the minimum acceptable content has been provided and meets applicable guidance.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

		assessment work plan as part of the overall project work plan incorporating implementation of the risk assessment and methodologies per USEPA Risk Assessment Guidance (RAGS), the State of South Carolina regulatory guidance, and USACE EM 200-1-4, Volumes I and II, as appropriate. UFP-QAPP content shall also meet the requirements of DoD Quality Systems Manual for Environmental Laboratories (current version). Draft QASP includes requirements in regulations, guidance, DIDs and the Quality Control Plan included in the WP.			
Task 2a, Explosives Site Plan	Prepare, submit and gain acceptance of an Explosives	Prepare required submission in accordance with DoD 6055.09-M, EM 385-1-97, Errata Sheet #3,	Acceptance of submission with two revisions. One additional revision is acceptable to	Review by Government using guidance cited to determine acceptability.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of

	Site Plan (ESP).	and DID WERS-003.01 as a standalone document for inclusion after acceptance into the WP.	incorporate EM-CX, USATCES and DDESB comments.		work at contractor's expense.
Task 3, GeoSpatial Data	Utilize a geographic information system (GIS) in the development of the Conceptual Site Model (CSM) and maintain and manage all project and geospatial data.	Manage and maintain project data, and develop CSM in GIS IAW DID WERS-007.01, EM 200-1-2, EM 1110-1-4009 and applicable Interim Guidance Documents.	Acceptance of CSM and GeoSpatial Data submissions, which also meet quality and formatting requirements.	Review by Government using cited to determine acceptability to determine acceptability.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
Task 4, RI/FS Field Activities	Conduct a remedial investigation in accordance with CERCLA, as amended, characterizing the nature and extent of MEC at the MRSs (MRS-R01-Range II – FUDS Project No. I04SC002501R01, MRS-R02 -	Field work, data quantity and quality, and analysis of said data (does not include area where Rights-of-entry were not obtained) provides the following results in the RI report: - Demonstrate that the work was performed in accordance with the applicable laws, regulations, and guidance documents;	Conduct the RI in accordance with the accepted/approved WP, UFP-QAPP, and QASP. QC data submitted meets requirement described in DID WERS-004.01. - Sampling field work and data meets established criteria within the accepted UFP-QAPP, SAP, and Work Plan. - No more than 3 CARs/948s for	Periodic inspection/review of field work and data. Verify compliance with accepted WP, UFP-QAPP and QASP. Quality control tests/documentation submitted per the QASP for government review. Additionally, statistical confidence will be calculated	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

	Range III-FUDS Project No. I04SC002501R02, MRS-R03 - Range IV-FUDS Project No.I04SC002501R03, and MRS-R09 -MG/ Rifle Range-FUDS Project No.I04SC002501R09**)** meeting the project DQOs as defined during the TPP process. This task shall include all field activities necessary to execute this task. For MC contamination, collect sufficient data that meets the project DQOs as defined during the TPP process, of known quality and quantity to determine the nature	- Demonstrate that all areas with elevated anomaly density or with potential to contain MEC traversed at the completion of fieldwork and that there is at least 90% chance of detecting these areas. - Demonstrate that in areas outside of the MEC-contaminated areas there is 90% confidence there is less than or equal to 0.1 UXO per acre in residential areas, 0.5 UXO per acre in low use areas and 1.0 UXO per acre in areas without intrusive activities. - Demonstrate that the boundaries of all identified MEC contaminated areas have been delineated to an accuracy of a maximum 250 feet, and demonstrate that at least 90% confidence has been achieved for bounding the	non-critical violations and/or 1 CAR/948 for critical violation. No unresolved Corrective action requests. - All final data and QC tests/documentation submitted. Government QA acceptance of QC tests/documentation gained. - No Class “A” Safety accidents, contractor at fault; No Class “B”, contractor at Fault, no more than 1 non-explosive Class “C” accident; and <2 non-explosive related Class “D” accidents, IAW AR 385-40. - Major safety violations, no more than 1 non-explosive related safety violation. - Minor safety violations, no more than 2 safety violations. - Zero letters of reprimand, grievances, or formal complaints.	using the Visual Sampling Plan software, UXO Estimator or some other statistical method. Boundary precision will be determined by evaluation of the sampling footprint as it relates to the reported contaminated/uncontaminated areas in question. Anomaly density profile and other remediation cost driver precision will be verified by QA of methods used.	

	and extent of munitions constituents (MC) to support and perform a human health and ecological baseline risk assessment.	potential depth of MEC. - Demonstrate that data inputs from the RI into the FS will enable remediation cost estimates with an accuracy of +50%/-30%. The work and reporting shall address the surface and sub-surface metallic anomaly density distribution (anomaly/acre) across identified MEC contaminated areas as well as other remediation cost drivers such as vegetation type and density, terrain conditions, soil type, exclusion zone evacuation costs, etc each to a level of accuracy within the range specified herein. - For areas unlikely to contain a target with elevated anomaly density, but with the potential for MEC/MC contamination (e.g. burial pits) the contractor			

		shall use historical data to narrowed the area and then apply the required confidence level. Additionally: - Perform the RI field activities in accordance with the accepted Work Plan and UFP-QAPP. - Proper disposal of all MEC, UXO, DMM, and MC encountered . - All Material Potentially Presenting an Explosive Hazard (MPPEH) processed in accordance with Chapter 14 and Errata Sheet No. 2.of EM 1110-1-4009. - Meet the project DQOs as defined by the TPP process. - All geophysics shall be IAW DID WERS-004.01. For this task order 1 acre of transects equals 14,520 lf (2.75 miles) of transects 3 feet wide. One acre's worth of grids equals seventeen (17) 2500 sf grids			

		or four (4) 10,000 sf grids. - -To the maximum extent practicable the contractor should conduct the field investigation by gathering sensor data that is digitally recorded and geo-referenced (geo-referencing need be no more accurate than is needed for the use of the data). Exceptions may include situations where other methods provided data and/or significant cost value in which case the contractor shall provide detailed justification in their proposal describing why the other methods provide a better value. In any case a geo-referenced permanent record of the investigation shall be delivered as part of the RI report (GIS of traverse and items located, digital geophysical data,			

		etc). - MC analyses shall be performed in accordance with the requirements of the Department of Defense (DoD) Quality Assurance Manual (QAM), WERS-009.01 Munitions Constituents Chemical Data Quality Deliverables, and the approved project specific UFP-QAPP. - As appropriate, the contractor shall implement statistical methods for its sampling plan.			
Task 4a, Evacuations	Provide support for evacuation of residences displaced due to intrusive investigation exclusion zones.	Support evacuation of residences in an efficient and timely manner so as not to cause delays in schedule and complains from the residences.	Necessary voluntary evacuations accomplished in a courteous and professional manner with no contract a fault delay to project schedule.	Government monitoring of evacuations, receipt of complaints from the public, unsolicited commendations	Satisfactory or greater CPARS rating/poor CPARS rating.
Task 5, Remedial Investigation Report	Prepare, submit and gain acceptance of a RI report.	The RI report shall document the results of the RI and previous investigations, and the Contractor shall	Acceptance of RI with two revisions. One additional revision is acceptable to incorporate EM-	Review of RI against guidance to verify that the minimum acceptable content has	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at

		prepare the report in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04, and the Army RI/FS guidance. The ecological and human health risk assessment shall be performed in accordance with the EPA Risk Assessment Guidance (RAGS) and USACE EM 200-1-4, Volumes I and II, as appropriate.	CX.	been provided.	contractor's expense.
Task 6, Feasibility Study and Report.	Conduct a feasibility study and prepare, submit and gain acceptance of a FS report.	The FS report shall document the results of the FS and prepared in accordance with EP 1110-1-18, EM CX Interim Guidance 06-04, and Army RI/FS guidance.	Acceptance of FS with two revisions. One additional revision is acceptable to incorporate EM-CX.	Review of FS against guidance to verify that the minimum acceptable content has been provided	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
Task 7, Proposed Plan	Prepare, submit and gain acceptance of Proposed Plan (PP).	Prepare the PP(s) in accordance with, ER 200-3-1, EP 1110-1-18, EM-CX Interim Guidance 06-04, EPA 540-R-98-031 and CERCLA, as amended.	Acceptance of PP with two revisions. One additional revision is acceptable to incorporate EM-CX.	Review of PP against guidance to verify that the minimum acceptable content has been provided.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
Task 8,	Prepare,	Prepare the DDs	Acceptance of	Review of	Satisfactory or

Decision Document. **Task 8a – MRS-R01 – RANGE II – FUDS Project No. I04SC002501 R01** **Task 8b – MRS-R02 – RANGE III – FUDS Project No. I04SC002501 R02.** **Task 8c – MRS-R03 - RANGE IV - FUDS Project No.I04SC002 501R03.** **Task 8d – MRS-R09 - MG/RIFLE RANGE - FUDS Project No.I04SC002 501R09.**	submit and obtain acceptance of DDs for each delineated MRS resulting from the RI	in accordance with ER 200-3-1, EP 1110-1-18, Attachment C, herein, EPA 540-R-98-031 and CERCLA, as amended.	DD(s) with two revisions. One additional revision is acceptable to incorporate EM-CX.	DD(s) against guidance to verify that the minimum acceptable content has been provided.	greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
Task 9, Community Relations Support:	Successfully complete public meetings and support the Charleston District with community relations.	Contractor attends and participates in meetings. Meeting materials are accepted by the government as required. Meeting	Acceptance of meeting materials with two revisions and acceptance of PP meeting transcripts in one revision. Meetings held are	Acceptance of required materials for meetings. Government will attend and evaluate the contractor's attendance,	Satisfactory or greater CPARS rating/poor CPARS rating.

		transcripts for PP meeting are accurate and prepared by a professional court reporter.	organized; and professional in nature. Contractor personnel in attendance are thoroughly familiar with the project. Zero letters of reprimand, grievances, or formal complaints.	participation and professional demeanor.	
Task 10, Community Relations Plan.	Update, submit and gain acceptance of a CRP.	Prepare the CRP in accordance with EP 200-3-1, ER 200-3-1, EM-CX Interim Guidance 06-04, guidance provided in the FUDS Public Involvement Toolkit and DENIX website.	Acceptance of CRP with two revisions.	Review of CRP against guidance to verify that the minimum acceptable content has been provided	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.
Task 11, Admin. Record	Update and maintain the Administrative Record for each MRS throughout the period of performance of this Task Order.	Prepare in accordance with the guidance in EP 200-3-1, Chapter 4 (Establishing and Maintaining Administrative Records) and Standard Operating Procedure for Formerly Used Defense Sites (FUDS) Records Management, Revision 5, dated January 2008 (or most recent	Administrative record will be evaluated against guidance for compliance with requirements, accuracy and completeness of the record, with up to one uncorrected deficiency remaining during the period of performance.	The government will visit, at least once, the administrative record's location and check for completeness and compliance with referenced EP; electronic submissions will be evaluated randomly upon receipt as data is entered into the record.	Satisfactory or greater CPARS rating/poor CPARS rating and/or re-performance of work at contractor's expense.

		version).			

Attachment B
PERFORMANCE METRICS

B.1 Performance Metrics for Performance Assessment Record (PAR)

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
PAR Category: Quality of Product or Service					
Performance indicator: Document reviews					
Draft Plans, Reports, and documents [Plans, documents and reports are considered draft until	All contract-milestone documents accepted as submitted	No substantive comments (i.e. limited to grammar, spelling, terminology) to any of the	Contractor met Acceptance Criteria	One or more documents required revisions to be resubmitted for approval prior to proceeding.	One or more documents did not comply with contract requirements, or one or more documents required more

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
accepted as final by the Government]		documents, but a few exceptions were noted and corrected		Two backchecks were required on one or more documents before original comments were resolved satisfactorily.	than two backchecks before original comments were resolved satisfactorily, or more than one document was rejected.
Performance indicator: Project Execution					
Process Compliance	Zero Corrective Action Requests (CAR) or 948s	1-2 CARs/948s for non-critical violations to WP requirements	Contractor met Acceptance Criteria	5-6 CARs/948s for non-critical violations and/or 2CARs/948 for critical violations	>6 CARS for non-critical violations and/or >2 CARs/948s for critical violations, or any unresolved CARs
Project Execution	Zero letters of reprimand, grievances, or formal complaints AND one or more unsolicited letters of commendation		Contractor met Acceptance Criteria	One letter of reprimand, grievance or formal complaint that was resolved through negotiation	More than one letter of reprimand, grievance or formal complaint that were resolved through negotiation
Task Completion			Contractor met Acceptance Criteria		Final data and QC documentation submitted but not accepted
PAR Category: Schedule					
Performance indicator: Timely completion of tasks					
Final Plans and Reports, project milestones,	All document submittals and task	Project closed out/final invoice	Project closed out/final invoice	Project closed out/final invoice accepted	Project closed out/final invoice accepted more

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
T.O. invoices	order milestones and invoices complete and accepted by T.O date, project closed out/final invoice approved ahead of schedule	accepted ahead of schedule	accepted on T.O. date	within 30 calendar days after T.O. date.	than 30 calendar days after T.O. date.
Project status reports accurate			Yes		No
Performance indicator: Impacts to schedule					
Impacts caused by Contractor or other causes identified, in writing to HNC CO/ PM, in a timely manner to apply acceptable corrective actions.			Yes		No
PAR Category: Cost Control (Not Applicable for Firm Fixed Price)					
Performance indicator: No unauthorized cost overruns					
Unauthorized cost overruns			No		Yes
Total Project Costs	Total contract invoices less than 98% of T.O. authorized amount	Total contract invoices greater than 98% but less than 99.99%of T.O. authorized amount	Total contract invoices between 99.99% and 100% of T.O. authorized amount	Total contract invoices greater than 100% but less than 105% of T.O. authorized amount	Total contract invoices greater than or equal to 105% of T.O. authorized amount

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
Performance indicator: Monthly cost report					
Monthly cost reports accurate			Yes		No
Performance indicator: Impacts to cost					
Impacts caused by Contractor or other causes identified, in writing to HNC CO/PM, in a timely manner to apply acceptable corrective actions.			Yes		No
PAR Category: Business Relations					
Performance indicator: Met contractual obligations					
Corrective Actions taken were timely and effective (Refer to CARs issued to Contractor)			Yes		No
Performance indicator: Professional and Ethical Conduct					
Meetings and correspondences with Public, project delivery team and other stakeholders	Zero letters of reprimand, grievances, or formal complaints AND one or more unsolicited letters of commendation		Contractor met Acceptance Criteria	One letter of reprimand, grievance or formal complaint that was resolved through negotiation	More than one letter of reprimand, grievance or formal complaint that were resolved through negotiation OR removal of one or more project personnel as a results of a letter of reprimand, grievance or formal

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
					complaint.
Performance indicator: Customer has overall satisfaction with work performed					
Customer survey results for rating period	4.0-5.0	3.0-3.9	2.0-2.9	1.0-1.9	<1.0
Performance indicator: Personnel responsive and cooperative					
Key personnel responsive, and cooperative	Always		Most Times		Almost Never
PAR Category: Management of Key Personnel and Resources					
Performance indicator: Personnel knowledgeable and effective in their areas of responsibility					
Personnel assigned to tasks	All personnel proposed by Contractor were assigned to project, some personnel were substituted by higher qualified individuals.		All personnel proposed by Contractor were assigned to project, some personnel were substituted by equally qualified individuals.	All personnel proposed by Contractor were assigned to project, some personnel were substituted by equally qualified individuals, Letter of reprimand received for personnel conduct from HNC.	All personnel proposed by Contractor were assigned to project, some personnel were substituted by lesser qualified individuals or HNC requested, in writing, removal of assigned personnel for poor performance.
Performance indicator: Personnel able to manage resources efficiently					
Instances when resource management had negative impact on project execution	0	1-2	3-4	5-6	>6
PAR Category: Safety					
Performance indicator: Accidents and Violations					
*No Class A Accidents, Contractor at fault	0 No class A accidents IAW AR	No class A accidents IAW AR 385-40	Contractor met Acceptance Criteria	<2 non-explosive related Class C accidents,	1 Any Class A accident IAW AR-385-10, or Any explosive

	Exceptional	**Very Good**	**Satisfactory**	**Marginal**	**Unsatisfactory**
	385-40			or 1 non-explosive Class B accident, IAW AR 385-10	related accident.
*Major safety violations	0 accidents/injuries No safety violations	0 accidents/injuries No safety violations		2 non-explosive safety violations.	>1 any violation of procedures for handling, storage, transportation, or use of explosives IAW the WP, and all Federal, State and local laws/ordinances.
*Minor safety violations	No safety violations	1 safety violation		3 safety violations	>3 safety violations

Classes of Accidents:

- **Class A:** Fatality or permanent total disability (Government Civilian, Military Personnel, and/or Contractor), or >$2,000,000 property damage.

- **Class B:** Permanent partial disability or impatient hospitalization of 3 or more persons (Government Civilian, Military Personnel, and/or Contractor), $500,000< $2,000,000 property damage.

- **Class C:** Lost Workday (Contractor) or Lost Time (Government Civilians), $50,000< $500,000 property damage.

- **Class D:** $2000 < $50,000 property damage.

* From Section C of Solicitation Number W912DY-04-R-0003, Amendment 000 W912DY-08-R-0016, Amendment 0007 (may be included but are not limited to these).

The following guidelines are provided for issuing ratings that are subjective in nature, these ratings will be supported by the weight of evidence documented during the government's surveillance efforts:

Exceptional: Performance *meets* contractual requirements and *exceeds many* to the Government's benefit. The contractual performance of the element or sub-element being assessed was accomplished with *few minor problems* for which corrective actions taken by the Contractor were *highly effective*.

Very Good: Performance *meets* contractual requirements and *exceeds some* to the Government's benefit. The contractual performance of the element or sub-element being assessed was accomplished with *some minor problems* for which corrective actions taken by the Contractor were *effective*.

Satisfactory: Performance *meets* contractual requirements. The contractual performance of the element or sub-element contains *some minor problems* for which corrective actions taken by the Contractor *appear or were satisfactory*.

Marginal: Performance *does not meet all* contractual requirements. The contractual performance of the element or sub-element being assessed reflects a *serious problem* for which the Contractor has *not yet identified corrective actions*. The Contractor's proposed actions appear only *marginally effective or were not fully implemented*.

Unsatisfactory: Performance *does not meet most* contractual requirements and *recovery is not likely* in a timely manner. The contractual performance of the element or sub-element contains *serious problems* for which the Contractor's corrective actions *appear or were ineffective.*

Attachment C

1. REQUIREMENTS AND PROCEDURES:

a. This interim guidance provides specific requirements for MMRP Decision Documents.

b. Format and content of ALL MMRP decision documents and action memoranda, regardless of signature authority shall be in accordance with IG 06-04 (EP 1110-1-18 dated 6 April 2006).

c. All decision documents or action memoranda, regardless of level of signature authority, will be accompanied by an Executive Summary that for Headquarters (HQ). USACE will forward to ACSIM-ISE and DASA (ESOH). The Executive Summary shall be kept to a single page, whenever possible, and will include:

(1) Title, including project name and project number, date DD (or AM) was signed and by whom,

(2) Brief description of the Munitions Response Sites (MRS), covered by the decision,

(3) Brief description of selected response action and its relationship to other cleanup actions,

(4) Degree of risk reduction,

(5) Present worth cost of selected response action, and the contribution to the cost-to-complete of all remedies for the FUDS Property,

(6) Amounts and fiscal year(s) that funds are required for remedial/removal action design and construction,

(7) Duration of any remedial action-operation (RA-O), removal action construction (RmA-C) and/or Long Term Monitoring (LTM) actions,

(8) Land use controls (LUC) required and means of maintaining them,

(9) Other potential response actions considered, and

(10) Expected result of the action.

d. The contractor shall include the following in Section 7 of the Decision Document:

- 7. AUTHORIZING SIGNATURE.
  The following general paragraph and signature block. (*Note: Signature block may not appear alone on a page – it must be on the same page with the preceding paragraph*):

  "This Decision Document presents the selected response action at [place]. The U.S. Army Corps of Engineers is the lead agency under the Defense Environmental Restoration Program (DERP) at the [FUDS property name] Formerly Used Defense Site, and has developed this Decision Document consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document will be incorporated into the larger Administrative Record file for [FUDS property name], which is available for public view at [address]. This document, presenting a selected remedy with a present worth cost estimate of [$$], is approved by the undersigned, pursuant to Memorandum, DAIM-ZA, September 9, 2003, subject: Policies for Staffing and Approving Decision Documents (DDs), and to Engineer Regulation 200-3-1, Formerly Used Defense Sites (FUDS) Program Policy."

  APPROVED:

(insert individual's signature block here) Date_____

For present worth cost estimate of $2M or less:
District Commander" Signature Block

For present worth cost estimate of more than $2M and less than or equal to $10M:
HQUSACE signature block for:
Chief, Department of Defense
Support Team
Directorate of Military Programs

For present worth cost estimate of more than $10M:

Signature block for ACSIM or DASA(ESOH) or both

Section E - Inspection and Acceptance

INSPECTION AND ACCEPTANCE TERMS

Supplies/services will be inspected/accepted at:

CLIN	INSPECT AT	INSPECT BY	ACCEPT AT	ACCEPT BY
0001	Destination	Government	Destination	Government
0002	N/A	N/A	N/A	Government
0003	N/A	N/A	N/A	Government
0004	N/A	N/A	N/A	Government
0005	N/A	N/A	N/A	Government
0006	N/A	N/A	N/A	Government
0007	N/A	N/A	N/A	Government
0008	N/A	N/A	N/A	Government
0009	N/A	N/A	N/A	Government
0010	N/A	N/A	N/A	Government
0011	N/A	N/A	N/A	Government
0012	N/A	N/A	N/A	Government
0013	N/A	N/A	N/A	Government

Section F - Deliveries or Performance

DELIVERY INFORMATION

CLIN	DELIVERY DATE	QUANTITY	SHIP TO ADDRESS	UIC
0001	19-AUG-2016	1	SEE SCHEDULE SEE SCHEDULE SEE SCHEDULE AA FOB: Destination	W912DY
0002	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0003	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0004	POP 19-AUG-2013 TO 18-AUG-2016	N/A	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0005	POP 19-AUG-2013 TO 18-AUG-2016	N/A	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0006	19-AUG-2016		(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0007	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0008	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0009	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0010	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0011	POP 19-AUG-2013 TO 18-AUG-2016	N/A	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0012	19-AUG-2016	1	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY
0013	POP 19-AUG-2013 TO 18-AUG-2016	N/A	(SAME AS PREVIOUS LOCATION) FOB: Destination	W912DY

Section G - Contract Administration Data

ACCOUNTING AND APPROPRIATION DATA

AA: 21320200000 088021 25407F07L649300822000 ENVR 09133
AMOUNT: $2,225,511.24
CIN W31RYO321944900001: $2,225,511.24

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APPENDIX B

SITE MAPS

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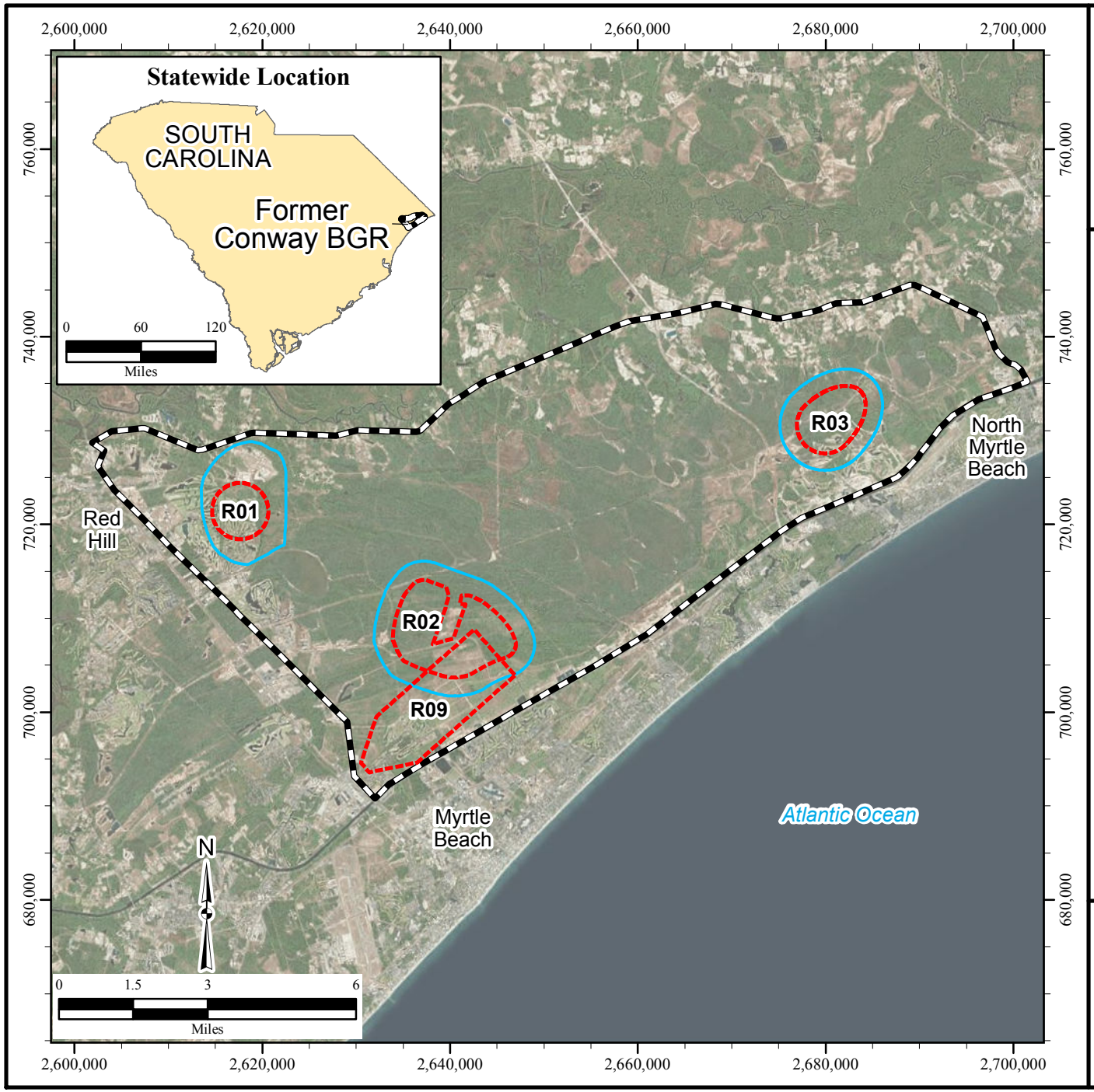

Figure B.1
General Location Map
Former Conway BGR

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range

\\Gst-srv-01\hglgis\Conway_MSIW\WP\ (B-01)Site_Locations.mxd
2/24/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

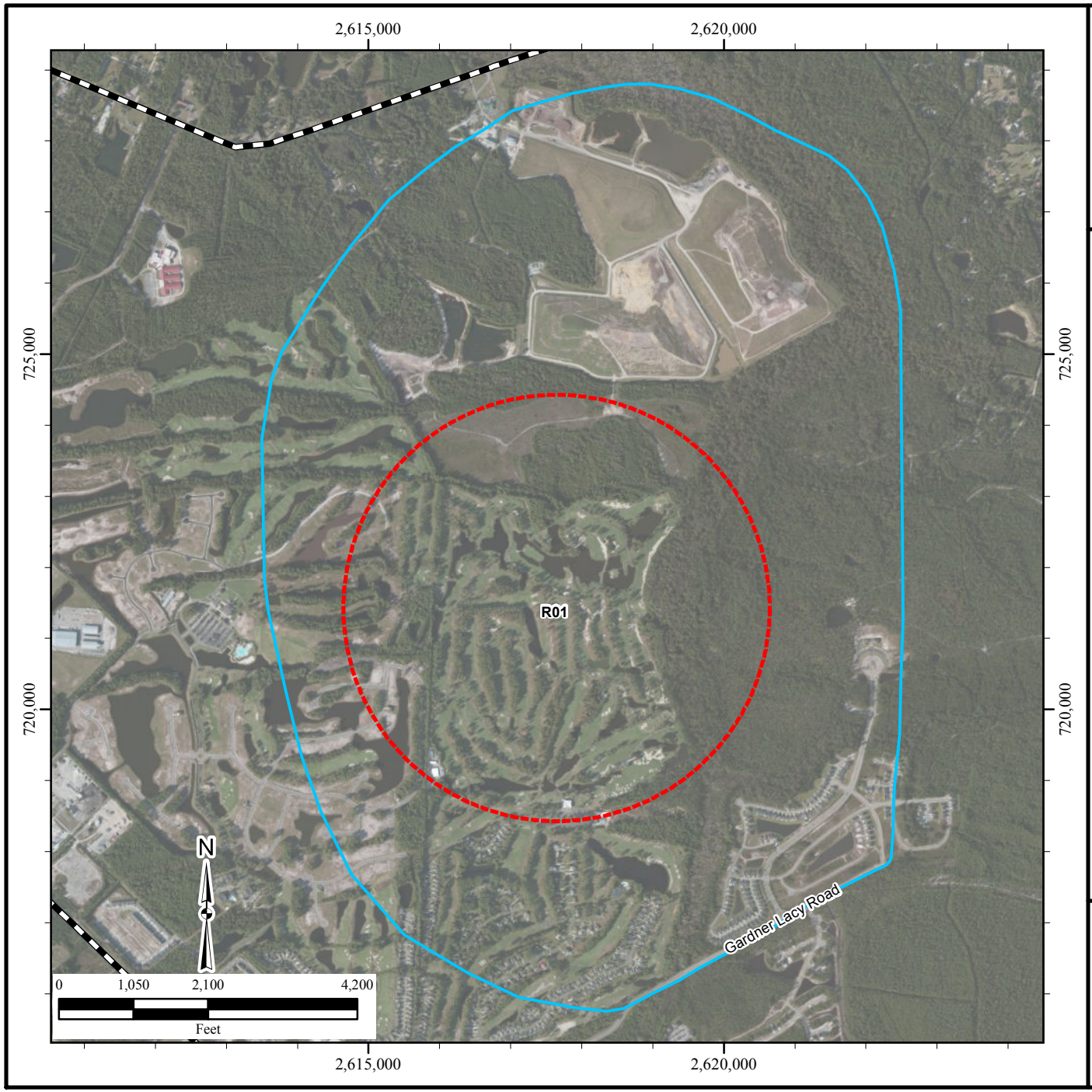

Figure B.2
MRS-R01
Range II Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

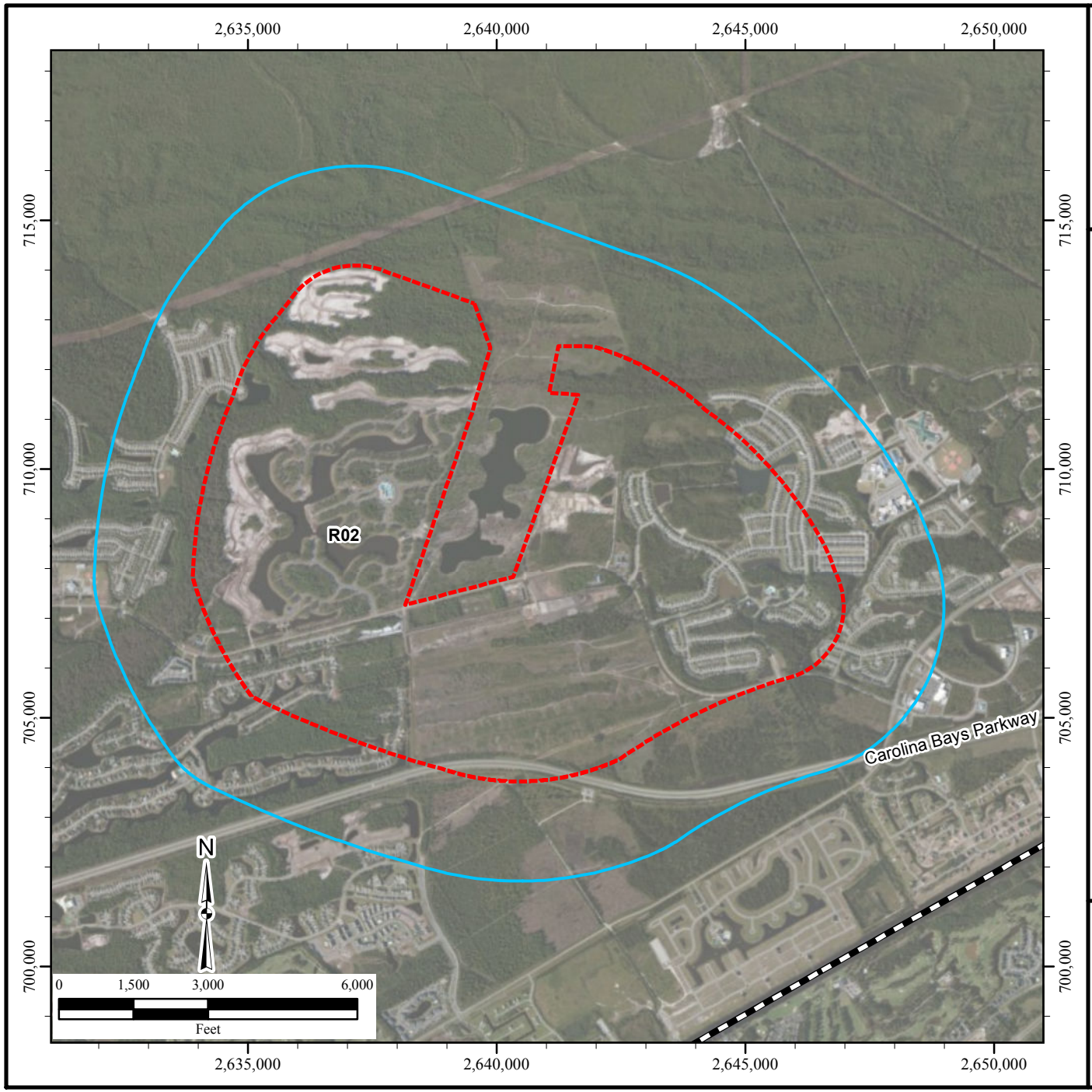

Figure B.3
MRS-R02
Range III Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

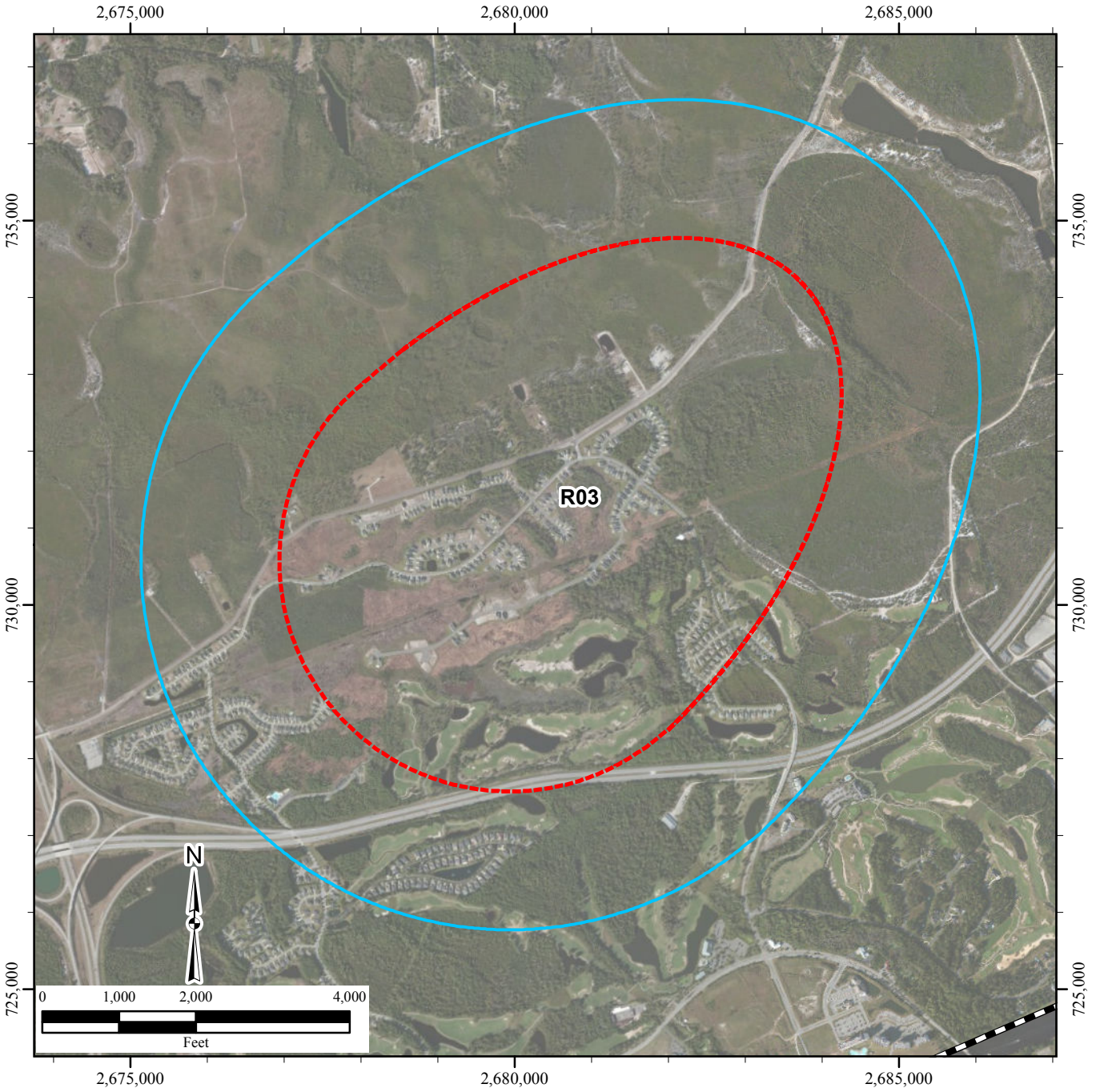

Figure B.4
MRS-R03
Range IV Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

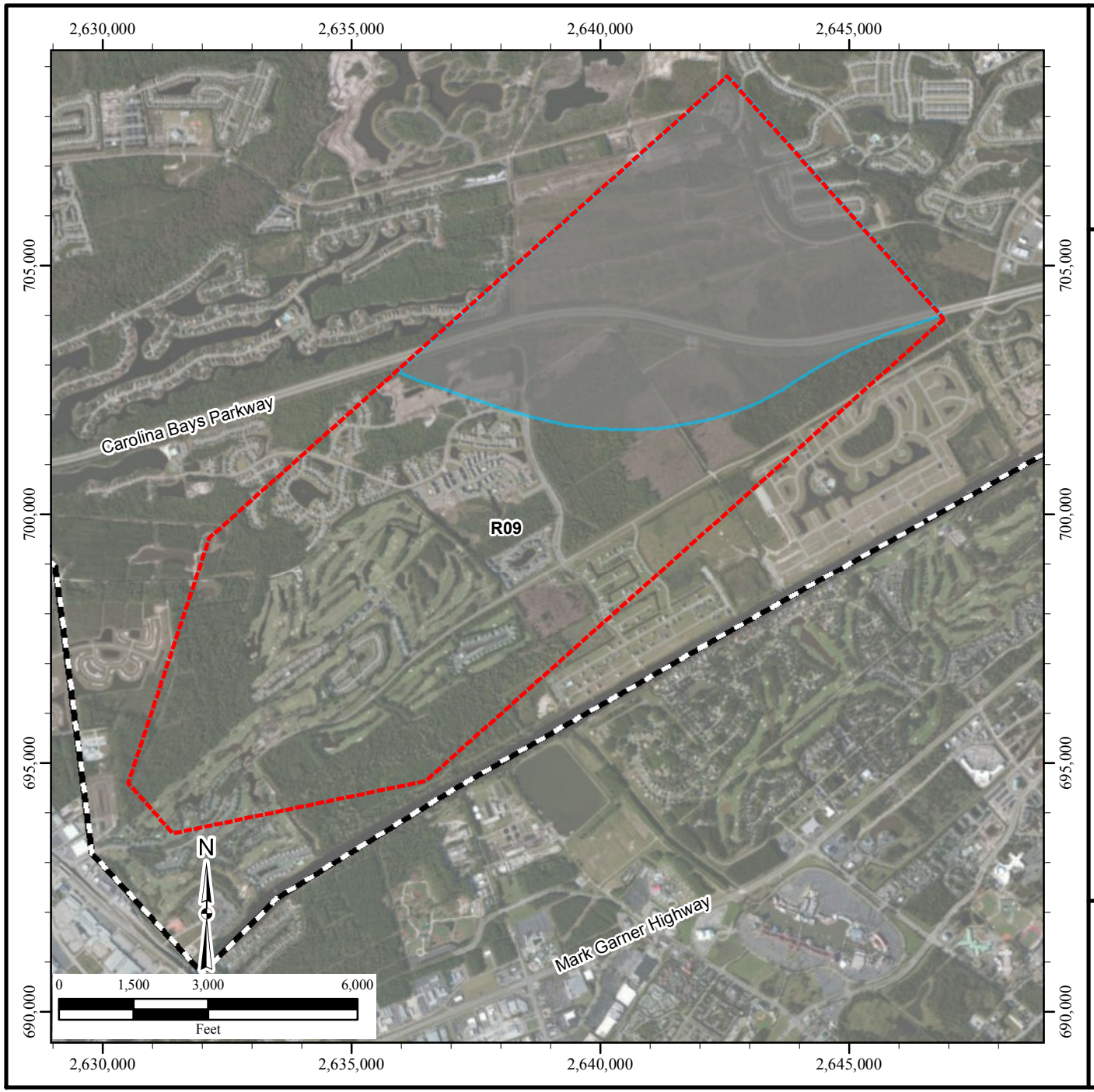

Figure B.5
MRS-R09
Machine Gun/Rifle Range
Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

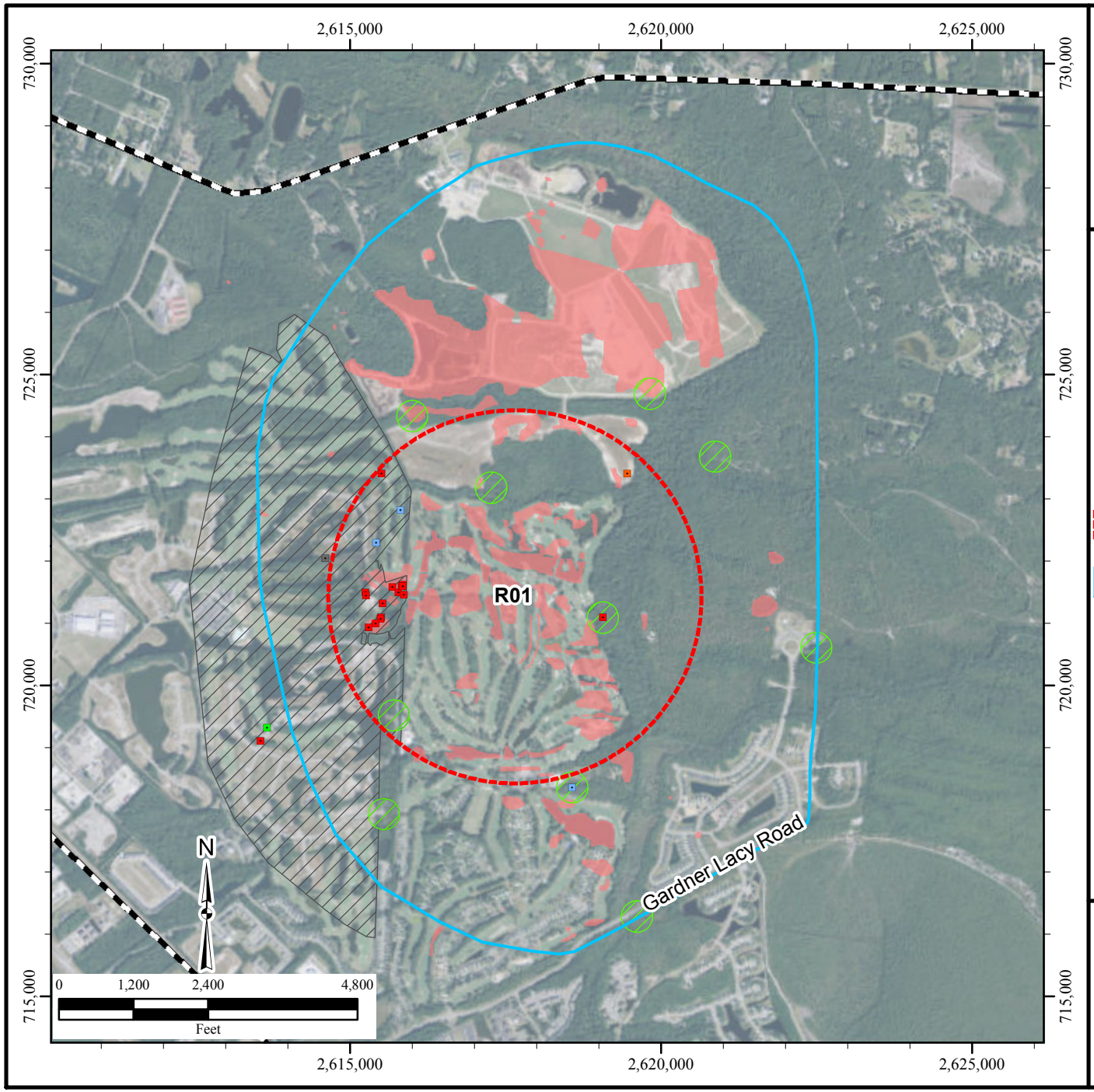

Figure B.6
MRS-R01
Range II
Historical Information and Previous Investigation

Legend

- 100lb Bomb (16 Items)
- 2.25" Rocket (1 Item)
- 20lb Bomb (1 Item)
- Small Arms (3 Items)
- Other (1 Item)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Previously Characterized Area within Investigation Area (45 acres)
- Previously Investigated Area
- Historical Use Area (318.6 acres)

Notes:
HGL considers it unlikely that munitions with HE filler are present within MRS-R01.
Coordinates in South Carolina Stateplane, NAD83, feet.
HE=high explosive
MRS=munitions response site

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7/9/2015 ARW
Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

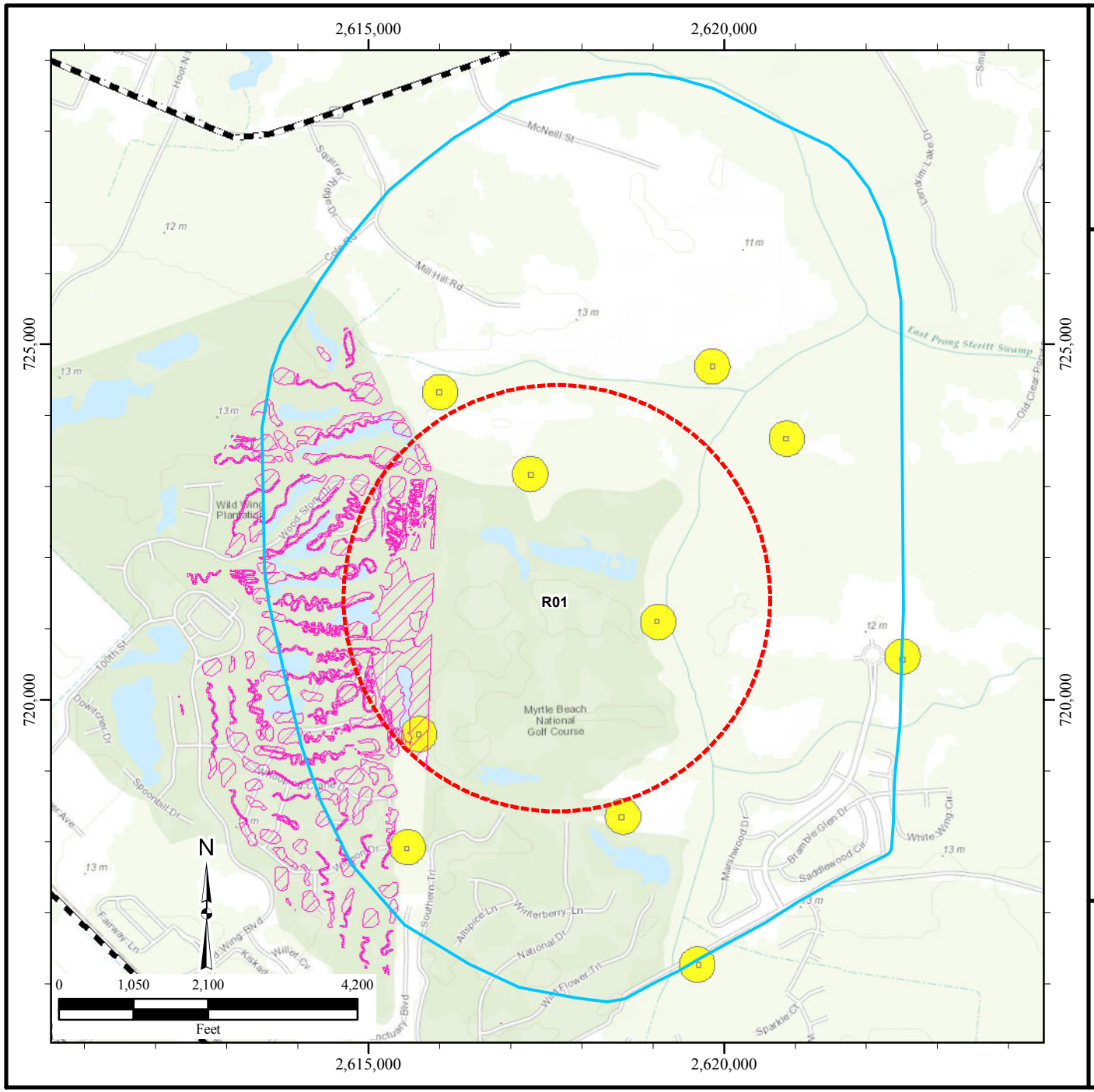

Figure B.6a
MRS-R01
Range II Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Funded by USACE

- Parsons, 2003 (Investigation)

Funded Privately

- EODT for Sun Star Subsurface 2006, (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

\\Gst-srv-01\hglgis\Conway_MSIW\WP\ (B-06a)R01_Historical_Work.mxd
4/2/2015 JP
Source: HGL, USACE, Parsons, Sun Star ArcGIS Online Topographic Imagery

HydroGeoLogic, Inc

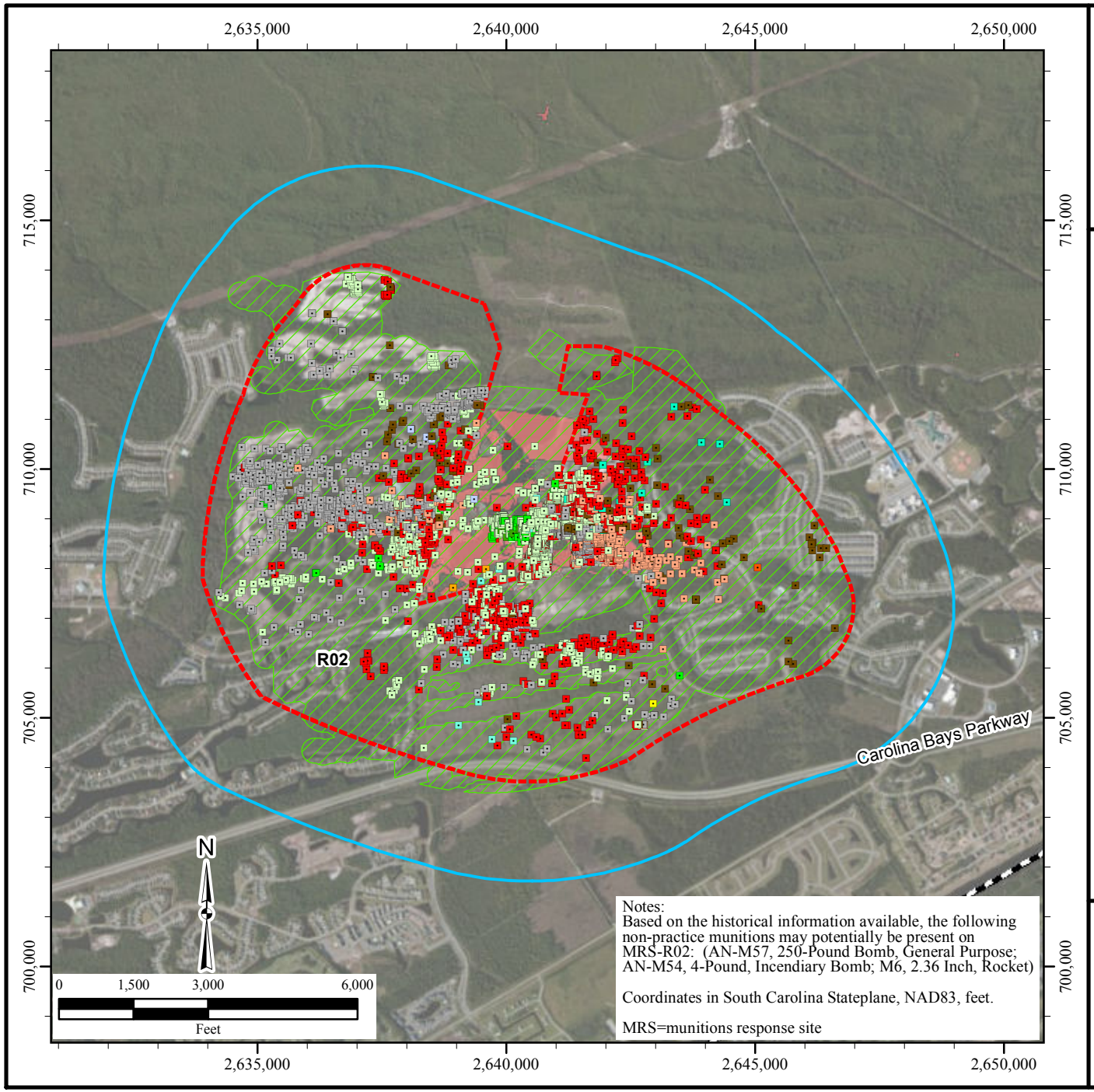

Figure B.7
MRS-R02
Range III
Historical Information and Previous Investigation

Legend

- 1.1" Projectile (4 Items)
- 100lb Bomb (1,278 Items)
- 10lb Bomb (2 Items)
- 2.25" Rocket (692 Items)
- 2.36" Rocket (3 Items)
- 2.75" Rocket (1 Item)
- 3" Rocket (1 Item)
- 20lb Bomb (156 Items)
- 250lb Bomb (17 Items)
- 37mm Projectile (31 Items)
- 4lb Bomb (3,923 Items)
- 5" Rocket (223 Items)
- 6lb Bomb (3 Items)
- Other (2,080 Items)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Previously Investigated Area (2057.6 acres)
- Historical Use Area (165.6 acres)

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4/8/2015 JP
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

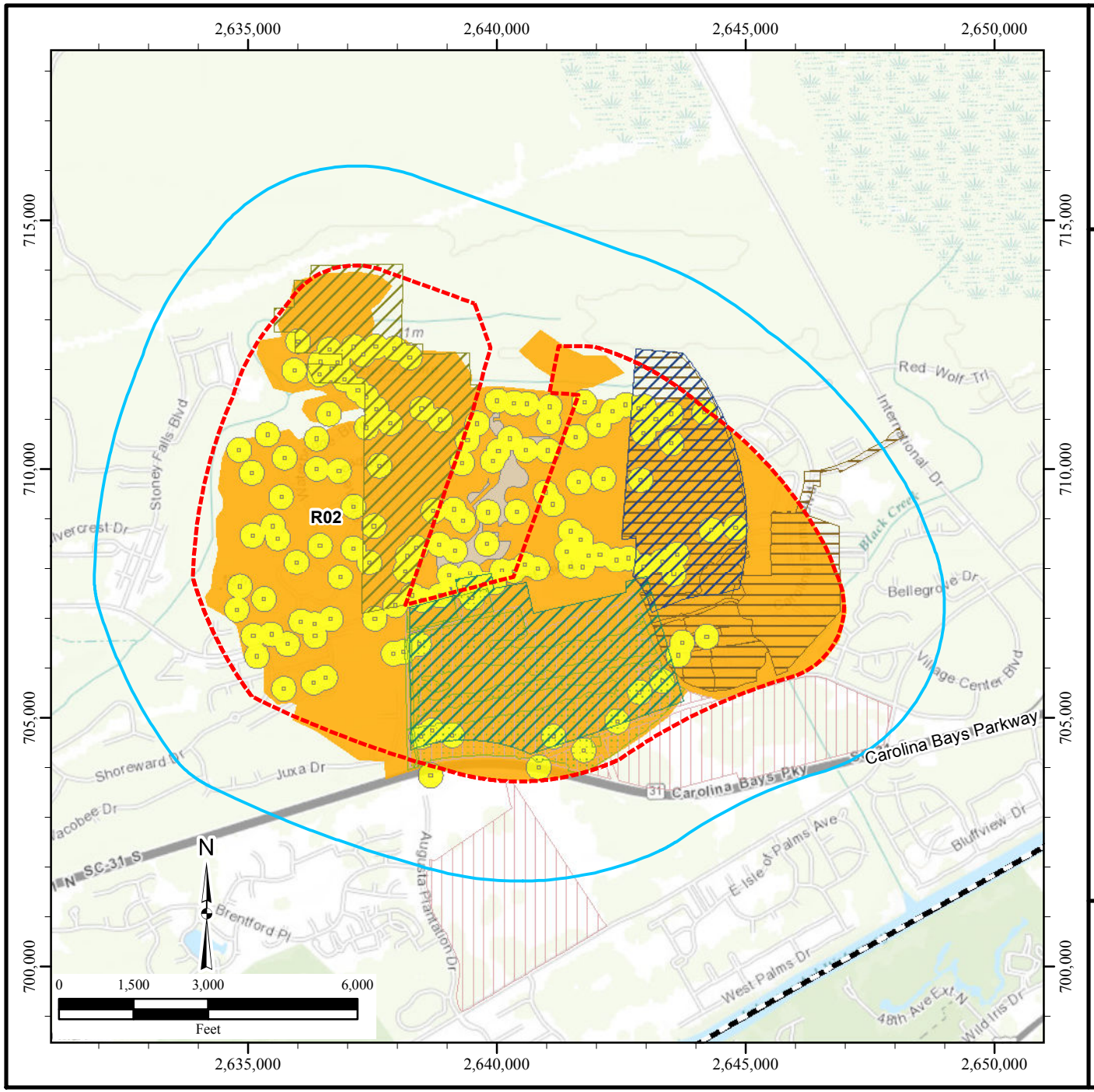

Figure B.7a
MRS-R02
Range III Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- Parsons, 2003 (Removal)
- EODT, 2012 (Investigation)

Funded Privately

- ERM for International Paper 2005, (Removal)
- Kestrel for LandBank 2006, (Removal)
- Kestrel for LandBank 2007, (Removal)
- Kestrel & Advent for Waterbridge 2009, (Removal)
- Tetra Tech for DR Horton 2006, (Removal)
- LandBank, 2001 (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
MRS=munitions response site

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4/2/2015 ARW
Source: HGL, USACE, ERM, Kestrel, Parsons, Tetra Tech ArcGIS Online Topographic Imagery

HydroGeoLogic, Inc

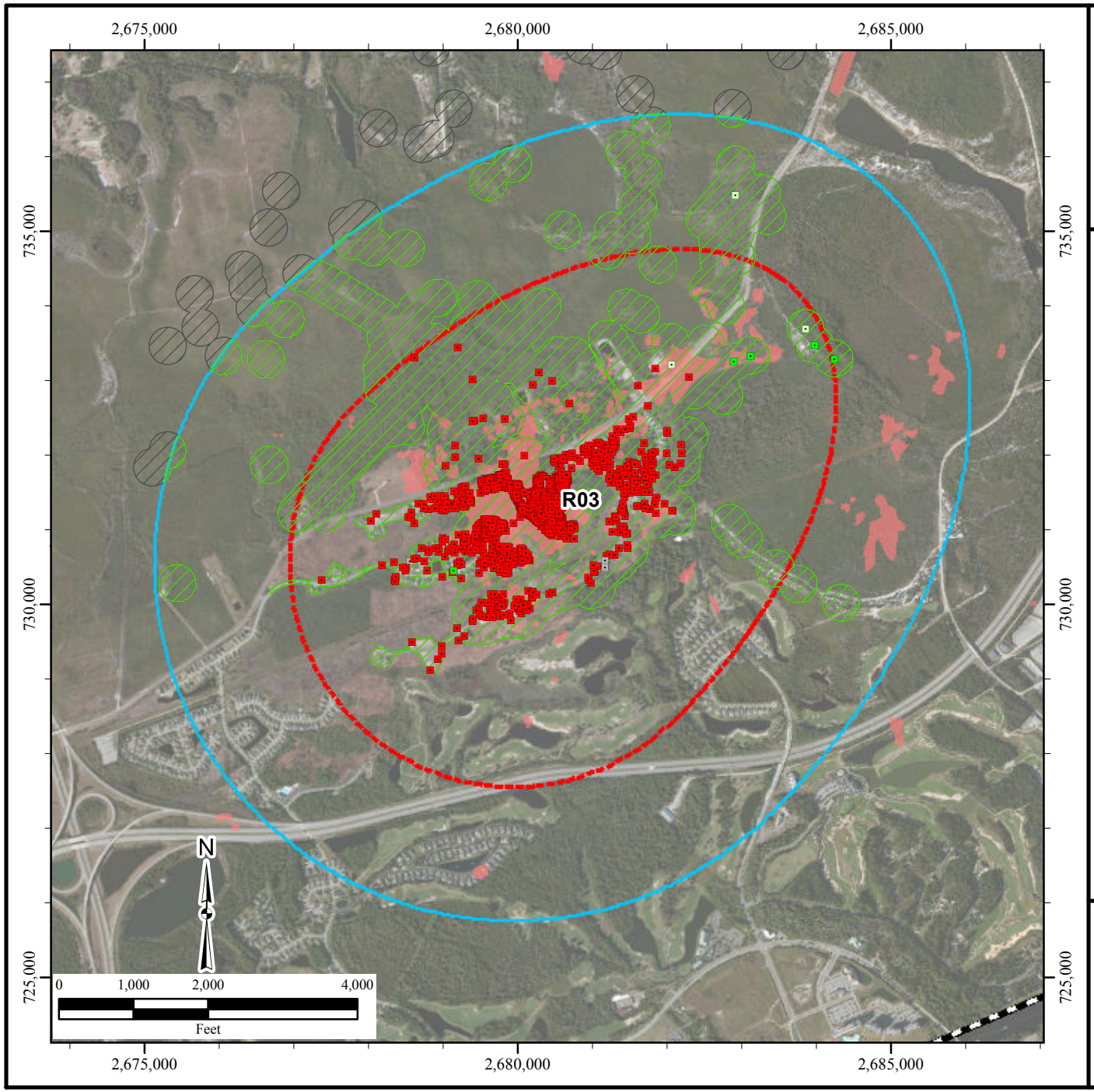

Figure B.8
MRS-R03
Range IV
Historical Information and Previous Investigation

Legend

- 100lb Bomb (1,386 Items)
- 2.75" Rocket (3 Items)
- 20lb Bomb (5 Items)
- 4lb Bomb (4 Items)
- Other (10 Items)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Previously Characterized Area within Investigation Area (570.8 acres)
- Previously Investigated Area
- Historical Use Area (103.0 acres)

Notes:
HGL considers it unlikely that munitions with HE filler are present within MRS-R03.
Coordinates in South Carolina Stateplane, NAD83, feet.
HE=high explosive
MRS=munitions response site

\\Gst-srv-01\hglgis\Conway_MSIW\WP\ (B-08)R03_Historical.mxd
4/8/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

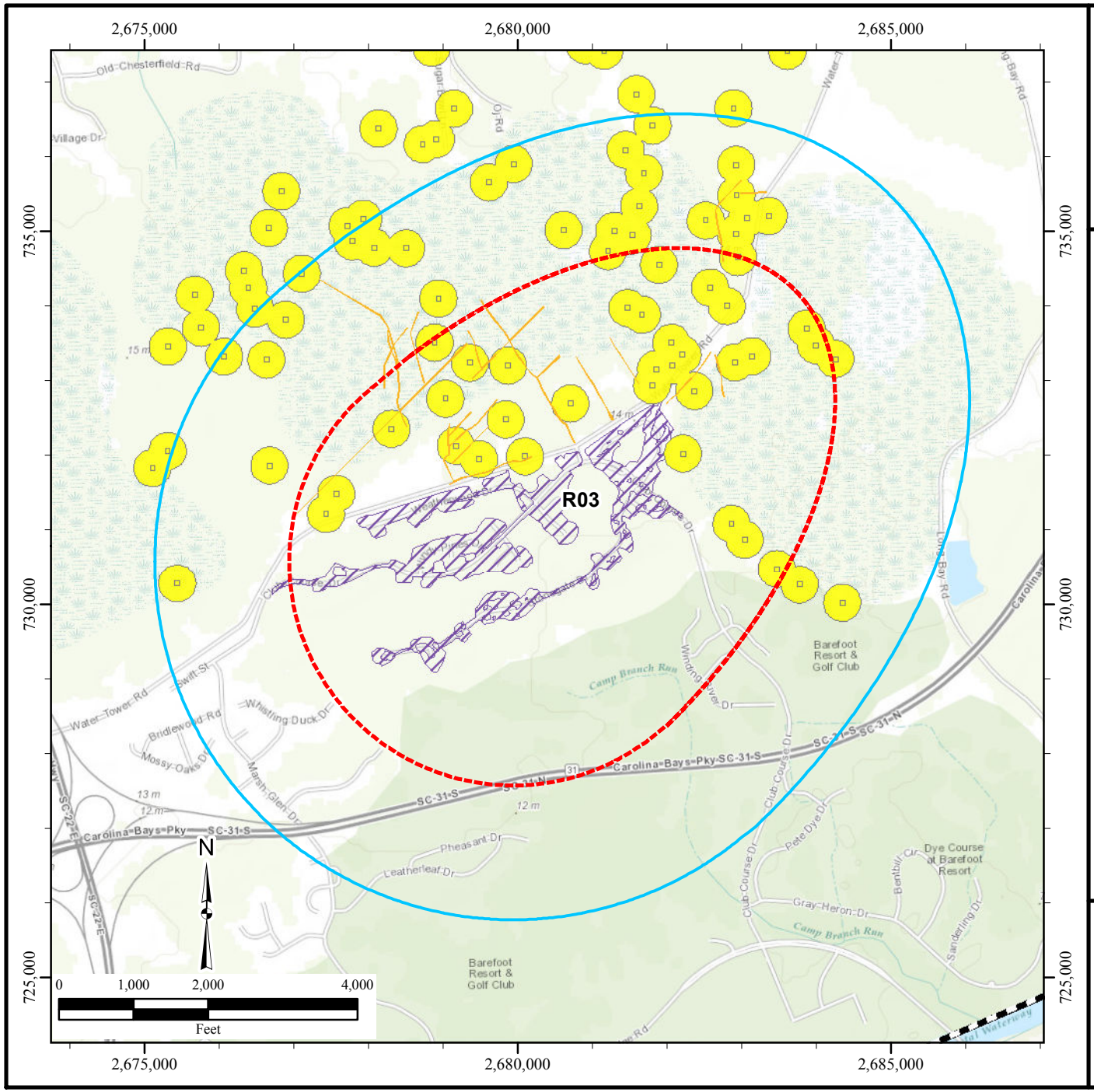

Figure B.8a
MRS-R03
Range IV Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- EODT, 2012 (Investigation)

Funded Privately

- USA Environmental for Centex 2005, (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 JP
Source: HGL, USACE, Parsons, USA Environmental, EODT ArcGIS Online Topographic Imagery

HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

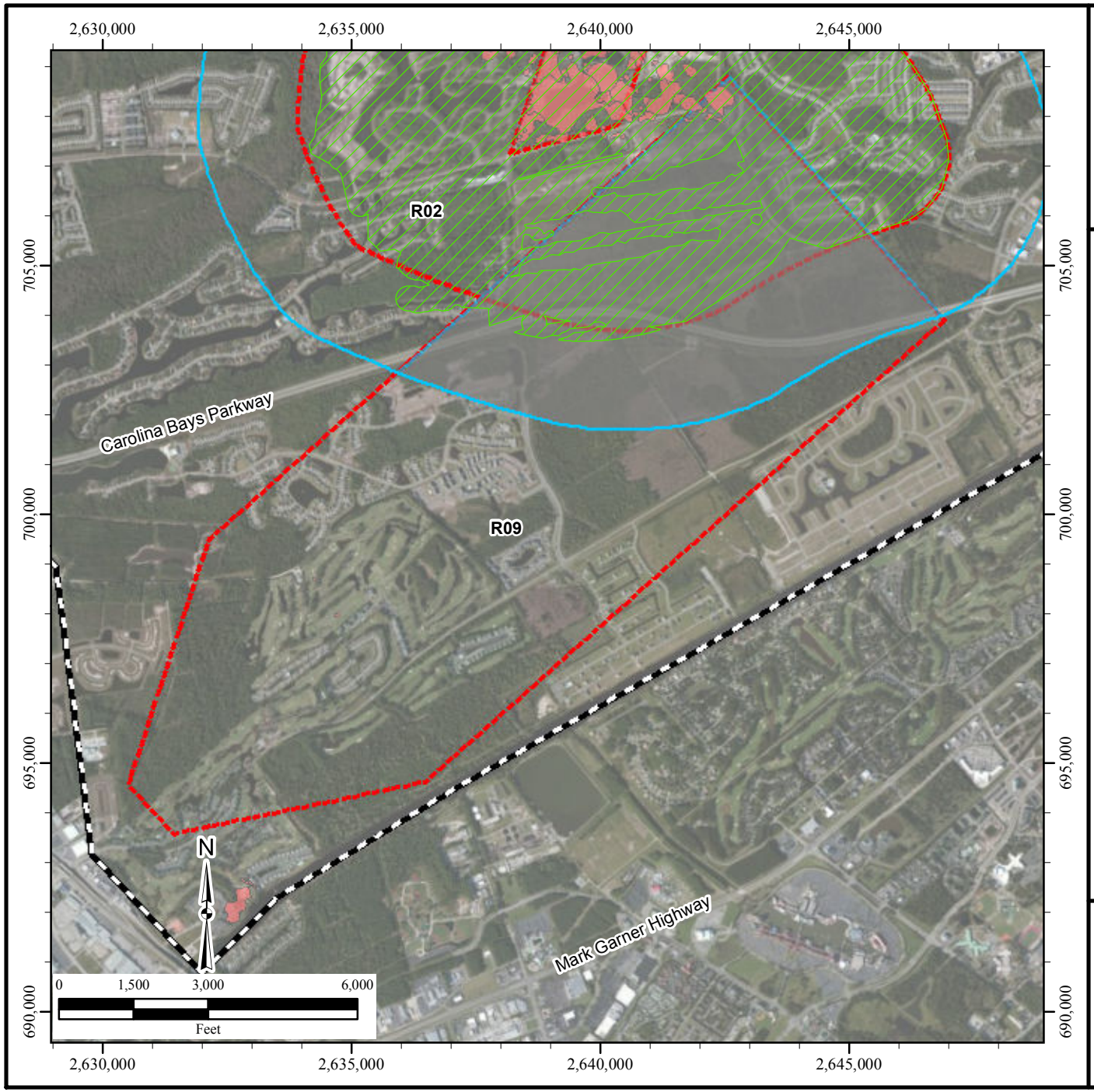


Figure B.9
MRS-R09
Machine Gun/Rifle Range
Historical Information
and Previous Investigation

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Expanded Investigation Area
- Portion Investigated under MRS-R02 (905.2 Acres)
- Previously Investigated Area
- Historical Use Area

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

\\Gst-srv-01\hglgis\Conway_MSIW\WP\ (B-09)R09_Historical.mxd
4/8/2015 CNL
Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

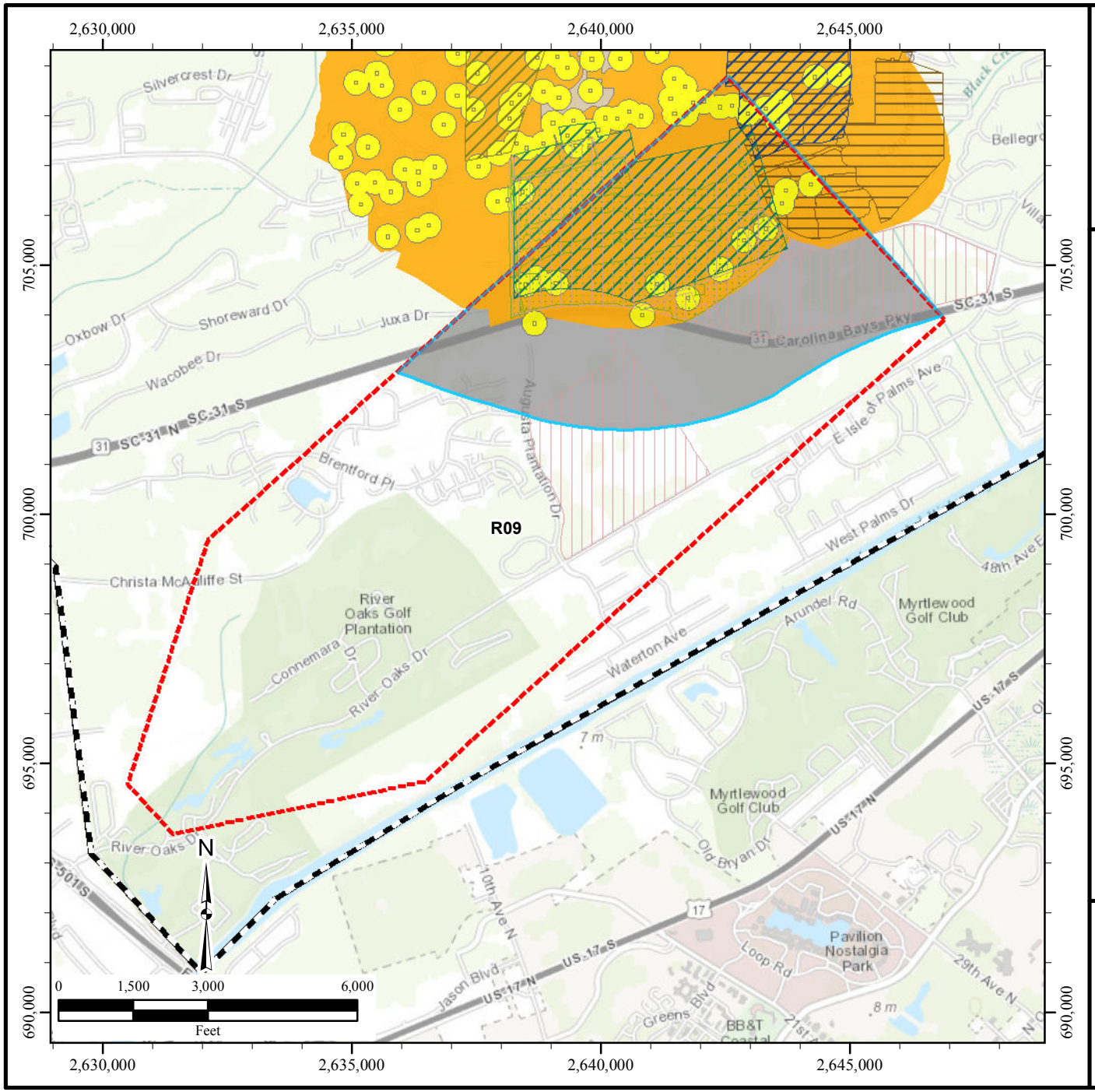


Figure B.9a
MRS-R09
Machine Gun/Rifle Range
Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- Parsons, 2003 (Removal)
- EODT, 2012 (Investigation)

Funded Privately

- ERM, 2005 (Removal)
- Kestrel, 2006 (Removal)
- Kestrel, 2007 (Removal)
- Kestrel, 2009 Advent, 2009 (Removal)
- Tetra Tech, 2006 (Removal)
- Landbank, 2001 (Removal)
- Sweet 16, LLC (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
MRS=munitions response site

\\Gst-srv-01\hglgis\Conway_MSIW\WP\(B-09a)R09_Historical_Work.mxd
4/2/2015 JP
Source: HGL, USACE, Parsons, ERM, Kestrel, Tetra Tech ArcGIS Online Topographic Imagery

HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

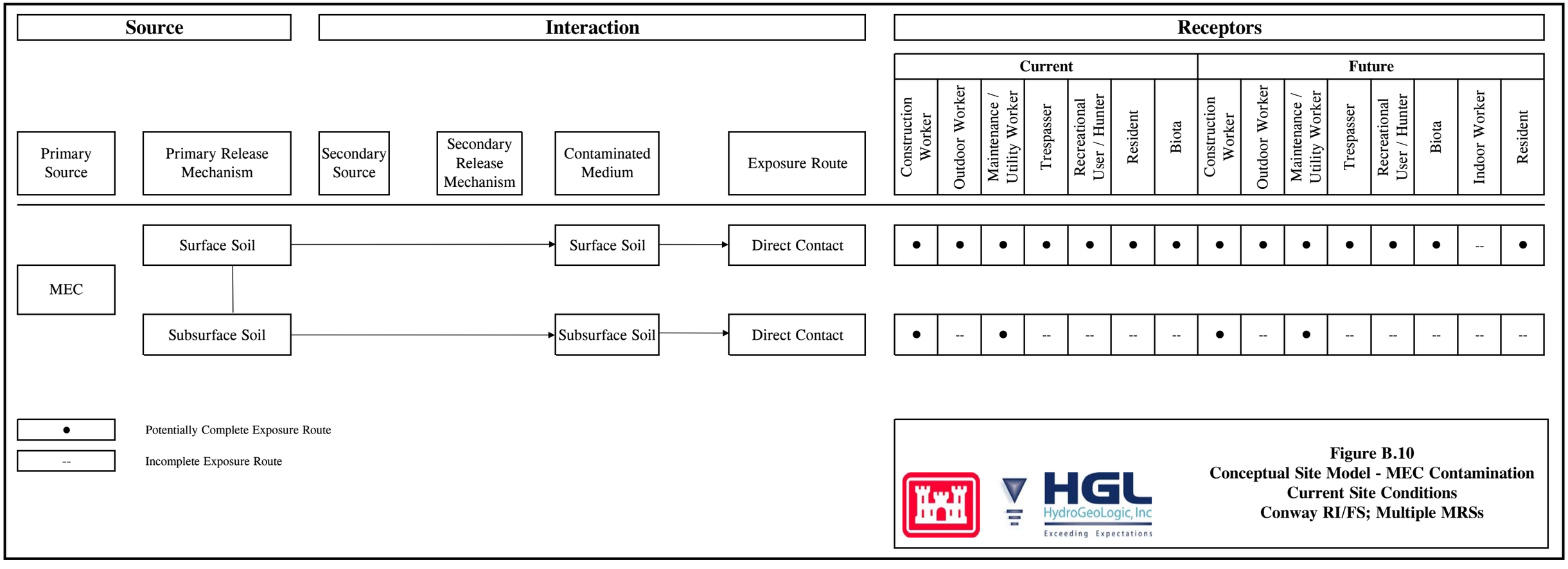


Figure B.10
Conceptual Site Model - MEC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

Source		Interaction				Receptors													
						Current							Future						
Primary Source	Primary Release Mechanism	Secondary Source	Secondary Release Mechanism	Contaminated Medium	Exposure Route	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Resident	Biota	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Biota	Indoor Worker	Resident
MC (from MEC presence)	Erosion and Stormwater Runoff			Surface Soil	Incidental Ingestion	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
					Dermal Contact	●	●	●	●	●	●	--	●	●	●	●	●	--	--	●
				Sediment	Incidental Ingestion	--	--	--	●	●	●	●	--	--	--	●	●	●	--	●
					Dermal Contact	--	--	--	●	●	●	--	--	--	--	●	●	--	--	●
		Surface Soil	Bioaccumulation	Vegetation/Prey	Ingestion	--	--	--	--	●	●	●	--	--	--	--	●	●	--	●
		Surface Soil	Dust Emissions	Ambient Air	Inhalation	●	●	●	●	●	●	--	●	●	●	●	●	--	●	●
		Subsurface Soil		Subsurface Soil	Incidental Ingestion	●	--	●	--	--	--	--	●	--	●	--	--	--	--	--
					Dermal Contact	●	--	●	--	--	--	--	●	--	●	--	--	--	--	--
	Leaching			Groundwater	Ingestion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Dermal Contact	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Inhalation while Showering	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Direct Contact[1]	--	--	--	--	--	--	●	--	--	--	--	--	●	--	--

● Potentially Complete Exposure Route

-- Incomplete Exposure Route

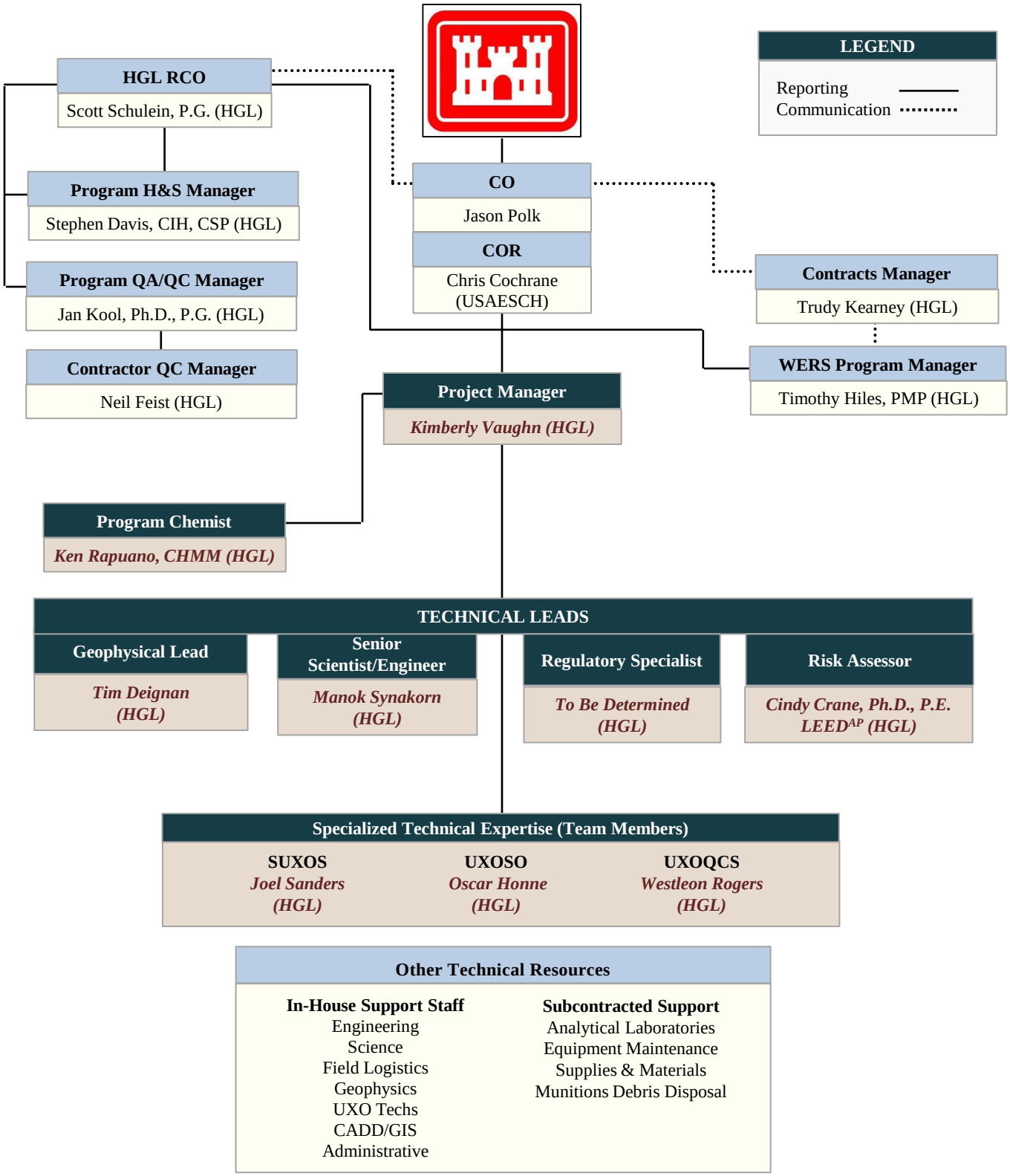
Note: The composition of future surface soil (surface soil data or pooled surface/subsurface soil data) will be determined after evaluation of the soil data.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

HydroGeoLogic, Inc
Exceeding Expectations

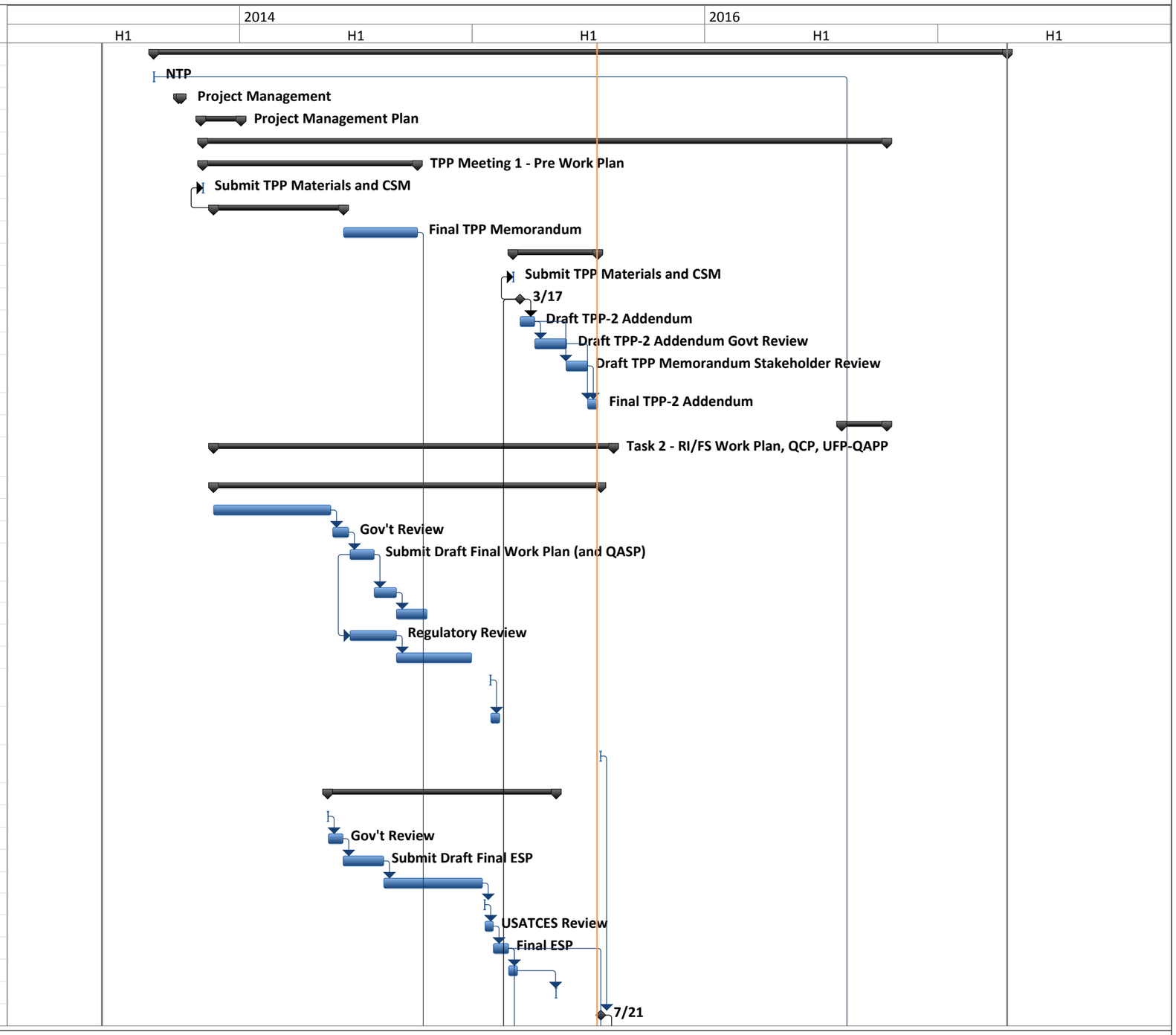
Figure B.11
Conceptual Site Model - MC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

Figure B.12 Organizational Chart



Conway Bombing and Gunnery Range RI/FS

ID	Task Name	Duration	Start	Finish
1	**Conway BGR RI/FS**	**935 days**	**Mon 8/19/13**	**Wed 4/19/17**
2	NTP	1 day	Mon 8/19/13	Mon 8/19/13
3	**Project Management**	**2 days**	**Fri 9/27/13**	**Mon 9/30/13**
8	**Project Management Plan**	**42 days**	**Fri 11/1/13**	**Thu 1/2/14**
12	**Task 1 - Technical Project Planning**	**747 days**	**Mon 11/4/13**	**Wed 10/12/16**
13	**TPP Meeting 1 - Pre Work Plan**	**232 days**	**Mon 11/4/13**	**Mon 10/6/14**
14	Submit TPP Materials and CSM	1 day	Mon 11/4/13	Mon 11/4/13
15	**TPP Meeting 1**	**140 days**	**Thu 11/21/13**	**Thu 6/12/14**
19	***Final TPP Memorandum***	80 days	Fri 6/13/14	Mon 10/6/14
20	**TPP Meeting 2 - Finalize Work Plan**	**94 days**	**Fri 3/6/15**	**Thu 7/16/15**
21	Submit TPP Materials and CSM	1 day	Fri 3/6/15	Fri 3/6/15
22	TPP Meeting 2	0 days	Tue 3/17/15	Tue 3/17/15
23	Draft TPP-2 Addendum	17 days	Tue 3/17/15	Wed 4/8/15
24	Draft TPP-2 Addendum Govt Review	35 days	Thu 4/9/15	Thu 5/28/15
25	Draft TPP Memorandum Stakeholder Review	24 days	Thu 5/28/15	Tue 6/30/15
26	***Final TPP-2 Addendum***	12 days	Wed 7/1/15	Thu 7/16/15
27	**TPP Meeting 3 - finalize RI**	**51 days**	**Wed 8/3/16**	**Wed 10/12/16**
34	**Task 2 - RI/FS Work Plan, QCP, UFP-QAPP**	**433 days**	**Thu 11/21/13**	**Mon 8/10/15**
35	**Draft Work Plan**	**419 days**	**Thu 11/21/13**	**Tue 7/21/15**
36	Draft Submittal	127 days	Thu 11/21/13	Fri 5/23/14
37	Gov't Review	19 days	Tue 5/27/14	Fri 6/20/14
38	Submit Draft Final Work Plan (and QASP)	27 days	Mon 6/23/14	Wed 7/30/14
39	Gov't Backcheck comments	24 days	Thu 7/31/14	Wed 9/3/14
40	Responses to Backcheck review	33 days	Thu 9/4/14	Tue 10/21/14
41	Regulatory Review	51 days	Mon 6/23/14	Wed 9/3/14
42	Responses to Regulator Comments	80 days	Thu 9/4/14	Tue 12/30/14
43	Additional USAESCH Backcheck Comments	1 day	Thu 1/29/15	Thu 1/29/15
44	RTCs and Draft Final Work Plan (Revised)	10 days	Fri 1/30/15	Thu 2/12/15
45	Final Work Plan (Incorporated TPP-2 Memorandum Revisions)	1 day	Tue 7/21/15	Tue 7/21/15
46	**Draft Explosive Site Plan (ESP)**	**248 days**	**Mon 5/19/14**	**Tue 5/12/15**
47	Draft Submittal	1 day	Mon 5/19/14	Mon 5/19/14
48	Gov't Review	16 days	Tue 5/20/14	Wed 6/11/14
49	Submit Draft Final ESP	45 days	Thu 6/12/14	Thu 8/14/14
50	Gov't Backcheck to ESP comments	105 days	Fri 8/15/14	Fri 1/16/15
51	Responses to ESP Backcheck review	1 day	Tue 1/20/15	Tue 1/20/15
52	USATCES Review	9 days	Wed 1/21/15	Mon 2/2/15
53	Final ESP	18 days	Tue 2/3/15	Thu 2/26/15
54	USATCES backcheck comments	10 days	Fri 2/27/15	Thu 3/12/15
55	DDESB Approval Memorandum	1 day	Tue 5/12/15	Tue 5/12/15
56	***Final Work Plan***	0 days	Tue 7/21/15	Tue 7/21/15

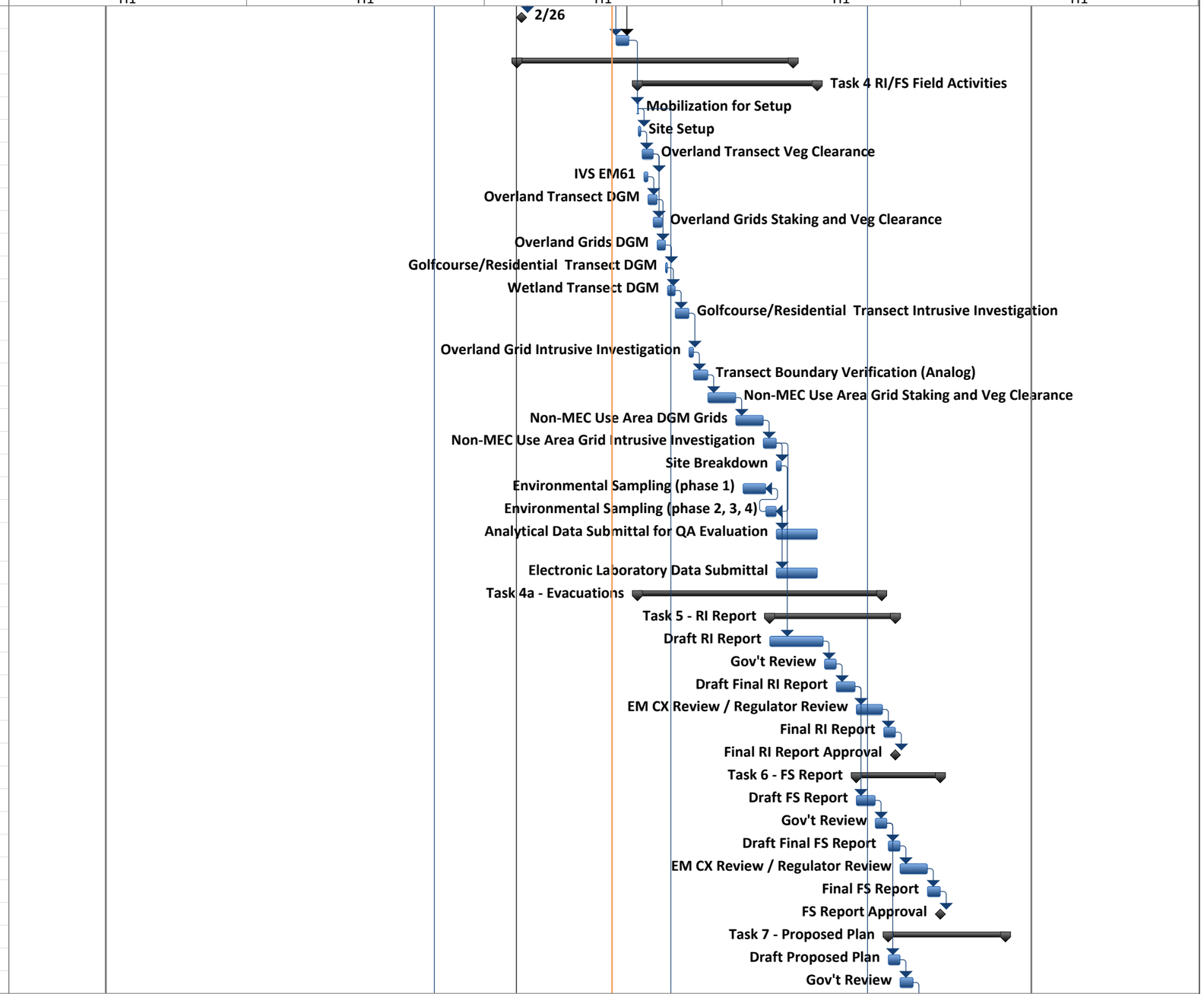


Date: Thu 7/16/15 | Task | Split | Milestone | Summary

Proposed Milestones

Conway Bombing and Gunnery Range RI/FS

ID	Task Name	Duration	Start	Finish
57	*Final Explosive Siting Plan*	0 days	Thu 2/26/15	Thu 2/26/15
58	NTP, Plan Approvals	14 days	Wed 7/22/15	Mon 8/10/15
59	**Task 3 - GIS**	**296 days**	**Fri 2/20/15**	**Mon 4/18/16**
65	**Task 4 RI/FS Field Activities**	**193 days**	**Mon 8/24/15**	**Wed 5/25/16**
66	Mobilization for Setup	1 day	Mon 8/24/15	Mon 8/24/15
67	Site Setup	4 days	Tue 8/25/15	Fri 8/28/15
68	Overland Transect Veg Clearance	12 days	Mon 8/31/15	Wed 9/16/15
69	IVS EM61	3 days	Thu 9/3/15	Tue 9/8/15
70	Overland Transect DGM	10 days	Wed 9/9/15	Tue 9/22/15
71	Overland Grids Staking and Veg Clearanc	10 days	Thu 9/17/15	Wed 9/30/15
72	Overland Grids DGM	9 days	Wed 9/23/15	Mon 10/5/15
73	Golfcourse/Residential Transect DGM	3 days	Tue 10/6/15	Thu 10/8/15
74	Wetland Transect DGM	7 days	Fri 10/9/15	Tue 10/20/15
75	Golfcourse/Residential Transect Intrusive Investigation	15 days	Wed 10/21/15	Tue 11/10/15
76	Overland Grid Intrusive Investigation	4 days	Wed 11/11/15	Tue 11/17/15
77	Transect Boundary Verification (Analog)	15 days	Wed 11/18/15	Wed 12/9/15
78	Non-MEC Use Area Grid Staking and Veg	30 days	Thu 12/10/15	Thu 1/21/16
79	Non-MEC Use Area DGM Grids	30 days	Fri 1/22/16	Thu 3/3/16
80	Non-MEC Use Area Grid Intrusive Investi	14 days	Fri 3/4/16	Wed 3/23/16
81	Site Breakdown	6 days	Thu 3/24/16	Thu 3/31/16
82	Environmental Sampling (phase 1)	25 days	Tue 2/2/16	Tue 3/8/16
83	Environmental Sampling (phase 2, 3, 4)	12 days	Tue 3/8/16	Wed 3/23/16
84	Analytical Data Submittal for QA Evaluation	45 days	Thu 3/24/16	Wed 5/25/16
85	Electronic Laboratory Data Submittal	45 days	Thu 3/24/16	Wed 5/25/16
86	**Task 4a - Evacuations**	**264 days**	**Mon 8/24/15**	**Thu 9/1/16**
89	**Task 5 - RI Report**	**139 days**	**Mon 3/14/16**	**Thu 9/22/16**
90	Draft RI Report	60 days	Mon 3/14/16	Fri 6/3/16
91	Gov't Review	14 days	Mon 6/6/16	Thu 6/23/16
92	Draft Final RI Report	21 days	Fri 6/24/16	Fri 7/22/16
93	EM CX Review / Regulator Review	30 days	Mon 7/25/16	Fri 9/2/16
94	Final RI Report	14 days	Mon 9/5/16	Thu 9/22/16
95	*Final RI Report Approval*	0 days	Thu 9/22/16	Thu 9/22/16
96	**Task 6 - FS Report**	**93 days**	**Mon 7/25/16**	**Wed 11/30/16**
97	Draft FS Report	21 days	Mon 7/25/16	Mon 8/22/16
98	Gov't Review	14 days	Tue 8/23/16	Fri 9/9/16
99	Draft Final FS Report	14 days	Mon 9/12/16	Thu 9/29/16
100	EM CX Review / Regulator Review	30 days	Fri 9/30/16	Thu 11/10/16
101	Final FS Report	14 days	Fri 11/11/16	Wed 11/30/16
102	*FS Report Approval*	0 days	Wed 11/30/16	Wed 11/30/16
103	**Task 7 - Proposed Plan**	**130 days**	**Mon 9/12/16**	**Fri 3/10/17**
104	Draft Proposed Plan	14 days	Mon 9/12/16	Thu 9/29/16
105	Gov't Review	14 days	Fri 9/30/16	Wed 10/19/16

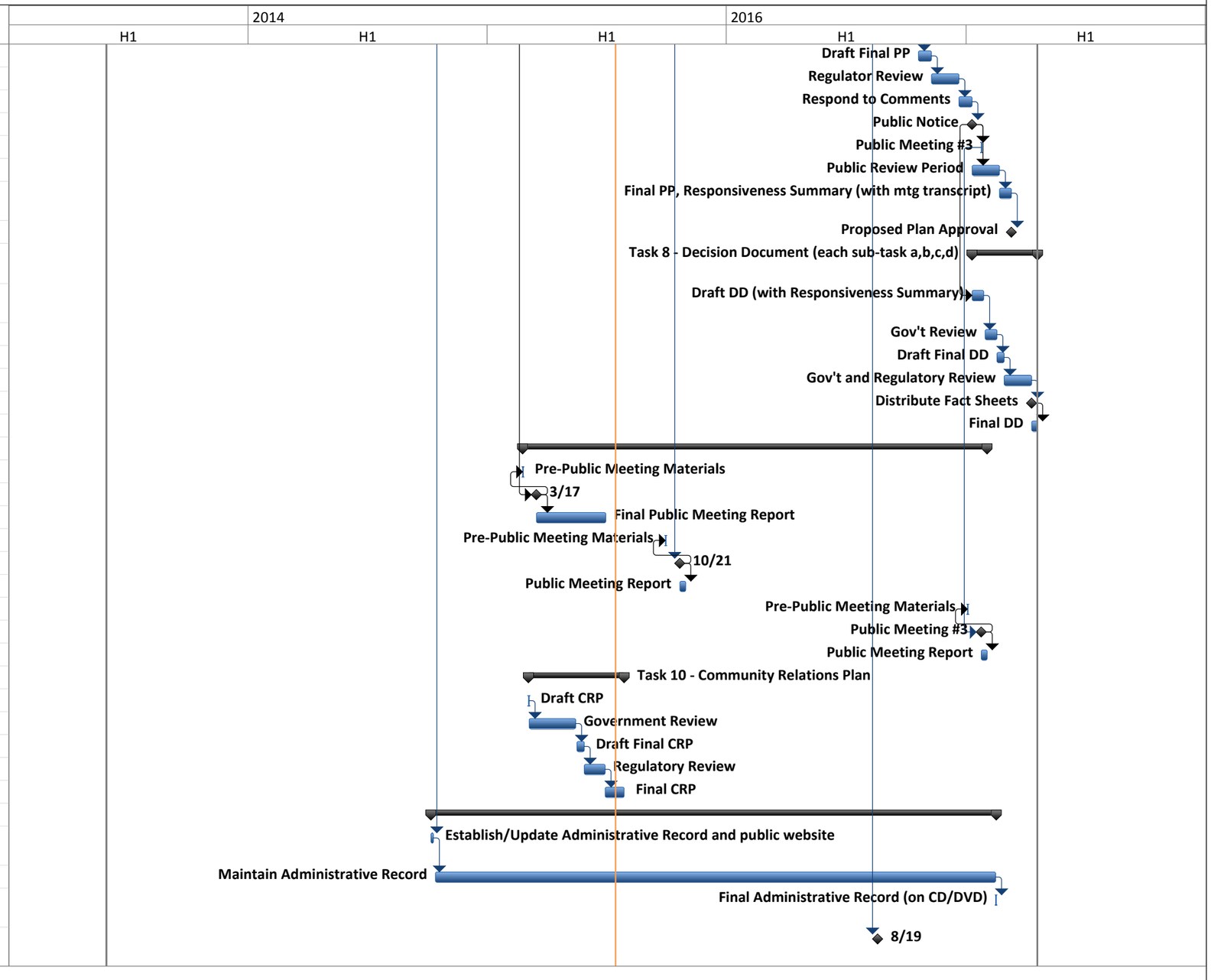


Date: Thu 7/16/15 | Task | Split | Milestone | Summary

Proposed Milestones

Conway Bombing and Gunnery Range RI/FS

ID	Task Name	Duration	Start	Finish
106	Draft Final PP	14 days	Thu 10/20/16	Tue 11/8/16
107	Regulator Review	30 days	Wed 11/9/16	Tue 12/20/16
108	Respond to Comments	14 days	Wed 12/21/16	Mon 1/9/17
109	Public Notice	0 days	Mon 1/9/17	Mon 1/9/17
110	Public Meeting #3	1 day	Tue 1/24/17	Tue 1/24/17
111	Public Review Period	30 days	Tue 1/10/17	Mon 2/20/17
112	Final PP, Responsiveness Summary (with mtg transcript)	14 days	Tue 2/21/17	Fri 3/10/17
113	*Proposed Plan Approval*	0 days	Fri 3/10/17	Fri 3/10/17
114	**Task 8 - Decision Document (each sub-task a,b,c,d)**	**72 days**	**Tue 1/10/17**	**Wed 4/19/17**
115	Draft DD (with Responsiveness Summary)	14 days	Tue 1/10/17	Fri 1/27/17
116	Gov't Review	14 days	Mon 1/30/17	Thu 2/16/17
117	Draft Final DD	7 days	Fri 2/17/17	Mon 2/27/17
118	Gov't and Regulatory Review	30 days	Tue 2/28/17	Mon 4/10/17
119	Distribute Fact Sheets	0 days	Mon 4/10/17	Mon 4/10/17
120	*Final DD*	7 days	Tue 4/11/17	Wed 4/19/17
121	**Task 9 - Community Relations Support**	**501 days**	**Tue 2/24/15**	**Wed 2/1/17**
122	Pre-Public Meeting Materials	1 day	Tue 2/24/15	Tue 2/24/15
123	**Public Meeting #1**	0 days	Tue 3/17/15	Tue 3/17/15
124	*Final Public Meeting Report*	75 days	Tue 3/17/15	Tue 6/30/15
125	Pre-Public Meeting Materials	1 day	Wed 9/30/15	Wed 9/30/15
126	**Public Meeting #2**	0 days	Wed 10/21/15	Wed 10/21/15
127	*Public Meeting Report*	7 days	Thu 10/22/15	Fri 10/30/15
128	Pre-Public Meeting Materials	1 day	Tue 1/3/17	Tue 1/3/17
129	**Public Meeting #3**	0 days	Tue 1/24/17	Tue 1/24/17
130	*Public Meeting Report*	7 days	Tue 1/24/17	Wed 2/1/17
131	**Task 10 - Community Relations Plan**	**103 days**	**Thu 3/5/15**	**Tue 7/28/15**
132	Draft CRP	1 day	Thu 3/5/15	Thu 3/5/15
133	Government Review	51 days	Fri 3/6/15	Fri 5/15/15
134	Draft Final CRP	8 days	Mon 5/18/15	Thu 5/28/15
135	Regulatory Review	22 days	Fri 5/29/15	Mon 6/29/15
136	*Final CRP*	21 days	Tue 6/30/15	Tue 7/28/15
137	**Task 11 - Administrative Record**	**605 days**	**Tue 10/7/14**	**Wed 2/15/17**
138	Establish/Update Administrative Record and public website	4 days	Tue 10/7/14	Fri 10/10/14
139	Maintain Administrative Record	30 mons	Tue 10/14/14	Tue 2/14/17
140	Final Administrative Record (on CD/DVD)	1 day	Wed 2/15/17	Wed 2/15/17
141	Period of Performance End (36 months NTP)	0 days	Fri 8/19/16	Fri 8/19/16

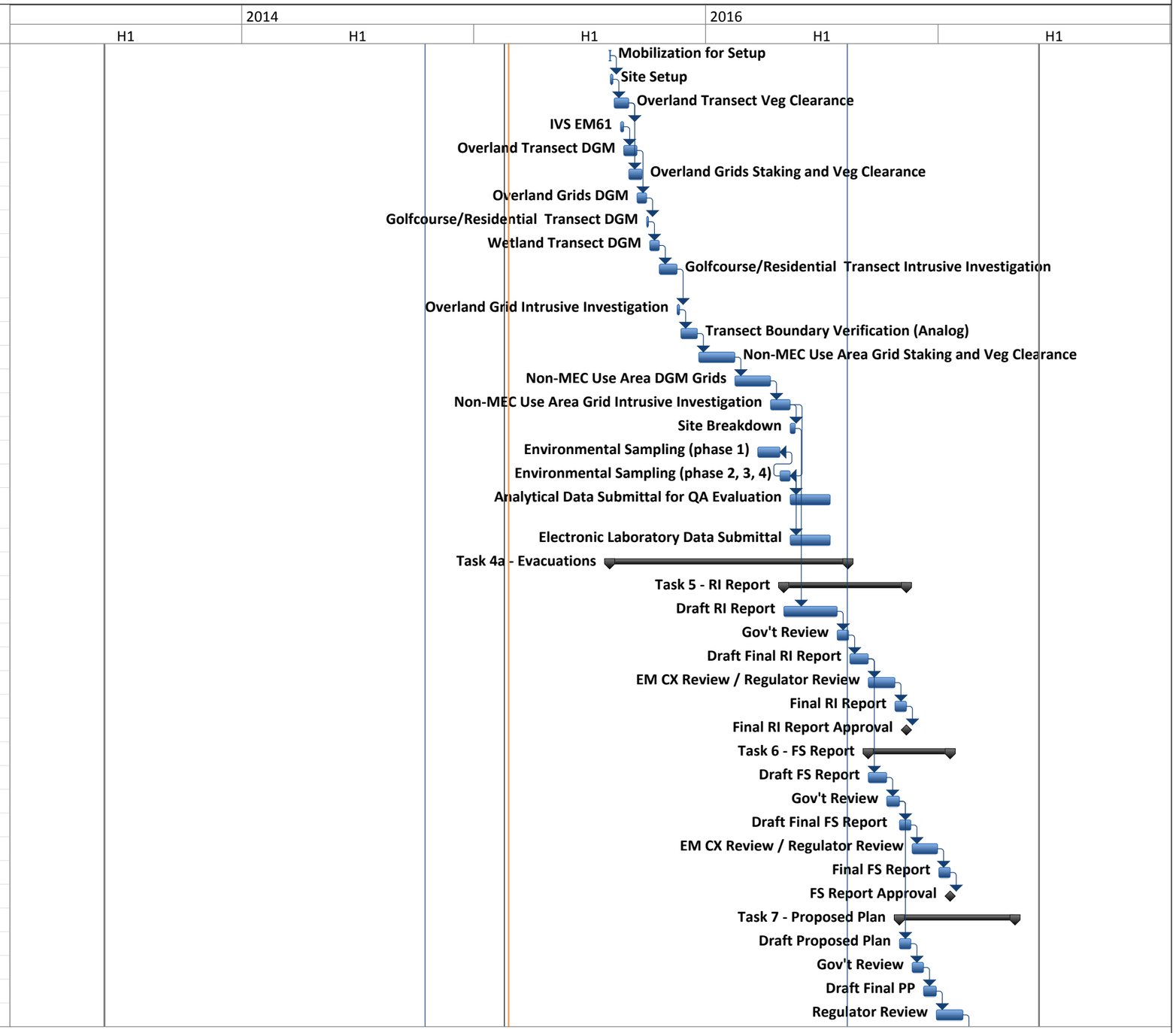


Date: Thu 7/16/15 | Task | Split | Milestone | Summary

Proposed Milestones

Conway Bombing and Gunnery Range RI/FS

ID	Task Name	Duration	Start	Finish
61	Mobilization for Setup	1 day	Mon 8/3/15	Mon 8/3/15
62	Site Setup	4 days	Tue 8/4/15	Fri 8/7/15
63	Overland Transect Veg Clearance	17 days	Mon 8/10/15	Tue 9/1/15
64	IVS EM61	3 days	Thu 8/20/15	Mon 8/24/15
65	Overland Transect DGM	14 days	Tue 8/25/15	Mon 9/14/15
66	Overland Grids Staking and Veg Clearanc	14 days	Wed 9/2/15	Tue 9/22/15
67	Overland Grids DGM	11 days	Tue 9/15/15	Tue 9/29/15
68	Golfcourse/Residential Transect DGM	3 days	Wed 9/30/15	Fri 10/2/15
69	Wetland Transect DGM	10 days	Mon 10/5/15	Mon 10/19/15
70	Golfcourse/Residential Transect Intrusive Investigation	19 days	Tue 10/20/15	Mon 11/16/15
71	Overland Grid Intrusive Investigation	4 days	Tue 11/17/15	Fri 11/20/15
72	Transect Boundary Verification (Analog)	19 days	Mon 11/23/15	Fri 12/18/15
73	Non-MEC Use Area Grid Staking and Veg	40 days	Mon 12/21/15	Mon 2/15/16
74	Non-MEC Use Area DGM Grids	40 days	Tue 2/16/16	Mon 4/11/16
75	Non-MEC Use Area Grid Intrusive Investi	23 days	Tue 4/12/16	Thu 5/12/16
76	Site Breakdown	6 days	Fri 5/13/16	Fri 5/20/16
77	Environmental Sampling (phase 1)	25 days	Wed 3/23/16	Wed 4/27/16
78	Environmental Sampling (phase 2, 3, 4)	12 days	Wed 4/27/16	Thu 5/12/16
79	Analytical Data Submittal for QA Evaluation	45 days	Fri 5/13/16	Thu 7/14/16
80	Electronic Laboratory Data Submittal	45 days	Fri 5/13/16	Thu 7/14/16
81	**Task 4a - Evacuations**	**264 days**	**Mon 8/3/15**	**Thu 8/11/16**
84	**Task 5 - RI Report**	**139 days**	**Tue 5/3/16**	**Fri 11/11/16**
85	Draft RI Report	60 days	Tue 5/3/16	Mon 7/25/16
86	Gov't Review	14 days	Tue 7/26/16	Fri 8/12/16
87	Draft Final RI Report	21 days	Mon 8/15/16	Mon 9/12/16
88	EM CX Review / Regulator Review	30 days	Tue 9/13/16	Mon 10/24/16
89	Final RI Report	14 days	Tue 10/25/16	Fri 11/11/16
90	*Final RI Report Approval*	0 days	Fri 11/11/16	Fri 11/11/16
91	**Task 6 - FS Report**	**93 days**	**Tue 9/13/16**	**Thu 1/19/17**
92	Draft FS Report	21 days	Tue 9/13/16	Tue 10/11/16
93	Gov't Review	14 days	Wed 10/12/16	Mon 10/31/16
94	Draft Final FS Report	14 days	Tue 11/1/16	Fri 11/18/16
95	EM CX Review / Regulator Review	30 days	Mon 11/21/16	Fri 12/30/16
96	Final FS Report	14 days	Mon 1/2/17	Thu 1/19/17
97	*FS Report Approval*	0 days	Thu 1/19/17	Thu 1/19/17
98	**Task 7 - Proposed Plan**	**130 days**	**Tue 11/1/16**	**Mon 5/1/17**
99	Draft Proposed Plan	14 days	Tue 11/1/16	Fri 11/18/16
100	Gov't Review	14 days	Mon 11/21/16	Thu 12/8/16
101	Draft Final PP	14 days	Fri 12/9/16	Wed 12/28/16
102	Regulator Review	30 days	Thu 12/29/16	Wed 2/8/17



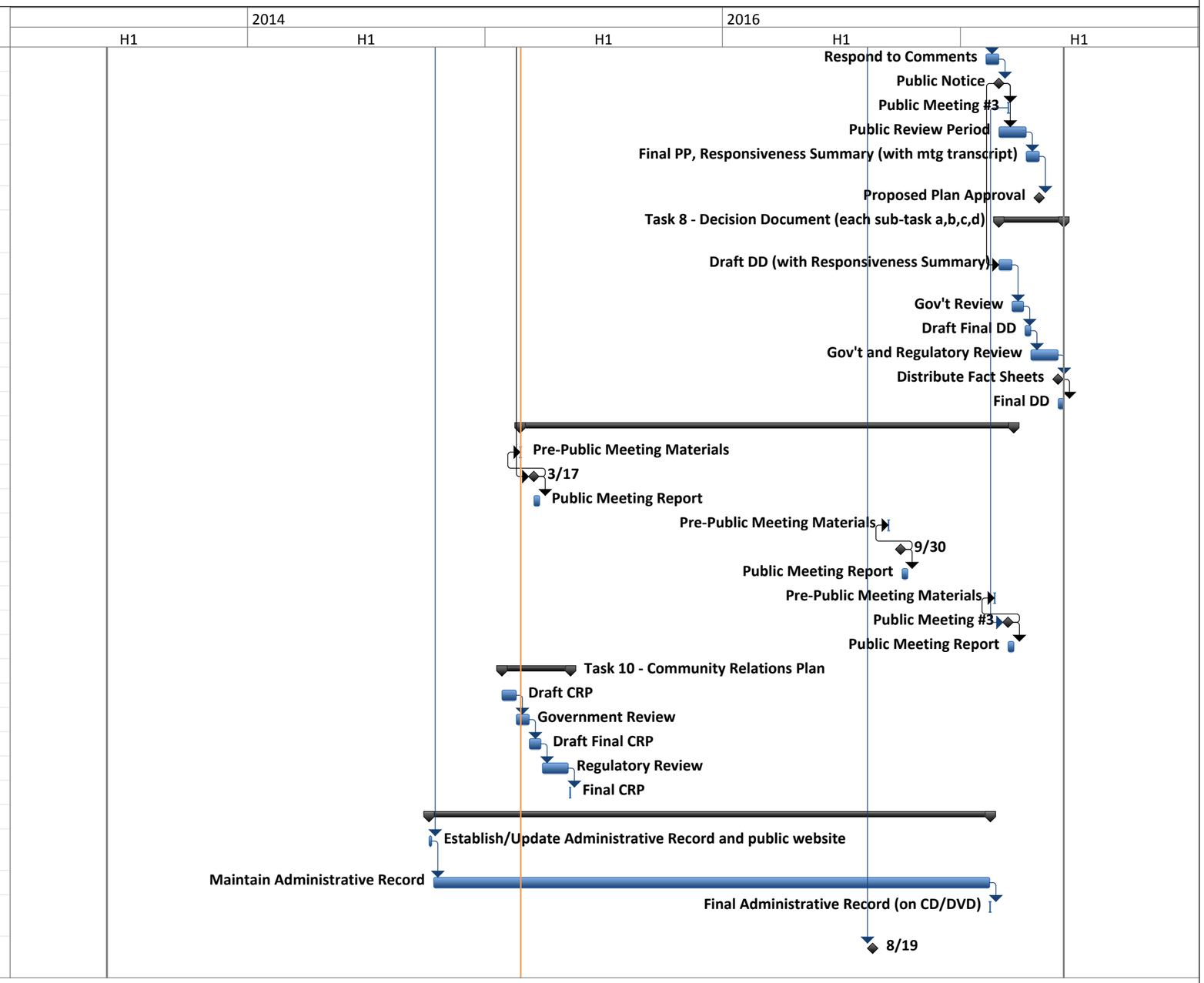
Date: Wed 2/25/15 | Task | Split | Milestone ◆ | Summary

Proposed Milestones

Page 2

Conway Bombing and Gunnery Range RI/FS

ID	Task Name	Duration	Start	Finish
103	Respond to Comments	14 days	Thu 2/9/17	Tue 2/28/17
104	Public Notice	0 days	Tue 2/28/17	Tue 2/28/17
105	Public Meeting #3	1 day	Wed 3/15/17	Wed 3/15/17
106	Public Review Period	30 days	Wed 3/1/17	Tue 4/11/17
107	Final PP, Responsiveness Summary (with mtg transcript)	14 days	Wed 4/12/17	Mon 5/1/17
108	*Proposed Plan Approval*	0 days	Mon 5/1/17	Mon 5/1/17
109	**Task 8 - Decision Document (each sub-task a,b,c,d)**	**72 days**	**Wed 3/1/17**	**Thu 6/8/17**
110	Draft DD (with Responsiveness Summary)	14 days	Wed 3/1/17	Mon 3/20/17
111	Gov't Review	14 days	Tue 3/21/17	Fri 4/7/17
112	Draft Final DD	7 days	Mon 4/10/17	Tue 4/18/17
113	Gov't and Regulatory Review	30 days	Wed 4/19/17	Tue 5/30/17
114	Distribute Fact Sheets	0 days	Tue 5/30/17	Tue 5/30/17
115	*Final DD*	7 days	Wed 5/31/17	Thu 6/8/17
116	**Task 9 - Community Relations Support**	**537 days**	**Tue 2/24/15**	**Thu 3/23/17**
117	Pre-Public Meeting Materials	1 day	Tue 2/24/15	Tue 2/24/15
118	**Public Meeting #1**	0 days	Tue 3/17/15	Tue 3/17/15
119	*Public Meeting Report*	7 days	Tue 3/17/15	Wed 3/25/15
120	Pre-Public Meeting Materials	1 day	Mon 9/12/16	Mon 9/12/16
121	**Public Meeting #2**	0 days	Fri 9/30/16	Fri 9/30/16
122	*Public Meeting Report*	7 days	Mon 10/3/16	Tue 10/11/16
123	Pre-Public Meeting Materials	1 day	Wed 2/22/17	Wed 2/22/17
124	**Public Meeting #3**	0 days	Wed 3/15/17	Wed 3/15/17
125	*Public Meeting Report*	7 days	Wed 3/15/17	Thu 3/23/17
126	**Task 10 - Community Relations Plan**	**75.5 days**	**Tue 1/27/15**	**Tue 5/12/15**
127	Draft CRP	16 days	Tue 1/27/15	Tue 2/17/15
128	Government Review	14 days	Wed 2/18/15	Mon 3/9/15
129	Draft Final CRP	14 days	Tue 3/10/15	Fri 3/27/15
130	Regulatory Review	30 days	Mon 3/30/15	Fri 5/8/15
131	*Final CRP*	1.5 days	Mon 5/11/15	Tue 5/12/15
132	**Task 11 - Administrative Record**	**605 days**	**Tue 10/7/14**	**Wed 2/15/17**
133	Establish/Update Administrative Record and public website	4 days	Tue 10/7/14	Fri 10/10/14
134	Maintain Administrative Record	30 mons	Tue 10/14/14	Tue 2/14/17
135	Final Administrative Record (on CD/DVD)	1 day	Wed 2/15/17	Wed 2/15/17
136	Period of Performance End (36 months NTP)	0 days	Fri 8/19/16	Fri 8/19/16



Date: Wed 2/25/15 | Task | Split | Milestone ◆ | Summary

Proposed Milestones

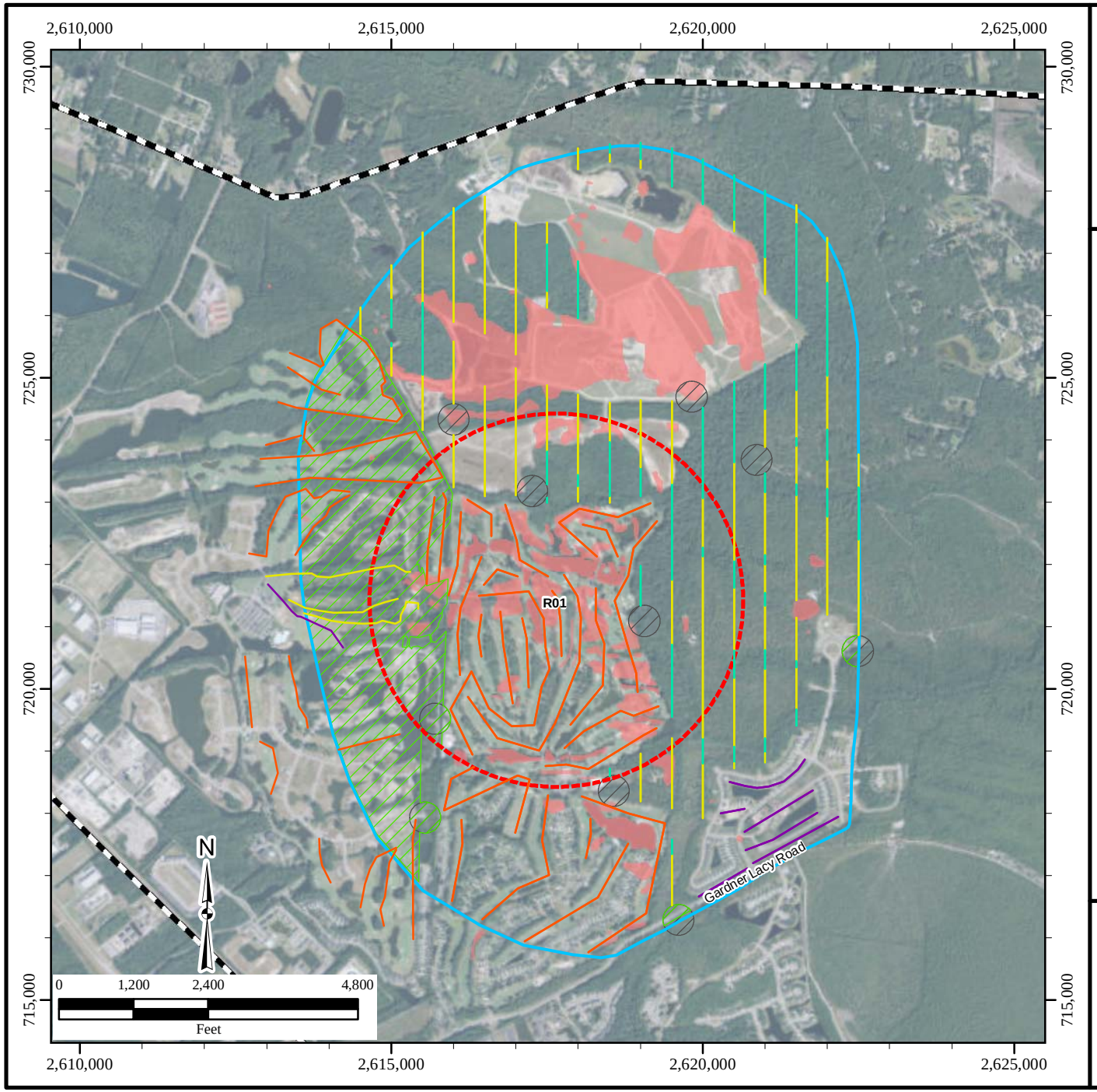


Figure B.14
MRS-R01
Range II
Field Activity

Legend

- Overland Transect (55,981 ft)
- Wetland Transect (25,318 ft)
- Golf Course Transect (78,018 ft)
- Residential Transect (8,445 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Previously Investigated Area within Investigation Area (362 acres)
- Previously Investigated Area
- Historical Use Area (318.6 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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7/16/2015 CNL
Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

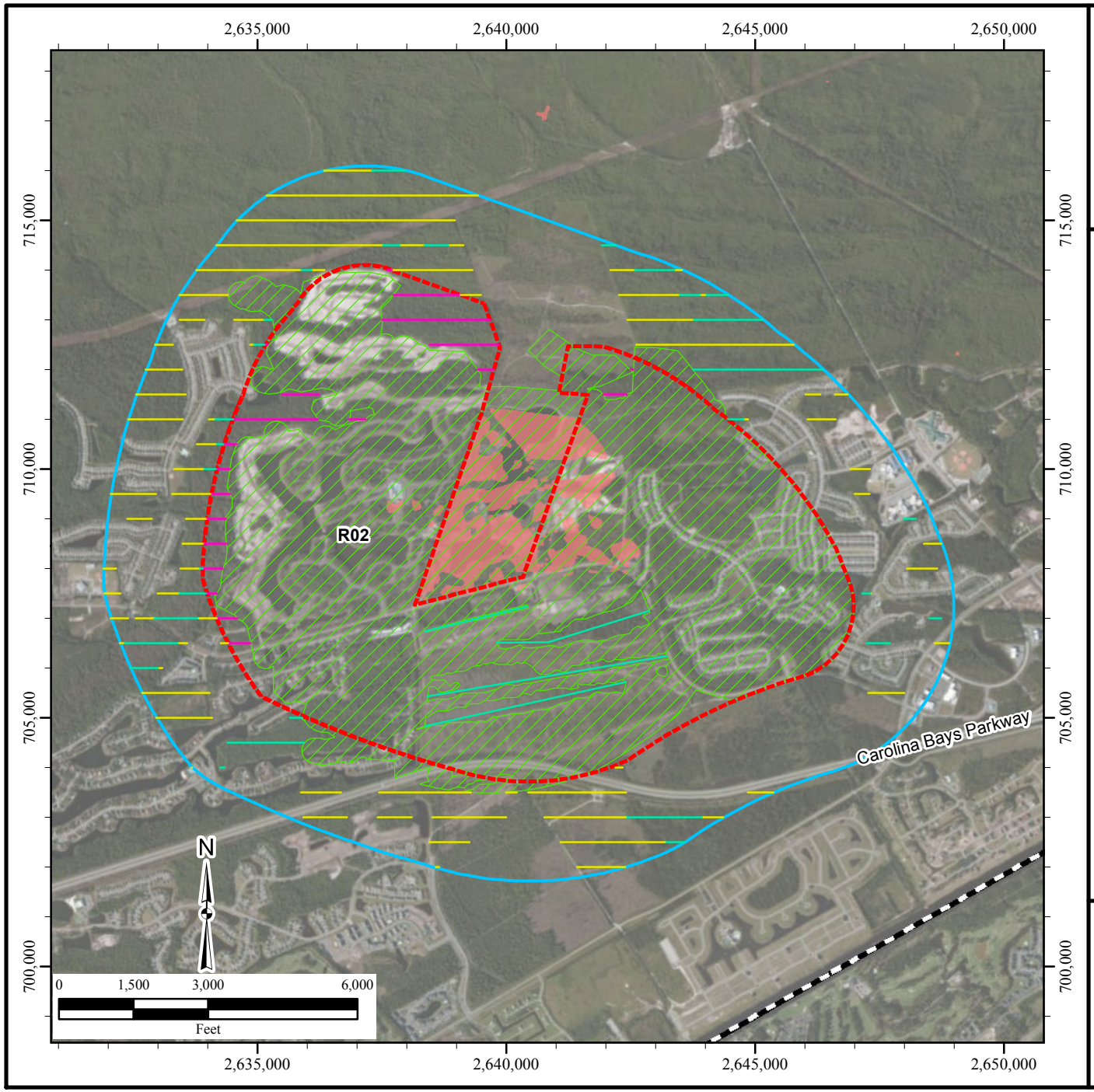

Figure B.15
MRS-R02
Range III
Field Activity

Legend

- Overland Transect (58,366.1 ft)
- Wetland Transect (31,513.7 ft)
- Mag and Dig Transect (11,893.2 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Previously Investigated Area (1,966.3. acres)
- Historical Use Area (165.6 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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HydroGeoLogic, Inc

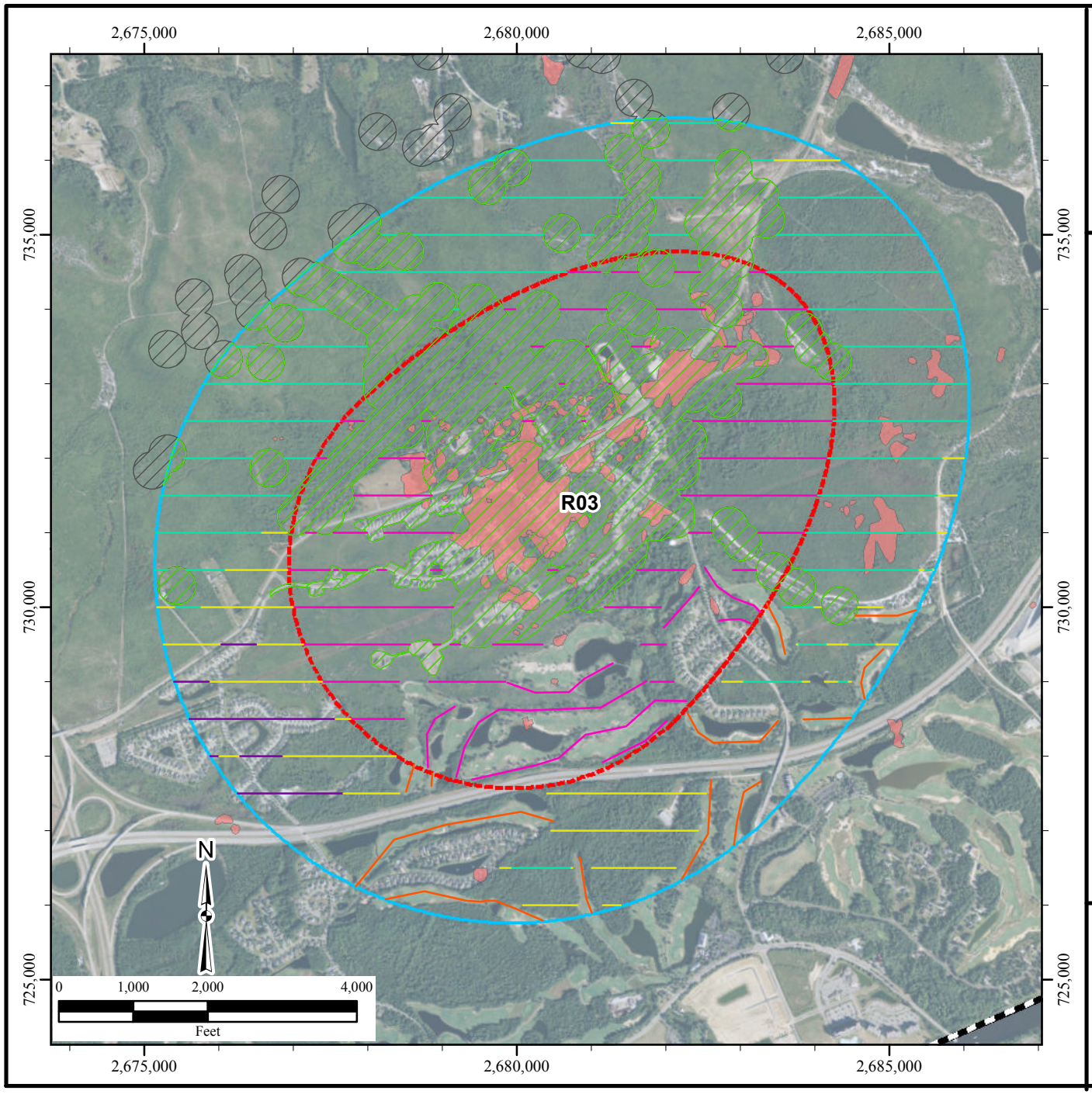

Figure B.16
MRS-R03
Range IV
Field Activity

Legend

- Overland Transect (18,544 ft)
- Wetland Transect (45,718 ft)
- Golf Course Transect (13,419 ft)
- Mag and Dig Transect (39,428 ft)
- Residential Transect (4,989 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Previously Investigated Area within Investigation Area (570.8 acres)
- Previously Investigated Area
- Historical Use Area (103.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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HGL HydroGeoLogic, Inc

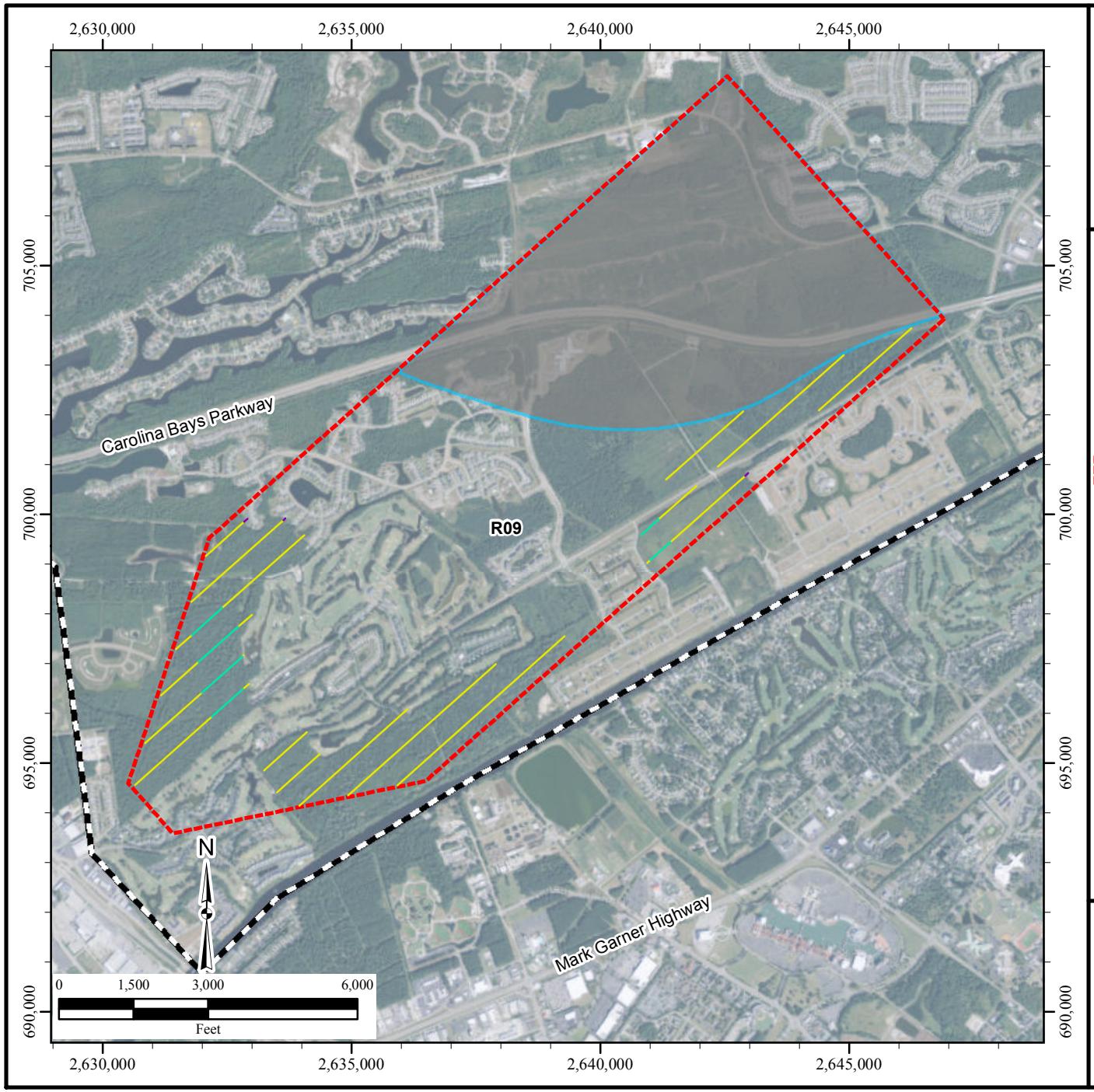

Figure B.17
MRS-R09
Machine Gun/Rifle Range
Field Activity

Legend

- Overland Transect (36,024 ft)
- Residential Transect (231 ft)
- Wetland Transect (4,874 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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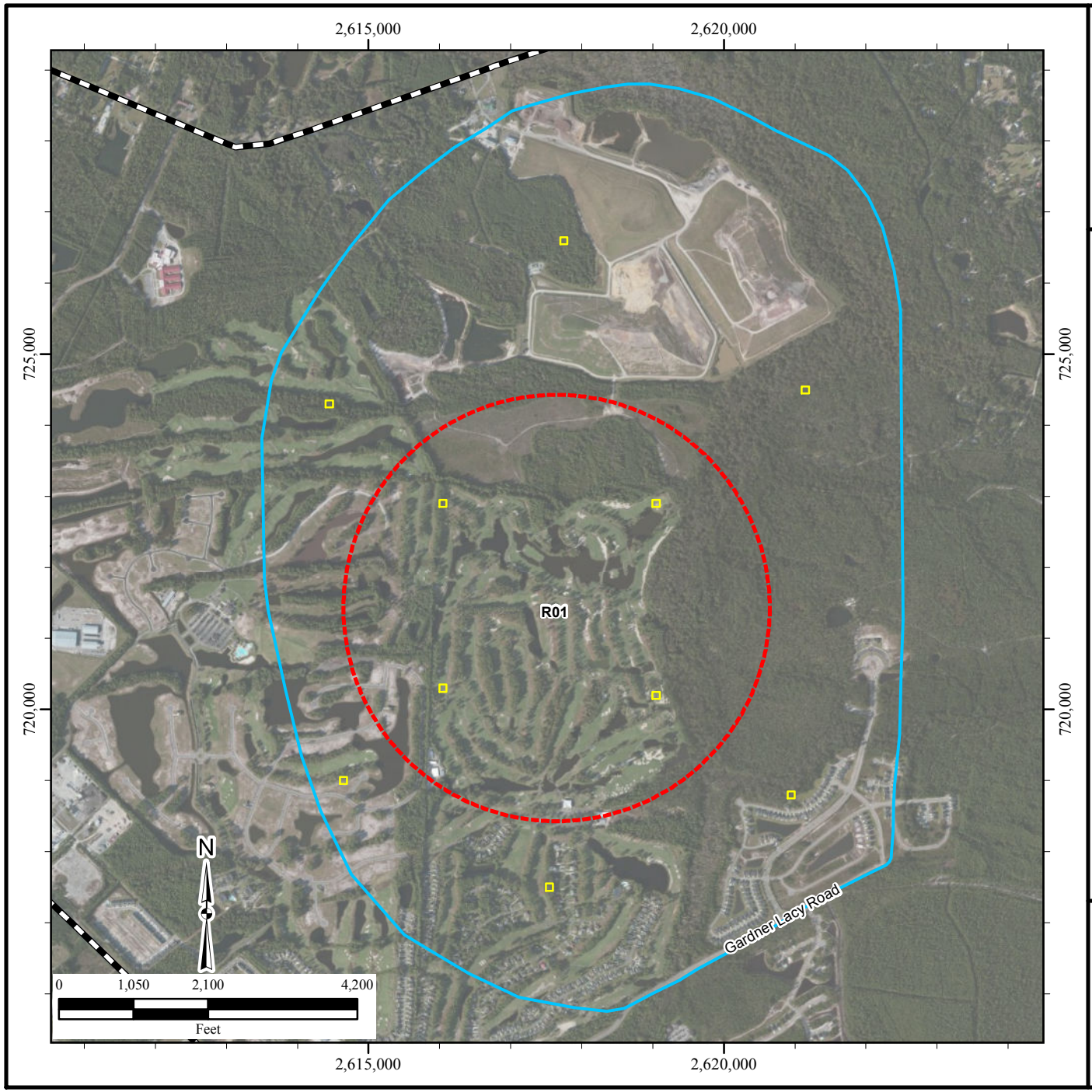

Figure B.18
MRS-R01
Range II
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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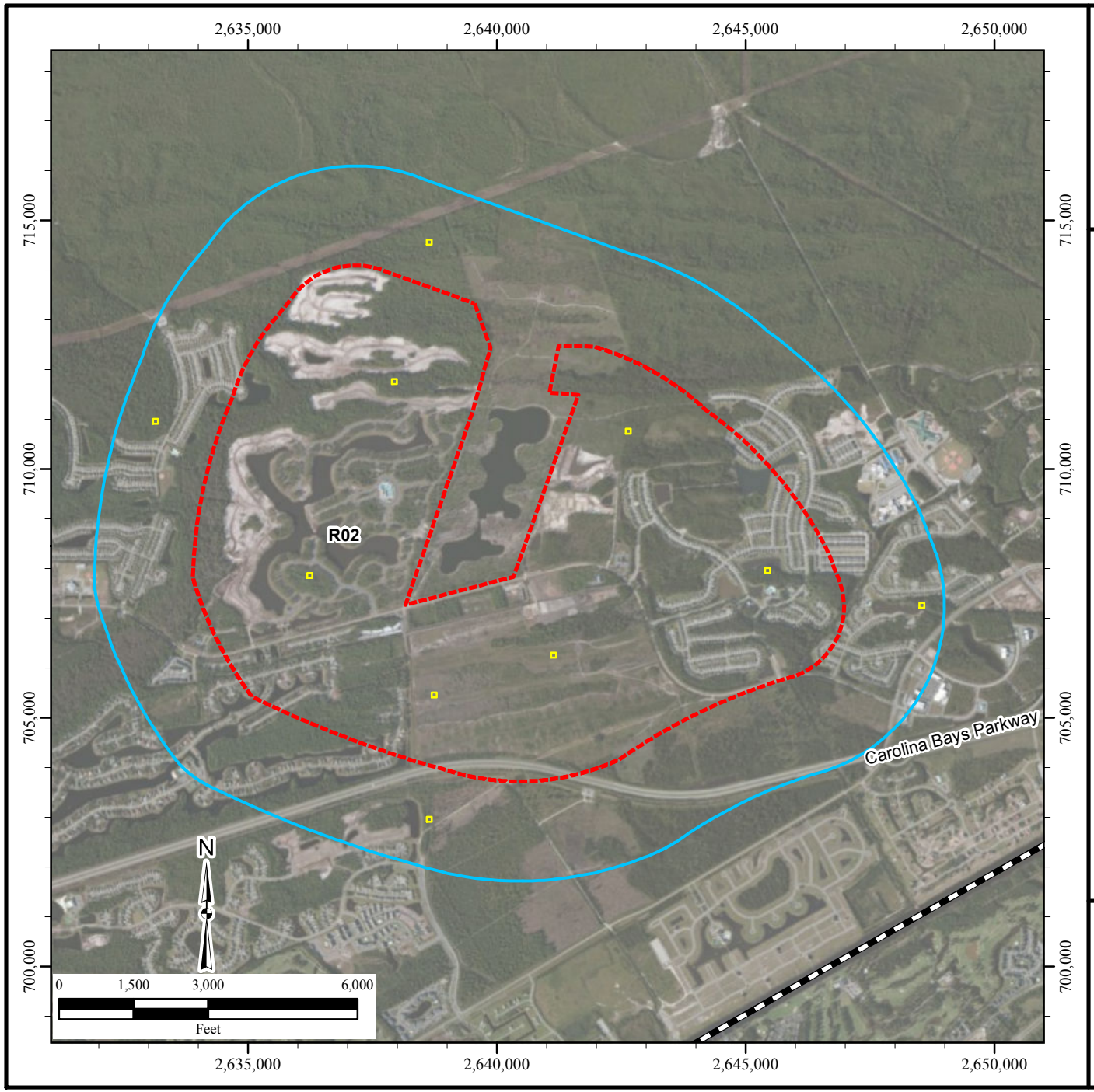

Figure B.19
MRS-R02
Range III
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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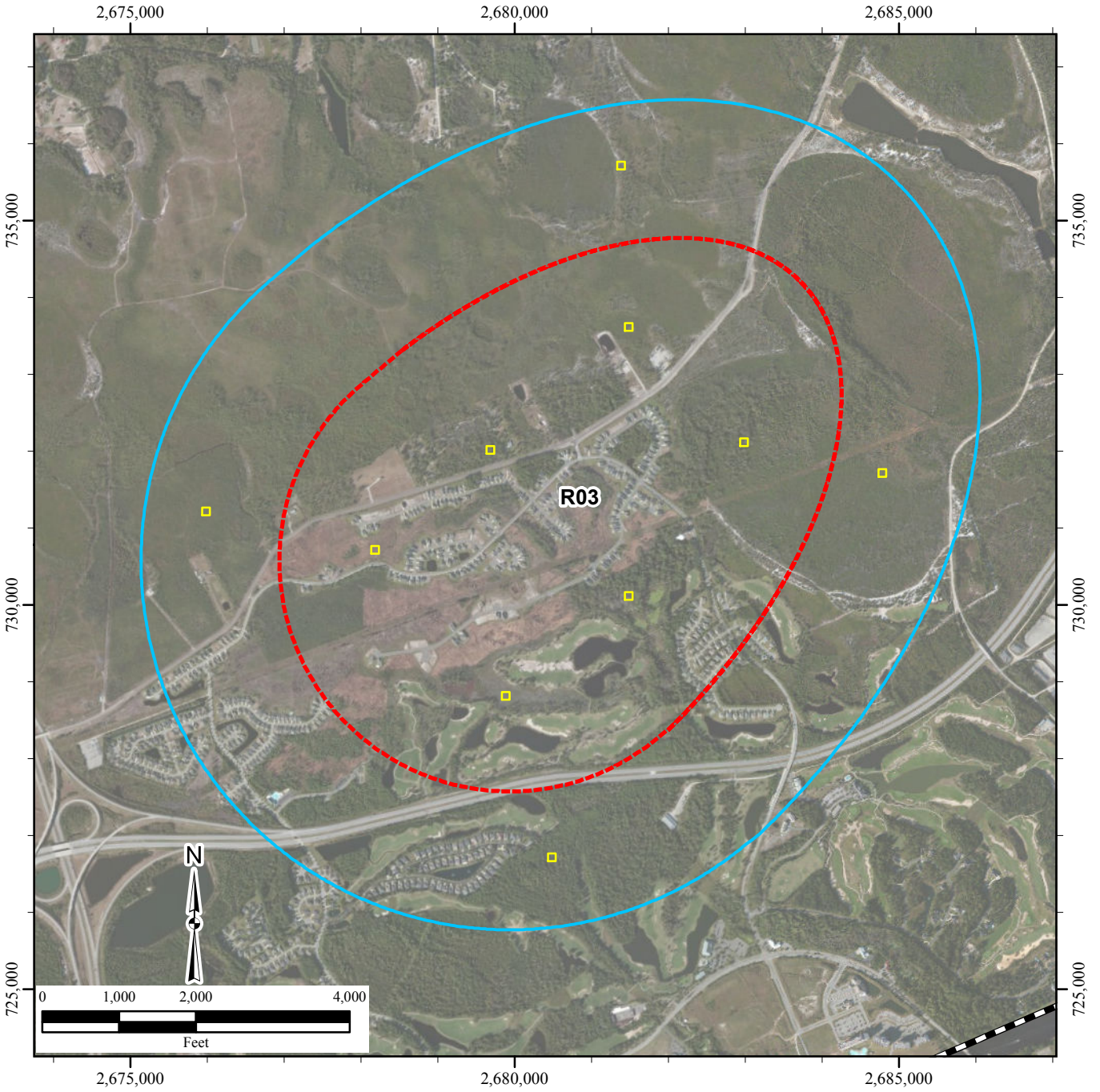

Figure B.20
MRS-R03
Range IV
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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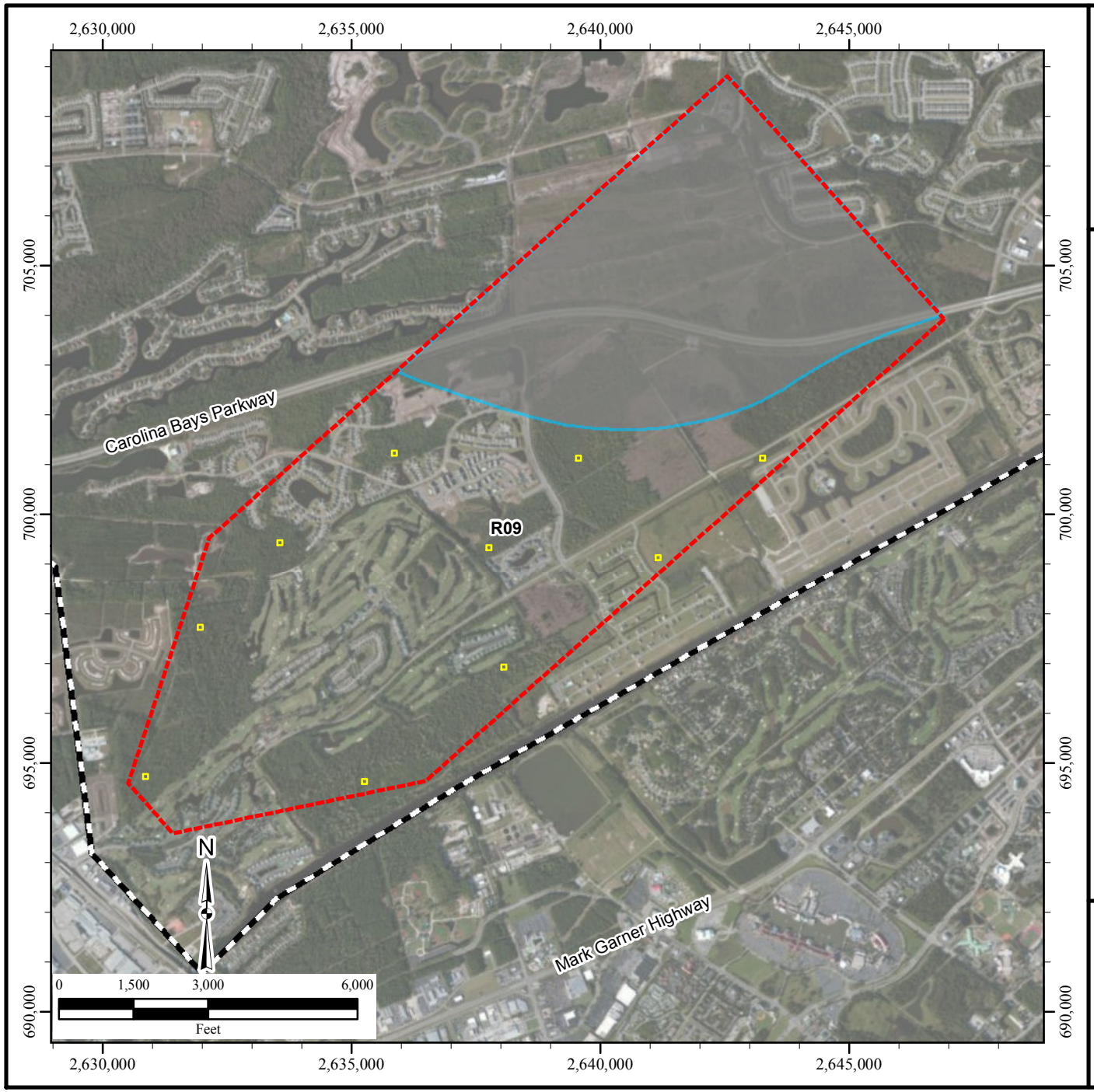

Figure B.21
MRS-R09
Machine Gun/Rifle Range
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

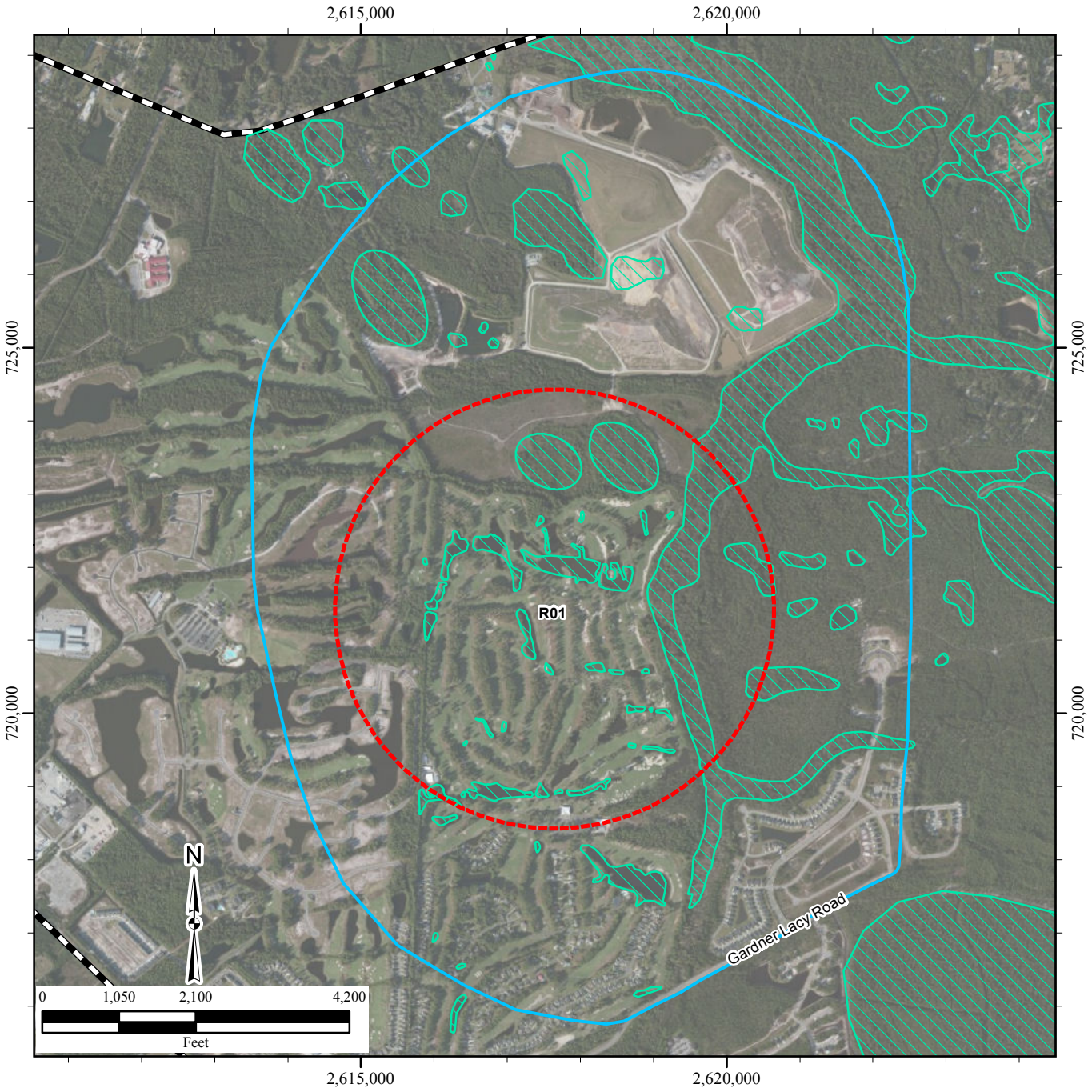

Figure B.22
MRS-R01
Range II Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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Source: HGL, USGS, USACE, NWI ArcGIS Online World Imagery

HydroGeoLogic, Inc

Figure B.23
MRS-R02
Range III Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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HydroGeoLogic, Inc

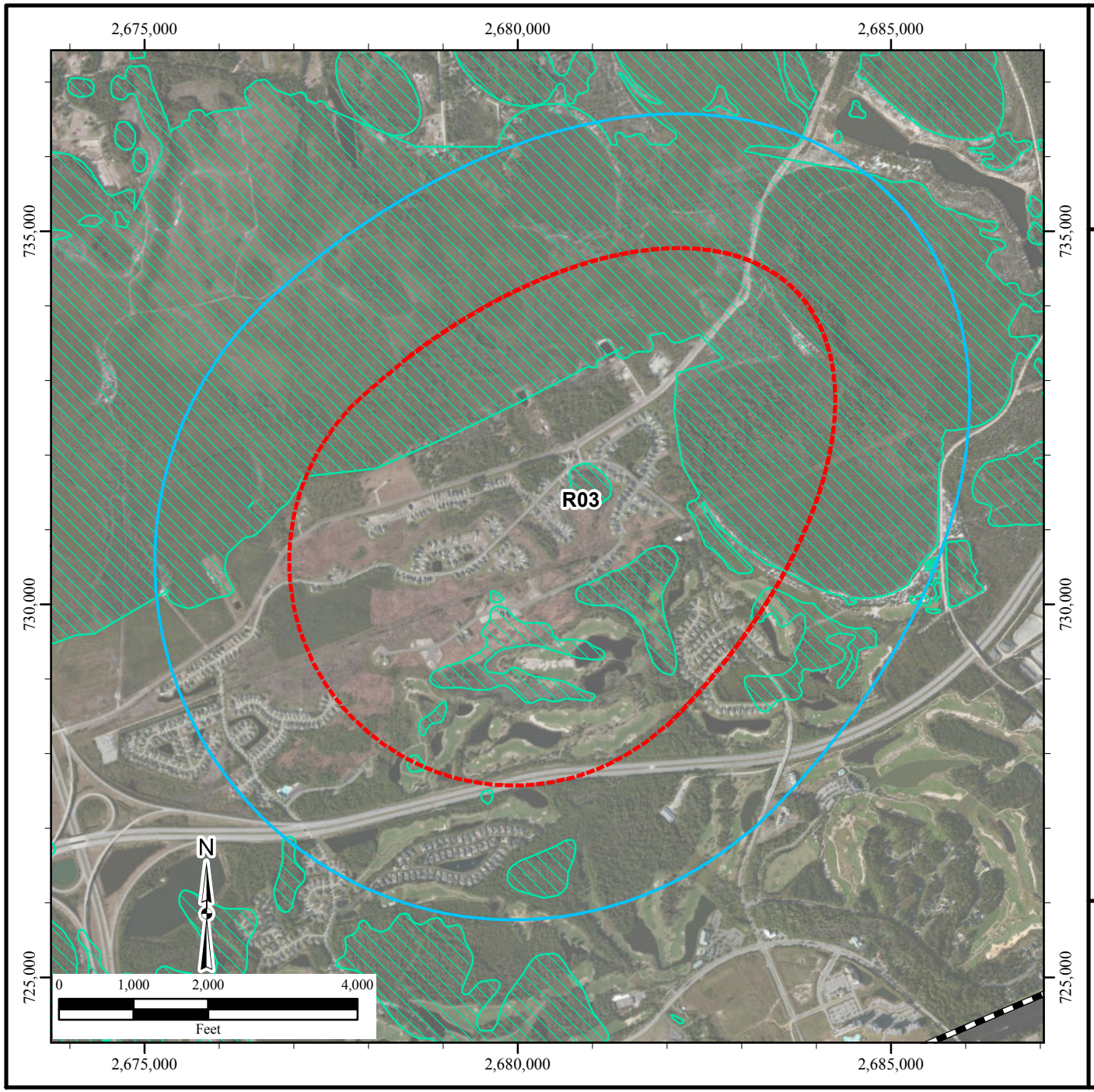

Figure B.24
MRS-R03
Range IV Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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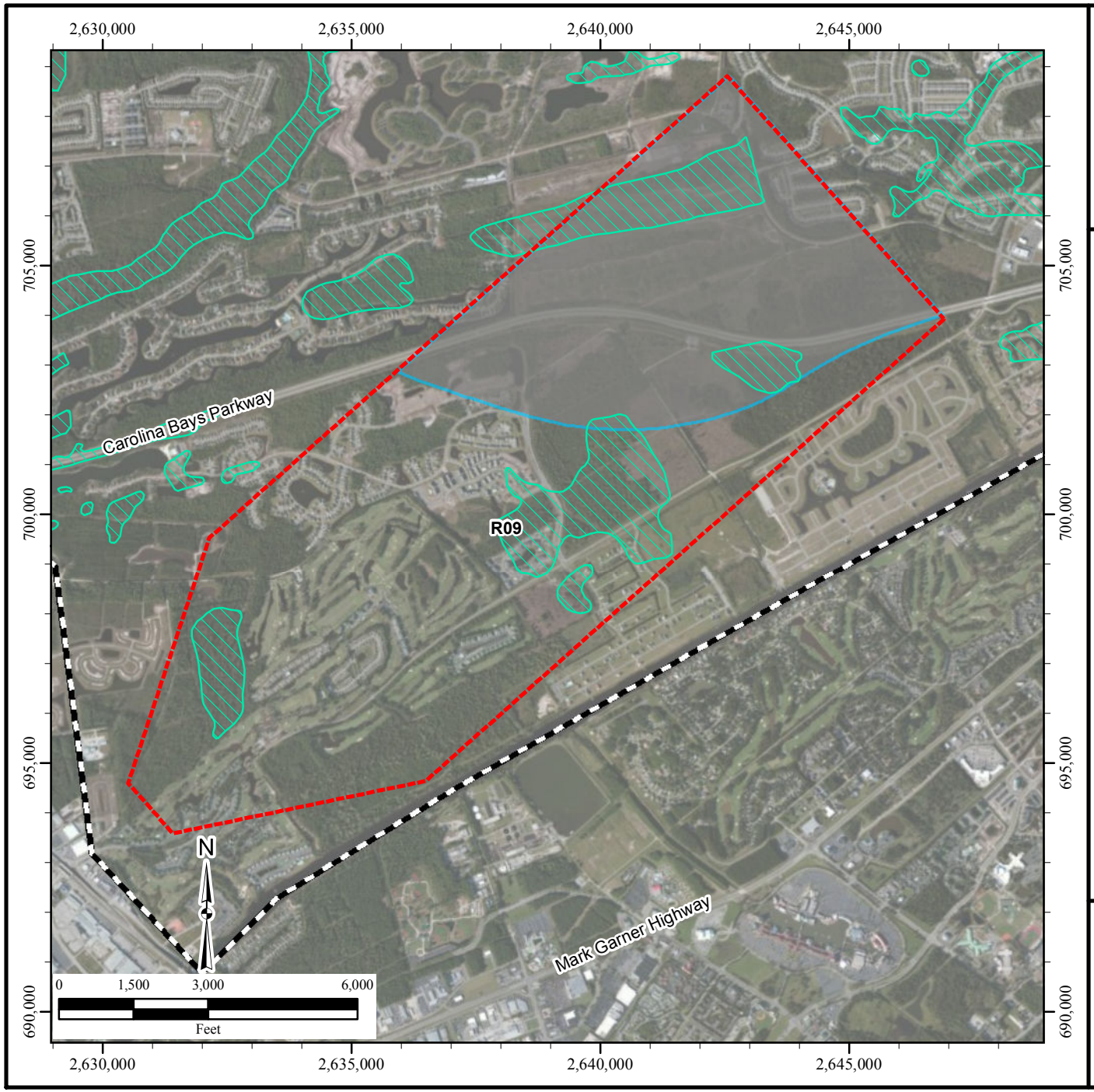

Figure B.25
MRS-R09
Machine Gun/Rifle Range
Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS R02 (905.2 Acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE, NWI ArcGIS Online World Imagery

HydroGeoLogic, Inc

HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Federal Explosives License/Permit
(18 U.S.C. Chapter 40)

In accordance with the provisions of Title XI, Organized Crime Control Act of 1970, and the regulations issued thereunder (27 CFR Part 555), you may engage in the activity specified in this license or permit within the limitations of Chapter 40, Title 18, United States Code and the regulations issued thereunder, until the expiration date shown. **THIS LICENSE IS NOT TRANSFERABLE UNDER 27 CFR 555.53.** See "WARNINGS" and "NOTICES" on reverse.

Direct ATF Correspondence To	ATF - Chief, FELC 244 Needy Road Martinsburg, WV 25405-9431	License/Permit Number	**1-AL-089-20-7F-00632**
Chief, Federal Explosives Licensing Center (FELC)	Christopher R. Reeves	Expiration Date	**June 1, 2017**

Name
HYDROGEOLOGIC, INC MUNITIONS RESPONSE TEAM

Premises Address (Changes? Notify the FELC at least 10 days before the move.)
5030 BRADFORD DRIVE BLDG 1, SUITE 230
HUNTSVILLE, AL 35805-

Type of License or Permit
20-MANUFACTURER OF EXPLOSIVES

Purchasing Certification Statement

The licensee or permittee named above shall use a copy of this license or permit to assist a transferor of explosives to verify the identity and the licensed status of the licensee or permittee as provided by 27 CFR Part 555. The signature on each copy must be an original signature. A faxed, scanned or e-mailed copy of the license or permit with a signature intended to be an original signature is acceptable. The signature must be that of the Federal Explosives Licensee (FEL) or a responsible person of the FEL. I certify that this is a true copy of a license or permit issued to the licensee or permittee named above to engage in the business or operations specified above under "Type of License or Permit."

Mailing Address (Changes? Notify the FELC of any changes.)

HYDROGEOLOGIC, INC
HYDROGEOLOGIC, INC MUNITIONS RESPONSE TEAM
5030 BRADFORD DRIVE BLDG 1, SUITE 230
HUNTSVILLE, AL 35805-

NW

Licensee/Permittee Responsible Person Signature

UXO OPS MANAGER

Position/Title

NEIL W. FEIST

Printed Name

05/15/2014

Date

Previous Edition is Obsolete

HYDROGEOLOGIC, INC;5030 BRADFORD DRIVE BLDG 1, SUITE 230;35805-;1-AL-089-20-7F-00632;June 1, 2017;20 MANUFACTURER OF EXPLOSIVES

ATF Form 5400.14/5400.15 Part 1
Revised October 2011

Federal Explosives License (FEL) Customer Service Information

Federal Explosives Licensing Center (FELC)
244 Needy Road
Martinsburg, WV 25405-9431

Toll-free Telephone Number: (877) 283-3352
Fax Number: (304) 616-4401
E-mail: FELC@atf.gov

ATF Homepage: www.atf.gov

Change of Address *(27 CFR 555.54(a)(1))*. Licensees or permittees may during the term of their current license or permit remove their business or operations to a new location at which they intend regularly to carry on such business or operations. The licensee or permittee is required to give notification of the new location of the business or operations not less than 10 days prior to such removal with the Chief, Federal Explosives Licensing Center. The license or permit will be valid for the remainder of the term of the original license or permit. **(The Chief, FELC, shall, if the licensee or permittee is not qualified, refer the request for amended license or permit to the Director of Industry Operations for denial in accordance with § 555.54.)**

Right of Succession *(27 CFR 555.59)*. (a) Certain persons other than the licensee or permittee may secure the right to carry on the same explosive materials business or operations at the same address shown on, and for the remainder of the term of, a current license or permit. Such persons are: (1) The surviving spouse or child, or executor, administrator, or other legal representative of a deceased licensee or permittee; and (2) A receiver or trustee in bankruptcy, or an assignee for benefit of creditors. (b) In order to secure the right provided by this section, the person or persons continuing the business or operations shall furnish the license or permit for for that business or operations for endorsement of such succession to the Chief, FELC, within 30 days from the date on which the successor begins to carry on the business or operations.

(Continued on reverse side)

Cut Here ✂

Federal Explosives License/Permit (FEL) Information Card

License/Permit Name: **HYDROGEOLOGIC, INC**

Business Name: **HYDROGEOLOGIC, INC MUNITIONS RESPONSE TEAM**

License/Permit Number: **1-AL-089-20-7F-00632**

License/Permit Type: **20-MANUFACTURER OF EXPLOSIVES**

Expiration: **June 1, 2017**

Please Note: Not Valid for the Sale or Other Disposition of Explosives.

APPENDIX C

PROJECT CONTACT INFORMATION

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Table C.1
Project Delivery Team Contact Information
RI/FS at the Former Conway BGR

Name/Organization	Address	Telephone/Email
Chris Cochrane USAESCH Contracting Officer's Representative	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1696 (c) 256-990-0888 chris.cochrane@usace.army.mil
Chase Hamley USAESCH COR	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1569 (c) 256-698-4027 Chase.G.Hamley@usace.army.mil
Kelly Longberg USAESCH Technical Manager	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1408 (c) 256-541-0907 kelly.d.longberg@usace.army.mil
Debra Edwards USAESCH Geophysicist	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1626 debra.l.edwards@usace.army.mil
Julie Hiscox USACE Savannah District FUDS Program Manager	USACE Savannah District 100 W. Oglethorpe Avenue Savannah, GA 31401-0889	(o) 912-652-5363 (c) 912-429-1474 julie.a.hiscox@usace.army.mil
Ray Livermore USACE Wilmington District Project Manager	USACE Wilmington District 69 Darlington Avenue Wilmington, NC 28402-1890	(910) 251-4702 Raymond.R.Livermore@usace.army.mil
Susan Byrd SCDHEC Land and Waste Management Division Project Manager	SCDHEC Land and Waste Management Division 2600 Bull Street Columbia, SC 29201	(o) 803-898-0308
Horry County Administrator's Office	Horry County Administrator's Office 1301 Second Avenue Conway, SC 29526	(o) 843-915-5020
Janardan Patel HydroGeoLogic, Inc. Program Manager	HydroGeoLogic, Inc (HGL) 11107 Sunset Hills Road Suite 400 Reston, VA 20190	(o) 703-736-4507 jpatel@hgl.com
Kimberly Vaughn HydroGeoLogic, Inc. Project Manager	HydroGeoLogic, Inc. 1403 Balmorhea Lane Round Rock, TX 78664	(o) 512-828-6684 (c) 512-658-6828 kvaughn@hgl.com
Neil Feist HydroGeoLogic, Inc. MMRP Operations Manager	HydroGeoLogic, Inc. 5030 Bradford Drive Building 1, Suite 230 Huntsville, AL 35805	(o) 256-970-2103 (c) 256-714-5808 nfeist@hgl.com

FUDS = Formerly Used Defense Site
SCDHEC = South Carolina Department of Health and Environmental Control
USACE = U.S. Army Corps of Engineers
USAESCH = U.S. Army Engineering Support Center, Huntsville

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APPENDIX D

ACCIDENT PREVENTION PLAN

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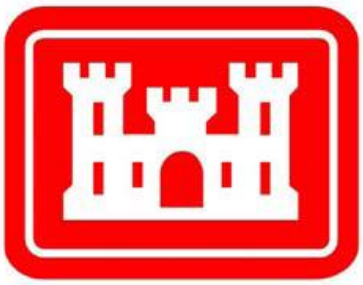
FINAL
ACCIDENT PREVENTION PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA

CONTRACT NO. W912DY-10-D-0023
TASK ORDER NO. 0018

Prepared for



U.S. Army Corps of Engineers
U.S. Army Engineering and Support Center, Huntsville

Prepared by:

HydroGeoLogic, Inc.
11107 Sunset Hills Road
Suite 400
Reston, VA 20190

July 2015

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EMERGENCY INFORMATION

To facilitate quick retrieval of information in the event of an emergency, this summary has been placed in the front of this Accident Prevention Plan. In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. In most emergency situations, telephone contact should first be made with the site point of contact, who will then notify the appropriate response teams. In the event of a life-threatening emergency, emergency personnel should be contacted before the site point of contact.

EMERGENCY TELEPHONE NUMBERS AND PROJECT CONTACTS

Fire, Police, Emergency Medical Services	911	
Emergency Medical Care **Grand Strand Regional Medical Center** 809 82nd Pkwy Myrtle Beach, SC 29572 Grandstrandmed.com **Beach Urgent Care** 9672 N Kings Hwy Myrtle Beach, SC 29572 Beachurgentcare.com	(843) 692-1000 (843) 497-2273	
National Poison Control	(800) 222-1222	
National Response Center Environmental Emergencies	(800) 424-8802	
Client		
U.S. Army Engineer Support Center-Huntsville (USAESCH), Project Manager	Chris Cochrane	(256) 895-1696 chris.cochrane@usace.army.mil
USAESCH, Project Manager	Chase Hamley	(256) 895-1569 Chase.G.Hamley@usace.army.mil
U.S. Army Corps of Engineers, Wilmington District (CESAW), Project Manager	Ray Livermore	(910) 251-4702 Raymond.R.Livermore@usace.army.mil
U.S. Army Corps of Engineers, Savannah District (CESAS), Project Manager	Julie Hiscox	(912) 652-5363 Julie.A.Hiscox@usace.army.mil
South Carolina Department of Health & Environmental Control, Project Manager	Susan Byrd	(803) 898-0308
HydroGeoLogic, Inc.		
HGL 24/7 Emergency Number	(800) 341-3647	
Project Manager	Kimberly Vaughn	(512) 828-6684 kvaughn@hgl.com
Senior Unexploded Ordnance Supervisor	Joel Sanders	(435) 919-9770
Unexploded Ordnance Safety Officer	Oscar Honne	(915) 503-4083
Corporate Health and Safety Director	Stephen Davis, CIH, CSP	(865) 659-0499 sdavis@hgl.com
Project Health and Safety Manager	Edie Scala-Hampson, CIH, CHMM	(847) 409-6384 escala-Hampson@hgl.com
HGL Corporate Occupational Physician *WorkCare 24-Hour Hotline Nurse	Peter Greaney, MD	(714) 978-7488, ext. 114 *(888) 449-7787

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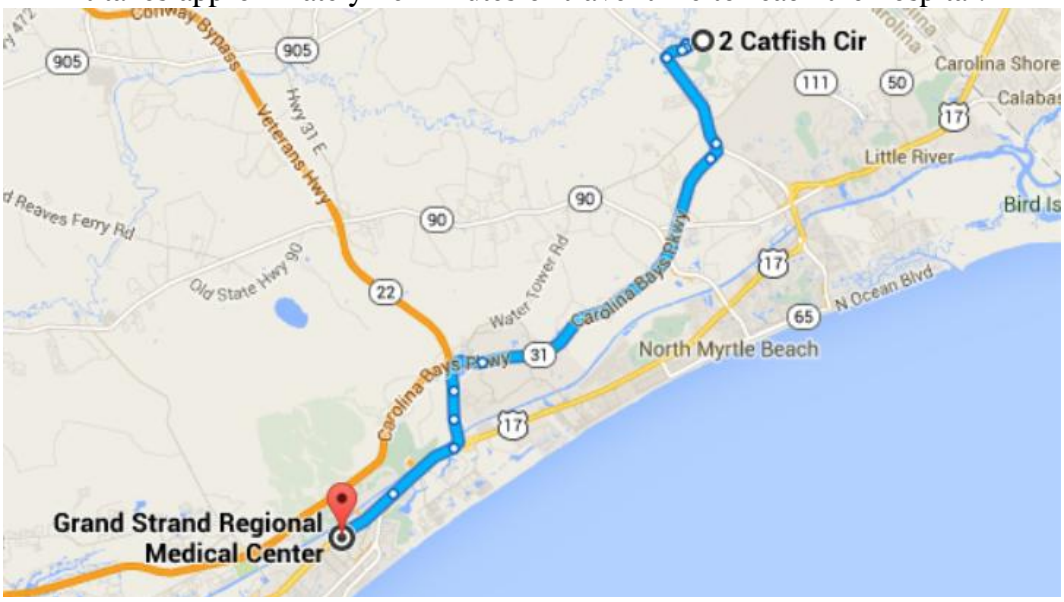
ROUTE MAP AND DIRECTIONS TO
GRAND STRAND REGIONAL MEDICAL CENTER (HOSPITAL)

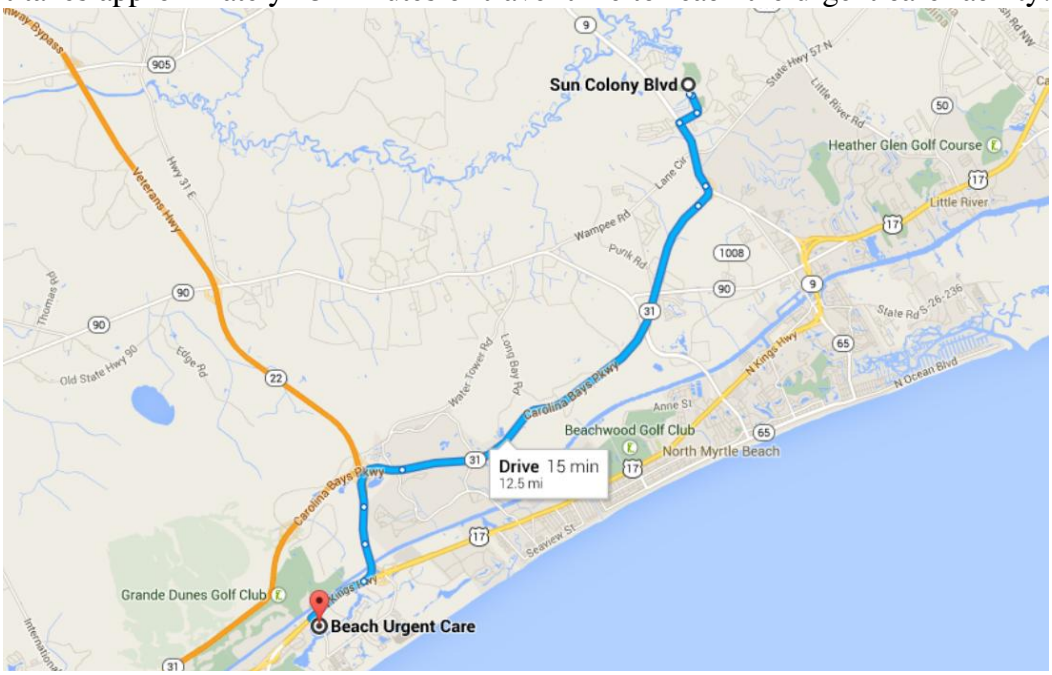
It takes approximately 20 minutes of travel time to reach the hospital.



Directions from 2 Cat Fish Circle to Grand Strand Regional Medical Center:

- Head northwest on Catfish Cir toward Bass Ct
- Take the 1st left onto Bass Ct
- Take the 1st right to stay on Bass Ct
- Continue onto Rum Bluff Blvd
- Turn left onto SC-9 S
- Turn right onto the S Carolina 31 ramp to Myrtle Beach/Georgetown/Surfside Beach
- Merge onto SC-31
- Take the S Carolina 22 E exit toward Myrtle Beach
- Merge onto SC-22 E
- Exit onto US-17 S toward Myrtle Beach
- Merge onto US-17 S
- Merge onto US-17 S via the ramp to Conway/Georgetown
- Turn left onto 82nd Pkwy
- Grand Strand Regional Medical Center: 809 82nd Pkwy, Myrtle Beach, SC 29572

It takes approximately 15 minutes of travel time to reach the urgent care facility.



Directions Sun Colony Blvd to Beach Urgent Care:

- Head west on Sun Colony Blvd toward Brighton Ln
- At the traffic circle, take the 1st exit and stay on Sun Colony Blvd
- Turn left onto SC-9 S
- Turn right onto the S Carolina 31 ramp to Myrtle Beach/Georgetown/Surfside Beach
- Merge onto SC-31
- Take the S Carolina 22 E exit toward Myrtle Beach
- Merge onto SC-22 E
- Exit onto US-17 S toward Myrtle Beach
- Merge onto US-17 S
- Beach Urgent Care: 9672 N Kings Hwy, Myrtle Beach, SC 29572

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LIST OF ACRONYMS AND ABBREVIATIONS

AHA	activity hazard analysis
APP	Accident Prevention Plan
BGR	Bombing and Gunnery Range
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CESAS	USACE, Savannah District
CESAW	USACE, Wilmington District
CFR	Code of Federal Regulations
CHSD	Corporate Health and Safety Director
CIH	Certified Industrial Hygienist
CPR	cardiopulmonary resuscitation
CSP	Certified Safety Professional
DA	Department of the Army
DART	days away, restricted, or transferred
DD	decision document
DDESB	Department of Defense Explosives Safety Board
DGM	digital geophysical mapping
DID	data item description
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
EM	Engineer Manual
EMR	experience modification rate
EPA	U.S. Environmental Protection Agency
EZ	exclusion zone
FS	Feasibility Study
H&S	health and safety
HAZWOPER	Hazardous Waste Operations and Emergency Response
HGL	HydroGeoLogic, Inc.
HSP	Health and Safety Program
HTRW	hazardous, toxic, and radioactive waste
IAW	in accordance with
IGD	interim guidance document
MC	munitions constituents
MD	munitions debris

MEC	munitions and explosives of concern
MG	machine gun
mph	miles per hour
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MSDS	material safety data sheet
NAICS	North American Industry Classification System
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
OSIC	On-Scene Incident Commander
PAN	Preliminary Accident Notification
PHSM	project health and safety manger
PM	Project Manager
PP	Proposed Plan
PPE	personal protective equipment
PWS	performance work statement
RI	Remedial Investigation
RR	rifle range
SDS	safety data sheet
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SUXOS	Senior UXO Supervisor
TO	task order
TP	Technical Paper
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineer Support Center-Huntsville
UXO	unexploded ordnance
UXOSO	UXO Safety Officer
WERS	Worldwide Environmental Remediation Services
WBGT	wet bulb globe temperature
WP	Work Plan

ACCIDENT PREVENTION PLAN ACKNOWLEDGMENT

I have read, understand, and agree to abide by the provisions as detailed in this Accident Prevention Plan and Site Safety and Health Plan prepared by HydroGeoLogic, Inc. 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.

Printed Name	**Company**	**Signature**	**Date**

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ACCIDENT PREVENTION PLAN
FORMER CONWAY BOMBING AND GUNNERY RANGE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORRY COUNTY, SOUTH CAROLINA

1.0 SIGNATURE SHEET

1.1 PLAN PREPARED BY:

Digitally signed by Neil Feist
DN: cn=Neil Feist, o, ou=HGL, email=nfeist@hgl.com, c=US
Date: 2015.07.17 09:43:50 -05'00'

_____ Date: _____

Neil Feist
UXO Operations Manager
HydroGeoLogic, Inc.
(256) 970-2103

1.2 PLAN APPROVAL:

Janardan J Patel Digitally signed by Janardan J Patel
DN: cn=Janardan J Patel, o=HGL, ou=ECD, email=jpatel@hgl.com, c=US
Date: 2015.07.17 14:02:59 -04'00'

_____ Date: 07/17/2015

Janardan Patel
Vice President/Munitions Response Program Manager
HydroGeoLogic, Inc.
(703) 736-4507

1.3 PLAN CONCURRENCE:

Steve Davis Digitally signed by Steve Davis
DN: cn=Steve Davis, o=HGL, ou=EHS, email=sdavis@hgl.com, c=US
Date: 2015.07.17 13:37:30 -04'00'

_____ Date: _____

Stephen Davis, CIH, CSP
Corporate Health and Safety Director
HydroGeoLogic, Inc.
(865) 659-0499

Digitally signed by Kimberly Vaughn
DN: cn=Kimberly Vaughn, o=HGL, ou, email=kvaughn@hgl.com, c=US
Date: 2015.07.17 09:58:20 -05'00'

_____ Date: _____

Kimberly Vaughn, P.G.
Project Manager
HydroGeoLogic, Inc.
(512) 828 6684

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2.0 BACKGROUND INFORMATION

This Accident Prevention Plan (APP) and accompanying Site Safety and Health Plan (SSHP) (Attachment 1) describe the safety program that will be implemented by HydroGeoLogic, Inc. (HGL) during work under Contract No. W912DY-10-D-0023, Task Order No. 0018, at the former Conway Bombing and Gunnery Range (BGR), Horry County, South Carolina. This APP was prepared in accordance with (IAW) U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 385-1-1, *Safety and Health Requirements Manual*, Appendix A, Minimum Basic Outline for APPs, and Data Item Descriptions (DIDs) Worldwide Environmental Remediation Services (WERS)-005.01, Accident Prevention Plan. This APP is supplemented by the SSHP and interfaces with HGL's Corporate Health and Safety Program (HSP) manual.

The purpose of this APP is to establish the site-specific safety and health procedures, practices, and equipment to be implemented to protect field personnel from potential hazards associated with project site activities that may be suspect of containing munitions and explosives of concern (MEC). The APP assigns responsibilities, establishes standard operating procedures (SOPs), and provides contingency plans for situations that may arise during the field activities.

HGL and its subcontractors will comply with applicable Occupational Safety and Health Administration (OSHA) regulation (29 Code of Federal Regulations [CFR] 1910 and 1926) and all performance work statements (PWSs). Field activities involving work in areas potentially containing unexploded ordnance (UXO) hazards will be conducted in full compliance with the safety standards of the USACE, the Department of the Army (DA), and the U.S. Department of Defense (DoD), and with state and local safety requirements regarding personnel, equipment, and procedures.

The primary project activities for this Remedial Investigation (RI)/Feasibility Study (FS) will include: brush clearance to facilitates digital geophysical mapping (DGM) surveys, geophysical detection, and investigation of anomalies; disposal of MEC and munitions debris (MD); and environmental sampling.

The following job-specific background information is provided for reference.

2.1 CONTRACTOR

HGL (Corporate Office)
11107 Sunset Hills Road
Suite 400
Reston, Virginia 20190
(703) 478-5186

2.2 CONTRACT NUMBER

Contract No: W912DY-10-D-0023
Task Order No: 0018

2.3 PROJECT NAME

RI/FS, Former Conway BGR, Horry County, South Carolina.

2.4 PROJECT DESCRIPTION

The objective of this task order (TO) is to perform an RI/FS to characterize the nature and extent of MEC at four munitions response sites (MRSs) located at the former Conway BGR, and achieve acceptance of a decision document (DD) for each delineated MRS in compliance with factors listed in 40 CFR 300.430(d)(2); Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), DoD, Department of the Army, and USACE regulations and guidance that include Interim Guidance Documents (IGDs) and DIDs. HGL will meet this objective by:

- Designing and completing an RI;
- Evaluating alternatives for each MRS and documenting the results in an FS;
- Preparing a Proposed Plan (PP) that details the potential remedies evaluated and provides rationale for selection of the recommended alternative to the public; and
- Submitting a DD that documents acceptance of the selected remedy.

The RI/FS will be conducted IAW the U.S. Army Engineer Support Center-Huntsville (USAESCH) PWS, Revision 1, dated April 11, 2013. The four MRSs are:

- MRS-R01, Range II Range
- MRS-R02, Range III
- MRS-R03, Range IV
- MRS-R09, Machine Gun (MG)/Rifle Range (RR)

Figure B.1 in Appendix B of the RI/FS Work Plan (WP) provides the regional location of the former Conway BGR and the general locations of the four MRSs.

2.5 CONTRACTOR ACCIDENT EXPERIENCE

Table 2.1 provides HGL's 5-year accident and incident history as well as its experience modification rates (EMRs) for the policy periods in question. HGL's days away, restricted, or transferred (DART) and total recordable incident rates are much lower than the average rates for other companies operating under the same North American Industry Classification System (NAICS) code. HGL's EMR is consistently less than 1.0 and was 0.92 for the 2012-2013 policy year.

Table 2.1
Health and Safety Performance Indicators

Year	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
EMR	0.84	0.82	0.81	0.92	
Year	**2009**	**2010**	**2011**	**2012**	**2013**
Fatalities	0.00	0.00	0.00	0.00	0.00
DART Cases	1.00	2.00	1.00	0.00	0.00
DART Case Incident Rates	0.37	0.74	0.34	0.00	0.00
BLS DART Incident Rate (562910)	3.30	3.00	3.00		
DART Lost Time	9.00	30.00	2.00	0.00	0.00
Total Recordable Cases	1.00	5.00	3.00	2.00	1.00
Total Recordable Incident Rate	0.37	1.85	1.01	0.72	0.38
BLS Total Incident Rate (562910)	5.20	4.50	4.90		
Average Number of Employees	310.00	345.00	371.50	371.00	283.00
Hours Worked	534080	534425	592696	553533	521646

2.6 PHASES OF WORK AND HAZARDOUS ACTIVITIES REQUIRING ACTIVITY HAZARD ANALYSIS

Work will consist of the following phases, each of which is discussed in detail in the SSHP (Attachment 1) and the Activity Hazard Analysis (AHA) forms (Attachment 3):

- Mobilization and site preparation,
- Brush clearing,
- Geophysical system ground reconnaissance,
- Intrusive investigation of anomalies (i.e., anomaly reacquisition and excavation or mag and dig),
- Disposal of MEC and MD,
- Munitions Constituent (MC) sampling, and
- Demobilization.

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3.0 STATEMENT OF HEALTH AND SAFETY POLICY

HGL is committed to providing a safe and healthful workplace, free of recognized hazards, and to conduct its operations in accordance with applicable federal, state, and local environmental, health and safety (H&S) standards, regulations and laws including those of the U.S. Department of Labor, OSHA, the U.S. Environmental Protection Agency (EPA), and U.S. Department of Transportation (DOT).

The H&S of HGL employees, our clients' employees, and the public, are of the utmost concern to HGL. Therefore, it is my policy, both personal and official, that everything within reason shall be done throughout this company to maintain or improve our HSP.

Each HGL employee has a responsibility to their family, fellow employees, and to HGL to perform their duties in a safe manner. Each employee is expected to observe all H&S rules and follow all HGL policies and procedures. They must also immediately report, if possible correct, or if necessary stop the work activity when any unsafe condition is discovered.

More than personal safety is involved, however, because the existence of H&S hazards is proof of a wasteful, inefficient operation. Accidents and incidents interfere with ongoing operations, cause client dissatisfaction and damage to HGL's image. To be most effective, risk management must be integral with every aspect of operations. Optimal H&S performance must start with project planning and continue through purchasing, construction, operations, and maintenance.

Management must understand that accident prevention is as much their responsibility as any other phase of operations. It demands the same executive direction and control as does any other method of increasing the efficiency of operations. Each manager and supervisor is therefore held accountable for H&S within their areas of supervision, just as they are for production, quality, efficiency and profitability. Each manager and supervisor's H&S performance will be measured as part of their overall performance.

3.1 HGL'S CORPORATE HEALTH AND SAFETY PROGRAM

HGL's HSP is designed to provide the safety training and tools required to enable HGL management to provide a safe and compliant work environment for its employees, project personnel, subcontractors, and the general public in and around project sites.

HGL's goals for its HSP include maintaining company and project compliance with applicable federal and state regulations and client requirements; training and equipping our staff conduct their work in a safe and efficient manner; providing medical surveillance and after injuring medical care that prevents occupational illnesses and enhances recovery and return to work. Our accident experience goals for this program are zero recordable incidents, and minimizing first aid incidents as much as possible.

HGL provides spot bonuses to employees who exhibit exemplary understanding, concern, and character as it pertains to safety performance of the project and their fellow employees.

3.2 HGL'S HEALTH AND SAFETY PROGRAM NONCOMPLIANCE POLICIES AND PROCEDURES

HGL's HSP provides steps for addressing safety infractions as early as possible and returning to a safe and compliant work environment. Because infractions to H&S policies, SSHPs, and other safe work practices can be life threatening or could potentially cause serious injuries to the individual or others on a job site, the disciplinary policy for H&S infrations is more stringent than the general HGL progressive disciplinary policy. HGL has a multistep disciplinary policy in its Corporate Policy Manual covers infractions of company policy, procedures, and applicable regulations including safety regulations. A copy of this policy will be maintained on site.

3.3 HGL'S WRITTEN PROCEDURES FOR HOLDING MANAGERS AND SUPERVISORS ACCOUNTABLE FOR HEALTH AND SAFETY

Written H&S goals are developed annually for members of the management team. The goals are designed to advance development of the HSP at HGL, involve all levels of employees, proactively address H&S issues, and force accountability of H&S for the management team. Management personnel are held accountable for completion of these goals, and compensation is tied to the success of an individual's performance in meeting the goals. The multi-step procedures are outlined in the Corporate policy which will be maintained on site.

Peter S. Huyakorn

Peter S. Huyakorn
President

4.0 RESPONSIBILITIES AND LINES OF AUTHORITY

All personnel are responsible for continuous adherence to this APP and HGL's HSP during the performance of their work.

The following sections discuss the project personnel, the organizations that they represent, and their roles on the project. Each person is responsible for his/her own H&S, completing tasks in a safe manner, and reporting any unsafe acts or conditions to the Senior UXO Supervisor (SUXOS) and UXO Safety Officer (UXOSO). All persons on site are responsible for continuous adherence to APP procedures during the performance of project work. In no situation may work be performed in a manner that conflicts with the intent of or the inherent safety precautions expressed in this APP. All HGL and subcontractor personnel are required to read and acknowledge their understanding of this APP by signing the APP acknowledgement form located in the front of this document and by cooperating with project management to ensure a safe work site.

A detailed organizational chart for project management is provided as Figure B.12 in the accompanying WP.

4.1 IDENTIFICATION AND ACCOUNTABILITY OF PERSONNEL RESPONSIBLE FOR SAFETY

In matters related to workplace H&S, the UXOSO will direct and oversee field safety and will report directly to the Corporate H&S Director (CHSD), who reports to corporate management at the most senior level. The following HGL employees will have critical roles in the safe execution of this project.

4.1.1 Project Manager – Kimberly Vaughn, P.G.

The responsibilities of the project manager (PM) include:

- Ensuring conformance with HGL corporate and USACE H&S policies and procedures;
- Coordinating the project with USACE H&S personnel;
- Ensuring that the project has the necessary resources to operate safely;
- Ensuring that the project personnel satisfy HGL and USACE H&S requirements;
- Ensuring that project personnel implement the project APP/SSHP and have the appropriate regard for safe job performance;
- Ensuring that all fieldwork is properly documented; and
- Maintaining open H&S lines of communications between the client and all contractors.

4.1.2 Corporate Health and Safety Director – Stephen Davis

The CSHD is a Certified Industrial Hygienist (CIH) and Cerified Safety Professional (CSP). The responsibilities of the CHSD include the following:

- Overseeing the development and coordination of the APP/SSHP as required;
- Recommending changes to the APP/SSHP if warranted by changed conditions;
- Administering HGL's corporate HSP;
- Determining the level of personal protective equipment (PPE) required;
- Developing site-specific employee emergency response plans based on expected hazards;
- Confirming each HGL team member's suitability for work based on physician recommendations;
- Conducting field H&S audits to ensure conformance to the APP/SSHP and compliance with HGL H&S policies;
- Certifying that all workers have proper training per 29 CFR 1910.120(e);
- Updating equipment or procedures based on information obtained during site operations;
- Investigating significant accidents and illnesses, and implementing corrective action plans;
- Establishing air monitoring parameters based on expected contaminants; and
- Establishing employee exposure monitoring notification programs.

4.1.3 Senior Unexploded Ordnance Supervisor – Joel Sanders

The HGL SUXOS has direct responsibility for all MEC-related activities. The SUXOS will be responsible for the following:

- Providing initial MEC hazard awareness and recognition training to the field team personnel before field activities in a suspected MEC contaminated area commence;
- Coordinating with the UXOSO in establishing planned ingress, egress, and routine vehicle and footpath routes within the project area to avoid MEC hazards;
- Ensuring that surface MEC hazards are identified and visibly marked using pin-flags, and that verbal warnings and instructions are given to the field team;
- Providing MEC anomaly avoidance by ensuring that a qualified UXO technician is in front of any non-UXO field personnel when entering an area suspected of MEC contamination hazards;

- Ensuring that MEC items found are documented, properly inspected, and contained; and
- Coordinating explosive operations and final disposition of MEC hazards.

4.1.4 Unexploded Ordnance Safety Officer – Oscar Honne

The UXOSO reports to the CHSD and is responsible for field enforcement of the APP. All site MEC and MC activities will be conducted under the supervision of the HGL UXOSO on an "as needed" basis. The UXOSO will act as safety oversight for normal and emergency work, and will perform any necessary emergency notification as the On-Scene Incident Commander (OSIC). He is also responsible for the following:

- Authorizing stop work as related to H&S issues;
- Implementing the APP/SSHP;
- Enforcing all provisions of the APP/SSHP;
- Determining evacuation routes;
- Enforcing the use of the "buddy" system;
- Establishing work zones and exclusion zones (EZs);
- Investigating accidents, incidents, and near misses;
- Presenting daily safety meetings;
- Presenting training requirements to site personnel and visitors;
- Maintaining safety logs and records in the field;
- Implementing changes to the APP/SSHP as directed by the CHSD or project H&S manger (PHSM);
- Administering and enforcing the HSP;
- Enforcing the level of PPE required;
- Investigating work-related accidents and illnesses, and implementing corrective action plans;
- Establishing air-monitoring parameters based on expected contaminants;
- Establishing employee exposure monitoring notification programs;
- Stopping any operation that threatens the health or safety of the team or surrounding population; and
- Upgrading levels of protection based on site observations or monitoring results
- UXOSO will also complete and document daily safety inspections, equipment inspections, tailgate safety meetings, equipment calibration logs, air monitoring logs,

heat and/or cold stress monitoring logs, and any other safety and health documentation required by the this APP/SSHP.

4.1.5 Responsibilities at Project Level

All personnel involved in field activities are responsible for adherence to this APP during the performance of their work.

4.2 LINES OF AUTHORITY

A detailed organization chart depicting lines of authority for project management is found in B.12 of the WP. Roles and responsibilities of project personnel are explained in Section 2.2 of the WP.

5.0 SUBCONTRACTORS AND SUPPLIERS

When working in an EZ, employees of subcontractors will be escorted by HGL UXO-qualified personnel at all times to ensure that they avoid MEC hazards.

The UXOSO will require that employees of subcontractors adhere to applicable site safety requirements. This will involve consideration of the nature, location, and duration of their work tasks. At a minimum, employees of subcontractors will receive a daily briefing on anticipated risks and safety rules designed to mitigate those risks. The UXOSO will consult with the PHSM and/or CHSD, if questions arise. Subcontractors performing work at the site will attend a safety meeting as required by and held by the UXOSO each day prior to the start of work. The UXOSO will monitor subcontractor operations to ensure compliance with site safety requirements.

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6.0 TRAINING

All HGL employees, subcontractors employees, and site visitors must be trained IAW this APP. In every case, appropriate training will include briefings by the UXOSO on site hazards and work rules. In addition, the UXOSO will require evidence of prior completion of mandatory courses in some situations. The UXOSO will maintain a file of training certificates or other documentation verifying that these requirements have been met.

6.1 SITE-SPECIFIC SAFETY ORIENTATION

A detailed presentation on site risks and the workplace H&S program will be conducted by the UXOSO before work commences on the site, and at other times when new site workers arrive. Topics will include the following:

- Requirements and responsibilities for maintaining a safe and healthful work environment;
- General H&S policies and procedures;
- Safe work practices;
- Phases and sequence of work;
- Employee and supervisor responsibilities for reporting accidents;
- Emergency response plans and notification procedures for obtaining medical treatment;
- Work site communication;
- Access, egress, and evacuation routes;
- Route to the hospital;
- Procedures for reporting and correcting unsafe conditions or practices;
- Specific job hazards and the means to mitigate the risks;
- Names of and contact information for those responsible for safety program administration;
- Site hazards, hazard recognition, hazard control, and symptoms of excessive exposure to site hazards;
- MEC suspected on site;
- Material potentially presenting an explosive hazard (MPPEH) and precautions;
- Reporting requirements for MEC/UXO;
- Site control and work zone boundary locations and posting of hazards warning signs;
- Proper use of required PPE; and
- Safe use of engineering controls and equipment on the project site.

In addition, the UXOSO will provided detailed safety training in the following areas to workers exposed to the hazard described:

- **Chemical hazard communication**. If chemicals are brought onto the job site, employees potentially exposed to their hazards will receive appropriate safety training. This will include the details of the chemical hazard communication program described in Attachment 1, the SSHP.
- **Fire prevention and response**. The UXOSO will conduct training sessions on measures to prevent fires and procedures for suppressing fires. Employees will receive training in the use of fire extinguishers to fight incipient fires.
- **Control of hazardous energy (lockout/tagout)**. If site work involves the potential for injury from the release of stored energy, then employees will be trained in appropriate lockout/tagout procedures described in the SSHP.

The UXOSO will confer with the PHSM and/or CHSD to determine an appropriate schedule for re-training employees in site-specific safety topics. Annual or more frequent refresher sessions will be required.

Daily safety briefings will be conducted by the UXOSO for site personnel prior to the start of each day's activities. Such sessions will be used to discuss anticipated risks and safe practices to mitigate hazards.

The UXOSO also will conduct appropriate safety briefings for visitors and vendor representatives who will be on the site for short periods. The topics covered will be determined by the nature of the potential hazards to which they will be exposed.

6.2 MANDATORY TRAINING AND CERTIFICATION

The UXOSO will verify that the following training courses have been completed by on-site personnel:

- **UXO training**. Certification is required for site workers handling MPPEH items IAW DoD Explosives Safety Board (DDESB) Technical Paper (TP) 18.
- **Forty-hour course on H&S in hazardous waste operations.** Documentation of training as a site worker IAW 29 CFR 1926.65 is required for site workers and visitors potentially exposed to chemical, radiological, or ordnance hazards. Evidence of a recent annual refresher course also is required.
- **Eight-hour course on supervision of hazardous waste operations**. Documentation of training as a supervisor IAW 29 CFR 1926.65 is required for at least one HGL supervisor or manager present on the site.
- **Heavy equipment operation.** Documentation of training in the safe operation of heavy equipment will be required for operators of bulldozers, forklifts, backhoes, and similar machines.

- **First aid/cardiopulmonary resuscitation (CPR)**. Documentation of current certification in first aid/CPR will be required for a sufficient number of HGL employees to permit scheduling of at least two with this training on the project site at all times. Procedures to manage bloodborne pathogens should be a component of this training.
- **Respirator training**. The need for training in the use of respirators is **not** anticipated. However, if the PHSM and/or the CHSD deems that it is necessary, the UXOSO will require that anyone who uses a respirator provide evidence of appropriate training.
- **OSHA-approved 30-hour course on construction safety.** The UXOSO will keep on the site a certificate confirming that he received training in construction safety within the previous 3 years, IAW Paragraph 01.A.17 of EM 385-1-1.

In addition, the UXOSO will query new employees regarding their previous experience working on a hazardous waste site or MRS. He will arrange for an experienced supervisor to closely supervise inexperienced workers for at least the first 3 days of their work on the site.

6.3 PERIODIC SAFETY AND HEALTH TRAINING

Site-specific training will be provided for site workers including persons who might enter the active EZ or who are expected to work on site for more than three days at a time. Initial training will be conducted before the field task commences, then will be conducted as needed thereafter. During the initial site-specific training, the UXOSO will addrress physical, biological, and chemical hazards of the site, and ensure that employees have a thorough understanding of the APP/SSHO and H&S and SOPs and policies. This training will be conducted as necessary bafore new employees enter the EZ. Site-specific H&S training includes the following topics.

- Site history and background.
- Names of key on-site employees and their duties.
- Overview of personnel responsibilities for safety and health.
- Review of the APP.
- SOPs prepared specifically to address various H&S aspects of the project.
- Site control measures.
- Fire prevention measures.
- Engineering controls, such as dust suppression techniques.
- PPE requirements.
- Action levels for changing site PPE or evacuating the site.
- Heat or cold stress prevention, treatment, and monitoring.
- Proper use of heavy equipment and machinery, as required.

- Threatened and endangered species.
- Biological hazards including snakes, plants, and insect-borne disease.
- Other physical hazards such as slips, trips, and falls; noise; electrocution; being struck by something; or being caught in or between something.
- AHAs.
- Personal cleanliness and restrictions on eating, drinking, and smoking.
- Emergencies and review of emergency procedures and facilities, including universal precautions.
- Responsibilities and procedures for maintaining quality control.
- Procedures for site evacuation, decontamination, safe distances, place of refuge and assembly points, evacuation routes, and site security and control.

6.4 EMERGENCY RESPONSE TRAINING

Daily safety briefings will be conducted by the UXOSO for site personnel before the start of each day's activities. Such sessions will be used to discuss anticipated risks and safe practices to mitigate hazards. All site personnel, including subcontractors working on site, will attend the daily safety briefings. The UXOSO also will conduct appropriate safety briefings for visitors who may be on the site for short periods. The topics covered will be determined by the nature of the potential hazards to which they will be exposed.

Instructor qualifications are relative to the specific emergency response operation being conducted and are outlined in EM-385-1-1.

All employees will be made aware of the project emergency assistance network, the most probable route of evacuation from the site in the event of an emergency, and other emergency procedures included in the Project Plans. All employees will be briefed on the procedures and hazards specific to the site.

At the completion of site-specific training, 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 and the SSHP.

7.0 SAFETY AND HEALTH INSPECTIONS

Informal daily inspections will be conducted by the UXOSO to verify that site operations and personnel are complying with this APP and the SSHP. The results of these inspections will be recorded in the safety log and reported to the SUXOS.

The UXOSO will direct that any safety violation be corrected immediately, and he will halt work if a condition places employees at unacceptable risk. He will confer with the PHSM and/or CHSD if unsafe conditions cannot be corrected promptly, or if violations occur repeatedly.

The UXOSO will investigate every accident, injury, or near-miss event, and prepare a formal report of the incident for review by the PHSM and/or CHSD.

7.1 SAFETY INSPECTION SPECIFIC ASSIGNMENT OF RESPONSIBILITIES

Job site H&S inspections (reviews and audits) will be conducted by all levels of project management. The following reviews will be performed:

- The UXOSO will inspect the job site daily or more if events warrant. Findings will be documented on the daily H&S report and communicated to the project workers, PM, PHSM, and CHSD. A weekly summary report will be sent to the CHSD.
- The PM will direct site personnel to conduct an on-site safety audit during field activities. Findings will be documented on a field safety and health audit checklist and copied to the UXOSO, PHSM, and CHSD. Whenever possible, the UXOSO, PHSM, and CHSD will be included in these audits.
- The CHSD, or designated representative, may conduct unannounced job site safety audits at any time. Findings will be documented on a field safety and health audit checklist and copied to the PM, PHSM, and CHSD.

7.2 EXTERNAL INSPECTIONS/CERTIFICATIONS

Outside organizations or regulatory agencies may, at any time, perform inspections or audits of HGL's H&S practices. This policy does not apply to business-based (accounting or timesheet) audits.

The following individuals will be notified immediately when a regulatory agency inspector requests access to an HGL facility or work site for the purpose of a compliance inspection:

1. PM,
2. UXOSO,
3. SUXOS,
4. PHSM, and
5. CHSD.

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8.0 ACCIDENT REPORTING

In the event that a reportable accident occurs at the job site, the UXOSO will provide an immediate verbal notification to the HGL CHSD and to the USAESCH. WorkCare Incident Response will be called if injuries fall below 911 criteria.

Accidents will be investigated in depth to identify causes and control measures. USAESCH Preliminary Accident Notification (PAN) Form (APP Attachment 2) will be completed by the UXOSO and forwarded within 2 working days to the HGL CHSD and to the USAESCH PM.

A Form 3394 Report to USAESCH will be completed for accidents that result in one or more of the following outcomes:

- Fatal injury,
- Permanent total disability,
- Permanent partial disability,
- Hospitalization of three or more people resulting from a single occurrence,
- Property damage exceeding $2,000, or
- Three or more individuals become ill or have a medical condition which is suspected to be related to a site condition, or a hazardous or toxic agent on the site.

Based on the characterization of the accident and the level of personal injury, the CHSD will make and entry onto the yearly OSHA Form 300.

In the event of a significant near-miss event or other incident for which USAESCH reporting is not required, the UXOSO will investigate the incident and report the results of the investigation using appropriate HGL forms (Appendix F). These forms will be sent to the CHSD and to the HGL PM for review and action.

Daily records of first-aid treatments will be maintained by the UXOSO on prescribed forms.

Exposure data (personnel hours worked) will be provided to the PM by the SUXOS at regular intervals, and the PM will prepare the monthly reports for the USAESCH PM.

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9.0 PLANS (PROGRAMS, PROCEDURES) REQUIRED BY THE SAFETY MANUAL

The various safety plans listed below will be implemented during work on the project. These are found below or in the stated section or sections of the accompanying SSHP, unless a different document is cited.

9.1 LAYOUT PLANS

The temporary field office and vehicle parking will be established during site setup, and will also be located on the former Conway BGR. An equipment storage container will be placed near established accss roads, and near the break area.

9.1.1 Directions to Hospital

To facilitate the quick retrieval of information in the event of an emergency, the hospital route directions and maps to following two medical treatment facilities have been placed in the front of this document.

Emergency Medical Care
Grand Strand Regional Medical Center
809 82nd Pkwy
Myrtle Beach, SC 29572
Grandstrandmed.com

Beach Urgent Care
9672 N Kings Hwy
Myrtle Beach, SC 29572
Beachurgentcare.com

9.1.2 Emergency Treatment

At least two site workers qualified in first aid and CPR will be present on the site at all times. It is anticipated that workers with this training will assist others who have minor injuries on the site. The UXOSO will be trained in toxic chemical exposure detection and emergency treatment. If non-911 level injuries occur, WorkCare Incident Intervention shall be contacted and the incident reviewed with an Occupational Nurse or Doctor. Many of these types of injuries can be treated on site or after-hours and do not require a trip to the hospital emergency room or outpatient clinic. A map showing the route from the project site to the local hospital, emergency telephone numbers, hospital contact information, and directions to the hospital are also located in the front of this APP.

9.2 EMERGENCY RESPONSE PLANS

The Emergency Response Plan is included in SSHP Section 16.0. Emergency response plans are in place to address emergencies and the appropriate action to be taken by site personnel.

To facilitate the quick retrieval of information in the event of an emergency, the emergency points of contacts has been placed in the front of this APP. In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be notified. For emergency situations, telephone contact should be made with the site point of contact who will

then contact the appropriate response teams. In the event of a serious, life threatening emergency, emergency personnel should be contacted before contacting the site point of contact.

9.2.1 Procedures and Tests

Not applicable.

9.2.2 Spill Plans

A portable spill-response kit containing oil/solvent absorbent pillows/pads, PPE, and disposal supplies will be maintained in a readily accessible location where fuels, oils, solvents and other environmentally harmful materials are stored on site. The UXOSO will train workers in the proper use of such equipment.

9.2.3 Firefighting Plan

The following measures will be implemented during site field activities to minimize the risk of fire and/or explosion:

- Smoking will be permitted only in designated on-site smoking areas. All sources of ignition shall be prohibited within 50 feet of operations with a potential fire hazard.
- Flammable liquids will be stored in approved containers only. Only labeled/listed (by nationally recognized testing laboratory) containers and portable tanks shall be used for the storage of flammable and combustible liquids.
- Work areas will be cleared of excess vegetation and obstructions whenever practical.
- Portable fire extinguishers shall be provided on site. Fire extinguishers shall be approved by a nationally recognized testing laboratory to identify the listing and labeling organization and the fire test and performance standard the fire extinguisher meets or exceeds.
- Vehicles will not be parked on areas with tall grass.
- Storage trailers/boxes will be inspected daily.
- Smoking will be restricted to areas with minimal vegetation and cigarette butts will be disposed of in approved containers, not on the ground.

HGL does not anticipate that operations using flames (that is, welding and cutting) or the transfer, use, storage, or handling of flammable liquids will occur during the execution of this project. However, fuel products that may be available on site may be either flammable or combustible. In the unlikely event that petroleum products are ignited, these materials will burn rapidly with intense heat and the production of toxic gases and particulates. Personnel shall evacuate the immediate area and the SUXOS or UXOSO will immediately summon emergency assistance by calling 911.

9.2.4 Posting of Emergency Telephone Numbers

Emergency Contact information and telephone numbers are provided in the front cover of the APP and SSHP. This emergency contact information will also be posted in the field office on the HGL Health & Safety Bulletin Board, available in each project vehicle, and publically available in the Project Manager's resident office.

Emergency Telephone Numbers and Project Contacts *

This Emergency Information will be posted in the field office on the HGL Health & Safety Bulletin Board, available in each project vehicle, and publically available in the HGL's Project Manager's resident office. For emergency situations that occur on a facility with their own response team, the site point of contact listed below shall be called. For other project sites or for incidents occurring outside of project sites requiring emergency assistance, responding field staff shall call 911. Corporate notifications to the PM and the CHSD should be made after immediate needs are met. State and Federal spill reporting hotline notifications will be made by the appropriate party after discussions between the PM and the client.

Fire, Police, Emergency Medical Services	911	
Emergency Medical Care **Grand Strand Regional Medical Center** 809 82nd Pkwy Myrtle Beach, SC 29572 Grandstrandmed.com **Beach Urgent Care** 9672 N Kings Hwy Myrtle Beach, SC 29572 Beachurgentcare.com	(843) 692-1000 (843) 497-2273	
National Poison Control	(800) 222-1222	
National Response Center Environmental Emergencies	(800) 424-8802	
Client		
USAESCH, PM	Chris Cochrane	(256) 895-1696 chris.cochrane@usace.army.mil
USAESCH, PM	Chase Hamley	(256) 895-1569 Chase.G.Hamley@usace.army.mil
U.S. Army Corps of Engineers, Wilmington District (CESAW), PM	Ray Livermore	(910) 251-4702 Raymond.R.Livermore@usace.army.mil
U.S. Army Corps of Engineers, Savannah District (CESAS), PM	Julie Hiscox	(912) 652-5363 Julie.A.Hiscox@usace.army.mil
South Carolina Deptment of Health & Environmental Control, PM	Susan Byrd	(803) 898-0308
HydroGeoLogic, Inc.		
HGL 24/7 Emergency Number	(800) 341-3647	
PM	Kimberly Vaughn	(512) 828-6684 kvaughn@hgl.com
SUXOS	Joel Sanders	(435) 919-9770
UXOSO	Oscar Honne	(915) 503-4083
CHSD	Stephen Davis, CIH, CSP	(865) 659-0499 sdavis@hgl.com
Project H&S Manager	Edie Scala-Hampson, CIH, CHMM	(847) 409-6384 escala-Hampson@hgl.com
HGL Corporate Occupational Physician *WorkCare 24-Hour Hotline Nurse	Peter Greaney, MD	(714) 978-7488, ext. 114 *(888) 449-7787

9.2.5 Medical Support

A minimum of two personnel will have current training in CPR and first aid and have current certification documentation available. These individuals will be on site throughout the project. The HGL Occupational Physician will be available to provide patient-specific information in case medical treatment is needed. Dr. Peter Greaney of WorkCare can be reached at telephone number (714) 978-7488, extension 114. First Aid/CPR trained personnel identified for this project include:

- Oscar Honne (UXOSO)
- Joel Sanders (SUXOS)

If injuries are more serious, the UXOSO will assess the situation and determine a course of action consistent with the written emergency procedures, which are found in the accompanying SSHP. The UXOSO will determine whether the injured person should be transported using a site vehicle, or if an ambulance will be required to transport the injured person to a medical treatment facility.

Emergency medical services will be contacted by calling 911. The designated caller will remain on the line with the 911 operator unless the caller needs to assist the injured person. The offsite medical support will be provided by the two medical facilities listed in Section 9.1.1.

All onsite and offsite medical support will be conducted IAW the requirements of the PWS, and DA Pamphlet 50-6 and DA Pamphlet 40-173.

9.3 PLAN FOR PREVENTION OF ALCOHOL AND DRUG ABUSE

HGL's Substance Abuse Policy is administered by the HGL Human Resources Department, and will be applied at the project level in collaboration with the project UXOSO and the Senior Site Supervisor. HGL is committed to the elimination of drug and alcohol abuse in the workplace and among potential applicants for employment. The written policy, which is available upon request, provides for pre-employment, random, and for-cause testing.

All project personnel will be asked to read and abide by the HGL Substance Abuse Policy and Procedures located on the HGL SharePoint website. This policy will be posted at the job site and in the project office.

HGL Portal Home > Document Center > HGL Policies

HGL SharePoint link:
https://sharepoint.hgl.com/docs/HGL%20Policies/Substance%20Abuse%20Policy.pdf

9.4 SITE SANITATION PLAN

The following sanitation provisions will be established and maintained for the duration of this project. See USACE EM 385-1-1, Section 02.

- **Drinking Water**: An adequate supply of cool water will be supplied and kept in water coolers in the on-site support zone. The water cooler will be clearly marked as potable water only and kept closed.
- **Toilet Facilities**: HGL will provide a portable sanitary facility on the site; hand-washing stations will be made available.
- **Waste Disposal**: A trash receptacle will be provided in the support zone for the disposal of rubbish and other nonhazardous waste materials.

9.5 ACCESS AND HAUL ROAD PLAN

Not applicable. Access and haul roads are not within the PWS for this project.

9.6 RESPIRATORY PROTECTION PLAN

Not applicable. Respiratory hazards are not anticipated for this project.

9.7 HEALTH HAZARD CONTROL PROGRAM

Not applicable. Hazardous or toxic agents are not anticipated for this project.

9.8 HAZARD COMMUNICATION PROGRAM

A Hazard Communication Program will be implemented to provide information about manufactured hazardous substances, including chemical hazards and the control of those hazards. The written Hazard Communication Program includes information on container labeling, the use of safety data sheets (SDS), and personnel training. Hazardous waste substances are excluded from this program. The following policies and regulations will be followed: the HGL H&S Program Mannual, Section 5.1, Hazard Communication; USACE EM 385-1-1, Section 06.B.01, Hazard Communication; and 29 CFR 1910.1200 and 1926.59.

The UXOSO must ensure that project personnel can immediately obtain the required information about chemicals of concern during an emergency. The UXOSO is to perform the following:

- Complete an inventory of chemicals brought on site by HGL.
- Confirm that an inventory of chemicals brought on site by HGL subcontractors is available.
- Request or confirm locations of SDS/MSDSs from the client, contractors, and subcontractors for chemicals to which HGL employees potentially are exposed.

- Before or as the chemicals arrive on site, obtain an SDS/MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employee's required chemical-specific hazardous communication training.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

9.9 PROCESS SAFETY MANAGEMENT PLAN

Not applicable. HGL do not anticipate a process that will involve flammable liquid or gas on site in a quantity of 10,000 pounds or more during this project.

9.10 LEAD ABATEMENT PLAN

Not applicable. Lead hazards are not anticipated for this project.

9.11 ASBESTOS ABATEMENT PLAN

Not applicable. Asbestos hazards are not anticipated for this project.

9.12 RADIATION SAFETY PROGRAM

Not applicable. Radiation hazards are not anticipated for this project.

9.13 ABRASIVE BLASTING

Not applicable. Abrasive hazards are not anticipated for this project.

9.14 HEAT/COLD STRESS MONITORING PLAN

9.14.1 Heat Stress

The potential for heat stress is high for this project because the fieldwork may be conducted during the summer months, therefore, extra care must be taken to observe and respond to symptoms. Sweating does not cool the body unless the sweat is evaporated from the body. The use of some PPE can reduce the body's ability to eliminate large quantities of heat because the evaporation of sweat is decreased. The body's effort to maintain an acceptable temperature may become impaired and this may cause heat stress. Increased body temperature and physical discomfort also promote irritability and a decreased attention to the performance of hazardous tasks. If semi-permeable and impermeable PPE is used at the site, heat stress is a MAJOR HAZARD.

9.14.1.1 Types of Heat Stress

Heat stress related problems include heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. Heat rash occurs because sweat is not evaporating, making the skin wet most of the time. Standing erect and immobile allows blood to pool in the lower extremities. As a result, blood does not return to the heart to be pumped back to the brain and fainting may occur. Heat cramps are painful spasms of the muscles due to excessive salt loss resulting from profuse sweating. Heat exhaustion occurs because of the large fluid and salt loss from profuse sweating.

Heat stroke occurs when the body's temperature regulatory system has failed. Skin is hot, dry, red, and spotted. These skin color changes may not be readily evident in darker skinned individuals and other signs must be relied upon. The affected person may be mentally confused, delirious, and convulsions may occur. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area immediately. The person should be soaked with water and fanned to promote evaporation. Medical attention must be obtained immediately. EARLY RECOGNITION AND TREATMENT OF HEAT STROKE ARE THE ONLY MEANS OF PREVENTING BRAIN DAMAGE OR DEATH.

9.14.1.2 Early Symptoms of Heat Stress Related Problems

Personnel should recognize the early symptoms of heat stress. These symptoms include:

- Reduced performance,
- Lack of coordination,
- Lack of alertness,
- Unsteady walk,
- Excessive fatigue,
- Muscle cramps, or
- Dizziness.

9.14.1.3 Administrative Controls

Wet bulb globe temperature (WBGT) monitoring will be performed by the Site Safety and Health officer (SSHO) when temperatures on site exceed 75°F.

9.14.1.4 Work/Rest Regimen

The management of risk for heat stress exposures centers around the principal of job-specific controls. Controls that will be implemented to reduce the potential for heat stress includes: use of acclimated personnel, providing adequate replacement fluid, educating individuals to recognize the early symptoms of heat stress, use of cooling vest, physiological monitoring, and development of a work/rest schedule that will prevent the onset of heat stress. Work/rest regimens will be implemented in accordance with the limits specified in Table 9.1 for Level D PPE.

Work schedules may be adjusted in accordance with physiological monitoring results.

If at the end of a work period, the core body temperature for any team member exceeds 38°C (100.4 °F), then the next lower work/rest regimen will be instituted.

If no team member's core body temperature exceeds 37.5 °C (99.5 °F), then the next higher work/rest regimen may be instituted.

A WBGT monitor may be used to monitor for conditions that pose a threat of heat stress. WBGT monitoring should be conducted by the SSHO/SUXOS when workers are dressed in Level D ensembles and the ambient temperature exceeds 75 °F . Once the WBGT has been determined, the SSHO/SUXOS can estimate workers' metabolic heat load using Table 9.1 or Table 9.2 to determine the appropriate work/rest regimen. Modification to the work/rest schedule can be instituted by the SSHO/SUXOS based on physiological monitoring data.

Whenever a new team member begins work on site, that member's entire team will use Table 9.1 for establishing the work/rest regimen until the new team member is acclimated.

Table 9.1
Permissible Heat Exposure Threshold Limit Values °C and (°F WBGT)
when Level D PPE is Worn

Work/Rest Regimen	Workload		
	Light	**Moderate**	**Heavy**
Continuous Work	31 (88)	28 (82)	------
75% Work 25% Rest, each hour	31 (88)	29 (84)	27.5 (81)
50% Work 50% Rest, each hour	32 (90)	30 (86)	29 (84)
25% Work 75% Rest, each hour	32.5 (90)	31.5 (89)	30.5 (87)

NOTE: The workload category may be established by ranking each job into light, medium, or heavy categories on the basis of type of operation:

Light: (up to 200 kcal/hr or 800 Btu/hr): e.g., sitting or standing to control machines, performing light hand or arm work.

Moderate: (200-350 kcal/hr or 800-1400 Btu/hr): e.g., walking about with moderate lifting and pushing.

Heavy: (350-500 kcal/hr or 1400-2000 Btu/hr): e.g., pick and shovel work.

Use of cooling vests by team members may also modify the work/rest regimen or the time of stay for continuous work. In this event, work/rest regimens will be modified as described in above.

9.14.1.5 Prevention of Heat Stress

Proper training and preventive measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illnesses. To avoid heat stress, the following steps should be taken:

- Adjust work schedules.
  - Modify work/rest schedules as described above.
  - Mandate work slowdowns as needed.
- Perform work during cooler hours of the day, if possible.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Ensure workers are acclimated to weather conditions and have extensive experience in the selected level of PPE. Workers can be acclimatized by gradually increasing the workload over a period of days.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluids intake must approximately equal the amount of water lost in sweat, e.g., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kilograms [kg]) of weight loss. The normal thirst mechanism is not sensitive enough to ensure that enough water will be consumed to replace water lost through sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature at 50° to 60°F (10° to 16.6°C).
  - Provide small disposable cups that hold about 4 ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or diluted drinks) before beginning work.
  - Urge workers to drink a 16 ounce cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
- Train workers to recognize the symptoms of heat-related illnesses.
- Provide potassium supplements (banana or potassium chloride tablets).
- Rotate personnel and alternate job functions.

9.14.2 Cold Stress

Exposure to low temperatures presents a risk to employee safety and health both through the direct effect of the low temperature on the body and collateral effects such as slipping on ice, decreased dexterity, and reduced dependability of equipment. Work conducted in the winter months can become a hazard for field personnel due to cold exposure. All personnel must exercise increased care when working in cold environments to prevent accidents that may result from the cold. The effects of cold exposure include frostbite and hypothermia. Wind increases the impact of cold on a person's body. Systemic cold exposure is referred to as hypothermia. Local cold exposure is generally labeled frostbite. Recognition of the symptoms of cold-related illness will be discussed during the H&S briefing conducted prior to the onset of site activities.

Hypothermia is a life-threatening condition in which the core body temperature falls below 95°F. Hypothermia can occur at temperatures above freezing particularly when the skin or clothing becomes wet. During exposure to cold, maximum shivering occurs when the core temperature falls to 95°F. As hypothermia progresses, depression of the central nervous system becomes increasingly more severe (Table 9.2). This accounts for the progressive signs and symptoms ranging from sluggishness and slurred speech to disorientation and eventually unconsciousness.

Table 9.2
Progressive Clinical Symptoms of Hypothermia

Core Temperature (°F)	Clinical Symptoms
95	Maximum shivering
87 to 89	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated
84 to 86	Progressive loss of consciousness; muscular rigidity; respiratory rate decreases
79	Victim rarely conscious
70 to 72	Maximum risk of ventricular fibrillation

Frostbite is both the general and medical term given to areas of cold injury. Unlike hypothermia, frostbite rarely occurs unless environmental temperatures are less than freezing and usually less than 20°F. Frostbite injuries occur most commonly on the distal parts of the body (nose, earlobes, hands, and feet) that are subject to intense vasoconstriction. The three general categories of frostbite are:

- **Frostnip –** A whitened area of the skin that is slightly burning or painful.
- **Superficial Frostbite –** Waxy, white skin with a firm sensation but with some resiliency. Symptomatically feels "warm" to the victim with a notable cessation of pain.
- **Deep Frostbite –** Tissue damage deeper than the skin, at times, down to the bone. The skin is cold, numb, and hard.

9.14.2.1 Preventing Cold Exposure

In preventing cold stress, the SSHO must consider factors relating to both the worker and the environment. Training, medical screening, establishment of administrative controls, selecting proper work clothing, and wind-chill monitoring all contribute to the prevention of hypothermia and frostbite.

- **Training –** Recognizing the early signs and symptoms of cold stress can help prevent serious injury. Therefore, workers will be trained to recognize the symptoms of hypothermia and frostbite and have appropriate first-aid instruction. When the air temperature is below 50°F, the SSHO will inform workers of the proper clothing requirements and any work practices that are in effect to reduce cold exposure.

- **Administrative Controls –** The SSHO will establish a work/rest schedule based on worker monitoring. At the first sign of uncontrollable shivering the worker will be rested in a heated shelter. Work will stop when the air temperature reaches 0°F.
- **Clothing –** Workers will be encouraged to layer clothing when air temperature is below 50°F. Clothing that has a high insulation value will be worn under protective garments. Insulated gloves will be worn when the wind chill index is below 32°F.

9.15 CRYSTALLINE SILICA MONITORING PLAN

Not Applicable.

9.16 NIGHT OPERATIONS LIGHTING PLAN

Not applicable. Night operations are not within the PWS for this project. Activities will be performed during daylight hours only.

9.17 FIRE PREVENTION PLAN

A copy of the site-specific Fire Prevention Plan will be posted on site and implemented. See USACE EM 385-1-1, Section 09.A.01.

- Major work place fire hazards include the following:
  - Brush and range fires,
  - Flammable and combustible liquids,
  - Electrical fires, and
  - Waste materials and combustible waste.
- Potential ignition sources include the following:
  - Matches, lighters, sparks, and open flames,
  - Heat or sparks from vehicle engines or exhaust,
  - Electrical overloads or malfunctions,
  - Lightning and inclement weather,
  - Smoking,
  - Static discharge, and
  - Internal combustion.
- Types of fire suppression equipment include the following:
  - Water, and
  - Fire extinguishers.
- Housekeeping responsibilities include the following:
  - All site workers are responsible for fire prevention.
  - A good housekeeping program must be implemented.
  - Waste material must be removed daily.

In the event of a fire in the HGL field office, personnel will only attempt to extinguish the fire if it is identified as containable and one other person is present to act as a safety observer. All additional occupants will evacuate immediately following the posted emergency evacuation routes and go to the designated rally point. A head count will be taken by the senior person present to account for all personnel.

9.18 WILD LAND FIRE PREVENTION PLAN

Wild land fires will be responded to as indicated in Section 9.17, Fire Prevention Plan, and Section 9.2.3, Firefighting Plan. Additional fire prevention measures will be taken (e.g. brush removal, wetting area down) during planned UXO disposal activities. See USACE EM 385-1-1, Section 09.K.01.

9.19 HAZARDOUS ENERGY CONTROL PLAN

Not applicable. Hazardous energy locations are not anticipated for this project.

9.20 CRITICAL LIFT PROCEDURES

Not applicable. Critical lifts are not anticipated for this project.

9.21 CONTINGENCY PLAN FOR SEVERE WEATHER

Routinely monitoring weather conditions and reports may help reduce the impact of severe weather and natural disasters. Weather conditions will be a part of the daily briefing. It may be necessary to halt certain hazardous operations or stop work altogether to allow the situation to pass. The UXOSO must decide what operations, if any, are safe to perform based on existing and anticipated conditions.

Explosive and UXO operations must cease during thunderstorms and if there is any indication that lightning is approaching within 5 miles of the project location. See USACE EM 385-1-97, Section I.2.J.02.02.

The best protection against most severe weather episodes and natural disasters is to avoid them. This means seeking shelter before a storm hits. See USACE EM-385-1-1, Section 06.I.

9.21.1 Safe Locations During Severe Weather and Locations to Avoid

No place is absolutely safe from severe weather; however, some places are safer than others.

Large enclosed structures (substantially constructed buildings) tend to be much safer than smaller or open structures.

- The risk for lightning injury depends on whether the structure incorporates lightning protection, the construction materials used, and the size of the structure.

- In general, fully enclosed metal vehicles such as cars, trucks, buses, and vans, with the windows rolled up, provide good shelter from many weather conditions.

AVOID being in or near

- High places and open fields, isolated trees, rain or picnic shelters, communications towers, electrical equipment, pipes, flagpoles, light poles, bleachers (metal or wood), metal fences, or water (lakes, streams, rivers, etc.).

When inside a building AVOID

- Using a telephone, washing hands, or any contact with conductive surfaces with exposure to the outside (such as a metal doors or window frames, electrical wiring, telephone wiring, cable TV wiring, plumbing, etc.) if lightning is a factor.

9.21.2 Safety Guidelines for Individuals

Generally speaking, personnel should identify and seek shelter that is appropriate for the type of severe weather being encountered. Proper shelter always includes a sound structure and removal from the elements.

When available, attention is to be paid to warnings from sources such as the National Weather Service or National Oceanic and Atmospheric Administration (NOAA) and other credible weather detection systems. However, this information should not override good common sense.

9.22 FLOAT PLAN

Not Applicable.

9.23 SITE-SPECIFIC FALL PROTECTION & PREVENTION PLAN

Not applicable. Field activities at heights greater than 4 feet above ground surface are not within the PWS for this project.

9.24 DEMOLITION PLAN

Not applicable. Building or structure demolitions are not within the PWS for this project.

9.25 EXCAVATION/TRENCHING PLAN

HGL does not anticipate that it will have to excavate to a depth greater than 4 feet to retrieve the buried anomalies. However, if the anomaly is buried at a depth greater than 4 feet or if HGL has to dig to a greater depth to free the anomaly, the UXOSO, acting as an HGL Competent Person for excavation safety, will submit an excavation plan in accordance with EM 385-1-1, Section 25. The work on that particular anomaly or trench will be suspended until the excavation plan is prepared and approved.

9.26 EMERGENCY RESCUE (TUNNELING) PLAN

An Emergency Rescue Plan is not required for this project. Local emergency rescue capabilities will be utilized through the 911 system.

9.27 UNDERGROUND CONSTRUCTION FIRE PREVENTION AND PROTECTION PLAN

Not applicable. Underground activities are not within the PWS for this project.

9.28 COMPRESSED AIR PLAN

Not applicable. Compressed air activities are not within the PWS for this project.

9.29 FORM AND SHORING ERECTION AND REMOVAL PLANS

Not applicable. Form and shoring activities are not within the PWS for this project.

9.30 PRECAST CONCRETE PLAN

Not applicable.

9.31 LIFT SLAB PLANS

Not applicable. Jacking and slab activities are not within the PWS for this project.

9.32 STEEL ERECTION PLAN

Not applicable. Steel erection activities are not within the PWS for this project.

9.33 SITE SAFETY AND HEALTH PLAN FOR HTRW WORK

Not applicable. Hazardous, toxic, and radioactive waste (HTRW) work will not be performed during thid RI/FS.

9.34 LIFT SLAB PLANS

Not applicable

9.35 BLASTING SAFETY PLAN

Not applicable.

9.36 DIVING PLAN

Not applicable. Diving activities are not within the PWS for this project.

9.37 CONFINED SPACE

Not applicable. Confined space hazards are not anticipated for this project. However, excavations greater than 4 feet in depth will be considered confined spaces. Where there is the potential for buildup of vapors, permit-required confined space entry procedures will be followed. See USACE EM 385-1-1, Section 34.A.

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10.0 RISK MANAGEMENT PROCRESSES

HGL has analyzed the PWS and historical information to determine work risk hazards associated with fieldwork tasks to be performed at the site. The hazards likely to be encountered during fieldwork include classic safety, explosive ordnance, physical safety, and biological hazards. Chemical and ionizing radiation hazards are not likely to be encountered while performing fieldwork.

The following task hazard analysis includes both Hazardous Waste Operations and Emergency Response (HAZWOPER) and non-HAZWOPER related tasks, which may or may not occur during the initial phase of the project, but may occur during the removal of MEC or during the continuation of fieldwork. Table 10.1 presents the task hazard analysis for all planned work activities. The AHA sheets developed specifically for the hazardous tasks associated with this project site are located in Appendix F of the APP. Each AHA sheet provides job-specific steps, associated hazards, and those actions necessary to eliminate or minimize the potential hazards.

Table 10.1
Task Hazard Analysis

Potential Hazards	Tasks					
	MEC Intrusive Ops	Geophysical Investigation Surveying	MEC Excavation	MPPEH Processing	MC Soil Sampling	Off-road Vehicle Operations
Flying debris/objects			X	X		X
Noise > 85dBA		X	X	X		X
Electrical	X	X	X	X		X
Suspended loads		X	X	X		
Buried utilities, drums, tanks	X	X	X	X		
Slip, trip, fall	X	X	X	X	X	X
Back injury	X	X	X	X	X	X
Confined space entry			X			
Trenches/excavations			X		X	
Visible lightning	X	X	X	X	X	X
Vehicle traffic	X	X	X			X
Fires		X	X			X
Heavy equipment			X			
Explosive ordnance	X	X	X	X	X	
Biological	X	X	X	X	X	X
Heat/cold stress	X	X	X	X	X	X

Table 10.2 presents the principal steps, potential hazards, and recommended controls for the MEC/UXO tasks.

Table 10.2
Hazard Analysis Steps, Hazards, and Recommended Controls for MEC Tasks

Principal Steps	Potential Hazards	Recommended Controls
Transportation of explosive materials	Accidental detonation of explosives	Explosives will be transported IAW 49 CFR, Parts 100-199.
		Explosives will be transported in closed vehicles whenever possible.
		When using an open vehicle, explosives will be covered.
		Motor vehicles will be shut off when loading/unloading explosives.
		Beds of vehicles will have a nonconductive bed liner, dunnage, or sand bags to protect the explosives from contact with the metal bed and fittings.
		Initiating explosives, such as blasting caps, will remain separated at all times.
		Each vehicle used for the transport of MEC/UXO will be outfitted with a fire extinguisher and first aid kit.
	Accidental detonation of explosives	Trucks will not be refueled when loaded with MEC/UXO.
	Motor vehicle driver	Motor vehicle drivers operating within or outside the boundaries of any federal installation will be licensed in accordance with federal, state, and local regulations.
	Vehicle operations	Drivers will observe all posted speed limits while operating a motor vehicle on a public roadway.
		Vehicles transporting explosives off road will not exceed 20 miles per hour (mph).
		Chock wheels when loading or unloading MEC/UXO-related materials.
		All drivers will be licensed IAW state, local, and station regulations.
		The maximum vehicle speed while transporting explosives off paved roads will be 20 mph.
Storage of explosive materials	Environmental hazards Biological hazards Physical hazards Electrical hazards Suspended loads Fire hazards	PPE, delay of work effort PPE, repellants, avoidance PPE, proper lifting techniques, engineering controls PPE, grounding, equipment maintenance PPE, hardhats Non-sparking tools, grounding Fire extinguishers, prevention of smoking
	Accidental detonation of explosives	Materials will be stored in accordance with federal, state, and local regulations.
		Refer to the UXO subcontractor's SOPs for the storage of explosive materials.

Table 10.2 (continued)
Hazard Analysis Steps, Hazards, and Recommended Controls for MEC Tasks

Principal Steps	Potential Hazards	Recommended Controls
Surveying and establishing boundaries and grids	Accidental detonation of explosives	Personnel involved will attend a site-specific MEC/UXO recognition class prior to the commencement of any site activities.
		UXO personnel will escort non-UXO personnel at all times.
		Mark and avoid UXO. Only UXO personnel will handle MEC/UXO waste.
		Check location with magnetometer prior to driving stakes.
	Wildlife, slips, trips, falls, insects, poisonous plants, use of hand tools.	Refer to the AHA.
MEC avoidance	Accidental detonation of explosives	Personnel involved will attend a site-specific MEC/UXO recognition class prior to the commencement of any site activities.
		Personnel must remainalert and mark all MEC located.
		A UXO Technicain II or above will escort non-UXO personnel at all times. Intrusive operations will cease when nonessential personnel are within the EZ.
		Visual surface sweeps will be conducted with magnetometers or other suitable geophysical instrumentation to identify potential MEC/UXO.
MEC avoidance	Environmental hazards Biological hazards Physical hazards Fire hazards	PPE, delay of work effort PPE, repellants, avoidance PPE, proper lifting, engineering controls Prevention of smoking Fire extinguishers Drivers will not stop or park in grass areas that may catch fire from vehicle exhaust or heat.
Transportation of MEC	Accidental detonation of explosives	No personnel allowed in cargo compartment of vehicle.
	Accidental detonation of explosives	No MEC/UXO will be allowed in the passenger compartment of the vehicle.
		MEC/UXO will be blocked, braced, and secured.
		No smoking will be permitted in vehicles used for transport of MEC/UXO.
	Vehicle operations	Vehicles will be placarded IAW DOT regulations.
		Vehicles transporting explosives off road will not exceed 20 mph.
		Drivers will observe all posted speed limits while operating a motor vehicle on a public roadway.
UXO disposal operations	Accidental detonation of explosives	Procedures for safe demolition and explosives use will be observed.

Table 10.2 (continued)
Hazard Analysis Steps, Hazards, and Recommended Controls for MEC Tasks

Principal Steps	Potential Hazards	Recommended Controls
MEC-related scrap demilitarization	Accidental detonation of explosives	Only Explosive Ordnance Disposal/UXO technicians will perform explosive demilitarization of MEC-related scrap.
Inspection/certification of MPPEH	Accidental detonation of explosives	Only UXO technicians will inspect MPPEH and range-related scrap.
		Personnel in the immediate vicinity of MPPEH inspections will be kept to the minimum necessary for safe operations, but no fewer than two UXO technicians, consisting of at least one UXO Technician II and one UXO Technician III.
		Observe requirements of DoD 4160.21-M-1.
UXO disposal operations MEC-related scrap demilitarization Inspection/certification of MPPEH MEC intrusive activities	Noise hazards Environmental hazards Biological hazards Physical hazards Electrical hazards Suspended loads Fire hazards	Hearing protection, engineering controls PPE, delay of work effort PPE, repellants, avoidance PPE, proper lifting techniques, engineering controls PPE, grounding, equipment maintenance PPE, hardhats Non-sparking tools and grounding Fire extinguishers Prevention of smoking
MEC intrusive activities	Accidental detonation	The UXO team will follow MEC anomaly avoidance procedures during excavation activities.
		Personnel in the immediate vicinity of MEC operations will be kept to the minimum necessary for safe operations, but no less than two UXO technicians comprising of at least one UXO Technician II and one UXO Technician III.
		Do not subject MEC/UXO to heat, shock, or friction.
		Only hand excavation permitted when within 1 foot of known MEC/UXO.
		Hand-operated magnetometers will be used frequently to pinpoint the location of suspect MEC/UXO.
	Non-UXO personnel	Establish EZ; post warning signs, maintain site control.
		Stop all MEC/UXO operations when non-UXO personnel are within the EZ.

11.0 ABBREVIATED ACCIDENT PREVENTION PLAN

Not applicable. An abbreviated APP is not required under this project.

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ATTACHMENT 1

SITE SAFETY AND HEALTH PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

AAB	Army Air Base
AAF	Army Air Field
AHA	Activity Hazard Analysis
ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASR	Archive Search Report
BATF	Bureau of Alcohol, Tobacco, and Firearms
BGR	Bombing and Gunnery Range
CDC	Center for Disease Control
CFR	Code of Federal Regulations
CHSD	Corporate Health and Safety Director
CPR	cardiopulmonary resuscitation
DDESB	Department of Defense Explosives Safety Board
DGM	digital geophysical mapping
DID	data item description
DoD	U.S. Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EM	Engineering Manual
EOD	explosive ordnance disposal
EP	Engineering Pamphlet
ER	Engineering Regulation
ERP	emergency response plan
ESP	Explosives Site Plan
EZ	exclusion zone
FS	Feasibility Study
GPS	Global Positioning System
H&S	Health and Safety
HAZWOPER	Hazardous Waste Operations and Emergency Response
HGL	HydroGeoLogic, Inc.
IC	institutional control
IDW	investigation-derived waste
ISM	incremental sampling method
KO	Contracting Officer

MC	munitions constituent
MD	munitions debris
MEC	munitions and explosives of concern
MG	machine gun
mph	miles per hour
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MSDS	material safety data sheets
NDAI	No DoD Action Indicated
OE	ordnance and explosives
OESS	OE Safety Specialist
OJT	on-the-job-training
OSHA	Occupational Safety and Health Administration
PHSM	Project Health and Safety Manager
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PWP	plasticized WP
PWS	Performance Work Statement
RA	removal action
RI	remedial investigation
ROE	right-of-entry
RP	red phosphorus
RR	rifle range
SOP	standard operating procedure
SSHP	Site Safety and Health Plan
SUXOS	Senior UXO Supervisor
SZ	support zone
TCRA	time critical removal action
TO	task order
TP-18	Technical Paper 18
TVG	transverse magnetometer/gradiometer
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineer Support Center, Huntsville
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist

UXOSO	UXO Safety Officer
WERS	Worldwide Environmental Remediation Services
WBGT	wet bulb globe temperature
WNV	West Nile Virus
WP	white phosphorus
WP	work plan

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EMERGENCY INFORMATION

To facilitate quick retrieval of information in the event of an emergency, this summary has been placed in the front of this Accident Prevention Plan. In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. In most emergency situations, telephone contact should first be made with the site point of contact, who will then notify the appropriate response teams. In the event of a life-threatening emergency, emergency personnel should be contacted before the site point of contact.

EMERGENCY TELEPHONE NUMBERS AND PROJECT CONTACTS

Fire, Police, Emergency Medical Services	911	
Emergency Medical Care **Grand Strand Regional Medical Center** 809 82nd Pkwy Myrtle Beach, SC 29572 Grandstrandmed.com **Beach Urgent Care** 9672 N Kings Hwy Myrtle Beach, SC 29572 Beachurgentcare.com	(843) 692-1000 (843) 497-2273	
National Poison Control	(800) 222-1222	
National Response Center Environmental Emergencies	(800) 424-8802	
Client		
U.S. Army Engineer Support Center, Huntsville (USAESCH), Project Manager	Chris Cochrane	(256) 895-1696 chris.cochrane@usace.army.mil
USAESCH, Project Manager	Chase Hamley	(256) 895-1569 Chase.G.Hamley@usace.army.mil
U.S. Army Corps of Engineers, Wilmington District (CESAW), Project Manager	Ray Livermore	(910) 251-4702 Raymond.R.Livermore@usace.army.mil
U.S. Army Corps of Engineers, Savannah District (CESAS), Project Manager	Julie Hiscox	(912) 652-5363 Julie.A.Hiscox@usace.army.mil
South Carolina Department of Health & Environmental Control, Project Manager	Susan Byrd	(803) 898-0308
HydroGeoLogic, Inc.		
HGL 24/7 Emergency Number	(800) 341-3647	
Project Manager	Kimberly Vaughn	(512) 828-6684 kvaughn@hgl.com
Senior Unexploded Ordnance Supervisor	Joel Sanders	(435) 919-9770
Unexploded Ordnance Safety Officer	Oscar Honne	(915) 503-4083
Corporate Health and Safety Director	Stephen Davis, CIH, CSP	(865) 659-0499 sdavis@hgl.com
Project Health and Safety Manager	Edie Scala-Hampson, CIH, CHMM	(847) 409-6384 escala-Hampson@hgl.com
HGL Corporate Occupational Physician *WorkCare 24-Hour Hotline Nurse	Peter Greaney, MD	(714) 978-7488, ext. 114 *(888) 449-7787

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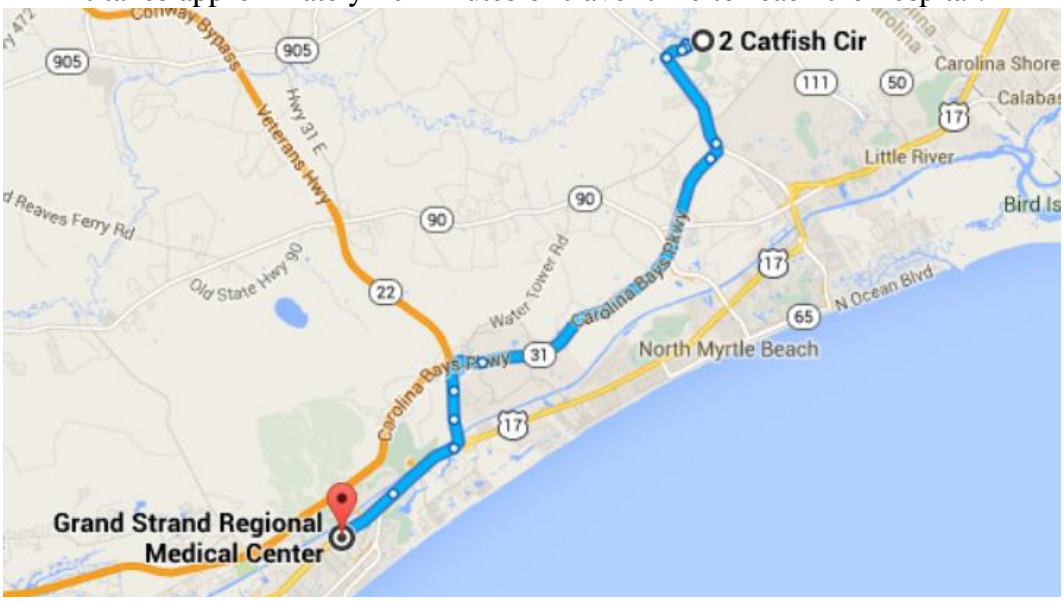
ROUTE MAP AND DIRECTIONS TO GRAND STRAND REGIONAL MEDICAL CENTER (HOSPITAL)

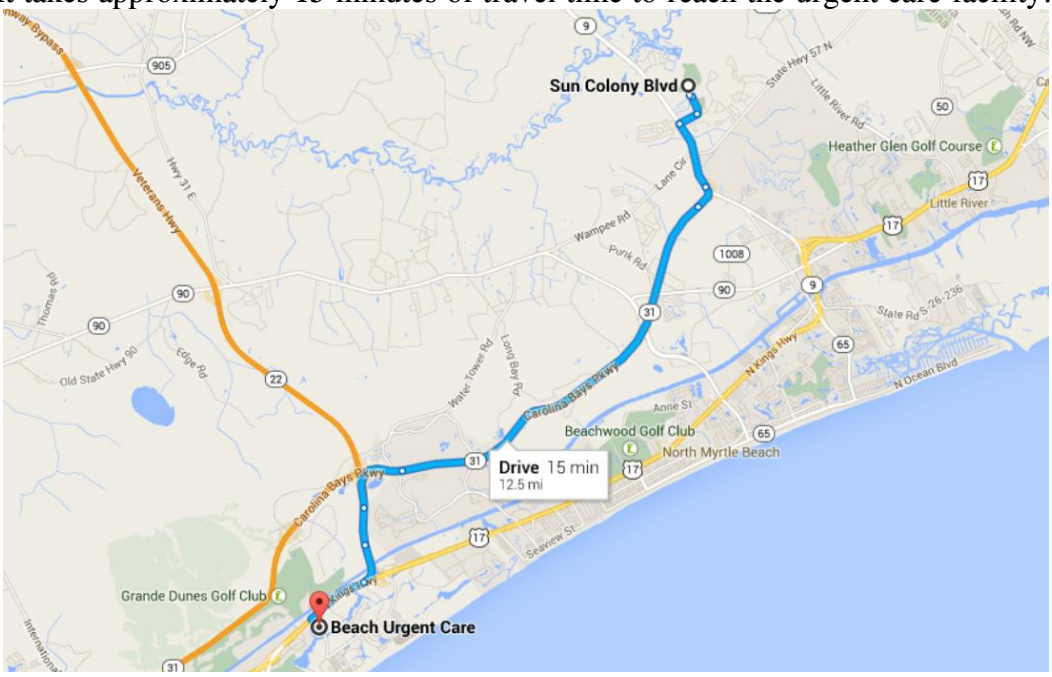
It takes approximately 20 minutes of travel time to reach the hospital.



Directions from 2 Cat Fish Circle to Grand Strand Regional Medical Center:

- Head northwest on Catfish Cir toward Bass Ct
- Take the 1st left onto Bass Ct
- Take the 1st right to stay on Bass Ct
- Continue onto Rum Bluff Blvd
- Turn left onto SC-9 S
- Turn right onto the S Carolina 31 ramp to Myrtle Beach/Georgetown/Surfside Beach
- Merge onto SC-31
- Take the S Carolina 22 E exit toward Myrtle Beach
- Merge onto SC-22 E
- Exit onto US-17 S toward Myrtle Beach
- Merge onto US-17 S
- Merge onto US-17 S via the ramp to Conway/Georgetown
- Turn left onto 82nd Pkwy
- Grand Strand Regional Medical Center: 809 82nd Pkwy, Myrtle Beach, SC 29572

It takes approximately 15 minutes of travel time to reach the urgent care facility.



Directions Sun Colony Blvd to Beach Urgent Care:

- Head west on Sun Colony Blvd toward Brighton Ln
- At the traffic circle, take the 1st exit and stay on Sun Colony Blvd
- Turn left onto SC-9 S
- Turn right onto the S Carolina 31 ramp to Myrtle Beach/Georgetown/Surfside Beach
- Merge onto SC-31
- Take the S Carolina 22 E exit toward Myrtle Beach
- Merge onto SC-22 E
- Exit onto US-17 S toward Myrtle Beach
- Merge onto US-17 S
- Beach Urgent Care: 9672 N Kings Hwy, Myrtle Beach, SC 29572

1.0 INTRODUCTION

The objective of this Site Safety and Health Plan (SSHP) is to ensure that safe working conditions exist during this project. These health and safety procedures have been established based on preliminary analysis of potential hazards present at the former Conway Bombing and Gunnery Range (BGR) Munitions Response Sites (MRSs). HydroGeoLogic, Inc. (HGL) has developed this SSHP to address occupational safety and health hazards associated with the completion of remedial investigation (RI) field activities at the project MRSs and specified in the Accident Prevention Plan (APP). The SSHP addresses the requirements of 29 Code of Federal Regulations (CFR) 1910.120(b)(4)(ii), 29 CFR 1926.65(b)(4)(ii), U.S. Army Corps of Engineers (USACE) Engineering Manual (EM) 385-1-1, Section 28, Engineering Regulation (ER) 385-1-95, and other Federal, state, and local safety and health requirements. The SSHP addresses those elements of safety, which are specific to the RI at former Conway BGR, and have the potential for negative effects on the health and safety of workers. Therefore, the level of detail provided in the SSHP has been tailored to address the type of work, complexity of operations to be accomplished, and the hazards anticipated for the former Conway BGR RI.

HGL has presented this SSHP as an attachment to the APP based on U.S. Army Engineering and Support Center (USAESCH) guidance (Data Item Description [DID] Worldwide Environmental Remediation Services [WERS]-005.01). Some of the required SSHP elements have been adequately addressed elsewhere in the work plan (WP) or APP. In an effort to eliminate redundancy, if a specific element has been previously addressed, the element of the SSHP is listed and the location in the WP/APP where the element is addressed has been identified.

The personal health and safety (H&S) of individuals directly or indirectly involved in HGL projects is of particular concern to HGL. Therefore, prudent and reasonable measures will be taken to establish and maintain safe and healthy working conditions.

This plan applies primarily to HGL personnel and activities. Subcontractors are more familiar with the H&S issues associated with the specific expertise for which they are hired; therefore, each subcontractor is responsible for developing their own SSHP that addresses those hazards.

This plan provides minimum guidelines for all site activities. It identifies the minimum controls, use of personal protective equipment (PPE), emergency procedures, training, etc. that will be implemented during this project. If necessitated by conditions encountered in the field, additional site-specific information will be added to this plan. No significant changes to this plan will be made without prior approval of the HGL Project Manager (PM) and the Corporate Health and Safety Director (CHSD) or the Project Health and Safety Manager (PHSM).

RI field activities will include the following:

- Munitions and explosives of concern (MEC), material potentially presenting an explosive hazard (MPPEH), and munitions debris (MD) identification, mapping, anomaly avoidance, removal, inspection and handling, and disposal.
  - HGL unexploded ordnance (UXO) technicians will conduct analog magnetometer surveys, MEC identification and mapping, anomaly avoidance and MEC/MPPEH/MD removal, inspection, handling and disposal.
- Vegetation Clearance
  - Limited vegetation clearance will be conducted by HGL UXO technicians to provide access for geophysical evaluation and soil sampling activities.
- Digital Geophysical Mapping (DGM)
  - HGL will provide oversight and escort for the DGM crew during DGM geophysical survey activities at the MRS.
  - Geophysical sensors anticipated for use on the project include the EM61-MKII (single-sensor and three-sensor array), Geometrics Metal Mapper, and the Geometrics 882 transverse magnetometer/gradiometer (TVG) (or equivalent).
- Surface and Subsurface Soil Sampling
  - HGL will collect surface and subsurface soil, sediment, and groundwater samples for laboratory analysis of explosives, metals, and perchlorate (groundwater only).
- Topographic Survey
  - HGL will provide escort and oversight if subcontractor topographic surveyors will be on site.
- Investigation-Derived Waste (IDW) Management
  - HGL will provide oversight, and sampling (soil and water) for waste characterization and disposal, if needed.
  - Subcontractor: IDW management firm will pick up, remove, and transport IDW (drums or liquids) from the site, if storage of site related waste is needed

1.1 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

The area that became the former Conway BGR was used for timber harvest and farming prior to 1940. From June 1940 to December 1941, the Army Air Corps conducted aerial photographing and charting and in 1941 support operations for a BGR were set up. In March 1942, the Savannah Army Air Base (AAB) and the Myrtle Beach municipal airport became the Myrtle Beach General BGR (renamed Myrtle Beach Army Air Field [AAF] in November 1943). Myrtle Beach AAF consisted of a cantonment area in Myrtle Beach, air to ground gunnery ranges in the Myrtle Beach area, the BGR in the Conway area (Conway BGR), a BGR in the Georgetown area, and crash target boats at Murrells Inlets. Other airfields/bases may also have utilized Conway BGR, including Columbia AAB, Greenville AAB, Florence

AAF, Morris Field and Charleston AAB. By 1948, the leases for the majority of the property had been terminated and land had been returned to private ownership.

The former Conway BGR historically consisted of 55,854 acres in Horry County, South Carolina, immediately southeast of Conway, South Carolina. There are nine MRSs included within Conway BGR; four are being addressed by this task order (TO). The four MRSs that are included in this TO scope of work are:

- MRS-R01, Range II Range
- MRS-R02, Range III
- MRS-R03, Range IV
- MRS-R09, Machine Gun (MG)/Rifle Range (RR)

1.2 MRS-R01, RANGE II

Based on the information provided in the Archive Search Report (ASR) Supplement, the historical usage of MRS-R01, Range II, was practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing.

The Engineering Evaluation/Cost Analysis (EE/CA) investigated MRS-R01, Range II, and identified the potential presence of MEC in Area A, which was a 425-acre circular area established at the center of MRS-R01, Range II. No risk due to MEC presence was identified in Area A-1 (a buffer created around the centrally located Area A). The EE/CA recommended clearance to depth only for planned construction sites within Area A (the 425-acre circular area). The EE/CA also recommended surface clearance elsewhere (in the buffer area) and institutional controls (ICs) throughout the MRS.

During the EE/CA, MD identified included a 100-lb practice bomb and SAA debris. The 2012 RI/Feasibility Study (FS) concluded that the potential for MEC hazard was "Unlikely" and that no munitions constituent (MC) contamination was present. The 2012 RI Report stated that MEC was not delineated; however, and recommended further investigation. The refusal of rights-of-entry (ROEs) impacted the RI field activities that could be conducted.

1.3 MRS-R02, RANGE III

Based on information in the ASR Supplement, the historical usage of MRS-R02, Range III, was high-and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing. Historical evidence at this MRS indicates that 100-pound (lb) practice bombs and 2.25-inch rockets were used.

A time critical removal action (TCRA) was performed in 2002 on 45 acres of MRS-R02, Range III. MEC items identified included the following:

- MK II 1.1-inch projectile;
- M38A2 100-lb sand-filled practice bombs;

- M48 practice 20-lb fragmentation bomb;
- Practice 5-inch HVAR warhead;
- M69 6-lb incendiary bomb;
- Fuzes, including M16 fuze burster, M16 igniter, and AN-M16 white phosphorus igniter; and
- M57 250-lb general purpose bomb.

Based on the presence of several AN-M54 and M50 incendiary bombs discovered at the site, the potential existed for these bombs to contain cadmium or to release cadmium oxide dust. Therefore, soil samples were collected and analyzed for cadmium to evaluate worker exposure.

The 2003 EE/CA covered MRS-R02, Range III. Of the four MRSs in this TO MRS-R02, Range III was the only one where the EE/CA confirmed that MEC was present. Similar to MRS-R01, Range II, the EE/CA established a central, circular Area B, with a surrounding buffer (Area B-1).

The EE/CA recommended clearance to depth and ICs for Area B. The EE/CA also recommended clearance to depth only at planned construction sites within the buffer surrounding (Area B-1). Surface clearances were recommended elsewhere along with ICs. MEC identified during the EE/CA included 4-lb incendiary bombs and MD identified included:

- 2.25-inch rockets;
- 4-lb incendiary bombs;
- 20-lb fragmentation bombs;
- 100-lb practice bombs; and
- SAA.

Soil and surface water sampling conducted in 2006 did not detect explosives. The metals detected (lead, zinc, cadmium, and mercury) were potentially related to MC. Privately funded entities performed removal actions (RAs) in 2005, 2006, and 2007 on various parcels within MRS-R02, and some of these investigations included MC sampling. MEC and MD were identified. The 2012 RI concluded that MEC was present but that MC contamination was not. The RI stated that MEC had been delineated, but still recommended that further investigation be conducted.

1.4 MRS-R03, RANGE IV

Based on the information in the ASR Supplement, the historical usage of MRS-R03, Range IV was for practice bombing, including medium-altitude bombing.

The EE/CA previously had identified the potential presence of MEC in both Area C and Area C-1, as they were designated at that time, in Range IV. The EE/CA recommended clearance

to depth only at planned construction sites, and surface clearance elsewhere for both areas. MD identified included the following:

- 4-lb incendiary bombs;
- 20-lb fragmentation bombs; and
- 100-lb practice bombs.

The 2012 RI report concluded that the potential for a MEC hazard was "Unlikely" and that no MC contamination was present. Although a MEC hazard was not anticipated for this MRS, further investigation was recommended.

1.5 MRS-R09, MACHINE GUN/RIFLE RANGE

Historical documentation indicates that activities at the MG Range were limited to firing bomber turrets and MGs in a ground-mounted mode, and that those at the RR were limited to basic rifle marksmanship training.

Of the previous investigations conducted at the MG/RR MRS, the EE/CA recommended a No U.S. Department of Defense (DoD) Action Indicated (NDAI) determination for this MRS. The 2012 RI concluded that the presence of MEC had been confirmed and delineated. The RI did not assess MC contamination and recommended further investigation.

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2.0 HAZARD/RISK ANALYSIS

HGL has analyzed the Performance Work Statement (PWS) and historical information to determine work risk hazards associated with field work tasks to be performed at the former Conway BGR MRSs. The hazards likely to be encountered during fieldwork include: classic safety, explosive ordnance, physical safety, and biological. Chemical and ionizing radiation hazards are not likely to be encountered while performing the fieldwork. The tasks and hazard/risk analyses detailed in this section shall be modified and approved throughout the project as needed to address changing work conditions.

The following task hazard analysis includes both Hazardous Waste Operations and Emergency Response (HAZWOPER) and non-HAZWOPER related tasks, which may or may not occur during the initial phase of the project, but may occur during the RA of MEC or during the continuation of fieldwork. Table 2.1 presents the task hazard analysis for all planned work activities. The Activity Hazard Analysis (AHA) Sheets developed specifically for the hazardous tasks associated with this project site are located in Attachment 3 of the APP. Each AHA Sheet provides job specific steps, associated hazards, and those actions necessary to eliminate or minimize the potential hazards.

Table 2.1
Task Hazard Analysis

Potential Hazards	Tasks					
	MEC Intrusive Ops	**Geophysical Investigation Surveying**	**MEC Excavation**	**MPPEH Processing**	**MC Soil Sampling**	**Off-road Vehicle Operations**
Flying debris/objects			X	X		X
Noise > 85dBA		X	X	X		X
Electrical	X	X	X	X		X
Suspended loads		X	X	X		
Buried utilities, drums, tanks	X	X	X	X		
Slip, trip, fall	X	X	X	X	X	X
Back injury	X	X	X	X	X	X
Confined space entry			X			
Trenches/excavations			X		X	
Visible lightning	X	X	X	X	X	X
Vehicle traffic	X	X	X			X
Fires		X	X			X
Heavy equipment			X			
Explosive Ordnance	X	X	X	X	X	
Biological	X	X	X	X	X	X
Heat/Cold Stress	X	X	X	X	X	X

Table 2.2 presents the principal steps, potential hazards, and recommended controls specifically for the MEC activities.

Table 2.2
MEC Activity, Potential Hazards, and Recommended Controls

MEC Activity	Potential Hazards	Recommended Controls
Transportation of explosive materials	Accidental detonation of explosives	Explosives will be transported in accordance with 49 CFR, Parts 100-199.
		Explosives will be transported in closed vehicles whenever possible.
		When using an open vehicle, explosives will be covered.
		Motor vehicles will be shut off when loading/unloading explosives.
		Beds of vehicles will have a nonconductive bed liner, dunnage, or sand bags to protect the explosives from contact with the metal bed and fittings.
		Initiating explosives, such as blasting caps, will remain separated at all times.
		Each vehicle used for the transport of MEC will be outfitted with a fire extinguisher and first-aid kit.
		Do not fuel trucks when loaded with MEC.
	Motor vehicle driver and vehicle operations	Motor vehicle drivers operating within or outside the boundaries of any federal installation will be licensed in accordance with federal, state, and local regulations.
		Drivers will observe all posted speed limits while operating a motor vehicle on a public roadway.
		Vehicles transporting explosives off pave roads will not exceed 20 miles per hour (mph).
		Chock wheels when loading or unloading MEC-related materials.
Storage of explosive materials	Noise hazards Environmental hazards Biological hazards Physical hazards Electrical hazards Suspended loads Fire hazards	Hearing Protection, Engineering controls PPE, Delay work effort PPE, Repellants, Avoidance PPE, Proper lifting, Engineering controls PPE, Grounding, Equipment maintenance PPE, Hardhats Non Sparking tools, Grounding, Always have available Fire extinguisher No Smoking
	Accidental detonation of explosives	Materials will be stored in accordance with federal, state and local regulations. Refer to the UXO Subcontractors Standard Operating Procedures (SOPs) for the Storage of Explosive Materials.

Table 2.2 (continued)
MEC Activity, Potential Hazards, and Recommended Controls

MEC Activity	Potential Hazards	Recommended Controls
Surveying and establishing boundaries and grids	Accidental detonation of explosives	Personnel involved will attend a site-specific MEC recognition class prior to the commencement of any site activities.
		UXO personnel will escort non-UXO personnel at all times.
		Mark and avoid UXO. Only UXO personnel will handle MEC waste.
		Check location with magnetometer before driving stakes.
	Wildlife, slips, trips, falls, insects, poisonous plants, use of hand tools.	Refer to the AHA.
MEC Avoidance	Accidental detonation of explosives	Personnel involved will attend a site-specific MEC recognition class prior to the commencement of any site activities.
		Be alert and mark all MEC located.
		An UXO Technician II or above will escort non-UXO personnel at all times. Intrusive operations will cease when nonessential personnel are within the exclusion zone (EZ).
		Visual surface sweeps will be conducted with magnetometers or other suitable geophysical instrumentation to identify potential MEC.
	Environmental hazards Biological hazards Physical hazards Fire hazards	PPE, Delay work effort PPE, Repellants, Avoidance PPE, Proper lifting, Engineering controls No Smoking Always have available fire extinguisher Drivers will not stop or park on or in grass areas that may catch fire from vehicle exhaust
Transportation of MEC	Accidental detonation of explosives	No personnel allowed in cargo compartment of vehicle.
	Accidental detonation of explosives	No MEC allowed in passenger compartment of vehicle.
		Block, brace, secure MEC.
		No smoking in vehicles used for transport of MEC.
	Vehicle operations	Placard vehicle in accordance with U.S. Department of Transportation regulations.
		Vehicles transporting explosives off road will not exceed 20 mph.
		Drivers will observe all posted speed limits while operating a motor vehicle on a public roadway.
UXO disposal operations	Accidental detonation of explosives	Observe procedures for safe demolition and explosives use

Table 2.2 (continued)
MEC Activity, Potential Hazards, and Recommended Controls

MEC Activity	Potential Hazards	Recommended Controls
MEC-Related Scrap Demilitarization	Accidental detonation of explosives	Only Explosive Ordnance Disposal (EOD)/UXO technicians will perform explosive demilitarization of MEC-related scrap.
Inspection/Certification of MPPEH	Accidental detonation of explosives	Only UXO technicians will inspect MPPEH and range-related scrap.
		Personnel in the immediate vicinity of MPPEH inspections will be kept to the minimum necessary for safe operations but no less than two UXO Technicians, comprising of at least one UXO Technician II and one UXO Technician III.
		Observe requirements of DoD 4160.21-M-1.
UXO disposal operations MEC-Related Scrap Demilitarization Inspection/Certification of MPPEH MEC Intrusive Activities	Noise hazards Environmental hazards Biological hazards Physical hazards Electrical hazards Suspended loads Fire hazards	Hearing Protection, Engineering controls PPE, Delay work effort PPE, Repellants, Avoidance PPE, Proper lifting, Engineering controls PPE, Grounding, Equipment maintenance PPE, Hardhats Non Sparking tools, Grounding, Always have available fire extinguisher No Smoking
MEC Intrusive Activities	Accidental detonation	The UXO team will follow MEC anomaly avoidance procedures during excavation activities
		Personnel in the immediate vicinity of MEC operations will be kept to the minimum necessary for safe operations, but no less than two UXO technicians with least one UXO Technician II and one UXO Technician III.
		Do not subject MEC to heat, shock, or friction.
		Only hand excavation permitted when within 1 foot of known MEC.
		Hand-operated magnetometers will be used frequently to pinpoint the location of suspect MEC.
	Non-UXO personnel	Establish EZ; post warning signs, maintain site control.
		Stop all MEC UXO operations when non-UXO personnel are within the EZ.

Table 2.3 lists the equipment to be used and inspection and training requirements for the project.

Table 2.3
Project Equipment and Training Requirements

Equipment to be Used	Inspection/ Test Requirements	Training Requirements
Vehicles	Daily – preventive maintenance and operational checks	Valid driver's license
Ordnance detection locators	Prior to operation	40-hour HAZWOPER (CFR 1910.120); 8-hour HAZWOPER Refresher (CFR 1910.120) 24-hour supervised field experience; Graduate of a formal military EOD or DoD certified training course
Demolition/explosive materials		Must have all the above certifications and a valid Bureau of Alcohol, Tobacco, and Firearms (BATF) Employee Possessor Questionnaire (ATF E-Form 5400.28) on file
Explosive vehicle	Explosive Vehicle Inspection (DD Form 626)	Must have all the above certifications and a valid driver's license
Blocking, bracing, and cushioning materials	Prior to operation	UXO Technician III certified or above
Fire extinguishers	Monthly	Site specific
First-aid kits	Weekly – inventory and inspection	Cardiopulmonary Resuscitation (CPR) and First Aid Certified
Manual hand tools	Prior to operation	On-the-job-training (OJT)
Mechanized equipment	Prior to operation	Operator's certificate
Heavy Equipment	Prior to operation	Operator's certificate
Geophysical instrumentation	Prior to operation	OJT
Global Positioning System (GPS) instrumentation	Prior to operation	OJT
PPE	Prior to use	Site specific
Communications equipment	Prior to operation	Site specific
Battery charging station	Prior to operation – visual Monthly – entire system	Site specific
Eye wash station	Weekly – visual Monthly – operational 90-day – solution replacement	Site specific
Weather monitoring equipment	Prior to operation	UXO Technician III or above

The principal anticipated hazard to site workers is UXO. This hazard will be managed through procedures stated in detail in the WP. There is no evidence that chemical or radiological hazards are present on the site. However, if evidence of these is discovered, the SSHO will notify the PM and UXO Safety Officer (UXOSO) as soon as possible. Appropriate addenda to this plan will be prepared.

In the unlikely event that a chemical weapon (or chemical weapons materiel) is encountered during operations, work will halt immediately, and personnel will withdraw upwind from the area. The USACE Ordnance and Explosives (OE) Safety Specialist (OESS) will be notified. Site personnel will stand by and wait for instructions from the USACE Contracting Officer (KO).

Biological hazards anticipated for this project site include bees, wasps, hornets, spiders, ticks, ants, mosquitoes, poisonous snakes, and blood-borne pathogens. Biological hazards are discussed in detail in Section 2.7 of this document.

The potential for exposure to MC could exist during collection of soil and water samples, and possibly during other times. Management of this hazard is discussed in Section 9.15 of this document.

If site conditions or activities occur that are not discussed in this document or in the APP, the UXOSO will notify the CHSD immediately and new procedures will be developed.

2.1 CLASSIC SAFETY

The following distinct phases of project work or distinct potentially hazardous operations have been identified:

- Mobilization and site preparation,
- Brush clearing,
- Digital geophysical mapping of transects and grids (both inland and wetland),
- Intrusive investigation of anomalies (i.e., anomaly reacquisition and excavation),
- Disposal of MEC and munitions debris,
- Environmental sampling, and
- Demobilization.

Hazards and potential for injury associated with these activities include the following:

- Lifting hazards, such as back strain, pulled muscles and tendons, pinched or crushed fingers and toes, and lacerations from sharp surfaces on objects lifted;
- Hazards associated with the operation of hand and power tools (e.g., chain saws), including lacerations and flying objects;
- Slip, trip, and fall hazards associated with ground cover, exposed tree/brush stumps, uneven terrain, rocks, and vegetation growth;
- Inclement weather events, such as heavy rain, and lightning;
- Sharp objects, including nails, broken glass, cultural debris, and exposed tree/brush stumps;
- Noise from heavy equipment;

- Vehicle accidents;
- Electrical shock from equipment; and
- Conditions that could cause heat-related illness.

An AHA for each of these phases is found in Attachment 3.

2.2 MUNITIONS

2.2.1 MPPEH Hazards

During the project MPPEH will be encountered by the field UXO teams. Every precaution will be taken to ensure all MEC operations are conducted safest possible manner.

2.2.2 MEC Hazard Safety

When MEC is encountered during any phase of work the Senior UXO Supervisor (SUXOS) and the UXOSO will be immediately notified. In general, the following MEC safety precautions and protocols will be followed:

- Positively identify all MEC.
- Always remain alert at all times for MEC, UXO and related scrap or MPPEH hazards.
- 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 personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- Always assume MEC hazards contain a live charge until determined otherwise.
- The age or condition of a MEC hazard does not decrease the 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 agent 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 approach a leaking white phosphorus (WP) munitions unless absolutely necessary as burning WP may detonate.
- DO NOT dismantle, strip, or handle any MEC unnecessarily.
- Submerge smoking (leaking) plasticized WP (PWP)/red phosphorous (RP)/WP munitions in water or cover with mud, wet sand, or earth as quickly and gently as possible if necessary to handle or transport.

- PWP/RP/WP will ignite and burn on contact with air. Handle crusted-over PWP/RP/WP with special care, breaking the crust can cause the round to begin burning again.
- DO NOT touch crusted white phosphorus**.** WP munitions are prone to leak causing smoke in hot weather.
- Additional protective clothing should be worn while removing residue or attempting to move a smoking PWP/RP/WP round into a water bath.
- DO NOT touch, move or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification.
- DO NOT touch, pick up, kick or move anything that is unfamiliar or unknown.
- DO NOT roll the item over or scrape the item to identify markings.
- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, leave the site immediately and seek shelter.
- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards.
- DO NOT walk across an area that the ground surface cannot be seen that has not been cleared of MEC hazards by the UXO Technician.
- DO NOT rely on color codes for positive identification of ordnance items or their contents.
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes.
- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.
- DO NOT be misled by markings on the MEC item stating “practice bomb,” “dummy,” or “inert.” Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly.
- Avoid the forward portions of munitions employing proximity fuzing.
- Assume unknown fuzes contain cocked strikers or anti-disturbance features.
- The location of any ordnance item found anomaly avoidance activities will be clearly marked so it can be easily located and avoided.
- Follow the procedures of the WP and SSHP; and upon locating any MEC hazards immediately notify the UXO Technician so appropriate measures can be taken.

The following warning shall be posted on site.

— WARNING —

REMOVING OR TAKING ANY MUNITIONS, EXPLOSIVE, OR UNEXPLODED ORDNANCE OR MUNITIONS RELATED DEBRIS FROM THE SITE BY ANY EMPLOYEE IS STRICTLY PROHIBITED

Supplemental "MEC Hazard Safety" information for munitions items potentially used at the Former Conway BGR MRSs includes the following:

Projectiles

- Determine if the projectile has been fired and if so consider it armed;
- Check for the presence of unburned tracers;
- Avoid the rear and front of rocket assisted projectiles;
- Handle projectile components such as powder increments, cartridges, and primers with caution; and
- Seal the open ends of projectiles or sheared projectile components with tape or other suitable material before transporting.

Grenades

- Do not attempt to re-install safety pins on a dud fired grenade;
- Do not attempt to withdraw impinged firing pins from the fuze of a dud fired grenade; and
- Do not dispose of grenades by functioning them as designed.

Rockets

- Approach and work on rockets from the side;
- Do not dismantle or strip dud fired rockets or rocket motors;
- Do not expose electrically fired munitions to radio transmissions within 25 feet;
- Do not transport an unfired rocket motor until having shielded the motor igniter from electromagnetic radiation; and
- Dispose of unfired rocket motors, with or without warheads, in such a manner as to prevent them from becoming propulsive.

Additional MEC safety precautions will be provided during daily safety meetings, presented as General Safety Precautions in HGL SOP 15.01 (Attachment 5), and are addressed in Engineering Pamphlet (EP) 385-1-97, *Explosives Safety and Health Requirements Manual*.

2.2.3 Explosive Demolition Operations

Explosive demolition operations will only be conducted by UXO-qualified personnel who meet the qualifications requirements of DoD Explosives Safety Board (DDESB) Technical Paper 18 (TP-18) and HGL SOP 15.00. Approved engineering controls will be used, as required, to mitigate explosive hazards associated with demolition operations. Demolition explosives and procedures are addressed in the WP Section 3.8 and HGL SOP 15.01 Explosive Demolition Operation. Each task has been analyzed to assess the potential safety hazards that may be encountered by site personnel and prescribe the proper engineering and/or administrative controls and/or PPE. These controls will ensure that the risks to health and safety are reduced or eliminated during project performance.

2.3 CHEMICAL

Chemical hazards are not likely to be encountered while performing the fieldwork, with the exception of hazardous substances brought on site for the execution of site activities. These chemical substances will be discussed in APP Section 9.8 Hazard Communication Program, and with associated material safety data sheet (MSDS).

2.4 PHYSICAL

The following physical hazards may be encountered during this project:

- Open trenches or pits and vegetation;
- Cuts and scrapes from visible or buried debris;
- Barbed wire fencing;
- Stress endured from excessive heat or cold; and
- Physical hazards are addressed in more detail in the AHA and the hazard control plan.

2.5 IONIZING RADIATION

Not applicable. Ionizing radiation hazards are not likely to be encountered while performing the fieldwork.

2.6 BIOLOGICAL HAZARDS

Biological hazards, which may be found on-site, include insects, arachnids (such as spiders and scorpions), snakes, and plants. Employee awareness and the safe work practices outlined in the following paragraphs should reduce the risk associated with these hazards to acceptable levels. Images of biological hazards associated with the project site are shown in Attachment 6.

2.6.1 Biting and Stinging Insects

Many types of biting and stinging insects such as mosquitoes, bees, wasps, spiders, and centipedes may be encountered on-site. The SUXOS or UXOSO (as applicable) will encourage the use of insect repellents, if deemed necessary. The biting insects of greatest concern are spiders, especially the black widow and the brown recluse spider. These spiders are of special concern due to the significant adverse health effects that can be caused by their bite.

2.6.2 Mosquitoes

The Centers for Disease Control and Prevention (CDC) has noted the increase of West Nile Virus (WNV) that is transmitted by bites from an infected mosquito. Mosquitoes live in nearly all environments, including urban, wooded, grassy, brushy, arid, or other areas that contain standing pools of water (seeps, drainage, watering holes, etc.).

Standard field gear (work boots, hats, socks, trousers, and work shirts) provide good protection against mosquito bites. Exposed skin is particularly susceptible to bites. However, even when wearing field gear, the following precautions shall be taken when working in areas that might be infested with mosquitoes:

- Spray outer clothing, BUT NOT YOUR SKIN, with an insect repellant that contains permethrin or permanone;
- Apply an insect repellant containing 33 percent DEET, Picardin, or Oil of Lemon eucalyptus to exposed skin (don't spray on cuts or wounds) and avoid areas of standing water as much as possible;
- Reduce time outdoors in evening; and
- Look for the symptoms of the onset of WNV, which occur within 3 to 15 days after being bitten by an infected mosquito.

2.6.3 Bees, Hornets and Wasps

Contact with stinging insects like bees, hornets, and wasps may present a hazard to site personnel. Extreme caution must be exercised whenever site and weather conditions increase the risk of encountering stinging insects.

With these things in mind and with the high probability of contact with stinging insects, all site personnel will comply with the following safe work practices:

- If a worker knows that he is hypersensitive to bee, wasp or hornet stings, he must inform the SUXOS or UXOSO (as applicable) prior to participation in site activities;
- All site personnel will be watchful for the presence of stinging insects and their nests, and will advise the SUXOS or UXOSO (as applicable) if observed;
- Any nests located on-site will be flagged and site personnel will be notified of its presence; and,

- If stung, site personnel will immediately report the incident to the SUXOS or UXOSO to obtain treatment and to allow the SUXOS or UXOSO (as applicable) to observe them for signs of allergic reaction.

2.6.4 Black Widow Spider

The Black Widow spider is not aggressive unless agitated when guarding her egg sac. They live in a variety of natural and domestic habitats such as under rocks and wooden boards, and in dense plant growth. The female spider is glossy black approximately 1-inch long, and marked with a characteristic red hourglass on the underside of the abdomen. The male, which is rarely seen, is smaller and has four pairs of red marks along the sides of the abdomen. Young black widow spiders are tan-to-gray in color and have orange and white "racing stripes" on their abdomens.

Black widow spider venom affects the nervous system. The venom causes pain in the lymph nodes. Other symptoms of a severe bite include nausea, elevated blood pressure, sweating, tremors and increased white blood cell counts. The wound may appear as a bluish red spot, surrounded by a whitish area. Victims of a black widow bite may exhibit the following signs or symptoms:

- Sensation of pinprick or minor burning at the time of the bite; and
- Appearance of small punctures (sometimes none are visible).

After 15 to 60 minutes, intense pain is felt at the site of the bite. The pain quickly spreads and is followed by profuse sweating, rigid abdominal muscles, muscle spasms, breathing difficulty, slurred speech, and poor coordination, dilated pupils, and generalized swelling of the face and extremities.

2.6.5 Brown Recluse Spider

Adult Brown Recluse spiders are soft bodied, yellowish tan to dark brown, about ¼- to ½-inch long, and have long, delicate grayish to dark brown legs covered with short, dark hairs. The leg span is about the size of a half-dollar.

The spider's most distinguishing characteristic is the existence of three pairs of eyes arranged in a semicircle on the forepart of the head and a dark, violin-shaped, marking immediately behind the semicircle of eyes. Normally, all spiders have 4 pairs of eyes; 8 altogether. The neck of the violin points toward the abdomen.

The spider may be found in sheltered corners among debris, in woodpiles, under loose bark and stones. Hands, underarms, lower abdomen, and the ankles are the areas of the body most likely to be bitten. A bite may go unnoticed for six to eight hours before a reddening, swelling, and blistering area around the wound starts to appear. A severe bite can produce an area of dead skin tissue that may require surgery. Victims of a brown recluse bite may exhibit the following signs or symptoms:

- Blistering at the site of the bite, followed by a local burning at the site 30 to 60 minutes after the bite;
- Formation of a large, red, swollen, pustule lesion with a bulls-eye appearance;
- Systemic affects may include a generalized rash, joint pain, chills, fever, nausea and vomiting; and
- Pain may become severe after eight hours, with the onset of tissue necrosis.

There is no effective first aid treatment for Black Widow or Brown Recluse bites. Except for very young, very old or weak victims, spider bites are not considered to be life threatening. Medical treatment must be sought, however, to reduce the extent of damage caused by the injected toxins. If the spider can be retrieved, it should be taken with the patient to medical treatment. If venomous spiders are suspected or known to be on-site, the SUXOS or UXOSO (as applicable) will brief the site personnel as to their identification and avoidance. As with stinging insects, site personnel should report to the SUXOS or UXOSO (as applicable) if they locate these spiders on-site or notice any type of bite while involved in site activities.

2.6.6 Plants Causing Skin Reactions

A variety of hazardous plants may be encountered onsite. The ailments associated with these plants range from mild hay fever to contact dermatitis to carcinogenic affects. The plants that present the greatest degree of risk to site personnel (i.e., potential for contact vs. affect produced) are those that produce skin reactions and skin and tissue injury.

The hazardous plants of greatest concern are those varieties found in the project area having the ability to cause redness, blisters, swelling, and intense burning and itching due to punctures, scrapes, or lacerations. Improper treatment of an injury can cause secondary infections to occur. Preventive measures that can prove effective for most site personnel are:

- Avoid contact with any hazardous plants on site;
- Remove gloves prior to touching face, neck, or other exposed areas of the body;
- Wash hands, face, or other exposed areas at the beginning of each break period and at the end of each workday; and
- Keep the skin covered as much as possible (i.e., long pants and long sleeved shirts) in areas where these plants are known to exist.

2.6.7 Mosquitoes, Ticks, and Other Insects

Biological hazards include, insects, ticks, centipedes, bees/wasps/hornets, and spiders. Poisonous snakes, domestic dogs, and hazardous plants also may be encountered on the project site. Employee awareness and the safe work practices listed below will minimize hazards. The UXOSO will make inquiries about likely biological hazards at the work site, and tailor training material accordingly. Images of potentially dangerous animals and plants that likely are present on the project site are found in Attachment 6.

Mosquitoes, flies, and fleas are likely site pests. The UXOSO will maintain a supply of insect repellant on the site and encourage its frequent use when the potential for insect bites exists. The following practices should be followed to avoid risks from poisonous plants:

- Avoid contact with any poisonous or unidentified plants. If poisonous plants are identified, warn others and notify the UXOSO;
- Wash hands, face or other exposed areas at the beginning of each break period and at the end of each work day;
- Avoid contact with contaminated tools, equipment and clothing; and wash these regularly; and
- Consider the use of barrier creams, detoxification/wash solutions and orally administered desensitization products.

All snakes should be considered venomous, and all should be avoided. Employees should be extremely cautious when they remove brush, lift rocks and debris, or enter wooded or grassy areas. Heavy gloves, high-top boots, chaps and other protective equipment should be used when needed to prevent contact with snakes.

The following precautions should be followed to avoid the risks of tick bites:

- Standard field gear (work boots, socks, and work uniform) provides good protection against tick bites, particularly if the openings are taped;
- Avoid direct skin contact with ticks by wearing long sleeves, long pants, socks, etc. Consider taping openings in clothing, if this can be done safely;
- When in the field, check yourself often for ticks, particularly on your lower legs and areas covered with hair;
- Spray outer clothing, particularly your pant legs and socks – but not your skin – with an insect repellent that is effective against ticks;
- To the extent feasible, avoid contact with bushes, tall grass, or brush;
- If you find a tick, remove it by pulling on it gently with tweezers (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, frequently seen with a small welt in the center;
- Also look for the signs of the onset of Rocky Mountain spotted fever, such as inflammation in the form of a rash comprising many red spots under the skin. Inflammation may occur three to 10 days after the tick bite; and

- Report symptoms such as flu-like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain to the UXOSO promptly. These could be the result of tick-borne disease.

Contact with centipedes and stinging insects like bees, hornets and wasps should be avoided to the extent feasible. The UXOSO will modify work rules as necessary to minimize contact, and implement the following procedures:

- If a worker knows that he is hypersensitive to bee, wasp or hornet stings, he must inform the UXOSO of this condition prior to participation in site activities;
- All site personnel will be watchful for the presence of stinging insects and their nests, and will advise the UXOSO if a nest or swarm is present in or near a work area;
- Any nests located will be treated with insecticide from a distance or marked for avoidance;
- Any employee who receives a sting will notify the UXOSO immediately, so that he can observe the affected employee for signs of allergic reaction; and
- Site personnel with a known hypersensitivity to stinging insects will keep required emergency medication on or near their person at all times.

Spiders should be avoided through the same practices discussed above for avoidance of reptiles, ticks, centipedes, and insects. Site personnel will report any suspected spider bite to the UXOSO immediately. Also, they should report the location of possibly venomous spiders observed during the work.

Project personnel will avoid contact with domestic or feral dogs – or any potentially dangerous large animals. They should do nothing to encourage dogs or other large animals to approach the work area, and practice strict avoidance if any should come near. Any bite or close contact with such animals should be reported to the UXOSO immediately.

2.6.8 Domestic Dogs

There is a potential for domestic dogs to run free throughout the site. These dogs may become aggressive if threatened or cornered, or for no apparent reason.

If approached by a dog that may attack:

- Never scream and run;
- Remain motionless, with hands at sides, and avoid eye contact with the dog;
- Once the dog loses interest slowly back away until the animal is out of sight;
- If the dog does attack, “feed” him a jacket, magnetometer, or anything that can be put between yourself and the dog; and

- If you fall or are knocked to the ground, curl into a ball with your hands over your ears and remain motionless. Try not to scream or roll around.

If bitten, immediately wash the wound with soap and water and get medical help. Notify the local animal care and control agency. Provide as much information as possible about the dog's size and color, and in which direction the dog left the area.

Never approach a strange dog. Do not pet a dog without letting the animal see and sniff you first. Never turn your back to a dog and run away. A dog's first instinct will be to chase and catch you. Always assume that a dog that does not know you may see you as an intruder or a threat.

2.6.9 Venomous Snakes

South Carolina has a variety of snakes; however, the Copperhead, Cottonmouth, Prairie Rattlesnake, and Timber Rattlesnakes are the venomous varieties native to the state. Prairie Rattlesnakes are members of the Pit Viper family, and are recognizable by their large, triangular or diamond-shaped head, and vertically elliptical pupils.

2.6.9.1 Copperhead

The Copperhead is the most common venomous snake in South Carolina. However, Copperheads are usually not aggressive and their bite is very rarely lethal. Like most members of the pit viper family, the Copperhead is a heavy-bodied snake. These snakes range between 24 and 36 inches in length and they are covered in hour-glass shaped crossbands which vary in coloration among different populations. The crossbands may be copper, pinkish, reddish brown, or orange. Copperheads are found state-wide in forests and sometimes in fields. The tips of the tails of young Copperheads are yellow and they flick them back and forth in a manner that attracts prey.

2.6.9.2 Cottonmouth Snake

Cottonmouths are relatively large heavy-bodied snakes that reach lengths between 30 and 48 inches. Their coloration ranges from olive to brown to black and the young have wide, dark crossbands. The adult's coloration is dark so the banding pattern is usually not apparent. Cottonmouths occupy marshes, swamps, and most other aquatic environments in the Coastal Plain and eastern Piedmont. They closely resemble many of the water snakes but they behave differently when confronted. Like other members of the pit viper family, they may shake their tail when aggravated. They are likely to stand their ground while opening their mouth and exposing the light lining of their mouth.

2.6.9.3 Timber Rattlesnakes

Timber Rattlesnakes are not aggressive and are sometimes reluctant to bite. This attribute makes them the preferred species of venomous snake used during snake handling religious services. However, if you encounter this snake you should leave it alone. Its venom is highly toxic and people have died from its bites. Timber Rattlesnakes range in size between 3 and 5

feet. The coloration of this species is blackish, yellowish, pinkish, or grayish with dark, bent, cross bands aligned along the dorsal length of its body. A reddish dorsal stripe runs between the crossbands and it has a black tail. Timber Rattlesnakes typically inhabit forest, nearby fields, and swampy areas and may be found throughout the various regions of South Carolina.

2.6.9.4 Snake Bite First Aid Treatment

If bitten, a person's physical reaction to the venom is aggravated by acute fear, anxiety, the amount of venom injected, and the speed of absorption of venom into the victim's circulation; the size of the victim; protection provided by clothing (including shoes and gloves); how quickly the victim receives antivenin therapy, and the location of the bite.

It should be noted that the American Red Cross does not advocate the use of snakebite kits for snakebite injuries; rather, experience has shown that the victim has a better chance of recovery without permanent damage when the site of the wound is immobilized and the victim rushed to the closest emergency medical facility (preferably within 30 minutes).

- **What to Do if Bitten by a Venomous Snake –** According to the American Red Cross, these steps should be taken:
  1. Wash the bite with soap and water.
  2. Immobilize the bitten area and keep it lower than the heart.
  3. Get medical help.

- **If a Victim is Unable to reach Medical Care within 30 Minutes.**
  1. Allow bite to bleed freely for 15 to 30 seconds.
  2. Cleanse and rapidly disinfect area.
  3. Wrap leg/arm rapidly with 3 to 6-inch Ace bandage past the knee or elbow joint. Leave fang marks open. Apply suction cup extractor (if available) immediately. Wrap bandage no tighter than one would for a sprain.
  4. Apply extractor until there is no more drainage from fang marks. The extractor can be left in place 30 minutes or more if necessary. It also aids in keeping the venom from spreading by applying a negative pressure against the tissue where the venom was initially deposited.
  5. If an extractor is not available: Apply direct pressure over bite using a 4×4-gauze pad folded in half twice. Tape in place with adhesive tape.
  6. Soak gauze pad in Betadine™ solution if available.
  7. Strap gauze pad tightly in place with adhesive tape.
  8. Overwrap dressing above and below bite area with ACE or crepe bandage.
  9. Wrap ACE bandage as tight as one would for a sprain; not too tight.
  10. Check for pulse above and below elastic wrap; if too tight, unpin and loosen.

11. Immobilize bitten extremity, use splinting if available.
12. Transport victim to nearest hospital or medical facility as soon as possible.
13. Try and identify, kill and bring (ONLY if safe to do so) offending snake.

- **What Not to Do if Bitten by a Venomous Snake**

1. DO NOT permit removal of pressure dressings or ACE bandage until you are at a facility ready and able to administer antivenin. As soon as the dressings are released the venom will spread. The hospital at this time must be prepared to administer the antidote (antivenin).
2. Do not eat or drink anything unless approved by medical sources.
3. Do not engage in strenuous physical activity.
4. Do not apply oral (mouth) suction to bite.
5. Do not cut into or incise bite marks with a blade.
6. Do not drink any alcohol or use any medication.
7. Do not apply either hot or cold packs.
8. Do not apply a narrow, constrictive tourniquet such as a belt, necktie or cord.

2.6.9.5 Protective Measures for Snakes

- Learn to identify poisonous snakes – this shall be reviewed during site-specific safety training;
- Watch where you sit, where you place your hands and feet, and where your step when exiting a vehicle;
- Avoid rock piles, crevices, and brushy areas. If movement of materials (such as rocks or brush) is necessary, use a remote means to initially relocate the material. Prior to entering an area, look and listen carefully;
- Do not place hands into holes, crevices, debris, or anyplace that may hide a snake;
- Never handle snakes that appear to be dead; and,
- Do not attempt to capture or kill ANY snakes.

2.7 MATERIAL HANDLING AND LIFTING PROCEDURES

Site personnel will exercise care in lifting and handling heavy or bulky items. No site worker will attempt to lift any item in excess of **50** pounds without assistance or use of a mechanical device. Materials being lifted either mechanically or manually will not be moved, or suspended, over personnel unless precautions have been made to protect the personnel from falling objects. Whenever heavy or bulky material is to be moved manually, the size, shape, and weight of the object and the distance and path of movement must be considered to prevent

joint and back injuries. The following hierarchy will be followed in selecting a means for material handling:

1. Movement of the material by mechanical device (i.e., lift truck, crane, etc.);
2. Movement by manual means using mechanical aid (i.e., dolly or cart); and
3. Movement manually in a planned manner with an adequate number of personnel.

The UXOSO will train employees in proper lifting techniques and require that they lift objects properly. The following procedures shall be followed:

1. A firm grip on the object is essential. Therefore the hands and object will be free of oil, grease, or water, any of which might prevent a firm grip.
2. The hands, and especially the fingers, will be kept away from any points where pinching or crushing could occur, especially when setting the object down.
3. The item will be inspected for metal slivers, jagged edges, burrs, rough or slippery surfaces and pinch points, and gloves will be used, if necessary, to protect the hands.
4. The feet will be placed far enough apart for good balance and stability.
5. Personnel will ensure that solid footing is available prior to lifting the object.
6. When lifting, personnel will remain as close to the load as possible, bend their legs at the knees, keep their back as straight as possible, and lift the object with the legs, as they are straightening from their bending position.
7. Never carry a load that cannot be seen over or around.
8. When placing an object down, the stance and position are identical to that for lifting, with the back kept straight and the legs bent at the knees, while the object is lowered.
9. When two or more people are required to handle an object, care should be taken to ensure the load is lifted and distributed uniformly between the individuals carrying the load. Each person, if possible, will face the direction in which the object is being carried.

2.8 ACTION LEVELS

Action levels and methods to mitigate the hazards noted above vary depending on the hazard. Controls, preventative measures, and treatments are discussed with listed hazardous conditions. Additional action levels and required actions are presented below:

- Implementation of engineering controls and safe work practices shall be discussed prior to starting of work or a new task;
- Upgrades/downgrades in levels of PPE shall be considered if hazards exist or if hazards are mitigated;
- Work stoppage or emergency evacuation of on-site personnel will be carried out if a hazardous condition warrants such action; and
- Public exposures to hazards created by site activities will be prevented or minimized.

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3.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This information is found in Section 4.0 of the APP. As field personnel are identified ahead of the field mobilization date, Appendix G of the WP will be updated to include the personnel qualifications certification letter. Mr. Stephen Davis, as personnel assigned specific safety and health responsibilities, has a resume included here.

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NAME: **STEPHEN L. DAVIS CIH, CSP** **HYDROGEOLOGIC, INC.**
TITLE: **Director, Environmental Health and Safety** **Reston, VA**

EDUCATION AND TRAINING:

M.S., Public Health, Industrial Hygiene specialization - University of South Carolina, 1983
Bachelor of Science in Zoology - Valdosta State University, 1975

PROFESSIONAL CERTIFICATIONS:
Certified Industrial Hygienist (#4213), by the American Board of Industrial Hygiene, 1989
Certified Safety Professional (#10044), by the Board of Certified Safety Professionals, 1991

EXPERIENCE SUMMARY:

Mr. Davis is a seasoned Environmental Health and Safety professional with a broad range of successful experience in both program and project management. He is focused on developing cost-effective and "common sense" solutions to EHS challenges within resource-constrained systems. Mr. Davis is highly effective at creating successful safety cultures in order to achieve regulatory compliance and excellent injury statistics. He has achieved effective workers comp case management and excellent safety statistics while being in compliance with client safety requirements and third party review systems. Mr. Davis also has experience in medical surveillance program management.

EMPLOYMENT HISTORY:

HydroGeoLogic, Inc., Director, Environmental Health & Safety, Reston VA, February 2014.
Program Manager for EHS, Workers Compensation, and Medical Surveillance programs. Responsible for execution and continuous improvement of systems to ensure the safety of HGL personnel, pursue HGL's zero incident goal, meet or exceed OSHA regulatory requirements, exceed client EHS requirements, effectively manage workers compensation claims, and achieve best-in-class safety statistics.

Science Applications International Corporation (SAIC), Environmental, Health and Safety and Quality Assurance Manager, Oak Ridge, TN, 2010 – 2012.
Program Manager for EHS and QA for the Federal Infrastructure organization within SAIC. Responsible for execution of systems to meet or exceed OSHA regulatory requirements, exceed client EHS and QA requirements, assess and minimize risks, effectively manage workers compensation claims, and achieve best-in-class safety statistics. Created business-unit level system for project and program risk review in order to identify and control risks such as serious health and safety risks, third party lawsuits, regulatory citations and fines, and environmental damage. System documented potential risks and agreed-upon risk controls and facilitated subsequent verification of execution and effectiveness. Managed QA program for

5,000 employee organization conducting multiple disparate types of activities subject to requirements of multiple government and commercial clients utilizing either NQA-1 or ISO 9001. 5,000 employee Business Unit achieved TRIR of 0.27 in 2011, which is less than 1/3 the average rate reported by the Bureau of Labor Statistics for engineering firms. Average TRIR for last 4 years was 0.37. 5,000 employee Business Unit received the National Safety Council Industry Leader award and was one of only 81 of the 54,000 NSC members to receive this award.

SAIC, Vice President, Environmental, Health and Safety, Oak Ridge, TN, 1993 to 2009. Program Manager for EHS for the Energy, Environment and Infrastructure Business Unit within SAIC. Responsible for execution of systems to meet or exceed OSHA regulatory requirements, exceed client EHS requirements, assess and minimize risks, effectively manage workers compensation claims, and achieve best-in-class safety statistics. Created and implemented EHS program compliant with ANSI Z-10 "American National Standard for Occupational Health and Safety Management Systems" for the 5,000 employee Business Unit. This program exceeded all regulatory requirements and established a system for establishing and tracking world-class safety practices and performance. Provided leadership and direction for activities of 7 EHS Managers of sub-tier organizations and dozens of site health and safety officers. Established successful Behavior Based Safety Program in compliance with multiple client requirements. This program allowed the organization to successfully satisfy rigorous requirements of several major oil and gas clients and federal agencies. Established EHS systems and documentation to achieve approval from multiple third-party review programs such as ISNetworld and PICS, and clients such as the Department of Energy, the US Army Corps of Engineers, and multiple major oil and gas clients. Created and implemented process to review and qualify subcontractors based on prior health and safety performance in order to ensure exceptional safety performance. This program served two important functions; 1) Exclude unsafe subcontractors and 2) Notify all subcontractors that only first-class EHS programs and execution were acceptable. Managed the EHS portions of successful acquisition of $20M in commercial oil and gas business. EHS systems and performance represented 20% to 40% of evaluation criteria for these bids. Established processes for workers compensation reporting and case management that facilitated significant reduction in OSHA recordable injury and illness rates. Provided EHS leadership for over $200M in work at 100s of sites. This work included Architect and Engineer (AE), Military Munitions Response Program (MMRP), Long Term Response Action (LTRA) and Hazardous Toxic and Radioactive Waste (HTRW) contracts for the US Army corps of Engineers Louisville District, Savannah District, St. Louis District, Omaha District, Northwestern Division, Buffalo District, Mobile District, and Nashville District. It also included similar work for the Air Force Center for Energy and the Environment (3P, 4P, 4PAE), the US Navy, the National Aeronautics and Space Administration, the National Guard Bureau, the Tennessee Department of Transportation, US Forest Service, Washington Department of Ecology, Department of Energy prime contractors, and multiple commercial clients including oil and gas companies. As part of this leadership; coordinated with clients regarding safety expectations, provided guidance to multiple regional and onsite health and safety officers, wrote or reviewed hundreds of health and safety plans and activity hazard analyses, conducted formal readiness reviews to verify preparations, conducted audits, conducted incident investigations, conducted EHS performance reviews and

compiled performance statistics. The challenges associated with these programs included Munitions and Explosives of Concern (MEC), residual explosives contamination, hazardous wastes, petroleum residues, ionizing radiation and radioactive contamination, operation and maintenance of onsite treatment systems, remedial construction, excavation, SCUBA diving, vessel operation, heavy equipment operation, elevated work and high voltage electrical systems. The Business Unit received the National Safety Council "Perfect Record" award for working 2,780,000 hours without a lost time injury or illness in 2009. The Business Unit received the National Safety Council "Occupational Excellence" award each year for ten consecutive years by maintaining a lost time incident rate of less than half the average rate for other businesses in its North American Industry Classification System code.

International Technology Corporation (IT), Regional Manager Health and Safety Consulting and Training, Knoxville, TN, 1983 to 1993.
Managed a consulting program delivering health and safety program audits, health and safety training, field project health and safety oversight, job hazard analyses, and occupational exposure monitoring for multiple clients including the Department of Energy, US Corps of Engineers, US Navy, and the California Department of Health Services. Successfully managed project to deliver health and safety support to the U.S. Army Corps of Engineers (USACE) at the Bruin Lagoon Superfund Site. The acid sludge disposal site was being remediated by excavating the sludge, mixing it with lime and soil and burying the mix on site. Services consisted of health and safety oversight of the remedial contractor, general health and safety technical advice, on-site monitoring with four real-time instruments mounted on all-terrain vehicle, and installation and maintenance of a real-time perimeter data logging system to collect and store results from multiple hydrogen sulfide and hydrogen chloride sensors. The perimeter monitoring system measured real-time concentrations, recorded instantaneous and average concentrations and provided immediate notification (alarmed) of unacceptable excursions. Following project completion the general results of the air-monitoring program were published and presented, with USACE and EPA input and approval, at the EPA Design and Construction Conference. Successfully managed second phase of job hazard analyses project for Ft. Bliss Army Post, Texas. Managed and participated in a project to perform hundreds of job hazard analyses at the Ft. Bliss Army Post for AIRHAS (HAZWRAP). Interviewed dozens of army personnel, observed maintenance and storage operations, inventoried chemical supplies, assessed the nature and severity of potential exposures, and identified issues and hazards that needed immediate attention. Reduced the data to Army codes and entered the accumulated data into the Army's Health Hazard Information Module database. Provided industrial hygiene support for remedial investigation at the U.S. Department of Energy (DOE) Feed Materials Production Center, Fernald, Ohio. The primary objective of this activity was to attain compliance with the requirements of 29 CFR 1910.120, the Hazardous Waste Operations and Emergency Response standard. Conducted detailed on-site hazard assessments, prepared over 20 task-specific health and safety plans including a line-by-line analysis of compliance with the OSHA lead standard, coordinated activities and hazard controls with DOE representatives, and conducted real-time air monitoring to assess employee exposures and verify compliance with exposure limits. Managed and participated in the development and delivery (over 20 sessions) of the 3-day "Hazard Appraisal and Recognition planning," course for the California Department of Health Services. This course was the basic

health and safety training for the state hazardous waste compliance officers. It was developed to meet the specific needs of the sponsor and included training in preparation of program-specific hazard assessment forms, use of program-specific monitoring instruments, and compliance with program-specific policies. The courses were presented on-site at multiple locations around the state. Managed and participated in 25 presentations of "The Navy Hazardous Substance Incident Response Management Course." This five-day course was presented in Kaneohe Bay HI, Pearl Harbor HI, Norfolk VA, Virginia Beach VA, Charleston SC, Washington, D.C., Guam, Oakland CA, Philadelphia PA, Pensacola FL, San Diego CA, Port Hueneme CA, and Seattle WA. Successful presentation required maintenance, shipment, and set-up of over two thousand pounds of gear including self-contained breathing apparatus, totally encapsulating chemical protective suits, air purifying respirators, and real time air monitoring instruments. Each course culminated in student-lead responses to simulated hazardous materials incidents.

U.S. CITIZEN: Yes

PUBLICATIONS AND TECHNICAL PRESENTATIONS:

Publications:

Davis, S.L., and B. Khona, 1991, "Airborne Exposure Control at an Acid Sludge Remedial Site," published in the proceedings of USEPA conference, Design and Construction Issues at Hazardous Waste Sites.

Davis, Stephen L., 1985, "Permeation Testing of Protective Gloves Exposed to Selected High Hazard Pesticides," report prepared under EPA contract number 68 03 3069, IT Corporation, Edison, New Jersey.

Davis, S.L., C.E. Feigley, and G.A. Dwiggins, 1984, "A Comparison of Two Methods Used to Measure Permeation of Glove Materials by a Complex Organic Mixture," American Society for Testing and Materials (ASTM) Special Technical Publication, First International ASTM Symposium on the Performance of Protective Clothing.

Technical Presentations:

Davis, Stephen, L., 1991, "Airborne Exposure Control at an Acid Sludge Remedial Site," USEPA Conference, Design and Construction Issues at Hazardous Waste Sites.

Davis, Stephen, L., 1985, "Industrial Hygiene Assessment for Initial Entry into Hazardous Waste Sites," Joint Conference of Occupational Health (JCOH), Orlando, Florida, 1985.

Davis, Stephen, L., 1983, "Permeation of Glove Materials by Liquefied Coal," Carolina's Section, American Industrial Hygiene Association, Asheville, North Carolina.

Davis, Stephen, L., 1983, "A Comparison of Two Methods Used to Measure Permeation of Glove Materials by a Complex Organic Mixture," Carolina's Section, American Industrial Hygiene Association, Asheville, North Carolina.

4.0 TRAINING

HGL and subcontracted UXO personnel working at this site have completed Naval EOD or other DoD certified UXO training program that details procedures for evaluation and disposal of MEC. All employees at this job site will have completed a training program prior to beginning work on-site, that complies with Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120(e)(9). All HGL employees who work at hazardous sites receive 40 hours of off-site training, and three days of actual field experience under the direct supervision of a trained, experienced, supervisor. Each employee also receives eight hours of OSHA refresher training annually.

In addition to the training described above, management and supervisors receive an additional eight hours of training on program supervision. At minimum, two field personnel will have received CPR/First Aid training. In the absence of an infirmary, clinic, or hospital in near proximity to workplaces, personnel should be adequately trained to render first aid and CPR. HGL does not require or designate employees to render first aid/CPR. Trained employees may provide first aid/CPR of their own free will as "Good Samaritans." Bloodborne pathogen awareness is provided during the CPR/First Aid training. Universal precautions require one to assume that all blood and bodily fluids contain pathogens and require the use of protective barriers to prevent exposure. Latex gloves and CPR barriers will be available in the first aid supplies and must be used. Additionally, washing any body part or surface that has been contaminated with blood is an important part of the universal precautions. The UXOSO should be notified of any potential contact with blood or body fluids resulting from first aid or CPR administered on the job. Additional training will be conducted when circumstances dictate.

Copies of training and qualifications for all staff will be on file during the field activities at the HGL field trailer. Additional details on safety training are found in Section 6.0 of the APP. Training certificates will be maintained in a file on the site by the UXOSO.

4.1 SITE-SPECIFIC TRAINING

The UXOSO will give site-specific training to all personnel prior to initial site entry. The training will include:

- Project scope to include organization and responsibilities, site orientation, facilities, access, egress, evacuation and emergency routes, and other general information; and
- All elements of the SSHP, including general safety, safe work practices, physical hazards, PPE, on/off-site emergencies, evacuation routes, emergency agencies/numbers, emergency equipment, medical emergencies, drug and alcohol, bloodborne pathogens, and other pertinent safety information.

4.2 TAILGATE MEETINGS

In addition to the above training, daily safety training will be provided each morning on site at a tailgate safety meeting. The health and safety considerations for the day's activities will be

reviewed. A tailgate safety meeting form will be signed upon completion of the tailgate safety meetings. The daily tailgate safety meeting will address that day's activities, safety issues, specific hazards, and emergency procedures, to include:

- Notification procedures and phone numbers;
- Rally points and safe areas;
- Hospital and evacuation routes; and
- Emergency equipment.

5.0 PERSONAL PROTECTIVE EQUIPMENT

PPE required at the site will be at a level necessary to protect personnel. Normal work clothing will be Level D. A hard hat is not required unless a possible head injury could result from the use of heavy equipment or overhead hazards. Ball caps or hats are recommended for sun protection. Steel toe footwear will not be worn while operating magnetometers or geophysical instruments. The minimum level of protection required of all personnel at all sweep areas is Level D. The following is Level D protection:

- Short or long sleeved cotton coverall or work clothing (e.g., long pants, jeans, short or long sleeved shirt);
- High-topped leather boots/shoes, composite toe;
- Safety glasses with side shields or goggles when an eye hazard exists;
- Hard hat, when an overhead hazard exists;
- Hearing protection, when working around heavy equipment or powered hand tools; and
- Reflective vests when working with traffic control; and
- Disposable Nitri-solve® (11 mil) or equivalent gloves whenever there is reasonable potential for contact with contaminated soils, groundwater, or equipment that may contain trace contamination. Disposable gloves will be changed frequently (at least every 15 minutes or with each new sample collection) to avoid breakthrough.

The level of protection is based on what is known about the site. The levels of protection may change as site conditions change. The UXOSO will monitor site conditions and provide information to the PM as necessary. The UXOSO may increase the levels of protection when necessary, but will not downgrade them without approval from the HGL CHSD. General decontamination and hand washing should be considered after exposure to soil, water, or potential contamination.

Upgrades in PPE will be determined by:

- Request from individual performing tasks;
- Change in work tasks that will increase contact or potential contact with hazardous materials;
- Occurrence or likely occurrence of gas or vapor emission; and
- Known or suspected presence of dermal hazards.

The required PPE for each task anticipated for this project is identified in Table 5.1.

Table 5.1
Initial PPE Required for Project Activities

Activity	PPE Required
• Mobilization and Site Preparation; • Instrument-assisted Visual Survey; • DGM; • Intrusive Investigation; • MCs Sampling; and • Site Restoration and Demobilization.	D to Modified Level D, ANSI Class 2 high visibility vest, hearing protection, safety glasses, hard hat and coveralls as needed.

Notes:
ANSI - American National Standards Institute

5.1 PPE FOR VISITORS

An adequate supply of basic PPE shall be maintained on site for visitors. Visitors will not be supplied with chemical protective clothing or respiratory protection.

5.2 PPE TRAINING

All field personnel receiving PPE training will be required to demonstrate an understanding of the training topics and the ability to correctly use the PPE. This will be accomplished through the UXOSO supervising and visually inspecting each individual's ability to properly don and use the PPE during initial use of the PPE.

When the UXOSO has reason to believe that any affected employee who has already been trained does not have the understanding and skill required he should retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:

- Changes in the workplace render previous training obsolete,
- Changes in the types of PPE to be used render previous training obsolete, or
- Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

Upon completion of the training and after each employee has successfully demonstrated the requisite understanding, the UXOSO will complete the Personnel PPE Training Certification form (Table 5.2). This form identifies the employees who attended the training course and successfully demonstrated the required knowledge; the date(s) of the training and demonstration session(s); and the PPE covered by the training session.

Table 5.2
Personnel PPE Training Certification Form (Example)

PROJECT INFORMATION			
Project Name:			
Site Location:			
Date of Classroom Instructions/Demonstration:			
Name of Instructor(s):			
PPE TRAINING COURSE ATTENDANTS			
The following personnel have attended the site PPE training course, and demonstrated, through use, an understanding of the donning/doffing procedures, inspection, cleaning, maintenance, storage, limitations, and proper disposal of the PPE listed on this certificate. These personnel are now qualified to use the site- and task-specific PPE, as required by the APP/SSHP.			
Name	**Organization**	**Date**	**Signature**
TYPES AND LEVELS OF PPE ADDRESSED DURING TRAINING			
Trainer's Initials	**PPE Reviewed**	**Remarks**	
TRAINER'S CERTIFICATION			
I the undersigned do hereby certify that the above listed personnel have received the requisite training and successfully demonstrated their ability to use the PPE listed above, in accordance with the HGL's Personal Protective Equipment Program.			
Name (Printed):	**Signature:**	**Date:**	

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6.0 MEDICAL SURVEILLANCE

HGL personnel are required to participate in the medical surveillance program, which is managed by the CHSD. The program includes initial and routine medical exams provided by a licensed physician at a WorkCare approved clinic. These exams are used to establish an initial baseline of the employee's health and then used to monitor their future health as they pertain to potential occupational exposures to hazardous agents, and fitness to work.

Workers exposed to site hazards, including all employees of HGL, will participate in a program of medical surveillance of the type specified in 29 CFR 1926.65, the OSHA standard on "Hazardous Waste Operations and Emergency Response." Such workers must present a physician's statement that they are medically qualified for (1) work in hazardous waste operations, and (2) the use of respirators. The UXOSO will evaluate all physicians' letters and refer any questions to the CHSD. Annual medical certification is required; a physician's statement must be no older than 1 year.

The UXOSO will take note of any restrictions stated on a physician's statement, and make arrangements to avoid any prohibited activity or condition. In addition, the UXOSO will monitor all employees to detect early signs of exhaustion, heat stress, or other conditions that might suggest a lack of fitness for a particular task.

Medical treatment received related to a workplace injury or illness will be managed in accordance with the OSHA standard referenced above. The UXOSO will notify the CHSD immediately if such an event occurs.

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7.0 EXPOSURE MONITORING AND AIR SAMPLING

No routine exposure monitoring or air sampling is anticipated. The UXOSO and the PHSM or CHSD will confer to assess the need for such testing, and they will implement a monitoring or sampling program if this is warranted by site activities or conditions.

The UXOSO will monitor employees' noise exposure with a calibrated sound level meter whenever noisy operations are in progress, and require the use of hearing protection whenever the sound level measured in a work area is 80 dBA or greater.

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8.0 HEAT STRESS AND COLD STRESS

Hot, humid work environments could present the risk of heat-related illness. It is also possible that cold, windy conditions could present the risk of hypothermia or frostbite. The UXOSO will remain alert to site conditions that could cause heat-related or cold-related illness. The UXOSO will implement procedures found in Attachments 4 or 5, if necessary.

8.1 HEAT STRESS

The potential for heat stress is high for this project because the fieldwork will be conducted mostly during the summer months in South Carolina. Therefore, extra care must be taken to observe and respond to symptoms. Sweating does not cool the body unless the sweat is evaporated from the body. The use of some PPE can reduce the body's ability to eliminate large quantities of heat because the evaporation of sweat is decreased. The body's effort to maintain an acceptable temperature may become impaired and this may cause heat stress. Increased body temperature and physical discomfort also promote irritability and a decreased attention to the performance of hazardous tasks. If semi-permeable and impermeable PPE is used at the site, heat stress is a MAJOR HAZARD.

8.1.1 Types of Heat Stress

Heat stress related problems include heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. Heat rash occurs because sweat is not evaporating; making the skin wet most of the time. Standing erect and immobile allows blood to pool in the lower extremities. As a result, blood does not return to the heart to be pumped back to the brain and fainting may occur. Heat cramps are painful spasms of the muscles due to excessive salt loss resulting from profuse sweating. Heat exhaustion occurs because of the large fluid and salt loss from profuse sweating.

Heat stroke occurs when the body's temperature regulatory system has failed. Skin is hot, dry, red, and spotted. These skin color changes may not be readily evident in darker skinned individuals and other signs must be relied upon. The affected person may be mentally confused, delirious, and convulsions may occur. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area immediately. The person should be soaked with water and fanned to promote evaporation. Medical attention must be obtained immediately.

EARLY RECOGNITION AND TREATMENT OF HEAT STROKE ARE THE ONLY MEANS OF PREVENTING BRAIN DAMAGE OR DEATH.

8.1.2 Early Symptoms of Heat Stress Related Problems

Personnel should recognize the early symptoms of heat stress. These symptoms include:

- Reduced performance;
- Lack of coordination;

- Lack of alertness;
- Unsteady walk;
- Excessive fatigue;
- Muscle cramps; or
- Dizziness.

8.1.3 Administrative Controls

Wet bulb globe temperature (WBGT) monitoring will be performed by the UXOSO when temperatures on site exceed 75°F.

8.1.4 Work/Rest Regimen

The management of risk for heat stress exposures centers around the principal of job-specific controls. Controls that will be implemented to reduce the potential for heat stress includes: use of acclimated personnel, providing adequate replacement fluid, educating individuals to recognize the early symptoms of heat stress, use of cooling vest, physiological monitoring, and development of a work/rest schedule that will prevent the onset of heat stress.

Work/rest regimens will be implemented in accordance with the limits specified in Table 8.1 for Level D PPE.

Table 8.1
Permissible Heat Exposure Threshold Limit Values (°C and [°F] WBGT)
when Level D PPE is Worn

Work/Rest Regimen	Workload		
	Light	Moderate	Heavy
Continuous Work	31 (88)	28 (82)	------
75% Work 25% Rest, each hour	31 (88)	29 (84)	27.5 (81)
50% Work 50% Rest, each hour	32 (90)	30 (86)	29 (84)
25% Work 75% Rest, each hour	32.5 (90)	31.5 (89)	30.5 (87)

NOTE: The workload category may be established by ranking each job into light, medium, or heavy categories on the basis of type of operation:

Light: (up to 200 kcal/hr or 800 Btu/hr): e.g., sitting or standing to control machines, performing light hand or arm work.

Moderate: (200-350 kcal/hr or 800-1400 Btu/hr): e.g., walking about with moderate lifting and pushing.

Heavy:(350-500 kcal/hr or 1400-2000 Btu/hr): e.g., pick and shovel work.

Work schedules may be adjusted in accordance with physiological monitoring results.

If at the end of a work period, the core body temperature for any team member exceeds 38°C (100.4°F), then the next lower work/rest regimen will be instituted.

If no team member's core body temperature exceeds 37.5°C (99.5 °F), then the next higher work/rest regimen may be instituted.

A WBGT monitor may be used to monitor for conditions that pose a threat of heat stress. WBGT monitoring should be conducted by the UXOSO when workers are dressed in Level D ensembles and the ambient temperature exceeds 75 °F. Once the WBGT has been determined, the UXOSO can estimate workers' metabolic heat load using Table 8.1 or 8.2 to determine the appropriate work/rest regimen. Modification to the work/rest schedule can be instituted by the UXOSO based on physiological monitoring data.

Whenever a new team member begins work on-site, that member's entire team will use Table 8.1 for establishing the work/rest regimen until the new team member is acclimated.

Use of cooling vests by team members may also modify the work/rest regimen or the time of stay for continuous work. In this event, work/rest regimens will be modified by the UXOSO.

8.1.5 Prevention of Heat Stress

Proper training and preventive measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illnesses. To avoid heat stress, the following steps should be taken:

- Adjust work schedules.
  - Modify work/rest schedules as described above.
  - Mandate work slowdowns as needed.
- Perform work during cooler hours of the day, if possible.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Ensure workers are acclimated to weather conditions and have extensive experience in the selected level of PPE. Workers can be acclimatized by gradually increasing the workload over a period of days.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluids intake must approximately equal the amount of water lost in sweat, e.g., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kilograms [kg]) of weight loss. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature at 50° to 60°F (10° to 16.6°C).
  - Provide small disposable cups that hold about 4 ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or diluted drinks) before beginning work.

  - Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
- Train workers to recognize the symptoms of heat-related illnesses.
- Provide potassium supplements (banana or potassium chloride tablets).
- Rotate personnel and alternate job functions.

8.2 COLD STRESS

8.2.1 General

Exposure to low temperatures presents a risk to employee safety and health both through the direct effect of the low temperature on the body and collateral effects such as slipping on ice, decreased dexterity, and reduced dependability of equipment. Work conducted in the winter months can become a hazard for field personnel due to cold exposure. All personnel must exercise increased care when working in cold environments to prevent accidents that may result from the cold. The effects of cold exposure include frostbite and hypothermia. Wind increases the impact of cold on a person's body. Systemic cold exposure is referred to as hypothermia. Local cold exposure is generally labeled frostbite. Recognition of the symptoms of cold-related illness will be discussed during the health and safety briefing conducted prior to the onset of site activities.

Hypothermia is a life-threatening condition in which the core body temperature falls below 95°F. Hypothermia can occur at temperatures above freezing particularly when the skin or clothing becomes wet. During exposure to cold, maximum shivering occurs when the core temperature falls to 95°F. As hypothermia progresses, depression of the central nervous system becomes increasingly more severe (Table 8.2). This accounts for the progressive signs and symptoms ranging from sluggishness and slurred speech to disorientation and eventually unconsciousness.

Table 8.2
Progressive Clinical Symptoms of Hypothermia

Core Temperature (°F)	Clinical Symptoms
95	Maximum shivering
87 to 89	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated
84 to 86	Progressive loss of consciousness; muscular rigidity; respiratory rate decreases
79	Victim rarely conscious
70 to 72	Maximum risk of ventricular fibrillation

Frostbite is both the general and medical term given to areas of cold injury. Unlike hypothermia, frostbite rarely occurs unless environmental temperatures are less than freezing and usually less than 20°F. Frostbite injuries occur most commonly on the distal parts of the

body (nose, earlobes, hands, and feet) that are subject to intense vasoconstriction. The three general categories of frostbite are:

- **Frostnip** - A whitened area of the skin that is slightly burning or painful.
- **Superficial frostbite** - Waxy, white skin with a firm sensation but with some resiliency. Symptomatically feels "warm" to the victim with a notable cessation of pain.
- **Deep frostbite** - Tissue damage deeper than the skin, at times, down to the bone. The skin is cold, numb, and hard.

8.2.2 Preventing Cold Exposure

In preventing cold stress, the UXOSO must consider factors relating to both the worker and the environment. Training, medical screening, establishment of administrative controls, selecting proper work clothing, and wind-chill monitoring all contribute to the prevention of hypothermia and frostbite.

- **Training** - Recognizing the early signs and symptoms of cold stress can help prevent serious injury. Therefore, workers will be trained to recognize the symptoms of hypothermia and frostbite and have appropriate first-aid instruction. When the air temperature is below 50°F, the UXOSO will inform workers of the proper clothing requirements and any work practices that are in effect to reduce cold exposure.
- **Administrative Controls** - The UXOSO will establish a work/rest schedule based upon worker monitoring. At the first sign of uncontrollable shivering the worker will be rested in a heated shelter. Work will stop when the air temperature reaches 0°F.
- **Clothing** - Workers will be encouraged to layer clothing when air temperature is below 50°F. Clothing that has a high insulation value will be worn under protective garments. Insulated gloves will be worn when the wind chill index is below 32°F.

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9.0 STANDARD OPERATING SAFETY PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

This section describes safety procedures, controls, and practices that all site personnel must follow to mitigate risks from hazards. The following rules are generally applicable:

- Administrative hazard control will be practiced for all site areas by restricting entrance to EZs to essential, qualified personnel.
- The buddy system will be used at all times by all field personnel. No one is to perform field work alone; visual, vocal, or radio communication will be maintained at all times.
- Direct contact with contaminated (or potentially contaminated) surfaces should be avoided. Walk around (not through) puddles, discolored surfaces, and contaminated ground. Do not kneel on the ground or set equipment on the ground. Stay away from any waste drums unless necessary. Bag equipment to protect it from contamination.
- Wearing open-toed, high-heeled, canvas, or cloth-top shoes will be prohibited in all areas other than office or general public areas. Slippers or other flimsy types of footwear will be strictly prohibited.
- Anyone reporting to work under the influence of alcohol and/or illegal drugs will be subject to disciplinary action. Any employee under a physician's care and/or taking prescribed medication must notify the Program Manager.
- Smoking will not be permitted in any area where hazardous chemicals or materials are in use or stored.
- Changes in work practices or work rules will be implemented only after a written safety plan amendment has been prepared and authorized. Changes will be communicated to all site personnel.
- Employees will generally be responsible for cleaning and maintaining PPE issued to them. Any noted defects in protective equipment will be reported immediately to the UXOSO.
- Personnel must report all injuries and/or illnesses to their supervisor. This includes minor injuries and near misses.
- Posted danger and warning signs indicating special hazards are to be obeyed at all times.
- All safety guards furnished by the manufacturer are to be used, including safety belts in vehicles.
- Horseplay, scuffling, running, and practical jokes will be prohibited.
- Loose or torn clothing, ties, scarves, wristwatches, bracelets, or rings shall not be worn when they may pose a safety hazard.

- Free access shall be maintained to fire extinguishers, power panels, emergency exits, exit doors, first-aid kits, safety showers, and eyewash stations.
- Supervisors will instruct and monitor employees in proper lifting techniques.
- The lifting capacity of mechanical equipment shall not be exceeded.
- Personnel shall be aware of prevailing weather conditions. When there is a threat of lightning, all work involving heavy equipment will cease.
- Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness requires enough illumination intensity to read a newspaper without difficulty.
- Good housekeeping must be maintained at all times in all project work areas.
- Specific areas will be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris, and shall be removed at regular intervals.
- All spills shall be cleaned up quickly. Oil and grease shall be cleaned from walking and working surfaces.

9.1 SITE RULE/PROHIBITION

All personnel on site will be required to follow the safe work practices contained in this SSHP, as they relate to the hazards encountered during site activities. All site personnel will be required to read, understand, and comply with the provisions of this SSHP. If new tasks or hazards are identified during site operations, which pose additional hazards, the SSHP will be amended by the PHSM or CHSD to include additional safe work practices and other control methods as needed.

9.1.1 Buddy System

The buddy system is a safety practice in which each individual is concerned with the health and well-being of co-workers. The buddy system will be implemented during all on-site activities and will be incorporated when workers may be isolated or as determined by the UXOSO. The UXOSO will assign “buddies” to ensure accounting of all site personnel.

At least two persons are required to be at the work area when work that might result in worker contamination or injury is conducted. When only one person is working on site, they will carry a cell phone and keep it turned on at all times while in the field and call in to the office at predetermined times in order to verify they are well. The predetermined call-in times from on site will, at a minimum, correspond to site arrival, mid-day, and site departure. The employee will also notify the client of their presence on site upon arrival.

9.1.2 Eating/Drinking/Smoking Restrictions

Hand and face washing facilities will be set up in the Support Zone (SZ) and will be utilized by all personnel exiting the EZ prior to eating, drinking, tobacco use, or other hand-to-face activities. Paper towels will be provided for drying. A trash receptacle will be provided for discarded paper towels. Eating, drinking and tobacco use will take place in the SZ.

Smoking will be permitted only in designated areas. These areas will be equipped with a fire extinguisher, as well as a can containing sand, where cigarette butts can be safety discarded without concern for the spread of fire. All lighters and matches will remain in the designated smoking area and will not be permitted into the site.

9.2 WORK PERMIT REQUIREMENTS

At this time HGL does not anticipate work permits for the work associated with this project. Should this situation change, this SSHP will be updated to include these additional hazards, and will handle them in accordance with the HGL's Corporate Safety and Health Program, which addresses all of these issues.

9.2.1 Radioactive Work

As there are no plans to perform work involving radioactive materials, work permits for this type of work will not be required.

9.2.2 Excavation

Prior to any excavation work, the installation will be informed of the location so that HGL can obtain information regarding potential buried utilities and permission to dig. As a precaution, the electric company will be advised on the location where excavation work will occur, and will be given the opportunity to advise HGL on the potential presence of utility lines in the area. Excavation work is not expected to be more than 4-ft below ground surface (bgs), so sloping or shoring will not be required.

9.2.3 Hot Work

Not applicable. As there are no plans for welding operations on this site, there will be no requirement for hot work permits.

9.2.4 Confined Spaces

Not applicable. As there are no plans for confined space work on this site, confined space permits will not be required.

9.3 MATERIAL HANDLING PROCEDURES

Many types of objects are handled in normal day-to-day operations. Care will be taken and training will be provided to all personnel for lifting and handling heavy or bulky items, as this

is the cause of many joint and back injuries. The following fundamentals address the proper lifting of materials to avoid joint and back injuries.

- The size, shape, and weight of the object to be lifted must be considered. Site personnel will not lift more than they can handle comfortably.
- A firm grip on the object is essential; therefore, the hands and object will be free of oil, grease, and water, which might prevent a firm grip.
- The hands, and especially the fingers, will be kept away from any points that may cause them to be pinched or crushed, especially when setting the object down.
- The item will be inspected for metal slivers, jagged edges, burrs, rough or slippery surfaces, and pinch points, and gloves will be used, if necessary, to protect the hands.
- The feet will be placed far enough apart for good balance and stability.
- Personnel will ensure that solid footing is available prior to lifting the object.
- When lifting, get as close to the load as possible, bend the legs at the knees, making sure that the back is kept as straight as possible.
- To lift the object, the legs are straightened from their bending position.
- Never carry a load that cannot be seen over or around.
- When placing an object down, the stance and position are identical to that for lifting, with the back kept straight, the legs bent at the knees, and the object lowered.
- If the item to be lifted is too large, bulky, or heavy (over 50 lb) for one person to safely lift, ask a co-worker for assistance. If a piece of material handling equipment is available that can do the job, the employee should use the equipment instead of trying to lift the object himself/herself.
- When two or more people are required to handle an object, coordination is essential to ensure that the load is lifted uniformly and that the weight is equally divided between the individuals carrying the load. When carrying the object, each person, if possible, will face the direction in which the object is being carried.

9.3.1 Soil

If workers will be required to handle potentially contaminated soil, they will use appropriate personal protective equipment based on the specific type of chemical contamination. Chemical contamination is not expected to be a concern for the soil on this site.

9.3.2 Liquid

If workers will be required to handle liquid chemical materials, appropriate personal protective equipment will be used based on the specific type of chemical(s) to which they may be exposed. All flammable liquids will be stored in approved flammable liquid containers and stored in designated flammable liquid storage areas. Grounding and bonding procedures will be used when dispensing flammable liquids from one container to another or into equipment.

No equipment will be fueled in the back of a pick-up truck with a bed liner due to static electricity concerns. No smoking will be permitted within at least 50 feet of flammable liquid use or storage.

9.3.3 Radioactive Materials

Radioactive materials are not expected to be encountered at this project site.

9.3.4 Spill Contingency

Small quantity containers of chemicals will be used at the work site, which will minimize the amount of hazardous materials that could potentially become part of a spill should an accident occur. The majority of chemicals used will include fuels, oils and lubricants for use in vegetation clearance equipment and heavy equipment. Spill clean-up kits will be available for use to clean up these chemicals and the impacted soils in the event a spill occurs. Chemical resistant gloves will be used during all cleanup activities. The spilled chemical and the contaminated soil will be cleaned up, placed in labeled plastic bags, and stored in drums or other secured location until such time as they can be removed from the site and sent to a certified disposition facility.

9.4 DRUM/CONTAINER/TANK HANDLING

There are no planned drums or tank handling activities associated with this project.

9.5 COMPREHENSIVE ACTIVITY HAZARD ANALYSIS OF TREATMENT TECHNOLOGIES

Treatment technologies are not expected to be used on this project.

9.6 HAZARD COMMUNICATIONS

The UXOSO is to perform the following:

- Complete an inventory of chemicals brought on site by HGL.
- Confirm that an inventory of chemicals brought on site by HGL subcontractors is available.
- Request or confirm locations of MSDS from the client, contractors, and subcontractors for chemicals to which HGL employees potentially are exposed.
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employee required chemical-specific Hazardous Communication training.

- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

9.7 MACHINE GUARDING

In order to protect site personnel from unguarded moving machinery and equipment surfaces, the requirements found in Subpart O of 29 CFR 1910, Section 16B of USAESCH EM 385-1-1 and the general provisions listed below will be followed:

- All reciprocating, rotating, or moving parts of machinery or equipment will be guarded in accordance with manufacturer's specifications, if they create a hazard through contact with personnel.
- No guard, safety appliance, or device will be removed from machinery or equipment or made ineffective except when making immediate repairs, lubrication, or adjustments, and then only after the power has been shut off.
- All guards or safety appliances removed for repair, lubrication, or adjustments will be replaced immediately upon completion of said activity and before the power is restored.

9.8 HAZARDOUS ENERGY CONTROL

All site personnel involved in the use of lock-out/ tag-out for the control of hazardous energy will receive on-site training. All training will comply with Section 12 of EM 385-1-1. In the event that tag-out procedures are used on site, authorized personnel will be trained in the following limitations of tags:

- Tags are essentially warning devices affixed to energy-isolating devices and do not provide the physical restraint on those devices that is provided by a lock;
- When a tag is attached to an energy-isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored or otherwise defeated;
- Tags must be legible and understandable by all authorized and affected personnel whose work operations are, or may be, in the area; and
- Tags must be securely attached to energy-isolating devices so that they cannot be inadvertently or accidentally detached during use.

9.9 ILLUMINATION

Potentially hazardous operations will be performed only during the time period from 30 minutes after sunrise to 30 minutes before sunset.

9.10 LIGHTNING AND SEVERE STORMS

The UXOSO will remain aware of weather forecasts and plan for inclement weather during project work. If inclement weather appears imminent, the safety officer will direct site workers to halt work and to take refuge in vehicles or nearby buildings. **A lightning detector will be present on the** site and will be monitored by the UXOSO when threatening weather is noted or when storms are forecast. If the UXOSO deems that lightning is a potential threat, he will order employees to take shelter in an enclosed building or in a vehicle.

9.11 SANITATION AND DRINKING WATER

An adequate supply of potable (drinkable) water will be provided on site at all times and will be supplied in accordance with the following provisions:

- Containers will be clearly marked, capable of being tightly closed, equipped with a tap, maintained in a sanitary manner, and cleaned at least weekly.
- Where single-service cups are provided, separate sanitary containers will be provided for the storage of the unused cups and for the disposal of the used cups.
- Water or other supplied beverages will not be dipped from the container by any means, and use of a common cup will not be allowed. Use of non-potable water is not anticipated; however, if containers of such water are used, they will be conspicuously labeled "Caution: water unfit for drinking, washing, or cooking."

Toilet and washing facilities will be available at the project site. The UXOSO will require proper hygienic practices to remove contaminants that might be present on the hands, clothing, or PPE, especially when personnel conduct environmental sampling for MC.

9.12 POWER AND HAND TOOL OPERATION

To control the hazards associated with power tool operation, the requirements outlined in EM 385-1-1, Chapter 13; and the safe work practices listed below will be observed when using power tools:

- Operation of power tools will be conducted by personnel trained in the use of the tool, its operation, and safety precautions.
- Power tools will be inspected prior to use, and defective equipment will be removed from service until repaired.
- Power tools with guards for moving parts will have such guards in place prior to and during use, and loose fitting clothing or long hair will be secured away from moving parts.
- Hands, feet, etc., will be kept away from all moving parts.

- Maintenance and/or adjustments to equipment will not be conducted while it is in operation or connected to a power source, and maintenance on gasoline-powered tools will be conducted only after the spark plug has been removed and secured.

Use of improper or defective hand tools can contribute significantly to the occurrence of accidents on site. Therefore, the requirements outlined in EM 385-1-1, Chapter 13 and the safe work practices listed below will be observed when using hand tools:

- Hand tools will be inspected for defects prior to each use.
- Defective hand tools will be removed from service and repaired or properly discarded.
- Tools will be selected and used in the manner for which they were designed.
- Be sure of footing and grip before using any tool.
- Do not use tools that have split handles, mushroom heads, worn jaws, or other defects.
- Leather work gloves will be worn to increase gripping ability and to protect the hand if a cut, laceration, or puncture hazard exists during the use of the tool.
- Safety glasses or a face shield will be used if use of tools presents an eye/face hazard.
- Do not use makeshift tools or other improper tools.

9.13 CHEMICAL HAZARD COMMUNICATION

The UXOSO will control the entry of chemical products into the work environment, and limit the number of such products to the minimum necessary for project execution. He will obtain a copy of a material safety data sheet for all such chemical products (unless an exception applies) and maintain these on the site. In addition, the UXOSO will review the hazards inherent in the storage and anticipated use of the chemicals, and provide training to workers exposed to these hazards. Such training will be provided upon initial assignment to the site and before use of the product. Supplemental training will be scheduled and presented whenever a new hazardous substance is introduced into the work area or whenever an employee changes job locations where different products are encountered.

The UXOSO will maintain on the site the following documents and records, and inform site workers of their place of storage: (1) The OSHA standard on chemical hazard communication (29 CFR 1910.1200) and (2) A list of chemical products on the site, with associated material safety data sheets.

Subcontractors will comply with the requirements presented above and will supply the UXOSO with copies of MSDSs for any chemical products that they bring onto the site.

9.14 CONTACT WITH CONTAMINATED SOIL OR WATER

Significant exposure to chemical contaminants in soil and water is unlikely. Limited potential for exposure to munitions constituents will exist when employees collect samples of soil, sediment or groundwater, or otherwise come into contact with soil or water. The UXOSO will inform site workers of the risks discussed below, and implement the precautions described.

Inhalation of chemical vapors and contaminated dust could occur during excavation operations. Chemical vapors could be present above freshly exposed earth long after excavation tasks are complete. Personnel will attempt to remain upwind of excavation operations, fresh excavations, and piles of freshly exposed earth.

The UXOSO will implement procedures to minimize skin contact with potentially contaminated soil and water. Personnel collecting environmental samples will wear disposable nitrile gloves during collection activities.

Ingestion of contaminants could occur through hand-to-mouth contact that is easily avoided. The UXOSO will require proper hygienic practices to prevent ingestion of contaminants that might be present on the hands, clothing, or PPE.

The UXOSO will halt work immediately and confer with the HGL manager of health and safety if evidence of grossly contaminated soil, sediment, or water is noted. Such evidence could include unusual odors, unusually discolored soil, sediment, or water, or the unexpected presence of chemical containers.

9.15 WORK AROUND HEAVY EQUIPMENT

The UXOSO will verify that operators have been trained in the safe operation of the heavy equipment that they are required to use. Personnel near operations involving heavy equipment will wear brightly colored safety vest, maintain a distance that is greater than the reach of the equipment, and maintain eye contact with the operator. Hard hats will be worn around excavating equipment. The backhoe will be lowered to the ground and equipment will be turned off when material is collected from the bucket or when workers approach for any other reason.

9.16 WORK AROUND DEEP WATER

The UXOSO will evaluate planned tasks carefully to determine the likelihood of slips or falls into deep water. If the hazard will be present, then the UXOSO will confer with the HGL PM before the task begins to determine appropriate safety precautions.

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10.0 SITE CONTROL MEASURES

10.1 WORK ZONE ACCESS CONTROL AND SECURITY

The UXOSO and other site mangers will control access to the site during operations, and enforce upon site visitors the restrictions found elsewhere in this document. If difficulties related to access control and site security arise, the UXOSO will confer with military authorities to identify corrective action.

10.2 WORK ZONES

The EZ around a potentially hazardous operation will be determined in each case by the UXOSO. When ordnance could be disturbed, the fragmentation distances established in the WP and Explosives Site Plan (ESP) will define the EZ. In other cases, the EZ will be dictated by the distance necessary to avoid work hazards, such as the steep edge of an excavation or heavy downwind dust concentrations. If heavy equipment is used, then the "reach" of the bucket, plus a few extra feet, will determine the radius of the EZ.

The SZ will include the office trailer, access roads, and adjacent areas so designated by the UXOSO. The UXOSO will implement procedures to prevent the transport of gross contamination from the EZ into the SZ on boots, clothing, tools and heavy equipment. The need for rigorous decontamination procedures is not anticipated.

The UXOSO will designate contamination-reduction zones where employees will remove gross contamination before entry into the SZ, or before movement of tools and equipment into the SZ, if necessary.

10.3 SITE COMMUNICATIONS

Effective on-site and off-site communication will be established prior to initiation of site activities. On-site communication will be used to coordinate site operations, to maintain site control, to convey safety information, and to alert site personnel to emergency situations. Off-site communication will be available to ensure effective coordination with off-site management personnel, the USACE, and emergency response services.

All site personnel will be familiar with the different methods of both on-site and off-site communication. The methods that will be used for on- and off-site communication will include:

1. On-site communications will consist of hand-held radios, cell phones or other supplied communication systems. Air horns, bullhorns, sirens, or hand signals can also be used, as needed, for communications.
2. Off-site communications will be accomplished by cell phones or other supplied communication systems. The UXOSO will verify that the 911 service is available, and make appropriate alternative arrangements if it is not available.

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11.0 PERSONNEL HYGIENE AND DECONTAMINATION

Personal hygiene, sanitary and washing facilities, personnel and Level D decontamination, and waste control plans are discussed below.

11.1 SANITARY FACILITIES

HGL will provide and maintain portable sanitary facilities with at least one unit for each 15 workers, in accordance with EM 385-1-1, Section 2. The sanitary facilities will be maintained and serviced at regular intervals. They will be located adjacent to or near the current work activities.

11.2 WASHING FACILITIES

HGL will provide hand-washing facilities, convenient to the work area, including potable washing water and soap. All hand-washing facilities will be supplied with soap, paper towels, and trash receptacles. All washing facilities or areas will be kept clean and free of trash.

All field personnel will wash their hands and face before eating, drinking, and before leaving the site for the day.

11.3 PERSONNEL DECONTAMINATION

Effective decontamination is not simply removing contamination, it begins with preventing contamination. PPE prevents the wearer from becoming contaminated, and good work practices reduce contamination of protective clothing and equipment.

11.4 LEVEL D DECONTAMINATION

No Level D personnel decontamination is anticipated for this project.

11.5 WASTE CONTROL AND DISPOSAL

Solid trash, paper towels, and other items used in the work areas will be classified as solid waste and containerized and disposed of as such.

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12.0 EQUIPMENT DECONTAMINATION

Only decontamination of the incremental sampling method (ISM) tool will be required during RI activities. Environmental sampling may generate several waste streams requiring disposal. IDW may include PPE, solid waste, and decontamination water. Based on the nature of the site and existing data, it is expected that only nonhazardous IDW will be generated during the field sampling event. Nonhazardous IDW such as decontamination fluids from the washing and rinsing of sampling equipment will be disposed to the ground at the site. It is expected that solid IDW (e.g., Tyvek suits, PPE, and other plastics) will be collected separately in trash bags and disposed of as municipal solid waste. Procedures for the decontamination of field equipment are presented in Section 3 of the WP.

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13.0 EMERGENCY EQUIPMENT AND FIRST-AID

The emergency equipment listed in Table 13.1 will be on site, stored in the location indicated, and available for use during the operation specified. Emergency equipment assigned to an area or team will be maintained in proper working order by the team, as directed by the team leader. The UXOSO will conduct an inspection of all emergency equipment at least weekly to ensure completeness and proper working order.

Table 13.1
Emergency Equipment Requirements

Emergency Equipment	No. Per Location	Area Where Item(s) Will Be Stored	Operation Requiring Specified Equipment
CPR Mask	1 ea.	SZ	All operations
Portable Eye Wash Kit*	2 ea.	Each vehicle	All operations
15-Minute Eye Wash*	1 ea.	SZ	All operations
Biohazard Kit	1 ea.	SZ	All operations
First Aid Kit	1 ea.	Each vehicle	All operations
Fire Extinguisher	1 ea.	Support vehicles, and SZ	All operations
Cellular Phone/ Site Communication	1 ea.	SUXOS/UXOSO and SZ	All operations

* If employees exposed to corrosives, strong irritants, or toxic chemicals

The size and number of first aid kits will be sufficient to accommodate the maximum number of people (including government personnel and visitors) on site at any given time.

When required, portable eyewash bottles will be available for immediate use while the injured person is transported to the area where the 15-minute eye flushing station will be available. After flushing, the eyes will be bandaged lightly, and the person will be transported to the appropriate medical facility for further evaluation and treatment, if needed.

Personnel administering first aid and/or CPR will comply with the following:

- Personnel will wear disposable latex gloves if there is any visible body fluid;
- The CPR Pocket Mask will be used when performing CPR and disposed of after;
- Personnel will immediately change clothing that becomes contaminated with body fluids as a result of performing first aid, or as soon as feasible; and
- Personnel will wash their hands immediately after performing first aid procedures.

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14.0 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

The Emergency Response Plan (ERP) addresses the following emergency response and contingency procedures: pre-emergency contingency planning, contacting off-site agencies, documentation, personnel, medical facility routes, and MSDS. Each is summarized below in this section.

14.1 PRE-EMERGENCY PLANNING

A pre-emergency contingency plan is a written document that sets forth policies and procedures, and outlines authority for responding to site emergencies. The contingency plan will be part of the SSHP, will anticipate the potential emergencies at the site; and will integrate actions by the local agencies, fire department, and medical facilities.

The contingency plan assigns the role of authority to the UXOSO and SUXOS. These two individuals are responsible for directing emergency response operations, notifying on-site and off-site personnel, requesting aid from outside sources, and documenting the event.

14.2 PERSONNEL AND LINES OF AUTHORITY FOR EMERGENCY SITUATIONS

In the event that an emergency arises, the appropriate immediate response must be taken by the first person to recognize the situation. The field crew shall contact emergency response services by calling 911 and then immediately notify the UXOSO of the incident. The authority to order personnel to evacuate the area rests with the SUXOS, UXOSO, or a qualified representative.

The UXOSO has full responsibility and commensurate authority for responding to any emergency that may occur at the MEC work site, until HGL is relieved by the proper authorities. With multiple teams working on site, emergency alerts will be broadcasted on mobile and/or hand portable field radios. The UXOSO will inform the SUXOS and PM of emergencies and response actions by telephone or fax as soon as reasonably practicable, followed by a written report providing full detail. HGL will provide the UXOSO with a cellular telephone and radio communication for use in the field, along with telephone numbers and frequencies that may be used to communicate with emergency services providers and other authorities.

– NOTICE –

The emergency services and contacts list is provided in the front of the APP and this SSHP on the Emergency Information page.

Emergency situations might arise as a result of fire, injury/accident, accidental initiation of explosives or ordnance, serious illness, or weather (such as lightning). It will be the responsibility of all personnel to be observant regarding the work environment, to personally practice safe work habits, and to insist that other personnel work safely. However, it is the duty of the UXOSO to ensure that the potential for emergencies is minimized at the work site

by closely observing personnel work habits and ensuring that the physical layout of the work site is established and maintained in such a way that there is minimal potential for accident.

14.3 CRITERIA AND PROCEDURES FOR EMERGENCY RECOGNITION

Emergency situations might arise due to fire, injury/accident, accidental initiation of explosives or ordnance, serious illness, or weather (e.g., lightning). It will be the responsibility of all personnel to be observant regarding the work environment, to personally practice safe work habits, and to insist that other personnel work safely. However, it is the duty of the UXOSO to ensure that the potential for emergencies is minimized at the work site by closely observing personnel work habits and ensuring that the physical layout of the work site is established and maintained in such a way that there is minimal potential for accident.

14.4 DECONTAMINATION AND MEDICAL TREATMENT OF INJURED PERSONNEL

The HGL occupational medical care provider will be available to provide patient specific information in case medical treatment is needed. For injuries or illnesses requiring local emergency medical services, notification via the 911 system or equivalent system will be made. Emergency response personnel will determine the best course of treatment and the medical treatment facility where this will occur. Personnel may be transported to the nearest medical treatment facility as determined by UXOSO or SUXOS.

Qualified first aid and CPR providers may treat minor injuries on site. Two field team members (HGL or subcontractor) must be trained to render both CPR and First Aid.

Trained employees may provide first aid/CPR of their own free will as Good Samaritans. A first aid kit, including necessary protection against blood borne pathogens, will be available in project vehicles. An adequate supply of fresh potable water for emergency eye wash purposes or portable emergency eyewash will be available.

If additional treatment beyond first aid is required, the injured personnel will be transported to the identified emergency medical care. A field vehicle will be made available to transport injured personnel to the identified medical facility. The Emergency Information Sheet and the map and directions indicating the fastest route to the hospital emergency room will be retained in each field vehicle. In all cases, the UXOSO or SUXOS shall accompany injured HGL workers to the hospital or medical care facility.

14.5 ROUTE MAPS TO THE CLOSEST MEDICAL FACILITY

Maps containing routes and written directions to the supporting medical facility are provided in the front of the APP and this document. This information will be given to all personnel at morning tailgate safety meetings, and a copy will be kept on site.

14.6 CRITERIA FOR ALERTING THE LOCAL COMMUNITY RESPONDERS

All personnel have the responsibility and authority to call 911 in the event of a medical emergency, fire, or other emergency. The UXOSO will determine whether additional local emergency services should be notified. The Emergency Contact Sheet is provided at the front of this SSHP for easy access.

In the event that evacuation of the general public is required due to either normal site operations or an emergency event, the safety point of contact, USACE OESS and HGL UXOSO, are responsible for contacting the appropriate local officials who execute and coordinate an evacuation.

14.7 MATERIAL SAFETY DATA SHEETS

When available, MSDS can provide valuable information when handling a chemical substance. Since the establishment of the Hazard Communication Standard (29 CFR 1910.1200), chemical manufacturers and distributors are required to provide MSDSs and warning labels on their products. Obtaining an MSDS on a chemical substance may provide valuable information on the chemical and physical hazards the material presents.

The sections on an MSDS and the information they can provide are:

- Chemical identity and manufacture information;
- Hazardous ingredients and exposure limits;
- Physical and chemical characteristics;
- Fire and explosion hazard data;
- Reactivity and stability data;
- Health hazard and medical treatment information;
- Precautions and protection for safe handling and use; and
- Control measures to avoid overexposure.

MSDSs are intended to provide comprehensive hazard information; however, many published MSDSs are incomplete and lack enough accurate information to assess a chemical hazard. Therefore, MSDSs should be used as a guide along with more in-depth information from other sources. Applicable MSDSs brought on site by HGL and its subcontractors will be filed in a binder, maintained on site at the HGL field office trailer, and will be available for project personnel at all times.

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15.0 EMERGENCY RESPONSE PLAN

The UXOSO will evaluate the nature of the emergency and take proper precautions to secure the site to protect project personnel and public safety. Depending on the emergency, personnel will follow the specific safety requirements below.

15.1 OPERATIONS

The frequency and severity of emergency situations can be dramatically reduced through proper implementation of the APP. However, if an emergency does occur, quick, decisive action is required. Delays in minutes can create or escalate life-threatening situations. In an emergency situation, site personnel involved in emergency response and rescue must be prepared to respond immediately. All required equipment must be on hand, in proper working order, and ready to use. To ensure rapid, effective response to a site emergency, the procedures and contingency plans outlined in this section must be implemented prior to and during any site activities involving exposure to safety and health hazards.

The following operations require the use or potential for exposure to hazardous substances:

- MEC operations,
- Soil Sampling,
- Excavation extent confirmation soil samples, and
- Heavy equipment operation.

15.2 PRE-EMERGENCY PLANNING WITH LOCAL EMERGENCY RESPONDERS

Prior to conducting site operations, HGL site representatives contacted and/or met with the appropriate local authorities. The purpose of the meetings was to inform local authorities of the nature of the site activities to be performed under this SSHP, and the potential hazards that the conduct of these activities pose to site personnel, the environment, and the general public.

15.2.1 Identification of Local Emergency Services

During the meeting with local authorities, HGL personnel will be informed as to the type of emergency services available through the local authorities and were given the contact phone numbers for these services. In the event that evacuation of the general public is required due to either normal site operations or an emergency event, the Safety point of contact (POC), USACE OESS, and HGL UXOSO are responsible for contacting the appropriate local officials who execute and coordinate an evacuation. The telephone numbers for pre-notified local emergency services are listed in Table 15.1.

Table 15.1
Local Emergency Services

Emergency Contact	Telephone Number
Fire/Emergency/Police	911
Grand Strand Regional Medical Center 809 82nd Pkwy Myrtle Beach, SC 29572 Grandstrandmed.com	(843) 692-1000
Beach Urgent Care 9672 N Kings Hwy Myrtle Beach, SC 29572 Beachurgentcare.com	(843) 497-2273

15.3 PERSONNEL ROLES AND LINES OF AUTHORITY, TRAINING, AND COMMUNICATION

Key personnel roles, lines of authority, and communications plan are described below. Also see Section 4.0 of the APP for personnel roles and lines of authority and Section 15.2 of this SSHP for emergency communications. Details on personnel training is provided in Section 6.0 of the APP.

15.3.1 Personnel On-Scene Incident Commander

In the event of an emergency, the UXOSO assumes the responsibility of the site. The alternate person to assume this role, in the event that the UXOSO is unavailable or incapacitated, is the SUXOS. The UXOSO has responsibility for directing all on-site and off-site response personnel and, as soon as possible, advises the USACE OESS of the emergency situation.

15.3.2 On-Site Emergency Response Services

HGL personnel are trained to provide first aid treatment for minor injuries. At least two people onsite will be first aid-and CPR-trained. The UXOSO will determine whether any injury requires treatment in addition to first aid. If there is any doubt as to whether or not additional treatment is necessary, the UXOSO will call 911 for follow-on advanced care and transport to hospital.

15.3.3 Off-Site Emergency Response Services

Off-site emergency response services that may be needed in the event of a site emergency include medical and law enforcement personnel. All requests for emergency services are accessible via the 911 telephone system.

15.4 EMERGENCY RECOGNITION AND PREVENTION

During the development of this SSHP, great attention has been given to identifying potential safety and health hazards associated with conducting site activities. Once identified, these hazards were assessed to determine if they could result in an emergency situation. Contingency

plans for responding to these potential emergency situations have been developed and are included in this section. The potential emergencies that may result during site activities are as follows:

- Injury or illness
- Fire/explosion
- Inclement weather

In the event that additional site or task hazard information becomes available during the project, the CHSD will assess this information to determine whether the contingency plans in this section need to be updated.

15.5 SAFE DISTANCES AND PLACES OF REFUGE

Safe distances and places of refuge will be addressed at the daily tailgate site safety meetings, depending on field activities. Work and EZs will vary from day to day. EZs will be established to protect the public during UXO intrusive activities and safe working distances will be established to protect site workers.

During an emergency situation all work will stop and field crews will return to the site trailer for further direction on the best place of refuge.

15.6 SITE SECURITY AND CONTROL

In an emergency, it is imperative that site control and security be maintained. The UXOSO will utilize the Personnel Site Entry/Exit Log to ensure all are present or accounted for at the pre-arranged emergency assembly points. Depending upon site size and configuration, weather and wind conditions, and the nature of the emergency, the following will, as applicable, be used to maintain site security:

- Close, but do not lock, gates as evacuation occurs;
- Erect flagging or barrier tape to prevent accidental entry; and
- Use vehicles to block access routes to the site, but ensure they can be moved rapidly if emergency vehicles must use the access route.

15.7 EVACUATION ROUTES AND PROCEDURES

Evacuation routes and procedures are discussed below.

15.7.1 Evacuation Route

The established evacuation route will be checked by the UXOSO and then traveled by all site personnel before the start of site activities to establish familiarity with the route. Emergency meeting points will vary from day to day depending on work location. The planned evacuation route will be discussed with the field crew at the daily tailgate safety briefing.

Emergency evacuation routes will be posted in the HGL field office at each room's exit point. All exit routes will be unobstructed and kept free of debris.

15.7.2 Medical Facilities

A map showing the location of the two medical facilities (Hospital) will be kept readily available in each project vehicle. The emergency number is 911.

15.7.3 Directions to Hospital

A map to the hospital will be in each vehicle and posted in the field. Directions and maps can also be found in the front of this document and the APP.

15.7.4 Medical Evacuation

Medical evacuation requirements will be determined by the emergency first responder. Personnel requiring additional treatment will be evacuated to the hospital. Any further treatment or evacuation will be arranged by the hospital site personnel who will receive specialized training that will be given by the UXOSO and conducted prior to initiating site activities involving safety and health hazards. Training will be documented using the site training log and will include the subjects listed below:

- Emergency chain-of-command;
- Communication methods and signals;
- Emergency equipment and PPE;
- Removing injured personnel from the site; and
- Emergency contacts, telephone numbers, and hospital route.

15.8 DECONTAMINATION

Leaking hazardous substances are not expected to be encountered in the MRSs. Field crews are to avoid drums or leaking substances, and to report them when discovered. The USACE PM will be notified and will make decisions on further actions if required.

15.9 EMERGENCY MEDICAL TREATMENT AND FIRST AID

In the event of an emergency, field crews will have first aid kits and at least two staff qualified to administer first aid. The objective will be to stabilize the victim and call for medical assistance. All work will stop during emergency situations and the UXOSO and SUXOS will be notified.

15.9.1 Assessing the Emergency

Available information related to the emergency and the on-site response capabilities should be evaluated and the information listed below obtained to the extent possible:

- What happened:
  - Type of incident.
- Casualties involved:
  - Victims (number, location, and condition),
  - Treatment required, and
  - Missing personnel.
- Cause of incident
- Extent of damage to structures, equipment, and terrain
- What can be done to mitigate the situation; consider:
  - Equipment and personnel needed for rescue and hazard mitigation;
  - Number of uninjured personnel available for response;
  - Resources available on site;
  - Resources available from off-site response groups and agencies;
  - Time needed for off-site response resources to reach the site; and
  - Hazards involved in rescue and response.

15.9.2 Rescue and Response Actions

Based on the information collected during the emergency assessment, the general actions listed below are taken, with some actions being conducted concurrently. No one is to attempt emergency response or rescue until the situation has been assessed and the appropriate response outlined by the UXOSO.

- Enforce the Buddy System:
  - Allow no one to enter a hazardous area without a partner, and
  - Personnel in the EZ should be in line-of-sight of or in communication with the UXOSO or their designee.
- Survey Casualties:
- Locate all victims and assess their condition, and
- Determine resources needed for stabilization and transport.
- Assess existing and potential hazards and determine:
  - Whether and how to respond,
  - The need for evacuation of site personnel and off-site population, and
  - The resources needed for evacuation and response.
- Request Aid:
  - Contact the required off-site/on-site personnel or facilities, such as ambulance, fire department and police, etc.

- Allocate Resources:
  - Allocate on-site personnel and equipment to rescue and initiate incident response operations.
- Control:
  - Assist in bringing the hazardous situation under complete or temporary control, and use measures to prevent the spread of the emergency (control fire, secure site, etc.).
- Extricate:
  - Remove or assist victims from the area.
- Stabilize:
  - Administer any medical procedures that are necessary before the victims can be moved,
  - Stabilize or permanently fix the hazardous condition, and
  - Attend to what caused the emergency and anything damaged or endangered by the emergency (e.g., drums, tanks).
- Transport:
  - Transport using either on-site or off-site assets.
- Casualty Logging:
  - Record the name of the victim, time of injury, destination, and condition upon transport.
- Evacuate:
  - Move site personnel to the rally point, a safe distance upwind of the incident, and
  - Monitor the incident for significant changes; the hazards may diminish, permitting personnel to re-enter the site, or hazards may increase and require public evacuation.
- Casualty Tracking:
  - Record disposition, condition, and location.

15.10 EMERGENCY ALERTING AND RESPONSE PROCEDURES

Emergency response procedures include all steps to be taken for notifying, evaluating, reacting to, documenting, and following up on a given emergency situation. To ensure all necessary elements are covered, the procedural steps outlined in this paragraph are implemented for each emergency, regardless of its nature.

15.10.1 Notification

Once the UXOSO has been informed of the emergency, the UXOSO will alert site personnel to the emergency using radio communication. This is done to:

- Notify personnel and get their attention;
- Stop work activity as required;
- Lower noise levels in order to speed and simplify communication; and
- Begin emergency or evacuation procedures.

If on-site HGL personnel or off-site emergency personnel are to enter the site in response to the emergency, the UXOSO, to the extent possible, will notify response personnel about the nature of the emergency, to include:

- What happened and when it happened;
- Where on site the emergency situation occurred;
- Who was involved and, if possible, the cause of the emergency;
- The extent of damage and what hazards may be involved; and
- What actions should be taken?

15.11 CRITIQUE OF RESPONSE AND FOLLOW-UP

Before normal site activities can resume, the site and personnel must be prepared and re-equipped to handle another emergency. It is also imperative that all federal, state, and local regulatory agencies be notified of the emergency. Therefore, the following activities must be conducted prior to re-starting of site activities:

- Notify all appropriate governmental agencies as required (i.e., OSHA must be notified if there have been any fatalities or three or more personnel hospitalized);
- Restock and clean all equipment and supplies utilized or damaged in the emergency;
- Conduct an accident investigation to determine the cause of the emergency and what preventative measures could be taken to ensure the emergency does not occur again;
- Complete the HGL Incident form (Appendix F); and
- Review and revise, as needed, the site operational procedures and, if necessary, update the SSHP to reflect the new procedures;

15.12 PPE AND EMERGENCY EQUIPMENT

Planned project PPE is Level D. Upgrades of Level D may be required if the situation dictates. Additional PPE such as safety glasses, hardhats, and gloves may be available from the UXOSO. HGL subcontractors will provide their own PPE for their field crews.

15.13 DOCUMENTATION

Information related to an emergency shall be recorded completely and accurately. Documentation will be performed as soon as possible after the emergency to ensure it is recorded while the events are vivid in the minds of the personnel involved. Information to be recorded will include:

- A chronological record of events;
- A listing of the personnel involved, including personnel on site, site personnel who responded, personnel in charge, and off-site groups or agencies that responded;
- A listing of the actions taken to minimize the effects of, or to mitigate, the emergency;
- An assessment of the potential exposures received by site personnel and the surrounding public; and
- A recording of the injuries or illnesses that occurred as a result of the emergency.

16.0 EMERGENCY RESPONSE TEAM

Not applicable, local fire and rescue personnel will be contacted in case of emergency.

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17.0 CONFINED SPACE ENTRY

Not applicable. Confined spaces are not expected to be an issue on this site, so confined space entry procedures will not be required.

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18.0 LOGS, REPORTS, AND RECORD KEEPING

18.1 RECORD KEEPING PROCEDURES

For all site work, field personnel will use bound logbooks with consecutively numbered pages. The field logbooks will be used to record the daily activities of the field team and to note any observations that might affect the quality of data. Alternatively, the use of electronic logbooks may be authorized for certain aspects of the field work. The field logbooks and site records will be utilized to record the data discussed below:

- **Daily Logbook:** The SUXOS will maintain the daily logbook. This journal will provide a summary of all operations conducted, including information on weather conditions, problem areas, WP variances, injuries, start/stop times, tailgate safety briefings, equipment discrepancies, MEC located, training conducted, visitors, and any additional information deemed appropriate. This log is maintained on-site in electronic format and is emailed to the PM for QC review and Weekly Status Report preparation at the end of each workweek
- **MEC Records Management:** The UXO Team Leader(s) (UXO Technician III) will prepare individual records for each MEC-related item located at the project site. Each MEC item will be given a unique identifying number to differentiate it from the others
- **Safety Logbook:** The UXOSO will maintain this log. The log will be used to record all safety-related matters associated with the specific project, such as safety briefings/meetings, including items covered and attendees, safety audits, as well as near misses, accidents, and other safety related incidents. It will include cause and corrective action(s) taken, weather conditions, and any other matters encompassing safety. This log is maintained on-site in an electronic format
- **Training Records:** The SUXOS will maintain training records for all site personnel. These records will contain training certificates, licenses, and other qualifying data for an individual's duty position
- **Quality Control Log:** The Unexploded Ordnance Quality Control Specialist (UXOQCS) will maintain this log and will record the performance and results of QC surveillance, inspections, seed placement and recovery, and audits
- **Team Leader Log:** The UXO Team Leader(s) will maintain a log of daily equipment operation checks that will validate the equipment quality prior to and after daily field operations
- **Visitors Log:** The SUXOS will maintain this log for all personnel who are not directly involved in site activities. This log will identify visitors by name, company, date, time in/out, and a contact phone number
- **Photographic Record:** The SUXOS will maintain a photographic record of all video recordings and photographs taken to document work and/or site conditions. Photographs and video will be kept on digital media. The files will be marked with a

unique identifying number relating back to the photographic log and will be transmitted to the HGL corporate office weekly

- **Site Maps:** The SUXOS will maintain working maps of the operating areas. These maps will be used to document MEC findings, task progression, and other pertinent activities and locations
- **Logbook Inspection:** Logbooks and records will be inspected by the SUXOS on a weekly basis. These inspections will focus on the completeness, accuracy, and legibility of the entries and records. Results of these inspections will be forwarded to the UXOQCS. However, the log keeper's immediate supervisor will review and initial in the logbook concurrence with the logbook entries on a daily basis. All logs are subject to audit by the UXOQCS at any time. Site documentation identified as incomplete or inaccurate will be evaluated for project impact with the appropriate action(s) taken to both prevent reoccurrence and correct missing documents. Changes to project logs and documentation resulting from inspection will be clearly documented.

The logbooks are used in preparation of the final reports and serve as an "official document" in the event of any problem area addressed after the completion of the project. All logbooks will be maintained on file for a period of 7 years after project completion. These logs may be digital and saved on a CD.

18.2 PERSONNEL EXPOSURE AND MEDICAL MONITORING RECORDS

Workers exposed to site hazards, including all employees of HGL, will participate in the program of medical surveillance described in Section 6.0. As part of the medical surveillance, physiological monitoring will be conducted to detect the symptoms of heat stress, cold stress or other hazards on the site. The UXOSO will maintain a written (or electronic) record of the measurements and observations required by this procedure. This information may be recorded as entries in the project safety log or as entries on a data sheet created for this purpose. The medical monitoring records will be maintained as part of the project record.

18.3 VISITORS INFORMATION AND REGISTRATION LOGS

The UXOSO will maintain a safety log to record all significant information related to workplace health and safety each day. The safety log should include: a record of safety briefings; details of any accidents, injuries, illnesses, or near misses; details related to the conduct and outcome of internal and external audits; the reason for and duration of safety-related "stop work" orders; and any other issues pertaining to site or personnel safety or health.

The UXOSO will document all safety-related training sessions in a training log or on appropriate forms collected in a file or notebook and maintained on the site. This log will include the initial site-specific training conducted prior to the start of site activities, the safety briefings, hazard-specific training, etc.

The UXOSO will maintain a visitor log, which will be used to record the entry and exit of all visitors. No visitors will be allowed to enter the project site without providing the information required.

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19.0 RESPONSE ACTION TO UNFORSEEN HAZARDS

Should any unforeseen hazard becomes evident during the performance of the fieldwork, the UXOSO will bring such hazard information to the attention of the CHSD and the on-site government safety representative (both verbally and in writing) for resolution as soon as possible. In the interim, the UXOSO will take all the necessary actions to reestablish and maintain safe working conditions.

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20.0 INJURY/ILLNESS/ACCIDENT REPORTS

Accident reporting is discussed in Section 8.0 of the APP.

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21.0 SAFETY EXPOSURE REPORT

Exposure data (personnel-hours worked) will be provided to the PM by the SUXOS at regular intervals, and the PM will prepare the monthly reports for the USACE PM.

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ATTACHMENT 2

HEALTH AND SAFETY FORMS

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SITE SAFETY OFFICER (SS0)
WET BULB GLOBE THERMOMETER (WBGT) LOG

DATE	TIME	DRY BULB TEMP (ºF)	WBGT TEMP (ºF)	RECOMMENDED WORK/REST REGIMEN (PER HOUR) WORK	REST
				/	
				/	
				/	
				/	
				/	
				/	
				/	
				/	
				/	
				/	

Permissible WBGT Heat Exposure Threshold Limit
Values are given in ºC and ºF

Table 2 lists values from the 2011 edition of the *American Conference of Governmental Industrial Hygienists* (ACGIH) publication *Threshold Limit Values (TLV®) and Biological Exposure Indices*. This table is intended as an initial screening tool to evaluate whether a heat stress situation may exist. Professional judgment is also of particular importance in assessing the level of heat stress and physiological heat strain of workers. The values in the table below are more protective and they are not intended to prescribe work and recovery periods, but suggest work in a cycle of work and recovery.

Table 2
Screening Criteria for TLV and Action Limit for Heat Stress Exposure

Allocation of Work in a Cycle of Work and Recovery	TLV WBGT values in °C				Action Limit WBGT Values in °C			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 - 100% work	31(87.8)	28(82.4)	-	-	28 (82.4)	25 (77)	-	-
50 - 75% work	31 (87.8)	29(84.2)	27.5 (81.5)	-	28.5 (83.3)	26 (78)	24 (75.2)	-
25 - 50% work	32 (89.6)	30(86)	29(84.2)	28 (82.4)	29.5 (85.1)	27 (80.6)	25.5 (77.9)	24.5 (76.1)
0 - 25% work	32.5(90.5)	31.5(88.7)	30.5 (86.9)	30 (86)	30 (86)	29 (84.2)	28 (82.4)	27 (80.6)

WBGT means the wet bulb globe temperature measured with a black globe thermometer (GT), wet bulb thermometer (WB), and a dry bulb (air) thermometer, and measured according to the following equations:

For indoor or outdoor environments without direct exposure to sunlight,

$$WBGT°C = 0.7WB + 0.3GT$$

For outdoor environments with direct exposure to sunlight,

$$WBGT°C = 0.7WB + 0.2GT + 0.1DB$$

USACE Accident Investigation Report

(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 Suppl to AR 385-40)	REQUIREMENT CONTROL SYMBOL: CEEC-S-8(R2)

1. ACCIDENT CLASSIFICATION

PERSONNEL CLASSIFICATION	INJURY/ILLNESS/FATAL	PROPERTY DAMAGE	MOTOR VEHICLE INVOLVED	DIVING
GOVERNMENT ☐ CIVILIAN ☐ MILITARY	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ CONTRACTOR	☐	☐ FIRE INVOLVED ☐ OTHER	☐	☐
☐ PUBLIC	☐ FATAL ☐ OTHER		☐	

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 (month/day/year)	b. TIME OF ACCIDENT (Military time) hrs	c. EXACT LOCATION OF ACCIDENT	d. CONTRACTOR'S NAME (1) PRIME: (2) SUBCONTRACTOR:

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)

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	g. TYPE AND SOURCE OF INJURY/ILLNESS
PRIMARY (CODE) #	TYPE (CODE) #
SECONDARY (CODE) #	SOURCE (CODE) #
f. NATURE OF ILLNESS/INJURY (CODE) #	

6. PUBLIC FATALITY *(Fill in line and correspondence code number in box - see help menu)*

a. ACTIVITY AT TIME OF ACCIDENT (CODE) #	b. PERSONAL FLOATATION DEVICE USED? ☐ YES ☐ NO ☐ N/A

7. MOTOR VEHICLE ACCIDENT

a. TYPE OF VEHICLE	b. TYPE OF COLLISION	c. SEAT BELTS	USED	NOT USED	NOT AVAILABLE
☐☐ PICKUP/VAN ☐☐ AUTOMOBILE ☐☐ TRUCK ☐☐ OTHER (Specify)	☐ SIDE SWIPE ☐ HEAD ON ☐ REAR END ☐ BROADSIDE ☐ ROLL OVER ☐ BACKING ☐ OTHER (Specify)	(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. TYPE OF VESSEL/FLOATING PLANT (CODE) #	b. TYPE OF COLLISION/MISHAP (CODE) #

10. ACCIDENT DESCRIPTION *(Use additional paper, if necessary)*

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11. CAUSAL FACTOR(S) *(Read Instruction 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?	☐	☐

a. *(CONTINUED)*	YES	NO
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?

☐ YES *(If yes, attach a copy.)* ☐ NO

12. TRAINING

a. WAS PERSON TRAINED TO PERFORM ACTIVITY/TASK?	b. TYPE OF TRAINING.	c. DATE OF MOST RECENT FORMAL TRAINING.
☐ YES ☐ NO	☐ CLASSROOM ☐ ON JOB	(Month) (Day) (Year)

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

b. INDIRECT CAUSE(S)

14. ACTION(S) TAKEN, ANTICIPATED OR RECOMMENDED TO ELIMINATE CAUSE(S).

DESCRIBE FULLY:

15. DATES FOR ACTIONS IDENTIFIED IN BLOCK 14.

a. BEGINNING (Month/Day/Year)	b. ANTICIPATED COMPLETION (Month/Day/Year)		
c. SIGNATURE AND TITLE OF SUPERVISOR COMPLETING REPORT CORPS _____ CONTRACTOR _____	d. DATE *(Mo/Da/Yr)*	e. ORGANIZATION IDENTIFIER *(Div, Br, Sect)*	f. OFFICE SYMBOL

16. MANAGEMENT REVIEW *(1st)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

17. MANAGEMENT REVIEW *(2nd - Chief Operations, Construction, Engineering, etc.)*

a. ☐ CONCUR b. ☐ NON CONCUR c. COMMENTS

SIGNATURE	TITLE	DATE

18. SAFETY AND OCCUPATIONAL HEALTH OFFICE REVIEW

a. ☐ CONCUR b. ☐ NON CONCUR c. ADDITIONAL ACTIONS/COMMENTS

SIGNATURE	TITLE	DATE

19. COMMAND APPROVAL

COMMENTS

COMMANDER SIGNATURE	DATE

Page 2 of 4 pages

*U.S. GOVERNMENT PRINTING OFFICE: 1993-0-791-757

Health and Safety Site Visitor Log

Project Name:		Project Number:		Delivery/Task Order:	
Site Name:		Location:			

This form shall be used to track entry into and departure from the ***EXCLUSION ZONE, CONTAMINATION REDUCTION ZONES, OR OTHER WORK ZONES*** on all HydroGeoLogic, Inc. sites. All Personnel shall sign in and out on the form by printing their name, initializing the form and noting the time in/out.

Date	Name	Representing	Purpose of visit	Escort Required		Equipment/ PPE Level	Time	
				Yes	No		In	Out

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Page _____ of _____.

HGL Vehicle Inspection Checklist

Vehicle Safety Inspection Checklist

Inspection date:	**Site name/location:**
Site Supervisor:	**Vehicle** (make and license plate number):
Mileage:	**Owner** (contractor/HGL/rental):

1. DOCUMENTATION:	Pass	Fail	5. BRAKES:	Pass	Fail
Registration and License Plate			Hand/Emergency		
Insurance			Service		
Emergency Route Map & Phone #s					
2. TIRES:	**Pass**	**Fail**	**6. BELTS:**	**Pass**	**Fail**
Pressure			Proper tension		
Condition			Condition		
3. EQUIPMENT:	**Pass**	**Fail**	**7. GENERAL:**	**Pass**	**Fail**
Fire extinguishers			Windshield		
First Aid/CPR/Burn Kits			Windshield Wipers		
Emergency Route Directions/Map			Windows (Condition/Operation)		
Vehicle Registration/Rental Contract			Seat Belts		
HGL Insurance Coverage Card			Steering		
Eyewash Kits			Horn		
Spare Tire			Gas Cap		
Tire Changing Equipment			Mirrors		
Tie downs ✱☐			Door/Window Handles/Latches		
Chocks ✱☐			Cleanliness		
Placards ✱☐			Exhaust System ✱☐		
4. FLUID LEVELS:	**Pass**	**Fail**	**8. LIGHTS:**	**Pass**	**Fail**
Oil			Headlights (high & low)		
Coolant			Brake Lights		
Brake			Parking		
Steering			Back-up		
Transmission			Turn Signals		
Windshield Wiper			Emergency Flashers		
Fluid Leaks			Interior Lights		
Last Oil Change (mileage):					

Notes:

1. To be used weekly for all vehicles EXCEPT explosive carriers that must be inspected prior to each explosives transport.
2. Items marked with an ✱ are required for explosive carriers and must be inspected prior to each use per HGL MRT SOP 15-0.
3. All forms with failures must note the deficiencies and forward a copy of this form within two working days to the Safety Officer.

Description of deficiencies:		
Corrective Actions to be taken:		
Inspection conducted by: (Printed name/signature)		
Deficiencies corrected by: (Printed name/signature)		

HGL MR Form 15.23 (Sep 2005)

HGL Safety Inspection Log

HydroGeoLogic, Inc
MUNITIONS RESPONSE TEAM

Site Safety Inspection Report

Dates (period covered):	Contract Number:	Delivery Order/Task Number:

Installation or Site Name:	Site Location (city and state):
Location of Inspection (Grid number or GPS coordinates,):	**Activity:**

Weather Conditions:	☐ Sunny	☐ Partly Cloudy	☐ Cloudy	☐ High temperatures	☐ Cold temperatures
Type of Inspection:	☐ Daily:	☐ Weekly	☐ Monthly	☐ Special	☐ Re-inspection

I. ACTVITY INSPECTED (indicate results by an "X")	SATISFACTORY	UNSATISFACTORY	NOT APPLICABLE
a. Site Mobilization/Demobilization			
b. Surface Sweep Operations			
c. Subsurface Operations			
d. Geophysical Operations			
e. Survey/Vegetation Removal Operations			
f. Heavy Equipment/Earth Moving Machinery			
g. Personal Protection Equipment			
h. Safe Work Practices			
i. Site Controls			
j. First Aid/Medical Equipment			
k. Fire Extinguisher/Fire Fighting Equipment			
l. Demolition Operations			
m. Explosive Storage			
n. Explosive Transportation Procedures			
o. Emergency Procedures			
II. OVERALL INSPECTION RESULTS			

III. COMMENTS:

IV. ACTIONS	YES	NO	COMMENTS
Work stopped due to safety violations:			
Safety violation noted:			
Personnel involved:			
Corrective measures:			
Re-inspection required:			
Demolitions Operations Conducted:			

V. SITE VISITORS	NAME	ORGINIZATION	PURPOSE

VI. SIGNATURES. *I acknowledge that I have been briefed on the results of this inspection and will take corrective actions as necessary.*

RECEPIENT (print name/signature)	SITE/UXO SAFETY OFFICER (print name/signature)	PROJECT MANAGER (print name/signature)

HGL MEC Form 15.20 (Sep 2008)

HGL Safety Meeting Attendance Log

HydroGeoLogic, Inc
MUNITIONS RESPONSE TEAM

Safety Meeting/Training Attendance Log

Date:		**Time:**		**Conducted by:**	
Site Name/Location:					
Contract Number:				**Delivery/Task Order Number:**	
Project Manager:				**Site Manager** (when applicable):	
(Senior) UXO Supervisor:				**Site Safety Officer/Unexploded Ordnance Safety Health Officer:**	

Training Provided: ☐ Initial Site Hazard ☐ Daily Safety Meeting ☐ Other:
☐ Weekly Safety Training ☐ Task/Hazard Specific

Weather Conditions: ☐ Fair ☐ Poor **Temperature (Low/High):** to °F **Wind speed:** mph **Direction:** **Precipitation:** % **Humidity:** %

I. TRAINING TOPICS COVERED

☐ Planned Site Activities	☐ Heat or Cold Stress	☐ Respirator Use
☐ Demolition Operations	☐ Biological Hazards	☐ Decontamination Procedures
☐ Site Controls	☐ Chemical Hazards	☐ Emergency Procedures/Route
☐ Exclusion Zone/Personnel Limits	☐ Routes of Chemical Exposure	☐ First Aid Procedures
☐ Site Communications	☐ Chemical Exposure Symptoms	☐ Buddy Team Procedures
☐ Physical Hazards	☐ Level/Type of PPE	☐ Other (describe topic(s) below)

Explain: _____

_____

Hospital/Clinic:	**Address:**	**Phone:**

II. SITE PERSONNEL / TRAINING ATTENDEES (Continued on 2nd page)

	Name	Signature	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

III. SAFETYBRIEF / TRAINING VERIFICATION

I certify that the personnel listed on this roster have received the safety and health training described above.

_____ _____

Site Manager or Senior UXO Supervisor — Site Safety and Health Officer or UXO Safety Officer

HGL MR Form 15.18 (Oct 2010)

Page _____ of _____.

HGL Safety Meeting Attendance Log (continued)

HGL HydroGeoLogic, Inc

Safety Meeting and Training Attendance Log

II. SITE PERSONNEL / TRAINING ATTENDEES (continued from 1st page)			
	Name	Signature	Company
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HGL MEC Form 15.18 (Oct 2010)

Page _____ of _____.

Vehicle Accident Report

Vehicle

Driver _____ Accident Date _____ Driver's License/State _____

Address _____

City _____ State _____ Zip _____ Phone _____

Vehicle # _____ Year _____ Make _____ Model _____ Plate # _____

State _____ Vehicle Owner: ( ) GSA ( ) Leased/Rent ( ) Private Vehicle

Vehicle Damage _____ Est. Repair Cost $_____

Other Vehicles

Driver _____ Driver's License _____ State _____

Address _____

City _____ State _____ Zip _____

Phone _____ SSN _____

Owner's Name (Check if same as driver { }) _____

Address _____ City _____ State _____ Zip _____

Insurance Company _____ Policy # _____

Vehicle: Year _____ Make _____ Model _____ Plate # _____ State _____

Vehicle Damage _____

Passenger(s) ( ) Yes ( ) No (List on back) Injuries ( ) Yes ( ) No (List names and address on back)

Accident Description

Date _____ Time _____

Location _____

Description _____

_____

_____

_____

_____

Witness _____ Address _____

Phone # _____

Police Officer's Name _____ Dept. _____

Employee _____ _____ _____
(Print Name) (Signature) (Date)

SUXOS _____ _____ _____
(Print Name) (Signature) (Date)

General Liability, Property Damage, and Loss Report

Project Location _____ **Task Order #**_____ **Date** _____

How did the damage or loss occur: _____

_____

Description of damage or loss: _____

_____

Identification of damaged or lost property: _____

_____

Location of damaged or lost property (before loss): _____

_____

Date and time of damaged or lost property: _____

Owner of damaged or lost property:

Name _____ **Phone #** _____

Address _____ **City/State** _____

Employer name & address _____

Injured Parties (Also complete a Supervisor Employee Injury Report)

1. **Name** _____ **Phone #** _____
   Address _____ **City/State** _____
   Employer name & address _____
2. **Name** _____ **Phone #** _____
   Address _____ **City/State** _____
   Employer name & address _____

Witnesses:

1. **Name** _____ **Phone #** _____
   Address _____ **City/State** _____
   Employer name & address _____
2. **Name** _____ **Phone #** _____
   Address _____ **City/State** _____
   Employer name & address _____

Were pictures taken? ( ) Yes ( ) No

Were police notified? ( ) Yes ( ) No Dept. _____

Employee _____ _____ _____
(Print Name) **(Signature)** **(Date)**

SUXOS _____ _____ _____
(Print Name) **(Signature)** **(Date)**

HGL Supervisor's Employee Injury Report

HGL

SUPERVISOR'S Incident Investigation Report

(To be completed by the employee's supervisor or other responsible administrative official)

Location where accident occurred	Employer's Premises: Yes No Job site: Yes No	Date of accident or illness
Who was injured?	Employee Non-Employee	Time of accident a.m. p.m.
Length of time with firm / Job title or occupation		
What property/equipment was damaged?		Property/equipment owned by:
What was employee doing when injury/illness occurred? (Add additional sheets if needed)		
How did injury/illness occur? List all objects and substances involved.		
Part of body affected/injured?		
Nature and extent of injury/illness and property damaged (be specific)		

PLEASE INDICATE ALL OF THE FOLLOWING WHICH CONTRIBUTED TO THE INJURY OR ILLNESS

____ Failure to lockout	____ Improper maintenance	____ Poor housekeeping
____ Failure to secure	____ Improper protective equipment	____ Unrealistic schedule/budget
____ Horseplay	____ Inoperative safety device	____ Unsafe arrangement or process
____ Fatigue	____ Lack of training or skill	____ Unsafe equipment
____ Improper guarding	____ Operating without authority	____ Unsafe position
____ Improper instruction	____ Physical or mental impairment	____ Other _____

_____

_____

_____

Supervisor's corrective action to ensure this type of accident does not recur:

Was employee trained in the appropriate use of Personal Protective Equipment/Proper safety procedures? ..... Yes ___ No ____
Was employee cautioned for failure to use Personal Protective Equipment/Proper safety procedures? ..... Yes ___ No ____
Did employee promptly report the injury/illness? ..... Yes ___ No ____
Is there modified duty available? ..... Yes ___ No ____
If so, Please describe: _____

Supervisor's name	Supervisor's signature	Phone#	Date
_____	_____	_____	_____

https://sharepoint.hgl.com/docs/munitions response/uxo personnel/01 - forms/safety/supervisor incident investigation report.doc July 2010 V0.0

HGL Incident Report

HGL INCIDENT REPORT

Section 1 – General Information			
Date of Occurrence	Date Reported	Reported to whom?	Time of Occurrence
Employee Name	Work Address	City, State, Zip Code	Work Phone Number
Date of Birth	Home Address	City, State, Zip Code	Home Phone Number
Occupation (Title)		Full time _____ Part time _____ Temporary _____	
Location of Occurrence	Address	City, State, Zip Code	
Description of Incident (include what employee was doing, work process, cause, injury and body part)			
Witness(es)	Address	City, State, Zip Code	Work Phone Number
Was First Aid given on-site? Yes _____ No _____ By whom?			
Was employee taken to hospital? Yes _____ No _____ Ambulance Yes _____ No _____ If so, provide name, address, and phone number of hospital and name of attending physician below:			
Name of Hospital:	Address:	City, State, Zip Code:	Phone Number:
Attending Physician:			
Did employee seek medical attention other than an emergency room? Yes _____ No _____ If so, provide practice name, address, phone number and name of attending physician below:			
Practice Name:	Address:	City, State, Zip Code:	Phone Number:
Attending Physician:			
Did employee lose time on the job? Yes _____ No _____ If so, how many days after the initial injury date? _____			
Was employee assigned light duty? Yes _____ No _____ If so, how many days after the initial injury date? _____			
Supervisor (print):	Signature:	Date:	
Employee (print):	Signature:	Date:	
Witness (print):	Signature:	Date:	
Witness (print):	Signature:	Date:	
Director, Health & Safety:	Signature:	Date:	

Incident Report Form 1 HGL 12/1/2009

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ATTACHMENT 3

ACTIVITY HAZARD ANALYSES

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ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: July 2011
Project Name: RI/FS Former Conway BGR
Activity/Work Task: Mobilization/Demobilization
Activity Location(s): Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Readiness Review-Health and Safety	Inadequate preparation which can lead to the pain and suffering of an accident	Conduct readiness review. Answer the following questions: • Have all site hazards been recognized? • Do you have all the necessary equipment to evaluate site hazards? • Are engineering, administrative and PPE controls ready to be implemented as needed? • Are back up emergency safety supplies and first aid supplies available and complete?	M
2. Mobilize Equipment, Tools and Safety Gear	Strains, sprains, awkward bending/lifts and ergonomic hazards	• Use proper lifting techniques. • Maintain good personal fitness • Ensure walking pathway is clear • Do not lift greater than 50 lbs. • Use mechanical assistance or 2 man lift whenever possible • Limit repetitive awkward motions	M
3. Travel to site	Traffic (road and site traffic)	• Assure vehicle is adjusted per your personal specifications and is in good working order and all cargo is secured and distractions are minimized. Familiarize yourself with the route and directions.	M
4. On-site Mobilization • Determine location for set up/staging equipment • Develop HGL's capability at the site, to include installation of office/equipment storage trailers, etc. • Set up office/storage trailers and other support services	Traffic-Struck by hazards	• Select location away from traffic • Place barricades for work site protection, if necessary • Wear high visibility vest • Stay clear of traffic and equipment. Have all necessary PPE (hardhat, safety glasses, hearing protection, vest, etc).	M
	Driving over soft ground Uneven and rough terrain	Choose location with level and firm soils	M
	Site access control-unwanted entry	Maintain a constant watch for intrusion of unauthorized personnel	L
	Electric shock	Require that all electrical power hook up, installations and disconnections be made or certified by a qualified electrician who will provide written certification of installation and grounding.	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Slip, trip and fall hazards	• Wear slip resistant footwear • Keep work area picked up and as clean as feasible and free of tripping and fall hazards.	M
	Flying debris	• Wear safety glasses when there is a potential for flying debris • Ensure eyewash is available	L
	Strains, sprains, awkward bending/lifts and ergonomic hazards-Tow trailer activities	• Use proper lifting techniques. • Maintain good personal fitness • Ensure walking pathway is clear • Do not lift greater than 50 lbs. • Use mechanical assistance or 2 man lift whenever possible • Limit repetitive awkward motions • Do not overexert or overstrain muscles/joints	M
	Noise-Hearing loss	Wear hearing protection if noise levels from neighboring equipment exceeds 85 dBA (if you cannot be heard speaking in a normal voice at arms distances)	M
	Spills and leaks	Maintain a portable spill response kit (if spills are possible) containing absorbent materials, non-sparking shovel, PPE and disposable supplies in a readily accessible location	L
	Hand tools-cut hazards, jamming, pinch points, struck-by	Assure that they are in good repair and used correctly. The right tool for the right job.	M
	Contact with equipment-Struck by	Conduct daily task specific briefings regarding the hazards associated with the tasks. All personnel will wear a minimum of Level D protection. All HGL subcontractors will be required to attend the site specific hazards health and safety training .Maintain eye contact with equipment operators if is necessary to enter active work zones	L
5. Removal and transport of equipment and supplies from the site	Take home toxics	• Note a source of Decon water on site. Do not bring contaminated PPE or boots into truck. • Use liners to prevent contamination of truck	M
	Same hazards as in step 4 above	See action to eliminate or minimize hazards in step 4	M

Equipment	Inspection	Training
1. All equipment and tools required for sit setup	Daily inspection	40-hr. HAZWOPER 8-hr. HAZWOPER HAZ COM

ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: July 2011
Project Name: RI/FS Former Conway BGR
Activity/Work Task: Munitions Response Area/Site Brush Clearing and Grubbing
Activity Location(s): Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Site access control	Unauthorized entry	• Implement positive site access control prior to site operations • Maintain a constant watch or surveillance for intrusion of unauthorized personnel. Positive site access control will be established prior to on-site operations using barricades, signs or other methods to ensure unauthorized access during tasks that could cause exposure to MEC or other safety and health hazards.	L
	MEC hazard/explosion, fire and overpressure	• Deliver daily task specific briefings regarding the hazards associated with the task and the procedures used to control/mitigate the hazards • Use required PPE as indicated in the SSHP, by all personnel inside the EZ • Require attendance, of all HGL subcontractors ,at the site specific hazards and health and safety training given by the HGL UXOSO • Implement MEC anomaly avoidance procedures. All non-UXO personnel will be escorted by a UXO Technician II or above. • Instruct non-UXO personnel to not touch or disturb any potential MEC items. Non-UXO personnel will adhere to the instructions of the UXO Technician II • In dense brush/vegetation areas use handheld detector/ locators to identify and mark MEC hazards • Have a fire extinguisher readily available • Turn off all motorized equipment during fueling.	M
2. Conduct surface Inspection of MEC hazard area/grid prior to brush/vegetation clearing	MEC hazard/explosion, fire and overpressure	• See Step 1 above	M
	Traffic-Struck by hazards	• Note all moving equipment in work areas • Wear Hi visibility vest • Make eye contact with equipment operators to let them know you are there • Use a spotter when visibility is poor (backing)	L
	Slip, trip and fall hazards -Walking over soft ground, uneven terrain	• Determine best access route before transporting equipment or walking in order to avoid tripping hazards • Wear slip resistant footwear with ankle support • Be aware of rocks, brush, animal boroughs and other hazards. Choose firm ground for walking, if possible	M

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Cuts, lacerations, flying debris from brush/vegetation (eye hazards)	• Wear thick clothing fabrics and appropriate PPE such as leather gloves when there is a potential for cuts and lacerations. • Wear safety glasses if there is a potential for dust and flying debris. • Ensure eye wash is available • Maintain adequate First Aid supplies	M
	Remote location	• Determine accessibility to associates, communication needs, first aid and rescue equipment and procedure. Institute buddy system.	L
	Environmental hazards Biologicals- Plants, insects, wildlife Adverse Weather Temperature Stresses UV Hazards	See General Site hazards actions	M
	Injury from physical exertion, sprains, sprains, awkward bending/lifts and ergonomic hazards	• Use proper lifting techniques • Assure solid footing • Maintain good personal level of fitness. Be alert to signs and symptoms of overexertion • Do not lift greater than 50 lbs. • Use mechanical assistance or 2 man lift whenever possible • Limit repetitive awkward motions • Have water available and first aid supplies • Take adequate rest/recovery periods	M
	Dust inhalation	Provide dust suppression if operation is generating too much dust.	L
	Environmental hazards Biologicals- Plants, insects, wildlife Adverse Weather Temperature Stresses UV Hazards	See General Site hazards actions See General Site hazards actions See General Site hazards actions See General Site hazards actions See General Site hazards actions	M
3. Install flag locators	Injury from unintentional contact-MEC/explosion, fire and overpressure (as indicated above)	• Visually screen the location prior to placing flag locators • Clear location with geophysical instrument prior to placing stake or monument (any soil penetrating activity). Any MEC items located will be marked with cross red pin flags or encircling the hazard with red flagging tape. The location will be reported to the SUXOS or UXOS • See Step 1 above for MEC hazards	M
4. Hand brush clearing/grubbing	Flying debris, dust, dirt, rocks, sparks, abrasions	• Select hand tools and power tools that are right for the job. Inspect all tools daily, prior to use. Defective tools must be tagged and removed from service immediately. • Wear safety glasses and other required PPE as indicated in the SSHP • Ensure that eyewash and first aid supplies are readily available • Wear abrasion resistant clothing (thick fabrics) • Watch for people ,plants, rocks, animals and animal burrows during clearing and grubbing	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Injury from unintentional contact-MEC/explosion, fire and overpressure (as indicated above)	• See Step 1 above for MEC	M
	Hand tools-struck by hazards/pinch points, jamming from applied force	• Follow the procedures and safety precautions specified by the manufacturer to ensure safe operation of all hand and power tools. When using machetes, no personnel will be within a 25 foot radius of the machete operator. The machete operator will use an attached wrist lanyard to prevent the machete escape from operator control • Assure tools are in good repair with adequate grips.	M
	Same hazards as Step 2, 3 and 4	• See step 2, 3 and 4	M
5. Use of mechanical brush/vegetation clearing equipment	Same hazards as Step 2, 3 and 4	• Inspect (inspection performed by UXO technician) all areas of the grid ahead of the vegetation removal crews with the aid of handheld magnetometers.	M
	Spills and leaks-Environmental damage	• Maintain a portable spill response kit containing absorbent materials, non-sparking shovel, PPE and disposable supplies in a readily accessible location • Screw caps on tightly and store fuel in designated area	L
	Noise-hearing loss	• Wear hearing protection when noise levels are above 85 dBA (when you cannot be hear speaking in a normal voice at arm's length)	M

Equipment	Inspection	Training
1. Hand tools	Daily inspections to ensure in good repair and not damaged	UXO personnel will be trained IAW DDESB TP 18 40-hr. HAZWOPER
2. Detector/locator equipment	Perform daily instrument function and calibration test	8-hr. HAZWOPER PPE Training
3. Hand/mechanical brush clearing equipment Chain saws, weed whackers, etc)	Perform daily equipment inspection and maintenance IAW manufacturer's specifications	Initial Site Safety /task Hazard Training Qualified operator trained in magnetometer/metal detector instrument operation

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ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: July 2011
Project Name: RI/FS Former Conway BGR
Task: Munitions Response Site – Geophysical Investigations
Activity Location(s): Former Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Load/Unload geophysical equipment	Walking over soft ground, uneven terrain/ Slip, trip and fall hazards	• Determine the best access route before transporting equipment. • Wear slip resistant footwear with ankle support. Pay attention to footing and best path of travel to avoid tripping hazards. • Prohibit jumping from truck beds • Be aware of rocks, brush, animal boroughs and other hazards. Choose firm ground for walking, if possible	L
	Heavy lifting : Injury from physical exertion, sprains, sprains, awkward bending/lifts, fatigue, and ergonomic hazards	• Use proper lifting technique to load geophysical equipment into back of truck. Equipment can weigh up to 30 lbs. Assure solid footing • Maintain good personal level of fitness. Be alert to signs and symptoms of overexertion • Do not lift greater than 50 lbs alone • Use mechanical assistance or 2 man lift whenever possible for awkward or heavy objects • Limit repetitive awkward motions • Have water available and first aid supplies • Take adequate work/rest periods	M
	General site hazards-project	• Deliver daily task specific briefings regarding the hazards associated with the task and the procedures used to control/mitigate the hazards • Use required PPE as indicated in the SSHP	M
2. Survey area with geophysical equipment and mark work area boundaries	Slips, trips and falls and steep slopes	• Wear slip resistant footwear with ankle support. Pay attention to footing and best path of travel to avoid tripping hazards. • Note terrain and footing and walk the area to be scanned (if possible) and mark uneven surfaces. Do not use geophysical equipment if slope is too steep to operate safely	M
	Remote location	• Determine accessibility to associates, communication needs, first aid and rescue equipment and procedure. Institute buddy system.	M
	Getting lost	• Sign in before departing for an area and inform office personnel of destination. Do not travel alone; bring a site map, compass and radio. Perform a radio check.	M
	Hand tools used to install stakes	• Select hand tools and power tools that are right for the job. • Inspect all tools daily, prior to use. Defective tools must be tagged and removed from service immediately.	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Sprains, strains	• Avoid twisting and turning when walking with the scanner • Be aware of terrain while traversing the proposed investigation grid	M
	Electrical shock	• Check weather reports before going out to the field and postpone geophysical surveys until weather clears (Note: A serious electrical shock can occur if contact is made with lightning while holding lightning attractive geophysical equipment.	M
	Repetitive motion	• Switch off sides of the body regularly to prevent strain. (Note: some of the equipment leans to one side) • Mark or survey area by bending with legs not the back, particularly if weight is being carried.	M
	Environmental hazards Biologicals- Plants, insects, wildlife Adverse Weather Temperature Stresses UV Hazards	See General Site hazards actions See General Site hazards actions See General Site hazards actions See General Site hazards actions See General Site hazards actions	M
3. Assembly/disassembly/maintenance of equipment	Pinch points	• Make sure that fingers/hands do not get caught between cord and plug in.	L
	Cuts	• Wear protective gloves while cutting to prevent injury. (Some equipment or support equipment may need the use of a blade). Use the right tool for the job.	L
	Electrical shock	• All circuits will be properly grounded and protected with fuses or circuit breakers	L
	Hazard communication-chemical exposure	• Label any and all containers as to contents (fuel can, glue, etc.) • Obtain MSDS	L
	Hand and skin injury-hand tools	• Use correct tools. Keep screws and bolts free of corrosion and adequately lubricated. Do not use excessive force.	L
	Traffic-Struck by hazards	• Note all moving equipment in work areas. • Wear High Vis vest. • Stay off roads if possible. • Place cones near vehicles and work areas.	L
4. Install flag locators	Injury from unintentional contact-MEC/explosion, fire and overpressure (as indicated above)	• Visually screen the location prior to placing flag locators • Clear location with geophysical instrument prior to placing stake or monument (any soil penetrating activity).. The location will be reported to the SUXOS or UXOS • See Step 1 above for MEC hazards	M

Equipment	Inspection	Training
1. Geophysical equipment	Battery integrity/charging, calibrating in the site field office Check for frayed segment and damaged connections	40-hr. HAZWOPER 8-hr. HAZWOPER PPE Training
2. Hand tools	Daily inspections to ensure in good repair and not damaged	Initial Site Safety /task Hazard Training Qualified operator trained in geophysical equipment operation

ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: August 2011

Project Name: RI/FS Former Conway BGR

Activity/Work Task: Inspection/Handling of Material Potentially Presenting an Explosive Hazard: Munitions and Range-Related Debris and Scrap

Activity Location(s): Former Conway BGR MRSs

Prepared By: Edie Scala-Hampson, CIH, CHMM

Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Site access control	Unauthorized entry	• Implement positive site access control prior to site operations • Maintain a constant watch or surveillance for intrusion of unauthorized personnel. Positive site access control will be established prior to on-site operations using barricades, signs or other methods to ensure unauthorized access during tasks that could cause exposure to MEC or other safety and health hazards. The MSD /EZ of will be established prior to initiation of MPPEH inspection and handling activities. UXO teams will observe the team separation distance (TSD) in accordance with the DDESB-approved ESS/ESP.	L
2. UXO Technicians will inspect MPPEH, MD, RD and scrap to insure an explosive hazard does not exist	MEC hazard/explosion, fire and overpressure	• Only trained and qualified UXO Technicians will perform MMPEH inspection activities. • Segregate all MPPEHH according to its classification as either Material Documented as an Explosive Hazard (MDEH) or Material Documented as Safe (MDAS). • Stow separately in locked/sealed containers in a secure area until final disposition. • Escort all non-UXO personnel by a UXO Technician • Instruct non-UXO personnel to not touch or disturb any potential MEC items. Non-UXO personnel will adhere to the instructions of the UXO Technician. • Have a fire extinguisher readily available. • Certify and verify documentation is completed using DD Form 1348-1A, *Material Transfer/Release* Form and the HGL Chain of Custody Manifest form before releasing physical control or custody of MPPEH, MD, RD or scrap.	M
	Chemical Hazards from EXPRAY use and MEC • DMSO (Dimethyl sulfoxide) 45% of EXPRAY. If the skin is in contact with any potentially hazardous chemicals (explosives, heavy metals such as lead volatile/semi-volatile compounds) DMSO will act as a vehicle for absorption of the chemical into the body This chemical is absorbed through the intact skin and acts as a carrier, transporting any chemicals in contact with the skin into the body • RDX • Tetryl • TNT	• Use in well-ventilated area. • Spray away from the body. • Do not inhale. • Wear proper personal protective equipment (PPE): Neoprene, butyl, Silver Shield brand, or 4H brand gloves • In case of accidental contact with eyes – flush with water. • Do not use near fire. • Do not puncture aerosol can	H

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Remote location	Determine accessibility to associates, communication needs, first aid and rescue equipment and procedure. Institute buddy system.	L
	Environmental hazards Biologicals- Plants, insects, wildlife Adverse Weather Temperature Stresses UV Hazards	See SSHP General Site hazards actions	M
	Injury from misidentification of MPPEH	Visually inspect all MPPEH by two independent 100 percent inspections by at least one UXO Technician II and one UXO Technician III to determine its status as either Material Documented as Explosive Hazard (MDEH) Or Material Documented as Safe (MDAS). All MPPEH will undergo a quality control inspection by a UXO Quality Control Specialist as specified by the site specific Work Plan and/ or Explosive Safety Submission/Plan.	M
	Contact with moving vehicles	Be aware of vehicle traffic. Stay off of roads	L

Equipment	Inspection	Training
Weigh scales	Perform calibration before each use	• UXO personnel will be trained IAW DDESB TP 18, DOD 4140.62, USACE EM 385-1-97 and EM 1110-1-4009 • Documentation of training will be kept on file at the project site • Initial Site Safety/Task hazard training • PPE training • 40 hr HAZWOPER, • 8 hr. Annual HAZWOPER • Training in survey instruments-magnetometers. • All personnel operating hand tools will be trained in the proper inspection, maintenance and use.

ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: February 2012
Project Name: RI/FS Former Conway BGR
Task: Demolition of MEC
Activity Location(s): Former Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Site access control	Unauthorized entry	• Implement positive site access controls prior to site operations. • Maintain a constant watch for intrusion of unauthorized personnel. Positive site access controls will include as required: barricades, signs or other methods to control unauthorized access during tasks that could cause exposure to MEC or other environmental/safety hazards. • Establish the MSD/EZ. IAW the DDESB-approved ESP • Employ UXO teams, that conduct simultaneous MEC activities, to observe the MSD for intentional detonations during explosive demolition operations	L
2. Using demolition explosives counter charge on MEC hazards to blow in place (BIP) or to conduct consolidated demolition shots.	MEC hazard/explosion, fire and overpressure	• Read and sign off on the HGL work plan and SSHP. Prior to commencing all explosive operations site personnel will be given task-specific briefings regarding the hazards associated with the task and the procedures used to control/mitigate the hazards. • Deliver daily task specific briefings, prior to commencing all explosive operations, regarding the hazards associated with the task and the procedures used to control/mitigate the hazards. • Use authorized, trained and qualified UXO Technicians to perform MEC explosive demolition and surface clearance activities. • Use required PPE as indicated in the SSHP, by all personnel inside the EZ. Minimum Level D. • Require attendance, of all HGL subcontractors ,at the site specific hazards and health and safety training given by the HGL UXOSO • Escort all non-UXO personnel by a UXO Technician II • Instruct non-UXO personnel to not touch or disturb any potential MEC items. Non-UXO personnel will adhere to the instructions of the UXO Technician II • Have a fire extinguisher readily available for protection of all non-essential personnel, only those personnel essential to the performance of the demolition operations will be permitted to work inside the MSD/EZ while MEC items are being primed for demolition. • Restrict entry: Any occupied building or public roadways in the MSD will be evacuated and/or blocked to prevent non-essential personnel from entering during demolition operations. • Comply with evacuation procedures. Before initiation of demolition explosive charges all HGL and subcontractor personnel will evacuate to a designated safe area outside of the EZ. • Use engineering controls if necessary to reduce the effect of blast and fragmentation. Sandbag or water mitigation will be used IAW with USAESH HNC-ED-CS-S-98-7, HNC-ED-CS-S-00-3, HNC safety advisory dated 7 Nov 11, and DDESB memo dated 29 Nov 10 (Classification regarding use of sandbags for mitigation of fragmentation and blast effects due to intentional detonations).	M

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Adverse weather and lightning	• Monitor and take appropriate precautions to protect personnel and property when there are warnings or indications of severe weather. Be aware of lightning, use the lightning 30/30 Rule: If it takes less than 30 seconds to hear thunder after seeing the flash, lightning is near enough to pose a threat; after the storm ends, wait 30 minutes before resuming work activities. If a lightning meter is used, MEC operations should cease from first lightning strike within six miles and wait 30 minutes from last strike before field activities resumes. • Suspend MEC operations when an electrical storm approaches to within 5 miles of the project location.	M
	Cuts and lacerations	• Wear thick clothing fabrics and appropriate PPE such as leather gloves when there is a potential for cuts and lacerations. • Wear safety glasses if there is a potential for dust and flying debris. • Maintain adequate First Aid supplies • Use Level D PPE per the APP for all tasks with the potential for cuts or lacerations. Personnel will be trained in the proper use and selection of the equipment and the tools they must use to complete their task and the hazards of exposed metal and other cut hazards.	L
	Eye hazards- Flying debris, dust, dirt, rocks, sparks, abrasions	• Use eye protection which meets ANZI/ASSE Z81 to protect eyes from hazards associated with MEC operations and flying debris • Select hand tools and power tools that are right for the job. Inspect all tools daily, prior to use. Defective tools must be tagged and removed from service immediately • Ensure that eyewash and first aid supplies are readily available • Wear abrasion resistant clothing (thick fabrics)	L
	Lifting	• Restrict lifts to 50 pounds or less. When lifting in excess of 50 pounds, but no more than 100 pounds two or more workers are required. Any item weighing more than 100 pounds will only be lifted using mechanical equipment or devices. Personnel will use safe lifting procedures and lift with their legs and not their backs and will be trained in proper lifting techniques.	L
	Mechanized equipment	• Inspect all mechanized equipment, prior to it being placed in use on site (per a competent person, IAW, the manufacturer's recommendations and requirements of this SSHP). All mechanized equipment will be inspected daily (while in use) to ensure safe operating conditions. Inspections will be conducted by the operator or a designated competent person at the beginning of the day of use. Prior to daily use braking and operating systems will be function checked and all safety devices will be in place. Whenever an unsafe condition or discrepancy is found the equipment will be immediately removed from service and prohibited from use until the unsafe condition is corrected. ONLY qualified operators holding an appropriate certification are permitted to operate mechanized equipment. Equipment operations will be conducted in a manner as to not endanger personnel. Equipment will not be mounted nor dismounted while moving.	L
	Physical injury from mechanized equipment	• Establish a clear safety zone at the maximum radius of the bucket. The safety zone will be clearly marked with orange safety cones or other demarcation. Personnel will remain clear and not enter the safety zone when excavator is in operation. All personnel working near the safety zone will wear PPE consisting of a high-visibility vest and head, foot and eye protection.	L
	Sprains and strains	• Wear sturdy footwear. • Avoid twisting or turning while opening doors and walking with hand-pulled equipment. • Use caution to not over exert or overstrain muscles and joints. • Know your limitations	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Slips, trips and falls	• Wear slip resistant footwear with ankle support • Determine best access route before transporting equipment or walking in order to avoid tripping hazards • Be aware of uneven walking surfaces, rocks, brush, animal boroughs and other hazards. • Avoid walking near cliffs or on inclined/slopes greater than 30 degrees. • Choose firm ground for walking, if possible • Continually inspect work area for hazards and practice good housekeeping procedures and maintain clear work areas to remove trip hazards.	L
	Contact with moving vehicles	• Be aware of vehicle traffic. Stay off of roads.	L
	Overhead hazards	• Wear hard hats in those areas with the potential for head injury. All protective head gear shall meet the current requirements of ANSI Z89.1.	L

Equipment	Inspection	Training
1. Remote firing device or initiators.	• Conduct preoperational inspection • Perform equipment function test.	• UXO Technicians will meet the training/certification requirements of DDESB Technical Paper 18. • Documentation of training will be kept on file at the project site. • Initial Site Safety/Task Hazard Training. • PPE Training. • 40 hr HAZWOPER. • 8 hr Annual HAZWOPER Refresher. • All personnel operating initiating firing devices will in training in the proper inspection, maintenance and use.

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ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: February 2012
Project Name: RI/FS Former Conway BGR
Task: DGM and DGPS Collection and Recording
Activity Location(s): Former Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Load/Unload Geophysical equipment	Walking over soft ground, uneven terrain/ Slip, trip and fall hazards	• Determine the best access route before transporting equipment. • Wear slip resistant footwear with ankle support. Pay attention to footing and best path of travel to avoid tripping hazards. • Prohibit jumping from truck beds or raised platforms. • Be aware of rocks, brush, animal boroughs and other hazards. Choose firm ground for walking, if possible	L
2. Setting up and operating: a. Precision Differential Global Positioning Systems (DGPS). b. Hand operated/towed metal detectors, locators and magnetometers. Perform DGM and DGPS survey data collection and recording using the EM61-Mk2 metal detector.	Dehydration, heat stress, sunburn	• Drink a minimum of two liters of water per day. Remain in shade whenever possible. Wear sunscreen with sun protection factor of at least 15.	L
	Heavy lifting: Injury from physical exertion, sprains, strains, awkward bending/lifts, fatigue, and ergonomic hazards	• Use proper lifting technique to load geophysical equipment into back of truck. • Assure solid footing • Maintain good personal level of fitness. Be alert to signs and symptoms of overexertion • Do not lift greater than 50 lbs. • Use mechanical assistance or 2 man lift whenever possible for awkward or heavy objects • Limit repetitive awkward motions • Have water available and first aid supplies	M
	Contact with MEC	• Deliver daily task specific briefings regarding the hazards associated with the task and procedures used to control/mitigate the hazards • Use required PPE as indicated by the SSHP, by all personnel inside the EZ. • Require attendance of all HGL and subcontractors at the site specific hazards and health and safety training given by the HGL UXOSO. • Escort all non-essential UXO personnel by a UXO Technician II or above. • Instruct non-UXO personnel to not touch or disturb any potential MEC items. Non-UXO personnel will adhere to the instruction of the UXO Technician.	M
	Adverse weather and lightning	• Monitor warnings or indications of severe weather conditions. Take appropriate precautions to protect personnel and property. Be aware of lightning, use the lightning 30/30 Rule: If it takes less than 30 seconds to hear thunder after seeing the flash, lightning is near enough to pose a threat; after	L

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
		the storm ends, wait 30 minutes before resuming work activities. If a lightning meter is used, MEC operations should cease from first lightning strike within six miles and wait 30 minutes from last strike before field activities resume. • Suspend all work activities when an electrical storm approaches to within 5 miles of the project location.	
	Slips, trips and falls	• Wear slip resistant footwear with ankle support. Pay attention to footing and best path of travel to avoid tripping hazards. • Note terrain and footing and walk the area to be scanned (if possible) and mark uneven surfaces. Do not use geophysical equipment if slope is too steep to operate safely.	M
	Traffic-struck hazards	• Note all moving equipment in work areas. • Wear High Vis vest. • Stay off roads if possible.	L
	General Site Hazards	• Refer to General Site Hazards AHA	
	Getting lost	• Sign in before beginning a hike, do not travel alone (use buddy system), and bring a topographic map compass and communication device.	L

Equipment	Inspection	Training
1. DGPS System 2. EM61-M2 metal detector 3. Batteries	• Inspect all electronic connections and system test for proper setup. • Perform data input validation. • Inspect equipment setup • Perform equipment detection validation test. • Secure batteries from movement and damage. • Inspect batteries daily for damage, cracks and leaks and remove from service when these conditions are present.	• Site-specific/task-specific safety training and Hazards Communications • 40 hr HAZWOPER • 8 hr HAZWOPER annual refresher • PPE • All personnel tasked with use of metal detectors, locators and magnetometers will be trained in their use.

ACTIVITY HAZARD ANALYSIS

Overall Risk Assessment Code (RAC): **M**

Date Prepared: February 2012
Project Name: RI/FS Former Conway BGR
Task: Surface and Subsurface Target Anomaly Investigation and Munitions and Explosive of Concern Clearance
Activity Location(s): Former Conway BGR MRSs
Prepared By: Edie Scala-Hampson, CIH, CHMM
Reviewed By: Ron Mendenhall, UXO Safety Manager

Risk Assessment Code 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	Hazards	Actions to Eliminate or Minimize Hazards	RAC
1. Conduct manual subsurface target anomaly investigation to clear MEC. 2. Establishment of subsurface grid or clearance area. 3. Conduct point detection magnetometer assisted excavations to investigate subsurface target anomaly.	General	Prior to commencing all explosive operations site personnel will be given task-specific briefings regarding the hazards associated with the task and the procedures used to control/mitigate the hazards. All personnel within the EZ will wear a minimum of Level D PPE. All employees and subcontractors required to read and sign-off on the HGL WP and SSHP.	L
	Unauthorized entry	Site personnel will maintain a constant watch for intrusion of unauthorized personnel. Positive site access control will be established prior to on-site operations using barricades, signs or other methods to ensure that unauthorized access during tasks that could cause exposure to MEC or other environmental/safety hazards. The MSDs/EZ will be established based on the munition with the greatest fragmentation distance (MGFD) identified in the DDESB-approved ESP/ESS prior to initiation of MEC activities.	L
	MEC hazard/explosion, fire and over pressure	• Deliver daily task specific briefings regarding the hazards associated with the task and procedures used to control/mitigate the hazards • Use required PPE as indicated by the SSHP, by all personnel inside the EZ. • Required attendance of all HGL and subcontractors at the site specific hazards and health and safety training given by the HGL UXOSO. • Escort all non-essential UXO personnel by a UXO Technician II or above. • Instruct non-UXO personnel to not touch or disturb any potential MEC items. Non-UXO personnel will adhere to the instruction of the UXO Technician. • Only trained and qualified UXO Technicians will authorize to perform MEC surface and subsurface clearance activities as specified the training requirement section of this AHA. • MEC operations will be suspended when an electrical storm approaches to within 5 miles of the project location.	M
	Adverse weather and lightning	• When there are warnings or indications of severe weather, conditions will be monitored and appropriate precautions taken to protect personnel and property. Be aware of lightning, use the Lightning 30/30 Rule: If it takes less than 30 seconds to hear thunder after seeing the flash, lightning is near enough to pose a threat; after the storm ends, wait 30 minutes before resuming work activities.	L
	Cave-in of excavated soil, open excavation and permits	Excavated soil will be placed two (2) feet away from the edge of the excavation area. A competent person will examine and determine if soil type requires protective measures using sloping or benching methods to protect employees from cave-ins. If anomaly is deeper than four (4) feet stop excavation and notify the UXOSO. When excavation exceeds a depth of 4 feet sufficient egress measures are required. Excavations shall be backfilled upon completion of anomaly clearance. Excavations not immediately backfilled or covered will be cordoned off to prevent personnel, livestock and wildlife from entering or falling into the excavation. When required, an excavation permit will be obtained by the Project Manager from the appropriate authority.	M

Job Steps	Hazards	Actions to Eliminate or Minimize Hazards	RAC
	Contact with moving vehicles	Be aware of vehicle traffic. Stay off of roads.	L
	Cuts and lacerations	Level D PPE with leather gloves will be used per the APP for all tasks with the potential for cuts or lacerations. Personnel will be trained in the proper use and selection of the equipment and tools they must use to complete their task and the hazards of exposed metal and other cut hazards.	L
	Eye hazards	Personnel will use protective eyewear which meets ANZI/ASSE Z81 to protect their eyes from hazards associated with MEC operations.	L
	Lifting	A single worker is restricted to lifting 50 or less. When lifting in excess of 50 pounds, but no more than 100 pounds two or more workers are required. Any item weighing more than 100 pounds will only be lifted using mechanical equipment or devices. Personnel will use safe lifting procedures and lift with their legs and not their backs and will be trained in proper lifting techniques.	L
	Mechanized equipment	Mechanized equipment shall be inspected prior to being placed in use on site by a competent person IAW the manufacturer recommendations and requirements of this SSHP. All mechanized equipment will be inspected daily (while in use) to ensure safe operating conditions. Inspections will be conducted by the operator or a designated competent person at the beginning of the day of use. Prior to daily use braking and operating systems will be function checked and all safety devices will be in place. Whenever an unsafe condition or discrepancy is found the equipment will be immediately removed from service and prohibited from use until the unsafe condition is corrected. ONLY qualified operators holding an appropriate certification are permitted to operate mechanized equipment. Equipment operations will be in a manner as to not endanger personnel and IAW with manufacturer's instructions. Equipment will not be mounted nor dismounted while moving.	M
	Physical injury from mechanized equipment	Establish a clear safety zone at the maximum radius of the bucket. The safety zone will be clearly marked with orange safety cones. Personnel will remain clear and not enter the safety zone when excavator is in operation. All personnel working near the safety zone will were PPE consisting of a high-visibility vest and head, foot and eye protection.	M
	Overhead hazards	Safety hard hats will be required in those areas with the potential for head injury. All protective head gear shall meet the current requirements of ANSI Z89.1	M
	Sprains and strains	Wear sturdy footwear. Avoid twisting or turning while opening doors and walking with hand-pulled equipment. Personnel will be cautioned about physical strain associated with strenuous activities that may be conducted on site. Personnel will use caution to not over exert themselves of overstrain muscles and joints.	L
	Slips, trips and falls	Ensure safe and secure footing, wear sturdy footwear, and continually inspect work area for hazards and practice good housekeeping procedures and maintain clear work areas to remove trip hazards. Personnel will also be aware of uneven walking, animal boroughs, ground surfaces tree roots, small scrubs and the potential for rocks and other trip hazards associated with the work site. Avoid walking near cliffs or on inclined/slopes greater than 30 degrees.	L

Equipment	Inspection	Training
1. Hand tools for excavating	Daily inspection of hand tools.	• UXO Technicians shall meet the training/certification requirements of DDESB Technical Paper 18. • 40 hr HAZWOPER. • 8 hr HAZWOPER annual refresher. • Documentation of training will be kept on file at the project site. • Initial Site Safety/Task Hazard Training. • Current equipment operator certificate • PPE Training.
2. Mechanized equipment	Daily inspections and tests IAW manufacturer's instructions and recommendations.	
3. Handheld magnetometers	Magnetometers will be response tested daily at the test plot to ensure proper operations. All magnetometer tests will be recorded in their respective equipment test log.	

ATTACHMENT 4

HEAT STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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WORKPLACE HEALTH AND SAFETY PROGRAM

HEAT STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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4.0 REFERENCES D-219

Appendix Background Material on Heat-Related Illnesses

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1.0 INTRODUCTION

Work in hot, humid environments can cause heat to accumulate in the body faster than it can be dissipated. This accumulation of heat can produce serious illnesses, which range from mild to fatal. The heat-related illnesses, which are described in the appendix, include heat rash, heat cramps, heat exhaustion, and heat stroke. The first three conditions normally do not have extremely serious consequences – unless an exhausted employee falls and suffers injury. Heat stroke, however, can cause death or permanent injury to the brain. For this reason, heat stroke should be treated as a medical emergency, and all heat-related illnesses should be prevented through application of the precautions discussed in this procedure. If situations are encountered that are not addressed in this document, the project manager or site safety officer should contact the corporate Safety Department to discuss appropriate protective measures.

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2.0 ASSESSMENT OF THE POTENTIAL FOR HEAT-RELATED ILLNESS

More than for any other physical agent, the potential health hazards from work in hot environments depend strongly on physiological factors that lead to a range of susceptibilities, depending on the level of acclimatization. Therefore, professional judgment is of particular importance in assessing the level of heat stress and physiological heat strain to provide adequate guidance for protecting nearly all healthy workers with due consideration of individual factors and the type of work.

A heat stress or strain condition exists when a person's body becomes warmer when heat is added faster than it is dissipated. Many factors affect the rate of heat addition and the rate of heat loss. Increased heat accumulation occurs when a person works more strenuously or exposes himself to a source of radiant heat (e.g., the sun or an industrial boiler). Loss of heat from the body is hindered by high humidity, low air movement, and high temperature of air and surrounding objects. Heavy clothing or additional protective equipment, which might be required on a project site, also can reduce the loss of heat and thus increase heat accumulation.

2.1 ENVIRONMENTAL DETERMINANTS

The environmental determinants of the potential for heat stress are the temperature and humidity of the air, the amount of air movement, and radiant heat from the sun or nearby hot objects. These parameters can be measured easily and combined to calculate the "wet bulb globe temperature index" (WBGT), a useful single-number indicator of the environmental contribution to heat stress exposure. (See HS-T-4.)

When workers are exposed to direct sunlight, that index is defined in the following way:

$$WBGT = 0.7 \times T_{nwb} + 0.2 \times T_g + 0.1 \times T_{db}$$

Where: WBGT is the Wet Bulb Globe Temperature Index,
T_g is the globe temperature (influenced by air temperature and radiant heat flux),
T_{db} is the dry bulb temperature (influenced by air temperature), and
T_{nwb} is the natural wet bulb temperature (influenced by air temperature, air humidity, and air movement).

When workers are not exposed to direct sunlight, the index is calculated in the following way:

$$WBGT = 0.7 \times T_{nwb} + 0.3 \times T_g$$

A higher value of WBGT indicates a greater potential for heat stress. Both higher air temperature and higher radiant heat increase the value of the WBGT index. Higher air movement and lower air humidity decrease the WBGT value by enhancing evaporative cooling

and lowering the T_{nwb} measurement. (Of course, higher air movement would not lower T_{nwb} if the relative humidity were 100%.)

An alternative to the WBGT index is "adjusted temperature," which is easier to estimate, but much less informative. It is obtained through the following simple calculation:

$$\text{Adjusted Temperature} = [\text{actual air temperature} + (13 \times \{\text{sunshine fraction}\})].$$

The actual air temperature is measured by means of a standard mercury thermometer with the bulb shielded from direct sunlight. "Sunshine fraction" is obtained through an estimate of the percent of the time that the sun is not covered by clouds thick enough to produce a shadow (100% sunshine = no cloud cover and sharp distinct shadows, and 0% sunshine = no shadows). Note that "sunshine fraction" = (percent sunlight)/100. Relative humidity and wind speed are not included in this much cruder determination of the potential for heat related illness.

2.2 THE CONTRIBUTION OF METABOLIC HEAT

Work generates body heat, which must be dissipated into the environment. More strenuous work generates more heat. At a given WBGT value (e.g., 85°F), it could be safe to perform continuous light work for hours – but very dangerous to perform heavy work without frequent breaks and other precautions. Any assessment of the potential for heat-related illness requires consideration of the work load. The following classification system may be used:

Work Load	Examples
Light	Sitting with moderate arm and leg movements. Standing with light work requiring mostly arm movement. Standing with light work at a machine with some walking about.
Moderate	Scrubbing in a standing position. Walking about with moderate lifting or pushing. Walking on level ground at 6 km/hr while carrying a 3 kg load.
Heavy	Shoveling dry sand. Intermittent heavy lifting with pushing or pulling (e.g., pick and shovel work).
Very Heavy	Shoveling wet sand.

Many jobs involve several task elements, some of which are more or less strenuous than others. It is appropriate in such cases to estimate an average work load over a 15 - 60 minute period. For example, the "moderate" category might be appropriate for a job that required walking and light carrying, with occasional digging with a shovel and moving of heavy objects.

2.3 THE CONTRIBUTIONS OF OTHER FACTORS

Work load and environmental factors are not the only determinants of the potential for heat-related illness. Heavy or impermeable protective clothing can increase the risk greatly, even if the work is not strenuous and the temperature is not high. Also, workers who are not

acclimatized to hot work environments are much more likely to experience the harmful effects of heat stress. Many other health and "lifestyle" variables are important as well. These are discussed in the sections that follow, and in the appendix.

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3.0 THRESHOLDS OF CONCERN

The risk of heat-related illness among healthy workers who are acclimatized to hot work is low if the WBGT value does not exceed the American Conference of Governmental Industrial Hygienists (ACGIH) "screening criteria" shown below:

Table 2 lists values from the 2011 edition of the ACGIH publication *Threshold Limit Values (TLV®) and Biological Exposure Indices*. This table is intended as an initial screening tool to evaluate whether a heat stress situation may exist. Professional judgment is also of particular importance in assessing the level of heat stress and physiological heat strain of workers. The values in the table below are more protective and they are not intended to prescribe work and recovery periods, but suggest work in a cycle of work and recovery.

Table 2
Screening Criteria for TLV and Action Limit for Heat Stress Exposure

Allocation of Work in a Cycle of Work and Recovery	TLV WBGT Values in °C (°F)				Action Limit WBGT Values in °C (°F)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 - 100% work	31(87.8)	28(82.4)	-	-	28 (82.4)	25 (77)	-	-
50 - 75% work	31 (87.8)	29(84.2)	27.5 (81.5)	-	28.5 (83.3)	26 (78)	24 (75.2)	-
25 - 50% work	32 (89.6)	30(86)	29(84.2)	28 (82.4)	29.5 (85.1)	27 (80.6)	25.5 (77.9)	24.5 (76.1)
0 - 25% work	32.5(90.5)	31.5(88.7)	30.5 (86.9)	30 (86)	30 (86)	29 (84.2)	28 (82.4)	27 (80.6)

WBGT means the wet bulb globe temperature measured with a black globe thermometer (GT), wet bulb thermometer (WB), and a dry bulb (air) thermometer (DB), and measured according to the following equations:

For indoor or outdoor environments without direct exposure to sunlight,

$$WBGT°C = 0.7WB + 0.3GT$$

For outdoor environments with direct exposure to sunlight,

$$WBGT°C = 0.7WB + 0.2GT + 0.1DB$$

When the air temperature exceeds 75 °F, the SSHO will begin measuring and recording the WBGT index at least once each hour. He or she then will specify an hourly work/rest cycle consistent with the data in the table above (to the extent feasible) for acclimatized workers wearing normal, permeable work clothing. (A more protective regimen will be specified for un-acclimatized workers. The corporate Safety Department will specify alternate regimens for workers wearing very heavy or impermeable protective clothing.)

The Site Safety and Health Officer (SSHO) will make feasible adjustments for more or less demanding tasks, as the ACGIH criteria indicate. Additional adjustments will be necessary if heavy protective clothing is worn by workers. (See the applicable site health and safety plan.)

3.1 PROTOCOL FOR USE OF ADJUSTED TEMPERATURE

If the adjusted temperature exceeds 72.5°F, then the SSHO will require that employees take at least a 15-minute break following each work period of maximum duration shown in the table below.

The SSHO will require physiological monitoring as described in Section 4.3 during each rest break, and take appropriate action as required by that section.

The SSHO will be very cautious in the use of adjusted temperature to protect employees, especially when humidity is high and air movement is low. Longer breaks and shorter work periods should be required in such situations. Extreme caution is warranted if work tasks are more than moderately strenuous, if heavy clothing is worn, or if the adjusted temperature greatly exceeds 90°F. The Safety Department should be consulted in such situations.

3.2 PHYSIOLOGICAL MONITORING

Physiological monitoring to detect the symptoms of heat stress is required under the following circumstances:

1. A feasible work/rest cycle is not sufficiently protective to conform to the ACGIH recommendations in Section 4.2.1,
2. The adjusted-temperature protocol described in Section 4.2.2 is used and the adjusted temperature in the workplace exceeds 72.5°F, or
3. Impermeable protective clothing is worn by workers in hot environments.

The SSHO will use one of the methods found in National Institute for Occupational Safety and Health (NIOSH) Publication 85-115 to conduct the physiological monitoring (see references). One of the following measurements shall be used:

1. Heart Rate. Count the radial (wrist) pulse during a 30-second period as early as possible in the rest period.
    a. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.
    b. If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third and keep the rest period the same.
2. Oral Temperature. Use a clinical thermometer (3 minutes under the tongue), or a similar device to measure the oral temperature, at the end of each work period (before drinking).
    a. If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
    b. If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Tympanic membrane (ear) temperature may be considered equivalent to oral temperature.

Personal monitoring devices that continuously measure heart rate and/or body temperature may be used with the approval of the Safety Department. The SSHO should become familiar with the operation of the devices and instruct employees on their proper use.

3.3 MAINTENANCE OF RECORDS

The SSHO will maintain a written (or electronic) record of measurements and observations required by this procedure. This information may be recorded as entries in the project safety log or as entries on a data sheet created for this purpose.

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4.0 REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents (American Conference of Governmental Industrial Hygienists, 2011).

NIOSH Publication 85-115, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (National Institute for Occupational Safety and Health, 1985).

Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety (Office of Public Affairs, Centers for Disease Control and Prevention, 1996).

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APPENDIX
BACKGROUND MATERIAL ON HEAT-RELATED ILLNESSES

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Heat Stroke

Heat stroke occurs when the body becomes unable to control its temperature. The body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Body temperature may rise to 106°F or higher within 10-15 minutes. **Heat stroke can cause death or permanent disability if emergency treatment is not given.**

Warning signs of heat stroke vary but may include:

- an extremely high body temperature (oral temperature above 103°F)
- red, hot, and dry skin (no sweating)
- rapid, strong pulse
- throbbing headache
- dizziness
- nausea
- confusion
- unconsciousness

If you see any of these signs, you may be dealing with a life threatening emergency. Have someone call for immediate medical assistance while you begin cooling the victim:

- Get the victim to a shady area.
- Cool the victim rapidly using whatever methods you can. For example, immerse the victim in a tub of cool water; place in a cool shower; spray with cool water from a garden hose; sponge with cool water; or if the humidity is low, wrap the victim in a cool, wet sheet and fan him or her vigorously.
- Monitor body temperature and continue cooling efforts until the body temperature drops to 101-102°F.
- If emergency medical personnel are delayed, call the hospital emergency room for further instructions.
- Do not give the victim alcohol to drink.
- Get medical assistance as soon as possible.

Sometimes a victim's muscles will begin to twitch uncontrollably as a result of heat stroke. If this happens, keep the victim from injuring himself, but do not place any object in the mouth and do not give fluids. If there is vomiting, make sure the airway remains open by turning the victim on his or her side.

Heat Exhaustion

Heat exhaustion is the body's response to an excessive loss of the water and salt contained in sweat. Those most at risk are elderly people, people with high blood pressure, and people working or exercising in a hot environment.

Warning signs of heat exhaustion include:

- heavy sweating
- paleness
- muscle cramps
- tiredness
- weakness
- dizziness
- headache
- nausea or vomiting
- fainting

The skin may be cool and moist. The victim's pulse rate will be fast and weak, and breathing will be fast and shallow. If heat exhaustion is untreated it may progress to heat stroke. Seek medical attention immediately if symptoms are severe or the victim has heart problems or high blood pressure. Otherwise, help the victim to cool off, and seek medical attention if symptoms worsen or last longer than one hour.

Cooling measures that may be effective include:

- cool, non-alcoholic beverages, as directed by your physician
- rest
- cool shower, bath, or sponge bath
- an air-conditioned environment
- lightweight clothing

Heat Cramps

Heat cramps usually affect people who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture. The low salt level in the muscles causes painful cramps. Heat cramps may also be a symptom of heat exhaustion.

Heat cramps are muscle pains or spasms—usually in the abdomen, arms, or legs—that may occur in association with strenuous activity. If you have heart problems or are on a low sodium diet, get medical attention for heat cramps.

If medical attention is not necessary, take these steps:

- Stop all activity, and sit quietly in a cool place.
- Drink clear juice or a sports beverage.
- Do not return to strenuous activity for a few hours after the cramps subside because further exertion may lead to heat exhaustion or heat stroke.
- Seek medical attention for heat cramps if they do not subside in one hour.

Heat Rash

Heat rash is a skin irritation caused by excessive sweating during hot, humid weather. It can occur at any age but is most common in young children.

Heat rash looks like a red cluster of pimples or small blisters. It is more likely to occur on the neck and upper chest, in the groin, under the breasts, and in elbow creases.

The best treatment for heat rash is to provide a cooler, less humid environment. Keep the affected area dry. Dusting powder may be used to increase comfort, but avoid using ointments or creams. They keep the skin warm and moist and may make the condition worse. Treating heat rash is simple and it usually does not require medical assistance. Other heat-related problems can be much more severe.

Sunburn

Sunburn should be avoided because it is damaging to the skin. Although the discomfort is usually minor and healing often occurs in about a week, a more severe sunburn may require medical attention.

Symptoms of sunburn are well known. The skin becomes red, painful, and abnormally warm after sun exposure.

Consult a doctor if these symptoms are present:

- fever
- fluid-filled blisters
- severe pain

Also, remember these tips when treating sunburn:

- Avoid repeated sun exposure.
- Apply cold compresses or immerse the sunburned area in cool water.
- Apply moisturizing lotion to affected areas. Do not use salve, butter, or ointment.
- Do not break blisters.

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ATTACHMENT 5

COLD STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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WORKPLACE HEALTH AND SAFETY PROGRAMS

COLD STRESS: ENVIRONMENTAL ASSESSMENT AND MANAGEMENT OF EXPOSURE

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1.0 INTRODUCTION

Exposure to freezing or cold temperatures can cause serious injuries. Among these is frostbite, the freezing of fluid in body tissue. Trench foot is another injury that can be produced by cold (but not necessarily freezing) temperatures when the feet are damp. Hypothermia, the severe drop in the core temperature of the body, is the most serious cold-related injury. It can occur after prolonged exposure to cold air, or after much briefer period of immersion in cold water. These workplace hazards are discussed in detail in the appendix.

This document describes procedures for assessing the potential for cold-related injury in the workplace and for implementing work rules to protect employees. It is designed to prevent exposure to conditions that could lead to either the freezing of exposed skin (frostbite) or a dangerous decrease in body temperature (hypothermia).

If situations are encountered that are not addressed in this document, the project manager or the site safety officer should contact Corporate Safety to discuss appropriate protective measures. Project managers and safety officers should consult Corporate Safety before any major modifications to this procedure are implemented.

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2.0 ASSESSMENT OF THE POTENTIAL FOR COLD STRESS

The potential for cold stress is determined primarily by two variables: the temperature of the air and the speed of the wind. At a given temperature, calm air is less dangerous. The "cooling power" of moving air on exposed flesh can be expressed as an equivalent chill temperature (ECT), which combines temperature and air speed. The following table shows values of ECT for various temperature and speed combinations.

The conditions represented by Zones B and C are extremely dangerous to exposed skin. Continuous exposure of exposed skin should not be permitted if the equivalent chill temperature is -25°F or less. Work under conditions represented by Zone A is much less dangerous to exposed skin. However, workers can suffer frostbite injury in the less severe environment if they develop a false sense of security and fail to take precautions.

The potential for hypothermia also is dependent upon air temperature and air speed. At low ECT values, precautions against this hazard are necessary, even if workers are dressed in well insulating clothing. The danger of hypothermia is especially severe if immersion in water is possible during the work.

EQUIVALENT CHILL TEMPERATURE (°F)
AT VARIOUS AIR TEMPERATURES AND WIND SPEEDS*

Estimated Wind Speed (mph)	Actual Temperature Reading (°F)											
	50	**40**	**30**	**20**	**10**	**Zero**	**- 10**	**- 20**	**- 30**	**- 40**	**- 50**	**- 60**
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	- 9	- 24	- 24	- 33	- 46	- 58	- 70	- 83	- 95
15	36	22	9	- 5	- 18	- 32	- 45	- 58	- 72	- 85	- 99	
20	32	18	4	- 10	- 25	- 39	- 53	- 67	- 82	- 96		
25	**Zone A**			- 15	- 29	- 44	- 59	- 74	- 88			
30	**Little Danger**			- 18	- 33	**Zone**	- 63	- 79	**Zone C**			
35	(in < 1hour, if skin is dry)			- 20	- 35	**B****	- 67	- 82	**Great Danger** (Flesh may freeze			
40	26	10	- 6	- 21	- 37	- 53	- 69	- 85	within 30 seconds.)			

*Zone B: Increasing Danger (Danger from freezing of exposed flesh within one minute.

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3.0 PREVENTION OF COLD-RELATED ILLNESS

The project or site safety and health officer (SSHO) will make an assessment of the potential for cold stress before field work begins. Work rules related to the prevention of cold-related injury will be required if conditions of the type represented in Zones A, B, or C in the table on page 2 are anticipated. Under such conditions, the SSHO will measure temperature and wind speed when work commences each day and at routine intervals (at least every four hours) thereafter, unless he or she believes that some other means of hazard assessment is adequate. The safety department must approve any alternative means of hazard assessment.

When work is conducted under conditions represented in Zones A, B, or C, the SSHO will implement work rules described below to manage the potential hazard.

3.1 GENERALLY APPLICABLE PRECAUTIONS

The SSHO will implement the following work rules, as appropriate, when conditions of the type represented in Zones A, B, or C in the table on page 2 occur in the work environment:

- Employees will receive training on the dangers and symptoms of cold-related injury and the work rules adopted to prevent it.
- Site workers will be warned that older individuals and people with circulatory problems might be at increased risk for clod-related injury, and that added precautions might be necessary to protect them.
- Each employee will be under protective observation by someone else during work; (i.e., use of the “buddy system” will be required, as it is on all Zapata Engineering projects).
- Employees who experience pain in the extremities or evident shivering will be removed from exposure to the cold work environment.
- Work must be halted if frostbite cannot be prevented. Continuous skin exposure will not be permitted when the ECT is –25°F or less (Zones B and C on page 2.
- Tasks should be scheduled to avoid long periods during which workers must sit or stand still.
- Work expectations for new employees should be adjusted downward for the first few days, to permit acclimatization to the cold conditions.
- Dehydration, which decreases blood flow to the extremities, should be avoided. Employees will be encouraged to replenish water lost to perspiration and respiration. The SSHO will provide soups and warm sweet drinks as appropriate.
- The SSHO will develop procedures that reduce the likelihood of immersion in water or soaking of the clothing by other means during project work. Such precautions should apply to any work with liquids like gasoline, alcohols, solvents, or cleaning fluids.

- The SSHO will plan for any likely scenarios that would lead to wet clothing (through immersion in water, soaking by mist, etc.), and provide for quick changing into dry clothing and treatment for hypothermia.
- Emergency plans will give special attention to the prevention of cold-related injury (hypothermia and freezing of damaged tissues).

3.2 SELECTION OF PROTECTIVE CLOTHING

The rules implemented by the SSHO will require that employees wear adequately insulating dry clothing if conditions of the type represented in Zones A, B, or C in the table on page 2 are anticipated. Workers should wear cold-protective clothing appropriate for the environmental conditions and the level of physical activity. The following considerations should guide the selection and use of protective clothing:

- Layered clothing should be used to preserve body heat. An easily removable outer windbreak garment should be worn in windy conditions.
- Inner garments and underwear should be made of fabrics that dry quickly and wick moisture away from the body.
- Outer garments should be made with provisions for easily ventilation to prevent the wetting of inner layers by sweat.
- An employee should not enter or remain in a cold work environment if his or her clothing is wet as a consequence of sweating. If clothing is wet, then the employee should change into dry clothing before returning to the cold environment.
- Gloves and/or mittens should be used as necessary to protect the hands, and employees should be warned not to touch very cold objects and surfaces with bare skin.
- Workers should routinely change socks and removable felt insoles to reduce moisture around the feet.
- Eye protection suitable to the type of hazard should be used. Special precautions against ultraviolet light and glare might be necessary in snow-covered terrain.
- Hardhat liners should be used if necessary. If work must be done on slippery surfaces, then shoe attachments that enhance traction should be used.

3.3 WORK/WARMING REGIMENS

If continuous work must be performed at an ECT below 19.4°F, then the SSHO or project manager will provide a heated shelter (tent, cabin, or similar space) for warming after exposure to the cold environment. Employees should be encouraged to use the shelter at frequent intervals, and upon (1) onset of heavy shivering, (2) occurrence of minor frostbite, or (3) onset of feelings of excessive fatigue, drowsiness, irritability, or euphoria.

The SSHO will monitor environmental conditions and implement a mandatory work/warming regimen that is at least as protective as the one recommended in the following table for those conditions.

WORK/WARMING SCHEDULE FOR A 4-HOUR SHIFT					
Air Temp. (°F)	**Air Speed (mph)**				
	Calm	**5**	**10**	**15**	**20**
- 15 to -19	Normal Breaks (1)	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks
- 20 to - 24	Normal Breaks (1)	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30min. max. work period with 5 breaks
- 25 to - 29	75 min. max. work period with 2 breaks	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	
- 30 to - 34	55 min. max. work period with 3 breaks	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks		
- 35 to - 39	40 min. max. work period with 4 breaks	30 min. max. work period with 5 breaks	**Non-emergency work should cease.**		
- 40 to - 44	30 min. max. work period with 5 breaks				
- 45 and below					

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4.0 REFERENCE MATERIAL ON MEDICAL CONDITIONS

4.1 FROSTBITE

What Happens to the Body: (1) Freezing in the deep layers of skin and tissue; (2) Pale, waxy-white skin color; (3) Skin becomes hard and numb; (4) Fingers, hands, toes, feet, ears, and nose normally are affected fires.

4.1.1 What Should Be Done? (land temperatures)

- Move the person to a warm dry area. Don't leave the person alone.
- Remove any wet or tight clothing that may cut off blood flow to the affected area.
- DO NOT rub the affected area, because rubbing causes damage to the skin and tissue.
- Gently place the affected area in a warm (105°F) water bath and monitor the water temperature to slowly warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast causing tissue damage. Warming takes about 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. NOTE: If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

4.2 HYPOTHERMIA - (MEDICAL EMERGENCY)

4.2.1 What Happens to the Body?

Normal body temperature (98.6°F/37°C) drops to or below 95°F (350°C); fatigue or drowsiness; uncontrolled shivering; cool bluish skin; slurred speech; clumsy movements; irritable, irrational or confused behavior.

4.2.2 What Should Be Done: (land temperatures)

- Call for emergency help (i.e., Ambulance or Call 911).
- Move the person to a warm, dry area. Don't leave the person alone. Remove any wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if they are alert. Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
- Have the person move their arms and legs to create muscle heat. If they are unable to do this, place warm bottles or hot packs in the arm pits, groin, neck, and head areas.

DO NOT rub the person's body or place them in warm water bath. This may stop their heart.

4.2.3 What Should Be Done? (water temperatures)

- Call for emergency help (Ambulance or Call 911). Body heat is lost up to 25 times faster in water.
- DO NOT remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. DO NOT attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses the body's heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

4.2.4 How to Protect Workers?

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train the workforce about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene).
- Take frequent short breaks in warm dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs).
- Drink warm, sweet beverages (sugar water, sports-type drinks). Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
- Eat warm, high-calorie foods like hot pasta dishes.

4.2.5 Workers Are at Increased Risk When?

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medication (check with your doctor, nurse, or pharmacy and ask if any medicines you are taking affect you while working in cold environments).
- They are in poor physical condition, have a poor diet, or are older.

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ATTACHMENT 6

IMAGES OF DANGEROUS ANIMALS AND PLANTS AT THE PROJECT SITE

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Feral Dog

Cottonmouth

Prairie Rattlesnake

Broadbanded Copperhead

Timber Rattlesnake

Ticks of various species

Widow Spiders of various species

Recluse Spiders

Various Bees, Wasps, Ants (including Fire Ants), Mosquitoes, and Centipedes

Poison Ivy

APPENDIX E

QUALITY ASSURANCE PROJECT PLAN

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LIST OF ACRONYMS AND ABBREVIATIONS

ADR	automated data review
amu	atomic mass unit
BGR	Bombing and Gunnery Range
bgs	below ground surface
°C	degrees Celsius
CA	corrective action
CAS	Chemical Abstracts Service
CCB	continuing calibration blank
CCV	continuing calibration verification
CD	cultural debris
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CoC	chain of custody
COR	contracting officer's representative
CQC	Chemical Quality Control
CRREL	Cold Regions Research and Engineering Laboratory
CSM	conceptual site model
%D	percent difference
DDESB TP-18	Department of Defense Explosives Safety Board Technical Paper 18
DGM	digital geophysical mapping
DL	detection limit
DoD	Department of Defense
DOT	U.S. Department of Transportation
DQCR	daily quality control report
DQI	data quality indicator
DQO	data quality objective
EB	equipment blank
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EODT	EOD Technology, Inc.
EPA	U.S. Environmental Protection Agency
ESL	ecological screening level
ES/MS	electrospray ionization/mass spectrometry
FS	feasibility study
FTL	Field Team Leader
FUDS	Formerly Used Defense Site

g	gram
GEL	GEL Laboratories, LLC
GPS	global positioning system
H&S	health and safety
HAZWOPER	Hazardous Waste Operations and Emergency Response
HGL	HydroGeoLogic, Inc.
HHRA	human health risk assessment
HNO_3	nitric acid
HPLC	high performance liquid chromatography
IAW	in accordance with
ICB	initial calibration blank
ICP-MS	inductively coupled plasma-mass spectrometry
ICS	interference check solution
ICV	initial calibration verification
ID	identification
IDW	investigation derived waste
IS	internal standard
ISM	incremental sampling methodology
kg	kilogram
L	liter
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MG	machine gun
mg/kg	milligrams per kilogram
mL	milliliter
MMRP	Military Munitions Response Program
MRS	munitions response site
MS	matrix spike
MSD	matrix spike duplicate

NA	not applicable
NV	no value available
.pdf	portable document format
PE	polyethylene
PM	project manager
PPE	personal protective equipment
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QSM	Department of Defense Quality Systems Manual for Environmental Laboratories
%R	percent recovery
r	correlation coefficient
r^2	correlation
RI	remedial investigation
RPD	relative percent difference
RR	rifle range
%RSD	percent relative standard deviation
RSL	regional screening level
RT	retention time
SCDHEC	South Carolina Department of Health and Environmental Control
SDG	sample delivery group
SEDD	staged electronic data deliverable
SL	screening level
SLERA	screening level ecological risk assessment
SOP	standard operating procedure
SUXOS	Senior Unexploded Ordnance Supervisor
TA Denver	TestAmerica Denver
TBD	to be determined
TPP	technical project planning
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville
UXO	unexploded ordnance
UXOSO	Unexploded Ordnance Safety Officer

WERS	Worldwide Environmental Services Contract
WP	work plan

QUALITY ASSURANCE PROJECT PLAN

INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared by HydroGeoLogic, Inc. (HGL) to support the remedial investigation (RI) and feasibility study (FS) that will be performed at four munitions response sites (MRSs) at Former Conway Bombing and Gunnery Range (BGR), Horry County, South Carolina. This work is being conducted for the U.S. Army Engineering Support Center, Huntsville (USAESCH) under Contract No. W912DY-10-D-0023, Task Order No. 0018. The four MRSs to be addressed by this project are:

- MRS-R01, Range II (Formerly Used Defense Site [FUDS] Project No. I04SC002501R01)
- MRS-R02, Range III (FUDS Project No. I04SC002501R02)
- MRS-R03, Range IV (FUDS Project No. I04SC002501R03)
- MRS-R09, Machine Gun (MG)/Rifle Range (RR) (FUDS Project No. I04SC002501R09)

The QAPP provides information on five areas: (1) Project Management and Objectives, (2) Measurement and Data Acquisition, (3) Field Sampling Rationale, (4) Assessment and Oversight, and (5) Data Review. This document meets the requirements and elements set forth in the *Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM)*, Version 4.2 (DoD, 2010)[1], and the U.S. Environmental Protection Agency (EPA) guidance document entitled *Uniform Federal Policy (UFP) for Quality Assurance Project Plans* (EPA, 2005). This QAPP provides a process for obtaining data of sufficient quality and quantity to satisfy project needs. It describes the functional activities, data quality objectives (DQOs), and measures necessary to obtain adequate data for a given purpose. Data acquisition, reporting, and evaluation will be completed in accordance with (IAW) this QAPP. As any new procedures are required, addenda to this document will be issued.

All staff participating in project/field efforts are required to read this plan and become familiar with the analytical procedures and the implementation of these procedures to ensure that analytical/sample goals are met consistently. In addition, key personnel are responsible for mentoring assigned staff in aspects of this QAPP that would have a potential impact on the work assigned to them.

[1] The DoD QSM version 5.0 was released in July 2013; however, accreditation under version 4.2 is considered to be valid by the DoD until such time as current laboratory accreditation is due for renewal. At the time of writing this QAPP, the project laboratory is operating under the accreditation obtained using the requirements of QSM version 4.2. The project laboratories will comply with the requirements of the most recent version of the QSM for which they are accredited at the time of project execution.

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QAPP Worksheet #1
Title and Approval Page

Site Name/Project Name: Former Conway BGR RI/FS
Site Location: Horry County, South Carolina

Title: Conway BGR RI/FS QAPP
Revision Number: 2
Revision Date: 2/3/2015
Page 1 of 2

Appendix E: Final RI/FS QAPP, Former Conway BGR, South Carolina
Document Title

USAESCH
Lead Organization

Kenneth F. Rapuano, CHMM, HGL
Preparer's Name and Organizational Affiliation

11107 Sunset Hills Road, Suite 400, Reston, Virginia 21090; (703) 736-4546; kfr@hgl.com
Preparer's Address, Telephone Number, and Email Address

July 2015
Preparation Date

Investigative Organization's Senior Chemist: _____
Signature
Kenneth F. Rapuano, CHMM, HGL _____
Printed Name/Organization/Date

Investigative Organization's Project Manager (PM): _____
Signature
Kimberly Vaughn, HGL _____
Printed Name/Organization/Date

Investigative Organization's Project Quality Assurance (QA)/Quality Control (QC) Manager: _____
Signature
Jan Kool, Ph.D., P.G., HGL _____
Printed Name/Organization/Date

QAPP Worksheet #1
Title and Approval Page (continued)

Site Name/Project Name: Former Conway BGR RI/FS
Site Location: Horry County, South Carolina

Title: Conway BGR RI/FS QAPP
Revision Number: 1
Revision Date: 5/12/2014
Page 2 of 2

Approval Signatures:

Lead Organization's PM:

Signature

Chris Cochrane, USAESCH
Printed Name/Organization/Date

Regulatory Organization:

Signature

Printed Name/Title/Organization/Date

Approval Authority

Other Approval Signatures:

Signature

Printed Name/Title/Organization/Date

Approval Authority

QAPP Worksheet #2
QAPP Identifying Information

Site Name/Project Name: Former Conway BGR RI/FS
Title: Conway BGR RI/FS QAPP
Site Location: Horry County, South Carolina
Revision Number: 0
Operable Units: Four MRSs
Revision Date: 5/12/2014
Contractor Name: HGL
Contract Number: W912DY-10-D-0023
Contract Title: Huntsville Center - Worldwide Environmental Services Contract (WERS)
Task Order Number: 0018

1. Identify guidance used to prepare the QAPP: UFP-QAPP; DoD QSM Version 4.2

2. Identify regulatory program: Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Superfund Amendments and Reauthorization Act of 1986

3. Identify approval entities: U.S. Army Corps of Engineers (USACE)

4. The QAPP is: generic or project-specific (circle one)

5. List dates of scoping sessions that were held: November 21, 2013 (Technical Project Planning [TPP] Session)

6. List dates and titles of QAPP documents written for previous site work, if applicable:

Title	Approval Date
None	Not Applicable (NA)

7. List organizational partners (stakeholders): USACE and SCDHEC

8. List data users: HGL; USACE; and SCDHEC

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below.

All QAPP worksheets are applicable.

QAPP Worksheet #2
QAPP Identifying Information (continued)

Required QAPP Element	QAPP Worksheet	Required Information
Project Management and Objectives		
2.1 Title and Approval Page	1	- Title and Approval Page
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	 2	 - Table of Contents - QAPP Identifying Information
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	 3 4	 - Distribution List - Project Personnel Sign-Off Sheet
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	 5 6 7 8	 - Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	 9 10	- Project Planning Session Documentation (including Data Needs Tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	11 12	- Site-Specific Project Quality Objectives - Measurement Performance Criteria Table
2.7 Secondary Data Evaluation	13	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	14 15 16	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table

QAPP Worksheet #2
QAPP Identifying Information (continued)

Required QAPP Element	QAPP Worksheet	Required Information
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	17 18 19 20 21 22	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/Standard Operating Procedure (SOP) Requirements Table - Analytical Methods/SOP Requirements Table - Field QC Sample Summary Table - Sampling SOPs - Project Sampling SOP Reference Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	23 24 25	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	 26 27	- Sample Handling System - Sample Collection, Documentation Handling, Tracking, and Custody SOPs - Sample Custody Requirements Table - Sample Container Identification - Sample Handling Flow Diagram - Example Chain of Custody (CoC) Form and Seal
3.4 QC Samples 3.4.1 Sampling QC Samples 3.4.2 Analytical QC Samples	28	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	29 30	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs

QAPP Worksheet #2
QAPP Identifying Information (continued)

Required QAPP Element	QAPP Worksheet	Required Information
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action (CA) Responses	31 32	- Planned Project Assessments Table - Assessments and Response Actions - Audit Checklists - Assessment Findings and CA Responses Table
4.2 QA Management Reports	33	- QA Management Reports Table
4.3 Final Project Report		- All information obtained during RI fieldwork
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	34 35 36 37	- Sampling and Analysis Verification (Step I) Process Table - Sampling and Analysis Validation (Steps IIa and IIb) Process Table - Sampling and Analysis Validation (Steps IIa and IIb) Summary Table - Data Usability Assessment

QAPP Worksheet #3
Distribution List

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Chris Cochrane	Contracting Officer's Representative (COR)	USAESCH	(256) 895-1696	chris.cochrane@usace.army.mil
Ray Livermore	District PM	USACE Wilmington	(910) 251-4702	Raymond.R.Livermore@usace.army.mil
Julie Hiscox	USACE SAD FUDS Program Manager	USACE Savannah	(912) 652-5363	julie.a.hiscox@usace.army.mil
Kelly Longberg	USACE Technical Manager	USAESCH	(256) 895-1408	kelly.d.longberg@usace.army.mil
Debra Edwards	Geophysicist	USAESCH	(256) 895-1626	debra.l.edwards@usace.army.mil
Cecil "Bud" Morgan	Environmental Manager	USAESCH	(256) 895-1491	cecil.w.morgan@usace.army.mil
Susan Byrd	PM	SCDHEC	(803) 898-0308	byrdsk@dhec.sc.gov
Kimberly Vaughn	PM	HGL	(512) 828-8864	kvaughn@hgl.com
Jan Kool	Program QA Manager	HGL	(703) 736-4545	jkool@hgl.com
Ken Rapuano	Project Chemist	HGL	(703) 736-4546	krapuano@hgl.com
Jeff Martin	Database Manager	HGL	(703) 736-4533	jmartin@hgl.com
Joel Sanders	Senior Unexploded Ordnance (UXO) Supervisor (SUXOS)	HGL	(435) 919-9770	jsanders@hgl.com
Oscar Honne	UXO Safety Officer (UXOSO)	HGL	(915) 503-4083	ohonne@hgl.com
Elaine Walker	Project Manager	TA Denver	(303) 736-0156	Elaine.Walker@testamericainc.com
Margaret Sleevi	QA Manager	TA Denver	(303) 736-0100	PeggyS.Sleevi@testamericainc.com
William Cicero	Laboratory Director	TA Denver	(303) 736-0100	William.Cicero@testamericainc.com
Joanne Harley	Project Manager	GEL[1]	(843) 769-7387	joanne.harley@gel.com
Pei Geng	Data Validation PM	LDC	(760) 827-1100 x141	pgeng@lab-data.com

GEL = GEL Laboratories, LLC
LDC = Laboratory Data Consultants
TA Denver = TestAmerica Denver
TBD = to be determined

[1] GEL will be providing QA analyses to support the usability assessment of the data produced by TA Denver.

QAPP Worksheet #4
Project Personnel Sign-Off Sheet

Project Personnel	Organization	Title	Signature	Date QAPP Read
Kimberly Vaughn	HGL	PM		
Jan B. Kool, Ph.D.	HGL	Program QA Manager		
Oscar Honne	HGL	UXOSO		
Ken Rapuano	HGL	Project Chemist		
Jeff Martin	HGL	Database Manager		
Joel Sanders	HGL	SUXOS		
TBD	HGL	Field Personnel		
TBD	HGL	Field Personnel		
Elaine Walker	TA Denver	Laboratory PM		
Joanne Harley	GEL	Laboratory PM		
Pei Geng	LDC	Data Validation PM		

QAPP Worksheet #5
Project Organizational Chart

See Figure B.12 of the Work Plan (WP).

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Point of Contact with HGL	HGL PM	Kimberly Vaughn	(512) 828-8864	Reporting of project information to the USACE PM through WPs, monthly progress reports, email updates, teleconference calls, and meetings.
Field deviations from QAPP Daily Field Progress Reports, Field CAs	Project Manager UXOSO	Kimberly Vaughn Oscar Honne	(512) 828-8864 (915) 503-4083	Notify HGL PM and Project Chemist of deviations from the QAPP in the field and rationale for changes. Document changes in field daily progress reports, field work variances, and memoranda to HGL PMs. Review SUXOS daily field progress reports and evaluate need for field CAs (in collaboration with PM); document CA in the daily field progress reports and memoranda to HGL PMs.
Day-to-Day Field Activities, Safety and QA Audits, Milestones	SUXOS	Joel Sanders	(435) 919-9770	Complete daily field progress reports and forward to HGL Field Team Leader (FTL). Report completion of milestones.
Reporting Laboratory Data Quality Issues	Laboratory PM	Elaine Walker	(303) 736-0156	All analytical QA/QC issues with project samples will be reported by the laboratory to the Project Chemist and HGL QA Officer.

QAPP Worksheet #6
Communication Pathways (continued)

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Laboratory Analytical CAs	Project Chemist/ Laboratory PM	Ken Rapuano/ Elaine Walker	(703) 736-4546/ (303) 736-0156	Need for laboratory CAs will be determined by the Project Chemist and/or laboratory PM or QA Manager and will be documented in memoranda to HGL PM.
Release of Analytical Data, QAPP Amendments	Project Chemist	Ken Rapuano	(703) 736-4546	Review of LDC data validation reports to ensure technical and contractual compliance. Amendments to the QAPP will be implemented as required by technical issues. Changes to the QAPP will be approved by the HGL and USACE PMs.
Data Tracking and Management	Data Coordinator	TBD	TBD	Track data from sample collection through log-in at laboratory to delivery by technical report/sample delivery group (SDG) and electronic data delivery into database. Assign data reports to validators and track the validation process. Alerts project chemist when data validation reports are available for review.

QAPP Worksheet #7
Personnel Responsibilities Table

Name	Title	Organizational Affiliation	Responsibilities
Kimberly Vaughn	PM	HGL	Provides overall management of the task order including cost, schedule, and technical quality. Manages project staffing, day-to-day project operations and activities, deliverable completion, field investigations, QC, and health and safety (H&S). Acts as the single point of contact for the contract. Maintains communication and coordination with USACE for the duration of the project, including progress and detailed cost reporting. Oversees the management and coordination between contractor staff, subcontractors, and USACE.
Neil Feist	UXO Operations Manager / HGL Technical Manager	HGL	Responsible for assisting PM and providing senior technical support on Military Munitions Response Program (MMRP)/CERCLA process documents, sampling program design and implementation, and project team coordination.
Oscar Honne	UXOSO	HGL	Initiates field CA if deemed necessary.
Jan Kool, Ph.D, P.G.	Program QA Manager	HGL	Responsible for program quality management, including training and programmatic quality processes and controls. Provides senior technical support on CERCLA process documents and sampling program design and implementation.
Ken Rapuano, CHMM	Project Chemist	HGL	Manages analytical and data validation subcontractors. Negotiates project specifications and coordinates the sample collection activity with laboratory capacity. Tracks all samples from collection through analysis, data validation, and report generation. Serves as the primary chemist for all analytical issues. Initiates CAs as deemed appropriate. Supervises the electronic loading for all analytical data to ensure compliance with contract requirements.
William Cicero	Laboratory Director	TA Denver	Supervises all laboratory personnel and provides guidance and direction as needed. Responsible for ensuring compliance and integration of facility operation with corporate and regulatory policies and procedures.

QAPP Worksheet #7
Personnel Responsibilities Table (continued)

Name	Title	Organizational Affiliation	Responsibilities
Margaret Sleevi	Laboratory QA Manager	TA Denver	Overall responsibility for the development, implementation, and maintenance of the laboratory's quality system and QC activities. Performs internal system and technical audits. Creates CA plans and recommends projects for process improvement. Troubleshoots and resolves problems and provides technical and administrative guidance to laboratory staff. Obtains and maintains laboratory license and permits and oversees laboratory accreditation and certification programs. Serves as the liaison between the laboratory and regulatory offices.
Elaine Walker	Laboratory PM	TA Denver	Serves as the laboratory's primary contact for the project. Utilizes a variety of project management tools for forecasting and production status tracking. Ensures laboratory compliance with project needs in both QC and project deliverables.
Stephen Davis	Corporate H&S Officer	HGL	Provides overall supervision of the HGL H&S program.

QAPP Worksheet #8
Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates
Field Sampling Team, Field Technicians, Geologists, Environmental Scientists, Engineers	40-Hour Occupational Safety and Health Administration Hazardous Waste Operations and Emergency Response (HAZWOPER) Training; 8-Hour HAZWOPER Refresher Training; First Aid/ Cardiopulmonary Resuscitation	Varies(1)	Varies(1)	All personnel performing on-site work	HGL	Certificates available upon request and maintained at project office.
FTLs	Same as above, plus 8-hour HAZWOPER Site Supervisor Training	Varies(1)	Varies(1)	FTLs	HGL	Certificates available upon request and maintained at project office.
UXO team	Same as above for field sampling team, plus UXO training IAW DoD Explosives Safety Board Technical Paper 18 (DDESB TP-18)	Varies(1)	Varies(1)	All UXO Technicians	HGL	Certificates available upon request and maintained at project office.
SUXOS, UXOSO	Same as above for Field Sampling Team and FTLs, plus UXO training IAW DDESB TP-18	Varies(1)	Varies(1)	SUXOS, UXO SO/QC	HGL	Certificates available upon request and maintained at project office.

(1) Training provider and date of training will vary from person to person due to individual scheduling of training.

QAPP Worksheet #9
Project Scoping Session Participants Sheet

Project Name Conway BGR RI/FS, Four MRSs **Projected Date(s) of Sampling** Summer/Fall 2014 **Project Manager** Chris Cochrane, USACE PM and COR	**Site Name:** Former Conway BGR **Site Location** Horry County, SC

Date of Session: November 21, 2013

Scoping Session Purpose: Develop approach for project planning and execution

Name	Affiliation	Phone #	Email Address
See Appendix H			

QAPP Worksheet #10
Problem Definition

The problem to be addressed by the project: The subject sites of this investigation are four MRSs at Former Conway BGR. These sites are potentially affected by contamination from MEC and munitions constituents (MC). All four MRSs have been partially investigated; however, existing information on the nature and extent of potential MEC and MC contamination is insufficient to evaluate and recommend remedial alternatives.
The environmental questions being asked: The following question is applicable to each of the subject MRSs: What is the nature and extent of MEC and MC contamination in site soils, groundwater, and sediment?
Observations from any site reconnaissance reports: See Worksheet #13.
A synopsis of secondary data or information from site reports: HGL performed an in depth review of available site-related documents and summarized site information from the four MRSs in a preliminary conceptual site model (CSM). The CSM describes the area size, suspected past DoD activities, potential MEC/munitions debris (MD), previous investigation/removal activities (if any), and current and future land use. The CSM was used to identify data needs and direct HGL's field investigation approach.
The possible classes of contaminants and the affected matrices: The contaminants of concern at each of the subject MRSs are explosives and selected metals. The potentially affected matrices are the surface and near subsurface soil, groundwater, and sediment. The matrix-specific methods and analyte lists are presented in Table 3.4 of the WP. The methods and analyte lists for this project are presented in Worksheets #15.1 through #15.4, along with the project action levels (PALs). The PALs presented in the soil Worksheet #15 tables are the EPA Regional Screening Levels (RSLs), which have been selected as the screening criteria for evaluating whether site contamination poses a potential risk to human health, and the ecological screening levels (ESLs) that will be used to determine if site contamination poses a threat to wildlife receptors. The PALs presented in the aqueous Worksheet #15 tables are the EPA maximum contaminant level (MCL) and the South Carolina criteria for water protection. Where South Carolina does not specify criteria for a chemical, the tap water RSL is presented.
The rationale for inclusion of chemical and non-chemical analyses: The site activities that may have caused contamination at each of the MRSs are well documented. The analyses selected are based on previous site investigations and knowledge about the potential contaminants associated with the activities that occurred at each MRS as described in Section 1.7 and in Tables 1.1 of the WP.
Information concerning various environmental indicators: Each MRS will be subject to transect investigation that will incorporate digital geophysical mapping (DGM) investigation. Surface and subsurface anomalies identified in the transect and grid investigations will be used to direct judgmentally located sampling locations (see Sections 3.8 and Table 3.1 of the WP).
Project decision conditions ("If..., then..." statements): Generally, if an analyte is detected above the applicable PAL, then this analyte will be retained as a contaminant of potential concern for further evaluation. In some decision populations, if analytes are detected above a human health-based PAL, then this will be the driver for additional site investigation. If analytes are detected above the ESLs, a decision will be made whether additional site investigation is warranted. If no target analytes are detected above any PALs at a site, then the need for any additional sampling or other action at that site will be evaluated. Each contaminant detected above the associated ecology-based PAL will be retained as a contaminant of potential ecological concern.

QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

Who will use the data? The primary data user will be USACE; secondary users will include SCDHEC and HGL.
What will the data be used for? The data will be used by HGL to prepare the site RI reports, the human health risk assessment (HHRA), and screening level ecological risk assessment (SLERA). USACE will use the data and the conclusions of the RI report to answer the environmental questions and support the project decision conditions (see Worksheet #10).
What types of data are needed? (target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques) Site-specific field screening and sampling requirements are described in Section 3.3 and Tables 3.1 of the WP. Site-specific analytical requirements are discussed in Section 3.13 and Table 3.3 of the WP. Target analyte lists are presented in QAPP Worksheets #15.1 through 15.4.
How "good" do the data need to be in order to support the environmental decision? The data must be of sufficient quality to support evaluation of results to support decisions about site risk and remedial options (including closure). Laboratory analytical data will be required to be definitive.
How much data are needed? (number of samples for each analytical group, matrix, and concentration) See WP Section 3.13.
Where, when, and how should the data be collected/generated? Following DGM data collection and analysis and intrusive investigation activities, sampling locations will be selected using the decision logic presented in Worksheet #18.
Who will collect and generate the data? HGL field teams under the supervision of the Site Supervisor identified in Worksheet #3. Analytical data will be generated by laboratories that are certified under the DoD Environmental Laboratory Accreditation Program (ELAP) for the analyses to be performed. These laboratories are also accredited by SCDHEC for all analyses to be performed where those analyses are included in SCDHEC's fields of accreditation.
How will the data be reported? Laboratory data will be reported in analytical packages (produced in portable document format [.pdf] format) that will at a minimum contain all necessary information to allow for review of the data quality elements listed in Attachment A. Electronic database deliverables (EDDs) will meet the requirements of a Staged Electronic Data Deliverable (SEDD), with a minimum requirement of a Stage 2a deliverable. Field data will be recorded in bound logbooks.
How will the data be archived? Complete project file records will be maintained in HGL's Reston, Virginia, office and will be updated by a project administrator under the PM's direction. Project records will be maintained during the period of performance for this project, plus 10 years.

QAPP Worksheet #12.1
Measurement Performance Criteria Table – Explosives by SW-846 Method 8330B

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure[1]	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Explosives			
Concentration Level	Low			
Analytical Method/SOP[2]	L-1			
Data Quality Indicator (DQI)	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Accuracy/Bias	Analyte-specific (see Worksheets #15.1 through 15.4)	Laboratory control sample (LCS) recoveries	1 per preparation batch (maximum of 20 samples)	A
		Matrix spike (MS)/Matrix spike duplicate (MSD) recoveries	1 per 20 field samples (selected by field team)	S&A
	Method-specific (see Worksheets #15.1 through 15.4)	Surrogate spikes	Every sample, blank, and standard	A
Precision	Relative percent difference (RPD) ≤20%	MS/MSD RPD	1 per 20 field samples (selected by field team)	S&A
		LCS/LCS duplicate (LCSD)[3] RPD	1 per preparation batch (maximum of 20 samples)	A
	RPD ≤50% (soil) RPD ≤30% (water)	Field duplicate analyses (grab samples)	1 per 10 field samples (selected by field team)	S&A
	Percent relative standard deviation (%RSD) ≤20%	Field replicate analyses (incremental sampling methodology [ISM] samples)	1 per 10 field samples (selected by field team)	S&A
	%RSD ≤20%	Laboratory replicate analyses (ISM samples)	1 per preparation batch (maximum of 20 samples)	A
Accuracy/Precision	%RSD ≤20% or correlation (r^2) ≥0.990 for each analyte	Five-point calibration for all analytes (minimum of six points required if using r^2 to evaluate)	Prior to sample analysis and recalibration as required	A
Accuracy/Precision	Percent difference (%D) ≤20% for each analyte	Second source calibration verification	1 per initial calibration	A
Accuracy/Precision	%D ≤20% for each analyte	Continuing calibration verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence	A

QAPP Worksheet #12.1
Measurement Performance Criteria Table – Explosives by SW-846 Method 8330B (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure[1]	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Explosives			
Concentration Level	Low			
Analytical Method/SOP[2]	L-1			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Accuracy/Bias and Representativeness	No analytes detected ≥ ½ limit of quantitation (LOQ) and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)	Method blank (MB)	1 per preparation batch (maximum of 20 samples)	A
		Grinding blank (ISM samples only)	Between each sample	A
Accuracy/Bias and Representativeness	No target compound concentrations ≥ ½LOQ	Equipment blank (EB)	1 per 20 field samples	S&A
Sensitivity	Detection limit (DL) for each analyte < limit of detection (LOD)	DL study	Preliminary determination, confirmed quarterly	A
	LOD for each analyte below associated regulatory limits, preferably by a factor of ≥ 3	LOD study	Preliminary determination, confirmed quarterly	A
	LOD ≤ LOQ for each analyte	LOQ study	Preliminary determination, confirmed quarterly	A
	LOQ for each analyte	At or above low concentration of calibration curve	Each initial calibration	A

QAPP Worksheet #12.1
Measurement Performance Criteria Table – Explosives by SW-846 Method 8330B (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure[1]	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Explosives			
Concentration Level	Low			
Analytical Method/SOP[2]	L-1			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Analyte Identification	Position shall be set using the midpoint standard of the calibration curve; on days when initial calibration is not performed, the initial CCV is used	Retention time window position establishment for each analyte and surrogate	Once per initial calibration and at the beginning of the analytical shift	A
	Results between primary and second column RPD $\leq 40\%$	Confirmation column	All positive results must be confirmed	A
Completeness	$\geq 95\%$	Data completeness check	After sampling and analysis complete	S&A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
[3] LCSD analysis is not a method requirement; however, if this information is provided, it will be evaluated.
[4] For low-level results (detected value $\leq$5x LOQ) or when one result is a non-detection, the control limit is absolute difference $\leq$LOQ (water) or $\leq$2x LOQ (soil). Non-detected values will be assigned the nominal value of the LOD for making this comparison.

QAPP Worksheet #12.2
Measurement Performance Criteria Table – Metals by SW-846 Method 6020A

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure1	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP2	L-2			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Accuracy/Bias	Analyte-specific (see Worksheets #15.5 through #15.8)	LCS recoveries	1 per preparation batch (maximum of 20 samples)	A
		MS/MSD recoveries	1 per 20 field samples (selected by field team)	S&A
	%D ≤10% for each analyte present ≥100× DL	Serial dilution (5x) analysis	1 per preparation batch (maximum of 20 samples)	A
	Percent recovery (%R) of 75-125% for each analyte	Post-digestion spike analysis	1 per preparation batch (maximum of 20 samples); required if target analyte not present ≥50x DL in parent sample selected for serial dilution or if serial dilution fails for an analyte meeting the DL criterion	A
Precision	RPD ≤20%	MS/MSD RPD[3]	1 per 20 field samples (selected by field team)	S&A
		LCS/LCSD[4] RPD	1 per preparation batch (maximum of 20 samples)	A
	RPD ≤30% (soil) RPD ≤20% (water)	Field duplicate analyses[5]	1 per 10 field samples (selected by field team)	S&A
	%RSD ≤20%	Field replicate analyses (ISM samples)	1 per 10 field samples (selected by field team)	S&A
	%RSD ≤20%	Laboratory replicate analyses (ISM samples)[6]	1 per preparation batch (maximum of 20 samples)	A
Accuracy/Precision	NA for two-point calibration. If multi-point calibration performed, correlation coefficient (r) ≥0.995	Calibration for all analytes (minimum of one point and a blank)	Daily, prior to sample analysis	A

QAPP Worksheet #12.2
Measurement Performance Criteria Table – Metals by SW-846 Method 6020A (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure1	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP2	L-2			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Accuracy/Precision	%D ≤10% for each analyte	Initial (second source) calibration verification (ICV)	Daily, prior to sample analysis	A
		CCV	After every 10 field samples, and at the end of the analysis sequence	A
Accuracy/Bias and Representativeness	No analytes detected ≥ ½ LOQ and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)	MB	1 per preparation batch (maximum of 20 samples)	A
		Initial calibration blank (ICB)	Immediately after ICV	A
		Continuing calibration blank (CCB)	Immediately after CCV	A
Accuracy/Bias and Representativeness	No target compound concentrations ≥ ½ LOQ	EB	1 per 20 field samples	S&A
Sensitivity	DL for each analyte < LOD	DL study	Preliminary determination, confirmed quarterly	A
	LOD for each analyte below associated regulatory limits, preferably by a factor of ≥3	LOD study	Preliminary determination, confirmed quarterly	A
	LOD ≤ LOQ for each analyte	LOQ study	Preliminary determination, confirmed quarterly	A
	%R of 80-120% for each analyte	Low-level calibration check at LOQ	Prior to sample analysis	A

QAPP Worksheet #12.2
Measurement Performance Criteria Table – Metals by SW-846 Method 6020A (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure1	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP2	L-2			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Sensitivity (cont.)	LOQ for each analyte	At or below low concentration of calibration curve (if multi-point calibration performed)	Each initial calibration	A
	Intensity within 30-120%	Intensity of the internal standards (ISs) in the sample relative to the corresponding IS intensities in the initial calibration	Every sample, blank, and standard	A
Accuracy/Bias and Representativeness	Absolute value of concentration for all non-spiked analytes <LOD (unless they are a verified trace impurity from one of the spiked analytes)	Interference check solution (ICS) A	Prior to sample analysis	A
	Spiked analyte %R of 80-120%	ICS A and ICS AB	Prior to sample analysis	A

QAPP Worksheet #12.2
Measurement Performance Criteria Table – Metals by SW-846 Method 6020A (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure1	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP2	L-2			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Analyte Identification	Mass calibration ≤0.1 atomic mass units (amu) from the true value; resolution <0.9 amu full width at 10% peak height. %RSD ≤5% for at least four replicate analyses	Mass spectrometer tuning	Prior to sample analysis	A
Completeness	≥95%	Data completeness check	After sampling and analysis complete	S&A

[1] Reference number from QAPP Worksheet #21.
[2] Reference number from QAPP Worksheet #23.
[3] Performing a laboratory duplicate (using the acceptance criteria listed for field duplicates) will be an acceptable alternative to performing an MSD to evaluate laboratory precision for grab sample analyses. MSD analysis is not required for ISM samples.
[4] LCSD analysis is not a method requirement; however, if this information is provided, it will be evaluated.
[5] For low-level results (detected value ≤5× LOQ) or when one result is a non-detection, the control limit is absolute difference ≤LOQ (water) or ≤2× LOQ (soil). Non-detected values will be assigned the nominal value of the LOD for making this comparison.
[6] This is a required QC element and replaces MSD analysis for ISM preparation batches.

QAPP Worksheet #12.3
Measurement Performance Criteria Table – Mercury by SW-846 Methods 7470A and 7471B

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure[1]	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP[2]	L-3 and L-4			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Screening Level Data Quality Elements				
Accuracy/Bias	Analyte-specific (see Worksheets #15.5 through #15.8)	LCS recoveries	1 per preparation batch (maximum of 20 samples)	A
		MS/MSD recoveries	1 per 20 field samples (selected by field team)	S&A
Precision	RPD ≤20%	MS/MSD RPD[3]	1 per 20 field samples (selected by field team)	S&A
		LCS/LCSD[4] RPD	1 per preparation batch (maximum of 20 samples)	A
	RPD ≤30% (water) RPD ≤50% (soil)	Field duplicate analyses (grab samples)[5]	1 per 10 field samples (selected by field team)	S&A
	%RSD ≤20%	Field triplicate analyses (ISM samples)[6]	1 per 10 field samples (selected by field team)	S&A
	%RSD ≤20%	Laboratory triplicate analyses (ISM samples)[6]	1 per preparation batch (maximum of 20 samples)	A
Accuracy/Bias and Representativeness	No analytes detected ≥ ½ LOQ and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); no analytes with negative drift with absolute value ≥ ½ LOQ	MB	1 per preparation batch (maximum of 20 samples)	A
Accuracy/Bias and Representativeness	No target compound concentrations ≥ ½ LOQ	EB	1 per 20 field samples	S&A

Worksheet #12.3
Measurement Performance Criteria Table – Mercury by SW-846 Methods 7470A and 7471B (continued)

Matrix	Water, Soil, Sediment, and QC Blanks			
Sampling Procedure[1]	Water: S-5; Soil: S-2, S-3, and S-4; QC Blanks: S-1			
Analytical Group	Metals			
Concentration Level	Low			
Analytical Method/SOP[2]	L-3 and L-4			
DQI	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Frequency of QC Check**	**QC Sample Assesses Errors for Sampling (S), Analytical (A), or Both (S&A)**
Sensitivity	DL for each analyte < LOD	DL study	Preliminary determination, confirmed quarterly	A
	LOD for each analyte below associated regulatory limits, preferably by a factor of ≥3	LOD study	Preliminary determination, confirmed quarterly	A
	LOD ≤ LOQ for each analyte	LOQ study	Preliminary determination, confirmed quarterly	A
Completeness	≥95%	Data completeness check	After sampling and analysis complete	S&A
Definitive Level Data Quality Elements				
Accuracy/Precision	r ≥0.995 for curve	Calibration for all analytes (minimum of five standards and a blank)	Daily, prior to sample analysis	A
Accuracy/Precision	%D ≤10% (or %R of 90-110%) for each analyte	ICV	Daily, prior to sample analysis	A
	%D ≤20% (or %R of 80-120%) for each analyte	CCV	After every 10 field samples, and at the end of the analysis sequence	A
Accuracy/Bias and Representativeness	No analytes detected >1/2 LOQ; no analytes with negative drift with absolute value >LOD	ICB	Immediately after ICV	A
		CCB	Immediately after CCV	A
Sensitivity	LOQ for each analyte	At or below low concentration of calibration curve	Each initial calibration	A

[1] Reference number from QAPP Worksheet #23.
[2] Reference number from QAPP Worksheet #21.
[3] Performing a laboratory duplicate (using the acceptance criteria listed for field duplicates) will be an acceptable alternative to performing an MSD to evaluate laboratory precision.
[4] LCSDs are not a method requirement; however, if this information is provided, it will be evaluated.
[5] For low-level results (detected value ≤5x LOQ) or when one result is a nondetection, the control limit is absolute difference ≤LOQ (water) or ≤2x LOQ (soil). Nondetected values will be assigned the nominal value of the LOD for making this comparison.
[6] Nondetected values will be assigned the nominal value of the LOD for making this comparison.

QAPP Worksheet #13.1
Secondary Data Criteria and Limitations Table, Former Conway BGR

Secondary Data	Data Source	Data	How Data Will Be Used	Limitations on Data Use
MC Sampling	Parsons, MC Sampling (2006)	Soil and surface water sampling were conducted in MRS-R02. No explosives were detected. The metals detected (lead, zinc, cadmium, and mercury) were related to MC potentially present.	Development of RI approach; guide MC sampling approach; revision of CSM, if needed.	Based on results, the nature and extent of MC is not considered to have been adequately characterized for the entire site.
RI Former Conway BGR	EOD Technology, Inc. (EODT), Remedial Investigation Former Conway Bombing and Gunnery Range (2012)	Concluded that no MC contamination was present in MRS-R01, MRS-R02, and MRS-R03. Did not assess MC contamination in MRS R09. The RI recommends further investigation.	Development of RI approach; guide MC sampling approach; revision of CSM, if needed	Based on RI results, the nature and extent of MC is not considered to have been adequately characterized. Further investigation was recommended.

A detailed discussion of previous investigations is provided in Section 1.7 of the WP.

QAPP Worksheet #14
Summary of Project Tasks

Sampling Tasks: WP Sections 3.13 and Tables 3.2 and 3.3.
Analysis Tasks: WP Section 3.13 and Tables 3.2 and 3.3.
QC Tasks: All matrices will have the following field QC samples collected and analyzed: duplicates (discrete samples), replicates (ISM samples), MS/MSDs, and EBs. All analytical methods will be controlled by initial and continuing calibration standards, tuning, surrogate spike results, LCSs, laboratory duplicates (discrete samples), laboratory replicates (ISM samples), and all other QC procedures defined in the project analytical methods and required to produce definitive data.
Secondary Data: See Worksheet #13.
Data Management Tasks: Analytical data will be delivered by the laboratory in a database that meets the requirements of SEDD. The database manager will generate project data tables to allow for any qualifiers required by the validation process to be applied directly to the database.
Documentation and Records: All field observations and sampling records will be entered into bound logbooks. CoC forms, air bills, field instrument calibration logs, and investigation-derived waste records will be prepared and retained.
Analytical Data Reports: Analytical data packages will be required to contain all data required to perform data review in accordance with the data validation protocols detailed in Attachment A. Sufficient documentation must be provided to allow for calibration, QC, blank, and other relevant information to be related to all associated sample analyses.
Assessment/Audit Tasks: Laboratory compliance with QSM and certification status reviewed prior to award of contract; laboratory precision, accuracy, and sensitivity performance compared to project requirements.
Data Review Tasks: The project laboratory will verify that all data are complete and correct for all samples received. Data will be validated by LDC IAW the data review protocols detailed in Attachment A. Data validation will review those items that are defined as Stage 2B data validation elements by the EPA in its *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). All data validation and review reports will be approved by the HGL project chemist before use. Data qualifiers will be applied to the database and will receive a 100 percent QC check on data entry. Following validation, data usability will be assessed using the procedures summarized in Worksheet #37 and presented in detail in Attachment B. CA will be initiated as required. Any data gaps and the impact on the overall data set will be evaluated on a site-specific basis.

QAPP Worksheet #15
Reference Limits and Evaluation Tables

The project-specific analytical method reference limits and evaluation tables are presented in Worksheets #15.1 through #15.8. These worksheets include the project analyte lists, the sensitivity limits achievable by the project laboratories, the associated screening levels, the control limits for accuracy (LCS/LCSD, MS/MSD, and surrogate recoveries), and the upper and lower limits that constitute a marginal exceedance of the control limit range. The analyses and target analytes specific to each matrix are listed in Table 3.5 of the WP. The laboratory SOPs for the preparation and analytical methods associated with the limits presented in Worksheets #15.1 through #15.8 are listed in Worksheet #23 and are presented in Attachment C. Note that the QSM requires laboratories to perform periodic DL, LOD, and LOQ checks and that laboratory sensitivity limits are subject to change in response to the results of these checks. The project laboratories will report project data using the most up-to-date sensitivity limits at the time analysis is performed. The accuracy control limits presented in Worksheets #15.1 through #15.8 are those presented in QSM version 4.2, where available. During project execution, laboratory accuracy limits will be required to meet the limits presented in the most recent version of the QSM under which the laboratory is accredited, including those analytes for which QSM version 4.2 does not present limits if those limits have been added in later versions.

The human health screening levels presented for soils are the RSLs for residential soil published in the RSL tables jointly developed by EPA Regions 3, 6, and 9, and updated in May 2014. The RSLs for non-carcinogens are concentrations that correspond to an analyte-specific hazard index of 1; the RSLs for carcinogens are concentrations that correspond to an analyte-specific cancer risk of 1×10^{-6}. The human health screening levels for groundwater are the South Carolina Water Quality Numeric Criteria for the Protection of Aquatic Life and Human Health for water and organism consumption as listed in the Appendix to South Carolina regulation R61-68: Water Classification and Standards. For those analytes that do not have a South Carolina criterion, the RSL for tap water is presented. The maximum contaminant levels (MCLs) established by South Carolina regulation R61-58 are also included in the groundwater tables.

The soil ESLs are soil and sediment screening levels presented in the EPA Region 4 Ecological Risk Assessment Bulletin; for those analytes that are not listed in the Region 4 guidance, the lower corresponding value listed in the EPA Region 5 ESLs and EPA Region 6 ESLs is presented. Ecological exposures to groundwater are expected to be limited and no ESLs are presented.

The EPA RSLs are revised semiannually, and regional and state human health and ecological screening values are subject to change. Prior to project data reporting and evaluation, HGL will review all relevant standards and ensure that the most recent screening values are used as the PALs.

QAPP Worksheet #15.1
Reference Limits and Evaluation Table – Explosives in Soil by Method 8330B

Analyte	CAS Number	TA Denver Sensitivity Limits (µg/kg)			Residential RSL (µg/kg)	Soil ESL (µg/kg)	Sediment ESL (µg/kg)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ					Upper Limit	Lower Limit
1,3,5-Trinitrobenzene	99-35-4	13.8	40	100	2,200,000	376	1,300,000	75 - 125	65	135
1,3-Dinitrobenzene	99-65-0	16.6	40	100	6200	655	8.61	80 - 125	70	135
2,4,6-Trinitrotoluene	118-96-7	30.7	40	100	21,000	6400	420,000	55 - 140	45	155
2,4-Dinitrotoluene	121-14-2	14.7	40	100	780	1280	14.4	80 - 125	75	130
2,6-Dinitrotoluene	606-20-2	19.1	40	100	780	32.8	39.8	80 - 120	70	130
2-Amino-4,6-dinitrotoluene	35572-78-2	32.9	40	100	150,000	10,000	34,000	80 - 125	75	130
2-Nitrotoluene	88-72-2	47.2	80	200	3200	9900	28,000	80 - 125	70	130
3-Nitrotoluene	99-08-1	64.0	80	200	6200	12,000	24,000	75 - 120	70	130
4-Amino-2,6-dinitrotoluene	19406-51-0	29.9	40	100	150,000	3600	9500	80 - 125	75	130
4-Nitrotoluene	99-99-0	36.5	100	200	33,000	22,000	52,000	75 - 125	70	135
HMX	2691-41-0	22.7	40	100	3,800,000	27,000	27,000,000	75 - 125	65	135
Nitrobenzene	98-95-3	85.0	100	300	5100	40,000	14.5	75 - 125	70	130
Nitroglycerin	55-63-0	215	400	2,000	6200	71,000	1,700,000	61 - 160	51	170
PETN	78-11-5	493	1,000	2,000	120,000	100,000	1,400,000	55 - 129	45	139
RDX	121-82-4	43.0	80	200	6000	7500	45,000	70 - 135	65	145
Tetryl	479-45-8	43.9	80	200	120,000	990	100,000	10 - 150	0	172
Surrogate										
1,2-Dinitrobenzene	528-29-0	NA	NA	NA	NA	NA	NA	83 - 122	NA	NA

Shading indicates an RSL or ecological benchmark that is lower than the associated LOD.

CAS = Chemical Abstracts Service
DL = detection limit
ESL = ecological screening level
LOD = limit of detection
LOQ = limit of quantitation
ME = marginal exceedance
µg/kg = micrograms per kilogram
NA = not applicable
RSL = Regional Screening Level

QAPP Worksheet #15.2a
Reference Limits and Evaluation Table – Explosives in Soil by Method 8330B for Grab Samples

Analyte	CAS Number	GEL Sensitivity Limits (µg/kg)			Residential RSL (µg/kg)	Soil ESL (µg/kg)	Sediment ESL (µg/kg)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ					Upper Limit	Lower Limit
1,3,5-Trinitrobenzene	99-35-4	150	300	500	2,200,000	376	1,300,000	67-123	NA	NA
1,3-Dinitrobenzene	99-65-0	150	300	500	6200	655	8.61	66-122	NA	NA
2,4,6-Trinitrotoluene	118-96-7	150	300	500	21,000	6400	420,000	73-117	NA	NA
2,4-Dinitrotoluene	121-14-2	150	300	500	780	1280	14.4	67-115	NA	NA
2,6-Dinitrotoluene	606-20-2	150	300	500	780	32.8	39.8	67-111	NA	NA
2-Amino-4,6-dinitrotoluene	35572-78-2	150	300	500	150,000	10,000	34,000	65-119	NA	NA
2-Nitrotoluene	88-72-2	150	300	500	3200	9900	28,000	66-118	NA	NA
3-Nitrotoluene	99-08-1	150	300	500	6200	12,000	24,000	68-120	NA	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	150	300	500	150,000	3600	9500	70-122	NA	NA
4-Nitrotoluene	99-99-0	150	300	500	33,000	22,000	52,000	66-118	NA	NA
HMX	2691-41-0	150	300	500	3,800,000	27,000	27,000,000	63-119	NA	NA
Nitrobenzene	98-95-3	150	300	500	5100	2260	14.5	65-121	NA	NA
Nitroglycerin	55-63-0	500	1000	2000	6200	71,000	1,700,000	55-123	NA	NA
PETN	78-11-5	250	500	1000	120,000	100,000	1,400,000	64-122	NA	NA
RDX	121-82-4	150	300	500	6000	7500	45,000	66-127	NA	NA
Tetryl	479-45-8	150	300	500	120,000	990	100,000	32-119	NA	NA
Surrogate										
3,4-Dinitrotoluene	610-39-9	NA	NA	NA	NA	NA	NA	71-122	NA	NA

Shading indicates an RSL or ecological benchmark that is lower than the associated LOD.

CAS = Chemical Abstracts Service
DL = detection limit
ESL = ecological screening level
LOD = limit of detection
LOQ = limit of quantitation
ME = marginal exceedance
µg/kg = micrograms per kilogram
NA = not applicable
RSL = Regional Screening Level

QAPP Worksheet #15.2b
Reference Limits and Evaluation Table – Explosives in Soil by Method 8330B for ISM Samples

Analyte	CAS Number	GEL Sensitivity Limits (µg/kg)			Residential RSL (µg/kg)	Soil ESL (µg/kg)	Sediment ESL (µg/kg)	Accuracy Control Limits (%)		ME (%R)	
		DL	LOD	LOQ				LCS	MS	Upper Limit	Lower Limit
1,3,5-Trinitrobenzene	99-35-4	64	128	200	2,200,000	376	1,300,000	22-118	72-115	NA	NA
1,3-Dinitrobenzene	99-65-0	64	128	200	6200	655	8.61	21-129	67-130	NA	NA
2,4,6-Trinitrotoluene	118-96-7	64	128	200	21,000	6400	420,000	31-131	67-148	NA	NA
2,4-Dinitrotoluene	121-14-2	64	128	200	780	1280	14.4	32-122	62-141	NA	NA
2,6-Dinitrotoluene	606-20-2	64	128	200	780	32.8	39.8	32-123	63-137	NA	NA
2-Amino-4,6-dinitrotoluene	35572-78-2	64	128	200	150,000	10,000	34,000	19-123	63-140	NA	NA
2-Nitrotoluene	88-72-2	64	128	200	3200	9900	28,000	0-126	68-128	NA	NA
3-Nitrotoluene	99-08-1	64	128	200	6200	12,000	24,000	5-123	58-136	NA	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	64	128	200	150,000	3600	9500	3-134	69-141	NA	NA
4-Nitrotoluene	99-99-0	64	128	200	33,000	22,000	52,000	5-124	58-138	NA	NA
HMX	2691-41-0	64	128	200	3,800,000	27,000	27,000,000	15-120	47-139	NA	NA
Nitrobenzene	98-95-3	64	128	200	5100	40,000	14.5	0-123	67-121	NA	NA
Nitroglycerin	55-63-0	84	168	400	6200	71,000	1,700,000	11-128	50-140	NA	NA
PETN	78-11-5	64	128	200	120,000	100,000	1,400,000	13-132	56-135	NA	NA
RDX	121-82-4	64	128	200	6000	7500	45,000	31-123	64-129	NA	NA
Tetryl	479-45-8	64	128	200	120,000	990	100,000	7-149	42-164	NA	NA
Surrogate											
3,4-Dinitrotoluene	610-39-9	NA	NA	NA	NA	NA	NA	71-122	71-122	NA	NA

QAPP Worksheet #15.3
Reference Limits and Evaluation Table – Explosives in Water by Method 8330B

Analyte	CAS Number	TA Denver Sensitivity Limits (µg/L)			PAL - SC Human Health (µg/L)	SC MCL (µg/L)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ				Upper Limit	Lower Limit
1,3,5-Trinitrobenzene	99-35-4	0.2	0.4	1.0	460 (B)	--	65-140	50	155
1,3-Dinitrobenzene	99-65-0	0.0887	0.15	0.4	1.5 (B)	--	45-160	30	175
2,4,6-Trinitrotoluene	118-96-7	0.0724	0.15	0.4	2.2 (B)	--	50-145	35	160
2,4-Dinitrotoluene	121-14-2	0.0838	0.15	0.4	0.11 (A)	--	60-135	45	150
2,6-Dinitrotoluene	606-20-2	0.0645	0.15	0.2	0.042 (B)	--	60-135	45	150
2-Amino-4,6-dinitrotoluene	35572-78-2	0.0507	0.15	0.2	30 (B)	--	50-155	35	170
2-Nitrotoluene	88-72-2	0.0855	0.15	0.4	0.27 (B)	--	45-135	30	150
3-Nitrotoluene	99-08-1	0.0834	0.15	0.4	1.3 (B)	--	50-130	35	145
4-Amino-2,6-dinitrotoluene	19406-51-0	0.0577	0.15	0.2	30 (B)	--	55-155	40	140
4-Nitrotoluene	99-99-0	0.2	0.4	1.0	3.7 (B)	--	50-130	35	145
HMX	2691-41-0	0.0876	0.15	0.4	780 (B)	--	80-115	65	130
Nitrobenzene	98-95-3	0.0910	0.15	0.4	17 (A)	--	50-140	35	155
Nitroglycerin	55-63-0	0.921	1.5	3.0	1.5 (B)	--	71-126	56	141
PETN	78-11-5	0.416	1.5	2.0	16 (B)	--	67-115	52	130
RDX	121-82-4	0.0523	0.15	0.2	0.61 (B)	--	50-160	35	175
Tetryl	479-45-8	0.0793	0.15	0.24	31 (B)	--	10-175	No ME	190
Surrogate									
1,2-Dinitrobenzene	528-29-0	NA	NA	NA	NA	NA	75-118	NA	NA

Shading indicates a screening value that is lower than the associated LOD.

(A) = indicates screening value source is the water and organism consumption human health criterion listed in the Appendix to R61-68.
(B) = indicates screening value source is the tap water RSL
MCL = maximum contaminant level
µg/L = micrograms per liter
PAL = project action level

QAPP Worksheet #15.4
Reference Limits and Evaluation Table – Explosives in Water by Method 8330B

Analyte	CAS Number	GEL Sensitivity Limits (µg/L)			PAL - SC Human Health (µg/L)	SC MCL (µg/L)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ				Upper Limit	Lower Limit
1,3,5-Trinitrobenzene	99-35-4	0.08	0.16	0.25	460 (B)	--	70-116	NA	NA
1,3-Dinitrobenzene	99-65-0	0.08	0.16	0.25	1.5 (B)	--	73-119	NA	NA
2,4,6-Trinitrotoluene	118-96-7	0.08	0.16	0.25	2.2 (B)	--	71-119	NA	NA
2,4-Dinitrotoluene	121-14-2	0.08	0.16	0.25	0.11 (A)	--	74-114	NA	NA
2,6-Dinitrotoluene	606-20-2	0.08	0.16	0.25	0.042 (B)	--	73-108	NA	NA
2-Amino-4,6-dinitrotoluene	35572-78-2	0.08	0.16	0.25	30 (B)	--	71-119	NA	NA
2-Nitrotoluene	88-72-2	0.082	0.164	0.25	0.27 (B)	--	65-111	NA	NA
3-Nitrotoluene	99-08-1	0.08	0.16	0.25	1.3 (B)	--	67-112	NA	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	0.08	0.16	0.25	30 (B)	--	75-120	NA	NA
4-Nitrotoluene	99-99-0	0.15	0.3	0.5	3.7 (B)	--	65-113	NA	NA
HMX	2691-41-0	0.08	0.16	0.25	780 (B)	--	61-118	NA	NA
Nitrobenzene	98-95-3	0.08	0.16	0.25	17 (A)	--	65-112	NA	NA
Nitroglycerin	55-63-0	0.166	0.332	0.5	1.5 (B)	--	59-110	NA	NA
PETN	78-11-5	0.1	0.2	0.5	16 (B)	--	64-119	NA	NA
RDX	121-82-4	0.08	0.16	0.25	0.61 (B)	--	71-125	NA	NA
Tetryl	479-45-8	0.08	0.16	0. 5	31 (B)	--	62-117	NA	NA
Surrogate									
3,4-Dinitrotoluene	610-39-9	NA	NA	NA	NA	NA	65-114	NA	NA

Shading indicates a screening value that is lower than the associated LOD.

(A) = indicates screening value source is the water and organism consumption human health criterion listed in the Appendix to R61-68.
(B) = indicates screening value source is the tap water RSL
MCL = maximum contaminant level
µg/L = micrograms per liter
PAL = project action level

QAPP Worksheet #15.5
Reference Limits and Evaluation Table – Metals in Soil by Methods 6020A and 7471B

Analyte	CAS Number	TA Denver Sensitivity Limits (mg/kg)			Residential RSL (mg/kg)	Soil ESL (mg/kg)	Sediment ESL (mg/kg)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ					Lower Limit	Upper Limit
Cadmium	7440-43-9	0.00938	0.025	0.10	70	1.6	0.676	80 - 120	75	NA
Lead	7439-92-1	0.0182	0.050	0.15	400[1]	50	30.2	80 - 120	NA	NA
Mercury (7471B)	7439-97-6	0.00553	0.0133	0.017	9.4	0.1	0.13	80 - 120	NA	NA
Zinc	7440-66-6	0.316	0.900	1.00	23,000	50	124	80 - 120	75	NA

[1] EPA maximum lead concentration in residential soil.

QAPP Worksheet #15.6
Reference Limits and Evaluation Table – Metals in Soil by Methods 6020A and 7471B

Analyte	CAS Number	GEL Sensitivity Limits (mg/kg)			Residential RSL (mg/kg)	Soil ESL (mg/kg)	Sediment ESL (mg/kg)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ					Lower Limit	Upper Limit
Cadmium	7440-43-9	0.02	0.04	0.2	70	1.6	0.676	80 - 120	75	NA
Lead	7439-92-1	0.1	0.2	0.4	400[1]	50	30.2	80 - 120	NA	NA
Mercury (7471B)	7439-97-6	0.004	0.008	0.01	9.4	0.1	0.13	80 - 120	NA	NA
Zinc	7440-66-6	0.4	0.8	2.0	23,000	50	124	80 - 120	75	NA

[1] EPA maximum lead concentration in residential soil.

QAPP Worksheet #15.7
Reference Limits and Evaluation Table – Metals in Water by Method 6020A and 7470A

Analyte	CAS Number	TA Denver Sensitivity Limits (µg/L)			PAL - SC Human Health (µg/L)	SC MCL (µg/L)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ				Lower Limit	Upper Limit
Cadmium	7440-43-9	0.100	0.12	1.0	Use MCL	5.0	80 - 120	NA	NA
Lead	7439-92-1	0.180	0.50	1.0	--	15[(1)]	80 - 120	NA	NA
Mercury (7470A)	7439-97-6	0.027	0.08	0.2	0.05 (A)	2.0	80 - 120	NA	NA
Zinc	7440-66-6	2.00	6.00	10.0	7,400 (A)	--	80 - 120	NA	NA

Shading indicates a screening value that is lower than the associated LOD.

(1) SC action level for lead presented in South Carolina regulation R61-58.11.

(A) = indicates screening value source is the water and organism consumption human health criterion listed in the Appendix to R61-68.

QAPP Worksheet #15.8
Reference Limits and Evaluation Table – Metals in Water by Method 6020A and 7470A

Analyte	CAS Number	TA Denver Sensitivity Limits (µg/L)			PAL - SC Human Health (µg/L)	SC MCL (µg/L)	Accuracy Control Limits (%)	ME (%R)	
		DL	LOD	LOQ				Lower Limit	Upper Limit
Cadmium	7440-43-9	0.11	0.22	1.0	Use MCL	5.0	80 - 120	NA	NA
Lead	7439-92-1	0.5	1.0	2.0	--	15[(1)]	80 - 120	NA	NA
Mercury (7470A)	7439-97-6	0.067	0.134	0.2	0.05 (A)	2.0	80 - 120	NA	NA
Zinc	7440-66-6	3.5	7.00	10.0	7,400 (A)	--	80 - 120	NA	NA

Shading indicates a screening value that is lower than the associated LOD.

(1) SC action level for lead presented in South Carolina regulation R61-58.11.

(A) = indicates screening value source is the water and organism consumption human health criterion listed in the Appendix to R61-68.

QAPP Worksheet #16
Project Schedule/Timeline Table

See Schedule, Figure B.13 in Appendix B of the Work Plan.

QAPP Worksheet #17
Sampling Design and Rationale

See Section 3.13 of the WP.

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Geophysical transect locations are shown on Figures B.14 through B.17 of the WP (presented in Appendix B). See Section 3.13 of the WP for procedures for identification of sampling locations. Locations will be determined for the ISM SUs and discrete sampling locations based on the following: (1) Reconnaissance transect and geophysical survey data evaluating the extent of surface MEC/MD and subsurface anomalies; and (2) MEC characterization (intrusive investigation data) evaluating the extent of subsurface MEC/MD. Based on this data, surface soil ISM SU and discrete sample locations will be proposed to the project team for concurrence. Based on the results of the initial, or Phase 1, ISM and discrete sample data, additional ISM and/or discrete surface and/or subsurface soil samples will be collected. Required parameters are presented in Table 3.3 of the WP. The field SOPs that will be used to collect project samples are listed in Worksheet #21. HGL field SOPs are presented in Appendix I of the WP.

QAPP Worksheet #19
Analytical SOP Requirements Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation Method/ SOP Reference	Sample Size	Containers	Preservation Requirements	Maximum Holding Time[1]
Soil (ISM)	Explosives	Low	8330B (SOPs L-1, P-1)	Per SOP[1]	Polyethylene bag containing 1.5 kg	Cool ≤6°C	14 days to extract[2]/ 40 days to analysis
Soil (Grab)	Explosives	Low	8330B (SOPs L-1, P-1)	Per SOP[1]	4-ounce glass jar	Cool ≤6°C	14 days to extract/ 40 days to analysis
Soil (ISM)	Metals	Low	6020A (SOPs L-2, P-2) and 7471B (L-3)	Per SOP[1]	Subsampled at the laboratory from homogenized explosives sample prior to grinding		6 months; 28 days for mercury
Soil (grab)	Metals	Low	6020A (SOPs L-2, P-2) and 7471B (L-3)	Per SOP[1]	4-ounce glass	Cool ≤6°C	6 months; 28 days for mercury
Water (including QC samples)	Explosives	Low	8330B (SOP L-1, P-3)	Per SOP[1]	2 1-L glass	Cool ≤6°C	7 days to extract/ 40 days to analysis
Water (including QC samples)	Metals	Low	6020A (SOP L-2, P-4) and 7470A (L-4)	Per SOP[1]	500 mL PE bottle	Cool ≤6°C; HNO_3 to pH ≤2	6 months; 28 days for mercury

[1] Laboratory subsample size will be as indicated in the laboratory SOPs listed in Worksheet #23 and presented in Attachment C.
[2] Samples must be air dried prior homogenization. Holding time to preparation is measured from the conclusion of the air drying step.

°C = degrees Celsius
g = gram
HNO_3 = nitric acid
ISM = incremental sampling methodology
kg = kilogram
L = liter
mL = milliliters
QC = Quality Control

QAPP Worksheet #20
Field Quality Control Sample Summary Table[1]

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Total Sampling Locations	Field Duplicate Pairs[2]	MS/MSD Pairs	Field Blanks	EBs	No. of QA Samples[4]	Total Samples to Laboratory
ISM Soil	HPLC	See Worksheet #19	See WP Section 3.13	1 per 10 samples	1 per 20 samples[3]	0	0	1 per 10 samples	TBD
	ICP-MS and CVAA	See Worksheet #19	See WP Section 3.13	1 per 10 samples	1 per 20 samples[3]	0	0	1 per 10 samples	TBD
Grab soil	HPLC, ICP-MS, and CVAA	See Worksheet #19	See WP Section 3.13	1 per 10 samples	1 per 20 samples[3]	0	1 per day	1 per 10 samples	TBD
Groundwater	HPLC, ICP-MS, and CVAA	See Worksheet #19	See WP Section 3.13	1 per 10 samples	1 per 20 samples	0	1 per day	1 per 10 samples	TBD

[1] All QC sample frequencies will be calculated on a per-site and per-matrix basis. Where both discrete sampling and ISM sampling is performed at the same site and matrix, the number of QC samples required will be calculated independently for each sampling method.
[2] Includes replicate (triplicate) samples collected by ISM.
[3] MS/MSD soil samples will be subsampled from the submitted material on a preparation batch-specific basis; no additional sample volume is required.
[4] QA sample analyses will be performed by GEL Laboratories of Charleston, SC (see Worksheet #30).

CVAA = cold-vapor atomic absorption spectrometry
HPLC = high performance liquid chromatography
ICP-MS = inductively coupled plasma-mass spectrometry

QAPP Worksheet #21
Project Sampling SOP References Table

Reference Number[1]	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work?	Comments
Field SOPs Referenced in this QAPP					
S-1	SOP 2.01: Sampling Equipment Cleaning and Decontamination	HGL	Bailers, trowels, ISM tool, and bowls	No	
S-2	SOP 2.03: Hand-Operated Auger Soil Sampling	HGL	Augers	No	
S-3	SOP 2.13: Surface and Shallow Depth Soil Sampling	HGL	Trowels and ISM tool	No	
S-4	SOP 2.15: Sediment Sampling	HGL	Trowels and bowls	No	
S-5	SOP 2.02: Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures	HGL	Pump, pump controller, real-time water quality analyzer	No	
Other Relevant Field SOPs					
NA	SOP 002: Incremental Sampling	HGL	IMS tool	No	
NA	SOP 2.04: Soil Sample Compositing	HGL	Trowels, and bowls	No	
NA	SOP 2.14: Geologic Borehole Logging	HGL	NA	No	
NA	SOP 4.07: Field Logbook Use and Maintenance	HGL	NA	No	
NA	SOP 15.00: Explosives Accountability and Management Program	HGL	NA	No	
NA	SOP 15.12: MEC Anomaly Avoidance Program	HGL	NA	No	
NA	SOP 15.50: Analog Geophysical Mapping with Real-Time Instrumentation and Anomaly Waypoint Mapping	HGL	Magnetometer and Global Positioning System (GPS)	No	
NA	SOP 15.60: DGM Using Geonics Ltd. EM61 Mk 2	HGL	Electromagnetic metal detector	No	

[1] All SOPs referenced in this worksheet are presented in Appendix I of the WP.

QAPP Worksheet #22
Field Equipment Calibration, Maintenance, Testing, and Inspection Table

SOPs for calibration, maintenance, testing and inspection are provided in Appendix I of the WP.

QAPP Worksheet #23
Analytical SOP References Table

Reference Number	Title, Revision Date, and/or Number[1]	Definitive or Screening Data	Analysis	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
L-1	DV-LC-0002: Nitroaromatic and Nitramine Explosive Compounds by HPLC (SW846 8330A & 8330B), Revision 14; 04/30/2013	Definitive	Explosives	HPLC	TA Denver	N
	GL-OA-E-068: Sample Processing and Analysis of Nitroaromatics, Nitroamines, and Nitrate Esters by SW-846 8330B, Revision 6; July 2012				GEL	
L-2	DV-MT-0022: Inductively Coupled Plasma Mass Spectrometry for Trace Element Analysis by SW-846 Method 6020A, Revision 1; 07/15/2013	Definitive	Metals	ICP-MS	TA Denver	N
	GL-MA-E-014: Determination of Metals by ICP-MS, Revision 25; March 2013				GEL	
L-3	DV-MT-0023: Mercury in Solids by CVAA (SW-846 7471B), Revision 2; 7/15/2013	Definitive	Mercury	CVAA	TA Denver	N
	GL-MA-E-010: Mercury Analysis Using the Perkin Elmer Automated Mercury Analyzer, Revision 28; June 2014				GEL	
L-4	DV-MT-0017: Mercury in Water by CVAA (SW-846 7470A), Revision 2; 07/13/2013	Definitive	Mercury	CVAA	TA Denver	N
	Same as L-3				GEL	
P-1	DV-OP-0018: Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples (SW-846 8330A & 8330B), Revision 4; 12/28/2012	Soil Preparation (Method L-1)	Organic Preparation	NA	TA Denver	N
	Included in L-1				GEL	
P-2	DV-IP-0015: Acid Digestion of Solids (EPA 3050B), Revision 5; 03/04/2013	Soil Preparation (Method L-2)	Inorganic Preparation	NA	TA Denver	N
	GL-MA-E-009: Acid Digestion of Sediments, Sludges, and Soils, Revision 24; June 2014				GEL	

QAPP Worksheet #23
Analytical SOP References Table (continued)

Reference Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Analysis	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
P-3	DV-OP-0017: Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Water Samples (SW-846 3535A), Revision 3; 05/30/2013	Water Preparation (Method L-1)	Organic Preparation	NA	TA Denver	N
	Included in L-1				GEL	
P-4	DV-IP-0014: Acid digestion of Aqueous Samples for Analysis by ICP-MS (SW-846 3005A, 3020A, 3050B, and EPA 200.8), Revision 4; 09/28/2012	Water Preparation (Method L-2)	Inorganic Preparation	NA	TA Denver	N
	GL-MA-E-006: Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS, Revision 11; June 2014				GEL	

[1] Project laboratories will use the most current revision of each applicable SOP during project execution.

QAPP Worksheet #24
Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
HPLC	Five-point initial calibration for all target analytes	Initial calibration prior to sample analysis. Perform instrument re-calibration once per year minimum.	%RSD of calibration factor for each analyte ≤20%. linear – $r^2 \geq 0.99$	Correct problem then repeat initial calibration	Laboratory Manager/Analyst	L-1
	ICV (must be from a second source)	Immediately following initial calibration	All analytes within 20% of expected value	Correct problem then repeat initial calibration	Laboratory Manager/Analyst	L-1
	Retention time (RT) verification	Update at start of run or daily	All standards within RT window	Correct problem then reprocess or re-analyze all samples analyzed since the last RT check	Laboratory Manager/Analyst	L-1
	CCV	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within 20% of expected value	Correct problem then repeat initial CCV and re-analyze all samples since last successful CCV.	Laboratory Manager/Analyst	L-1

QAPP Worksheet #24
Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
ICP/MS	Initial Calibration	Daily, minimum of one blank and one standard	None	NA	Laboratory Manager/Analyst	L-2
	Initial Calibration	Daily, optional multipoint calibration	$r \geq 0.995$	1) Evaluate system 2) Recalibrate	Laboratory Manager/Analyst	L-2
	ICV; must be from a second source	Following initial calibration	%R = 90%-110%	1) Evaluate system 2) Recalibrate as necessary	Laboratory Manager/Analyst	L-2
	Low-level calibration check standard	Daily, spiked at analyte-specific LOQs; not required if multipoint calibration performed	%R = 80%-120%	1) Evaluate system 2) Recalibrate as necessary	Laboratory Manager/Analyst	L-2
	CCV	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	All analytes within 10% of expected value and %RSD of replicate integrations <5%	Repeat calibration and reanalyze all samples since last successful calibration	Laboratory Manager/Analyst	L-2
	CCB	After every CCV	Must be <LOD	Correct problem then analyze calibration blank and previous 10 samples	Laboratory Manager/Analyst	L-2
	ICS A	At the beginning of an analytical run	Spiked analytes: Within 20% of expected value Non-spiked analytes: <LOD (unless they are a verified trace impurity from one of the spiked analytes)	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples	Laboratory Manager/Analyst	L-2
	ICS AB	At the beginning of an analytical run	Within 20% of expected value	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples	Laboratory Manager/Analyst	L-2

QAPP Worksheet #24
Analytical Instrument Calibration Table (continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference[1]
CVAA	Initial Calibration	Daily	r ≥ 0.995	1) Evaluate system 2) Recalibrate	Laboratory Manager/Analyst	L-3 and L-4
	ICV; must be from a second source	Following initial calibration	%R = 90% to 110%	1) Evaluate system 2) Recalibrate as necessary	Laboratory Manager/Analyst	L-3 and L-4
	CCV	Before sample analysis, after every 10 samples, and at the end of the analysis sequence	%R = 80% to 120%	1) Repeat calibration 2) Reanalyze all samples since last successful CCV	Laboratory Manager/Analyst	L-3 and L-4
	ICB/CCB	After every ICV/CCV	No analytes detected >LOD; no analytes with negative drift with absolute value >LOD	1) Correct problem 2) Analyze calibration blank and previous 10 samples	Laboratory Manager/Analyst	L-3 and L-4

[1] Analytical SOP References Table (Worksheet #23).

QAPP Worksheet #25
Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

All analytical instruments used for this project will be maintained IAW the requirements presented in each analytical method SOP (included as Attachment C) and the laboratory-specific QA Plan (Attachment D). The laboratory QA Plan also presents the documentation requirements for maintenance activities. Note that Attachments C and D only present the laboratory information from TestAmerica-Denver. GEL's considers their laboratory SOPs and laboratory QA Manual to be confidential business information; these documents are available for review upon request accompanied by a confidentiality agreement.

QAPP Worksheet #26
Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Site staff/HGL
Sample Packaging (Personnel/Organization): Site staff/HGL
Coordination of Shipment (Personnel/Organization): Site Supervisor/HGL and Sample Receipt Manager/Laboratory
Type of Shipment/Carrier: Priority Overnight - FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Management Staff/Laboratory
Sample Custody and Storage (Personnel/Organization): Sample Management Staff/Laboratory
Sample Preparation (Personnel/Organization): Organic Preparation Staff; Inorganic Preparation Staff; Bench Chemists/Laboratory
Sample Determinative Analysis (Personnel/Organization): Bench Chemists/Laboratory
SAMPLE ARCHIVING
Field Sample Storage (number of days from sample collection): Not applicable
Sample Extract/Digestate Storage (number of days from extraction/digestion): For 30 days from report release
Biological Sample Storage (number of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample management staff/Laboratory
Number of Days from Analysis: 30 from report release; up to 6 months on sample-specific request from HGL

QAPP Worksheet #27
Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to the laboratory):

SAMPLE COLLECTION:

- Soils: Ten (10) ISM and 10 discrete surface soil samples will be collected throughout each MRS as part of the Phase 1 RI field activities. An additional five ISM soil samples and/or discrete surface and/or shallow subsurface soil samples (<2 ft below ground surface [bgs]) will be collected from within the general area sampled during Phase 1 during Phase 2 sampling. See Tables 3.2 and 3.3 of the WP. Discrete surface soil samples will be collected from the ground surface to 0.5 feet bgs using decontaminated stainless steel equipment. Incremental samples will be collected using the Cold Regions Research and Engineering Laboratory (CRREL) ISM tool. QC samples will be collected using the same procedures used for primary environmental samples. Sample collection techniques and methods to be used to collect surface soil samples are summarized below.

  Surface soil incremental samples will be collected using a stainless steel ISM tool. Collected soil will be placed directly into polyethylene bags holding a minimum of 1.5 kg. All sampling equipment and tools will be decontaminated prior to use. After each sample has been collected, all sample containers will be placed in a cooler and maintained at 4°C ± 2°C pending shipment to the laboratory.

  Discrete soil samples will be collected using stainless steel spoons and trowels. Collected soil will be placed into stainless steel sampling bowls. Samples will be homogenized and placed into glass jars using stainless-steel spoons, augers, or sampling equipment. All sampling equipment and tools will be decontaminated prior to use; all sample jars will be glass with Teflon® septa and will be certified clean by the manufacturer. After each sample has been collected, all sample containers will be placed in a cooler and maintained at 4°C ± 2°C pending shipment to the laboratory.

- Sediment Sampling: Up to 20 sediment sample locations will be selected within each MRS as part of the Phase 2 RI field activities, if required. Sediment samples will be analyzed for selected metals (lead, zinc, cadmium, and mercury) and explosives. See Tables 3.2 and 3.3 of the WP.

  Sediment will be sampled with a decontaminated stainless-steel hand auger, coring device and/or stainless-steel spoon. Samples will be sealed and placed in coolers with ice immediately after collection.

- Groundwater Sampling: Groundwater samples may be collected using existing groundwater wells as part of the Phase 3 RI field activities. Samples, if collected, will be obtained from spigots or existing infrastructure. See Tables 3.2 and 3.3 of the WP.

EQUIPMENT DECONTAMINATION: Equipment used in sampling activities must be properly cleaned and decontaminated to ensure that chemical analysis results are reflective of the actual concentrations at sampling locations. Therefore, equipment used to conduct sampling activities will be decontaminated before sampling activities begin, between sampling activities, and after sampling activities have been completed. SOPs for the decontamination of equipment are provided in Appendix I.

QAPP Worksheet #27
Sample Custody Requirements (continued)

INVESTIGATION-DERIVED WASTE (IDW): Personal protective equipment (PPE) is classified as IDW and will be containerized and disposed of in a manner approved by USACE and SCDHEC. If for any reason soil or supplemental water needs to be containerized during the completion of the RI activities, all IDW will be segregated and containerized by medium.

IDW at Former Conway BGR will be identified and properly handled while it is being accumulated or stored on site. Hazardous waste will be contained and handled in compliance with the requirements listed below:

- HGL will provide USACE with a description of the process that generated the waste and will supply, when appropriate, laboratory analysis data to facilitate the determination of which wastes are hazardous and provide information necessary to prepare reports for regulatory agencies and higher commands.
- Wastes will be accumulated and/or stored at locations that comply with collection point operational standards.
- Waste generation will be minimized whenever possible or feasible.

FIELD DOCUMENTATION: Sample collection, storage, packing, and shipment will be properly documented to ensure chemical data integrity. The log will be a permanently bound field notebook. Field documentation will be entered using indelible ink. Corrections will be made by drawing a single line through the error, then initialing and dating the line. Each page will be dated, initialed, and sequentially numbered.

QC Reports will be prepared daily, dated, signed by the SUXOS, and sent to USACE upon completion of the fieldwork. These reports will include weather information at the time of sampling, sample identification, field instrument measurements, and calibrations. The cover of each notebook will bear the following:

- project name;
- project number; and
- opening and closing dates for data contained in the book.

The inside cover will include the address and telephone number of the HGL office.

At the beginning of each daily entry, the date, start time, weather, and planned activities will be recorded. The names of visitors and the purpose of their visits will be noted. Any deviations from the WP will be recorded along with the reason for the deviation.

QAPP Worksheet #27
Sample Custody Requirements (continued)

Pre-Sampling Activities

Sampling personnel will record in the field logbook the preparation activities that may be pertinent to the sampling event at each sampling location. For soil sampling, documentation may include information on the presence of MEC\MD\cultural debris (CD), geophysical anomaly identification (ID), site-specific munitions related factors for selection of sampling point (firing line, target, etc), the depth from which the samples were collected, and the equipment and materials that were used to collect the sample.

SAMPLE PACKAGING: The following procedures will be used for packing samples for shipping.

- Drain plug on cooler will be taped shut inside and out.
- Large plastic bag is placed in cooler as liner.
- Individual glass sample container will be wrapped in bubble wrap.
- Bubble-wrapped sample container is placed in small plastic bag.
- Bubble wrap or other packing material will be placed between individual sample containers in cooler.
- Samples will be packaged in thermally insulated, rigid coolers, according to U.S. Department of Transportation (DOT) Specifications 173, Subparts A and B, and 172, Subparts B, C, and D. Environmental samples and field QC blanks to be submitted to the analytical laboratory will be placed in a sample cooler along with ice and temperature blanks, and the final temperature blank temperature will be recorded.
- The cooler will be filled with enough ice to keep the temperature at 4°C $\pm$ 2°C during shipping and until arrival at laboratory; enough packing material will used so that individual sample jars are not insulated from the ice. (Note: Care must be taken to make sure jars are not touching each other to prevent breakage during shipment.)
- Cooler is closed and sealed with filament-style strapping tape or equivalent.
- At least two custody seals will be placed across the hinge line (one on the front and one on the side of the cooler) in a manner that will indicate whether tampering of the cooler has taken place.
- Posted on all four sides of the cooler will be “This Side Up” labels, and posted on two sides and on the top are “Fragile” labels.

QAPP Worksheet #27
Sample Custody Requirements (continued)

SAMPLE SHIPMENT: Each individual sample will be identified with an ID label or tag that will be affixed to the sample container in a manner that will prevent it from coming off when the sample container is cold or wet. The information recorded on the label will include:

- Sample ID number
- Source or location of sample
- Date sample was obtained
- Time sample was collected
- Sampler's initials

Sample coolers will be shipped to the analytical laboratory by overnight delivery. All samples will be kept on ice in a cooler containing a temperature blank after sample collection. Sample preparation and packaging will be completed at the end of each day that samples are collected. When samples are collected over the weekend, the samples will undergo preparation as normal; however, the samples will not be packaged for shipment. Samples collected on the weekend will be kept within a cooler on ice until all samples for the next shipment have been collected. On Mondays following weekends when samples have been collected, the iced samples will be repacked for overnight shipment.

Laboratory Sample Custody Procedures (receipt of samples, archiving, and disposal):

The designated sample custodian(s) and staff are responsible for samples received at the laboratory. In addition to receiving samples, the sample receipt staff is also responsible for documentation of sample receipt and storage before and after sample analysis. Summaries of the minimal laboratory receipt procedures are as follows:

- Upon receipt, sign, date, and document the time of sample receipt on the airbills or other shipping manifests received from the couriers.
- Sign the CoC form assuming custody of the samples. If a CoC form is not received with a set of samples, the laboratory will immediately notify the HGL PM.
- Inspect the sample cooler for integrity and then document the following information:
  - Type of courier and whether the samples were shipped or hand delivered (copies of the airbills are maintained).
  - Availability and condition of custody information.
  - Sample temperature.
  - Actual temperature of the temperature blank.
  - Presence of leaking or broken containers and indication of sample preservation.

QAPP Worksheet #27
Sample Custody Requirements (continued)

- Verify that the holding time has not been exceeded. If a sample has exceeded holding time, then the HGL Project Chemist must be notified.
- Match the sample container information (e.g., sample tag/label), CoC records, and all pertinent information associated with the sample. The sample custodian then verifies sample identity to ensure that all information is correct. Any inconsistencies are resolved with HGL through the Laboratory PM and CA measures are documented before sample analysis proceeds.

Samples submitted to off-site laboratories will be stored at 4°C for a minimum of 60 days following the completion of analyses or issue of final reports. Sample extracts and metals digestates will be stored for a period of 1 year following submittal of final reports. The laboratory is also responsible for the proper management and disposal of all sample residuals and extracts, following all applicable federal, state, and local laws; rules; and regulations.

Sample Identification Procedures: A sample identification system will be used to identify each environmental sample collected and field QC sample prepared during the Former Conway BGR RI field activities. This system will provide a tracking procedure to allow information about a particular sample or sample location to be retrieved easily and accurately and to ensure that each sample is unique. The HGL field manager and data coordinator will maintain a complete list of field sample numbers and site identifications. The first two letters will represent the sample type (SA - Shallow Anomaly, SB - Soil Boring, SS - Surface Soil, GW – Groundwater, SW/SD – Surface Water/Sediment). The next two numbers designate the Former Conway BGR site of concern: MRS-R01 Range II (R01), MRS-R02 Range III (R02), MRS-R03 Range IV (R03), and MRS-R09 Machine Gun/Rifle Range (R09). The last two digits will represent the sample location number. The format of typical field sample numbers is as follows:

Site ID	Sample Description
SA-R01-05	Soil sample collected from shallow anomaly from MRS-R01 Range II at location 05
SS-R09-03	Surface soil sample collected from the MRS-R09 Machine Gun/Rifle Range at sample location 3

Field Sample Number – This is a unique designation assigned by the field team to each environmental sample and field QC sample collected. It is an alphanumeric code that indicates the sample number for a site. For example, a field sample number of HGL02 for site ID SA 03 05 would indicate that it is the second soil sample collected from a shallow anomaly location. Re-collected samples will be designated with an "R" at the end of the field sample number (e.g., HGL XXR).

Duplicate, Triplicate, and Field QC Blanks – The following QC test and flagging codes will be used to identify duplicate environmental and field QC blank samples:

- A "D" entered in the flagging code field will be used to identify all field duplicates collected in the field.
- A "T" entered in the flagging code field will be used to identify all field triplicates collected in the field.
- An "R" entered in the QC test code field will be used to identify all equipment rinsate blanks collected in the field.
- An "F" entered in the QC test code field will be used to identify all field blanks collected in the field.

QAPP Worksheet #27
Sample Custody Requirements (continued)

Preprinted sample labels will be filled out at the time of sampling and will be attached to each container with waterproof tape. The label will be completed in indelible ink and contain the following information:

- Date and time sample collected;
- Media type;
- Method matrix;
- Purpose of the sample (parameter and sample group);
- MRS location;
- Field sample number;
- Depth;
- Installation;
- Preservative used (if any); and
- Initials of sample collector.

See Section 3.13 of the WP

CoC Procedures: The primary objective of sample custody is to provide accurate, verifiable, and traceable records of sample possession and handling from preparation and shipment of bottle ware through laboratory receipt, sample analyses, and data validation. A sample is considered in custody if it is:

- in actual possession of the sampler or transferee,
- in view of the sampler or transferee after establishment of physical possession,
- sealed for sample integrity by the sampler, and/or
- in a secured area, with access restricted to authorized personnel.

Container Preparation/Management

TA Denver will furnish sampling containers. Containers will be provided with batch number and the lot number for any preservatives provided to permit traceability. All standard custody procedures are maintained for pre-cleaned sample containers. If the containers must be stored between receipt by HGL and sample collection, they will be stored at the HGL field office or in a designated secure area near the site.

QAPP Worksheet #27
Sample Custody Requirements (continued)

CoC Documentation, Traceability, and Sample Integrity (Field)

After sample collection, all sample containers will be labeled with an identification number that uniquely identifies the sample. The sample identification number will be logged in the field logbook, preprinted sample/data sheets, and on the CoC Record with the following information:

- sampling location (MRS)
- sampling personnel,
- date and time of collection,
- field sample location and depth (if appropriate),
- observations of ambient (weather) conditions,
- type of sampling (composite or grab),
- method of sampling,
- sampling matrix or source,
- intended analyses and type of container,
- preservation method, and
- observations of physical characteristics of the sample.

CoC is maintained for samples transported from the field to the laboratory by common carrier. Completed custody forms must accompany each sealed cooler and are placed in a plastic bag, which is taped to the inside lid of the cooler. The sampling team in the field seals coolers with a custody seal to ensure that tampering would be immediately evident.

A sample identification number is recorded with waterproof ink on the container label. A copy of each packing slip associated with a shipment of samples is maintained in the project files.

See Section 3.13 of the WP.

QAPP Worksheet #28.1
Method QC Table – Explosives by SW-846 Method 8330B

Matrix	Soil
Analytical Group	HPLC
Concentration Level	Low
Sampling SOP	S-1, S-2, S-3, and S-4
Analytical Method/ SOP Reference	L-1
Sampler's Name	TBD
Field Sampling Organization	HGL
Analytical Organization	TA Denver
No. of Sample Locations	See WP Section 3.15

QC Element	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)
Retention Time Windows	Prior to initial calibration and after major maintenance	3 times standard deviation for each quantitation peak retention time from 72-hour study	Correct problem then reprocess or reanalyze all samples analyzed since the last retention time check	Laboratory Manager/ Laboratory Analyst	NA
MB	Every analytical batch (maximum of 20 samples)	Target analytes not detected ≥ ½ LOQ (see Worksheets 15.1 and 15.2) and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)	1) Rerun 2) Evaluate batch 3) Reanalyze or qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Representativeness
LCS (and LCSD, if performed)	Every analytical batch (maximum of 20 samples)	Analyte-specific %R acceptance criteria (see Worksheets 15.1 and 15.2); RPD ≤30% if LCSD performed	1) Rerun 2) Evaluate batch 3) Reanalyze or qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias (and Precision)

QAPP Worksheet #28.1
Method QC Table – Explosives by SW-846 Method 8330B (continued)

QC Element	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)
MS/MSD	As indicated on CoC forms, and as required for batch control	Analyte-specific %R acceptance criteria (see Worksheets 15.1 and 15.2); RPD ≤30% if MSD performed Not applicable if parent sample concentration ≥ 4× the spike level	1) Evaluate MS/MSD to assess matrix interference 2) Evaluate batch and qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Precision
Laboratory replicate analyses (ISM samples)	Every analytical batch (maximum of 20 samples)	%RSD ≤20%	1) Evaluate results to assess matrix interference 2) Evaluate batch and qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Precision
Surrogate Recovery	Every sample	Surrogate-specific %R acceptance criteria (see Worksheets 15.1 and 15.2)	1) Rerun 2) Reanalyze or qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias

QAPP Worksheet #28.2
Method QC Table – Metals by SW-846 Method 6020A and Mercury by 7470A/7471B

Matrix	Water and soil
Analytical Group	ICP-MS and CVAA
Concentration Level	Low
Sampling SOP	S-1, S-2, S-3, S-4, and S-5
Analytical Method/ SOP Reference	L-2, L-3, and L-4
Sampler's Name	TBD
Field Sampling Organization	HGL
Analytical Organization	TA Denver
No. of Sample Locations	See WP Section 3.15

QC Element	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)
ICB	Following ICV	Analytes not detected ≥ ½ LOQ (see Worksheet 15.1 through 15.4) and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); no negative values > |LOD|	1) Rerun 2) Clean system 3) Qualify results as appropriate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Representativeness
ICS	Beginning of analytical sequence	ICS A (spiked analytes): %R = 80% to 120% ICS A (non-spiked analytes): Absolute value of concentration for all non-spiked analytes < LOD (unless a verified trace impurity from standard solution) ICS AB: %R = 80% to 120%	1) Evaluate system 2) Recalibrate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Representativeness

QAPP Worksheet #28.2
Method QC Table – Metals by SW-846 Method 6020A and Mercury by 7470A/7471B (continued)

QC Element	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)
CCB	Following CCV	Analytes not detected ≥ ½ LOQ (see Worksheets 15.1 through 15.4) and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); no negative values > |LOD|	1) Rerun 2) Clean system 3) Reanalyze affected samples or qualify results as appropriate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Representativeness
MB	Every analytical batch (maximum of 20 samples)	Analytes not detected ≥ ½ LOQ (see Worksheets 15.1 through 15.4) and ≥ 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); no negative values > |LOD|	1) Rerun 2) Evaluate batch 3) Re-digest affected samples or qualify results as appropriate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Representativeness
LCS (and LCSD, if performed)	Every analytical batch (maximum of 20 samples)	Analyte-specific %R acceptance criteria (see Worksheets 15.1 through 15.4); RPD ≤20% if LCSD performed	1) Rerun. 2) Evaluate batch 3) Reanalyze or qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Precision
MS (and MSD, if performed)	Every analytical batch (maximum of 20 samples)	Analyte-specific %R acceptance criteria (see Worksheets 15.1 through 15.4); RPD ≤20% if MSD performed Not applicable if parent sample concentration ≥ 4× the spike level	1) Rerun; if still out, perform post-digestion spike 2) Evaluate batch 3) Qualify sample results as appropriate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias and Precision

QAPP Worksheet #28.2
Method QC Table – Metals by SW-846 Method 6020A and Mercury by 7470A/7471B (continued)

QC Element	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)
Laboratory Duplicate (if performed)	Every analytical batch (maximum of 20 samples)	RPD ≤20% (water) or ≤30% (soil) if both results >5x the LOQ; absolute difference <LOQ for evaluation of low-level results (<5x LOQ)	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate	Laboratory Manager/ Laboratory Analyst	Precision
Laboratory replicate analyses (ISM samples)	Every analytical batch (maximum of 20 samples)	%RSD ≤20%	1) Evaluate results to assess matrix interference 2) Evaluate batch and qualify results as necessary	Laboratory Manager/ Laboratory Analyst	Precision
Serial Dilution (ICP-MS only)	Every analytical batch (maximum of 20 samples)	%D ≤10% for all analytes present in the parent sample at concentrations >50x LOQ	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate	Laboratory Manager/ Laboratory Analyst	Accuracy/Bias
Post-Digestion Spike (ICP-MS only)	Every analytical batch of 20 samples, only if serial dilution analysis fails or analyte <DL criterion in serial dilution parent sample	%R = 75% to 125%	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate	Laboratory Manager/ Laboratory analyst	Accuracy/Bias

QAPP Worksheet #29
Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
Field notes (bound logbook)	Equipment calibration logs	Sample receipt, custody, and tracking records	Data validation reports	Project planning documents
Sample documentation forms	Equipment maintenance, testing, and inspection logs	Standard traceability logs	Automated data review reports	Project deliverables
Daily Quality Control Reports (DQCRs)	Equipment calibration logs	Equipment calibration logs	Database QC spreadsheets	Telephone logs, emails, faxes, and correspondence
CoC records	Field sampling data sheets	Sample preparation logs	Telephone logs, emails, faxes, and correspondence	Permits
Air bills	Waste disposal records	Analytical run logs		Site maps
Custody seals		Equipment maintenance, testing, and inspection logs		
Telephone logs, e-mails, faxes, and correspondence		Analytical discrepancy forms		
CA forms		Reported analytical results		
Photographs		Reported results for standards, QC checks, and QC samples		
		Data package completeness checklists		
		Sample disposal records		
		Extraction and cleanup records		
		Raw data (stored electronically)		
		Telephone logs, emails, faxes, and correspondence		

QAPP Worksheet #30
Analytical Services Table

Matrix	Analytical Group	Concentration Level	Sample Locations/ ID Numbers	Analytical SOP	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/ Organization
All	HPLC, ICP-MS, and CVAA	Low	All	L-1, L-2, L-3, and L-4 (Worksheet #23)	21 Days	TestAmerica 4955 Yarrow St. Arvada, CO 80002 (303) 736-0100	TestAmerica national laboratory network
All	HPLC, ICP-MS, and CVAA	Low	1 per 10 samples for each matrix	L-1, L-2, L-3, and L-4 (Worksheet #23)	21 Days	GEL Laboratories 2040 Savage Road Charleston, SC 29407 (843) 556-8171	TBD

QAPP Worksheet #31
Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Readiness Review: The activities during this phase include a review of all work requirements and procedures, including review of QAPP, SOPs, and DQCR with Field Staff. Verification that needed supplies, equipment, and other requirements (e.g. permits) are in place.	Preparatory Phase (prior to sampling at the site).	Internal	HGL	FTL	SUXOS	UXOSO	PM
Laboratory Assessment for Appropriate Certifications, Capacity, and QAPP Review with Staff	Prior to sampling mobilization	Internal	HGL	Project Chemist	Laboratory PM	Laboratory QA Manager	Project Chemist
Inspection of field notes to ensure that all pertinent data are recorded according to project requirements Inspection of individual sample labels and CoC forms for accuracy, completeness and consistency Inspection of the packaging of all samples Ensuring that primary and QA samples are correctly matched and recorded in the field logbook and CQC Reports	Initial Phase (during sampling activities).	Internal	HGL	FTL	SUXOS	UXOSO	PM

QAPP Worksheets #31
Planned Project Assessments Table (continued)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Daily Tailgate Safety Meeting	Daily	Internal	HGL	HGL Field Team Lead or SUXOS	UXOSO or HGL Technical Manager	UXOSO or HGL Technical Manager	HGL Corporate H&S Manager
General procedures and documentation will be checked to ensure that they are complete, accurate, and consistently, executed throughout the duration of the sampling phase Review of any field data, as required Monitoring of soil sampling to make sure that samples are properly collected, composited, stored, packaged and shipped.	Follow-up Phase (after sampling activities are completed). This phase inspection will be performed on an as-needed basis to ensure continued compliance with project requirements.	Internal	HGL	FTL	SUXOS	UXOSO	PM
Data Validation	Per SDG	Internal	HGL	TBD LDC Data Validator	Data Validation Manager	TBD LDC Data Validator	Data Validation Manager
Laboratory Report Deliverables and Analytical Results Against QAPP Requirements	As discrepancies are identified in the validation process	Internal	HGL	Project Chemist	Laboratory PM	Laboratory QA Manager	Laboratory QA Manager Project Chemist
Management Review	Following project audits or other nonconformance incidences	Internal	HGL	HGL PM	Depends on the specific non-conformance	Depends on the specific non-conformance	Program QA Manager

QAPP Worksheet #32
Assessment Findings and CA Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Time Frame for Response
Laboratory Assessment for Appropriate Certifications, Capacity and QAPP Review with Staff	Receipt of copies of certifications. Email traffic concerning lab capacity prior to sampling startup. QAPP sign-off sheet received from laboratory.	HGL PM HGL TM	48 hours	Response to email	HGL PM; HGL TM HGL FTL	48 hours after notification
Daily Safety Meeting	Verbal debriefing and daily sign-off log. If a safety incident occurs, a Supervisor Injury Employee Report is completed.	HGL PM HGL TM	Immediately	Included as part of the process of the Supervisor Injury Employee Report	HGL PM; HGL TM HGL Corporate H&S Manager	24 hours after notification
Daily Field Reporting and Field Forms	Contained with written report.	HGL FTL HGL TM	24 hours	DQCR would be amended with CA	HGL FTL HGL TM	24 hours after notification
Field Sampling and CoC Form Review Against QAPP Requirements	Communication may be in the form of email traffic	HGL PM; HGL FTL	24 hours after sampling	Response to email	HGL PM; HGL FTL	48 hours after notification

QAPP Worksheet #32
Assessment Findings and CA Responses (continued)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Time Frame for Response
Laboratory Report Contents and Analytical Results Against QAPP Requirements	Communication may be in the form of email traffic	HGL PM HGL TM HGL FTL	72 hours after receipt of analytical report	If required laboratory reports will be amended and corrections noted in the analytical narrative.	HGL PM HGL TM HGL FTL	72 hours after notification
Data Validation	Communication may be in the form of email traffic clarification of the analytical report or CAs due to deficiencies identified in the validation process.	Laboratory PM	24 hours after finding of deficiency	If required, laboratory reports will be amended and corrections noted in the analytical narrative and contained with the validation report.	HGL Project Chemist	Up to 7 days
Management Review	Audit report and/or NCR form	HGL PM Program QA Manager	Immediately	Audit reconciliation form or completed NCR form	HGL PM Program QA Manager	As specified in audit report or NCR form

QAPP Worksheet #33
QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Analytical discrepancy forms	As needed	Initiated on discovery of deficiency; completed within 3 days of CA	Project Staff/Section Manager (Laboratory)	Laboratory PM HGL Project Chemist
Daily QC Reports	Daily for each day of field work	Appendix to project report. If discrepancy identified, transmitted by fax to HGL PM the same business day.	HGL Field Team Lead UXOSO	HGL PM
SUXOS Daily Report	Daily for each day of field work	Submit to HGL PM weekly. Compile after action report as appendix to RI report.	HGL SUXOS	HGL PM
Data Validation Report	1/analytical method reported in each SDG	Completed within 3 weeks of data package receipt	LDC Data Validation Manager	HGL Project Chemist
Project Reports (RI Report, FS, Proposed Plan, and Decision Document)	See Section 2.4 of the WP	See Schedule, Figure B.13	HGL PM HGL TM	See Section 2.4 of the WP

QAPP Worksheet #34
Verification (Data Review Step I) Process Table

Verification Input	Description	Internal (I)/ External (E)	Responsible for Verification
CoC (shipping)	CoC forms will be reviewed upon completion and verified against the packed sample coolers and site sampling requirements. This QC check will be verified by initialing the CoC form next to the shipper's signature. A copy of the CoC form will be retained in the project file and the original and one copy will be taped inside the cooler in a waterproof bag.	E	HGL Field Team Lead
Log review	Log reviews will be performed on a daily basis. This review will be performed to verify that all field monitoring equipment was maintained, calibrated, and operated properly. In addition, the review denotes all required information has been correctly documented in the field logbooks and sample documentation sheets.	E	HGL Field Team Lead
CoC (receipt)	CoC forms will be reviewed and compared to cooler contents. Any discrepancies (sample bottles, sample IDs, requested methods) will be communicated to the Laboratory PM for resolution with the HGL PM.	I	Laboratory Sample Receipt Manager and PM
Analytical data package	All data used to prepare analytical data packages will be reviewed at multiple levels throughout the laboratory. The requirements for this review process are described in Appendix D. No data packages will be delivered to HGL without the necessary approval.	I	Laboratory PM
Analytical data package	Ensure that the appropriate analytical samples have been collected, appropriate site identifications have been used, and the correct analytical methods have been applied.	E	Sample Coordinator, HGL
Analytical data package[1]	Review the analytical reports to establish that all required forms, case narratives, samples, CoC forms, logbooks, and raw data have been included.	E	Data Validator, LDC
EDD (export)	All EDDs will be verified against the requirements of the SEDD database prior to transmittal to HGL.	I	Laboratory Database Manager

QAPP Worksheet #34
Verification (Data Review Step I) Process Table (continued)

Verification Input	Description	Internal (I)/ External (E)	Responsible for Verification
EDD (import)	Any EDD non-conformances from the laboratory are reviewed and addressed before the data is processed further. This check is performed on the EDD to ensure that it is in the correct format and that it contains the correct standard values. Any errors or warnings are addressed before processing the data further.	E	HGL Database Manager
Project database	All data qualifiers applied to the project database by manual entry will receive a 100% QC check for accuracy and completeness. Prior to final approval, each EDD output will receive a 10% QC check of electronically reported results against the hardcopy laboratory reports.	E	HGL Database Manager

[1] This verification step corresponds to Data Validation Stage 1 described in Worksheets #35 and #36.

QAPP Worksheet #35
Validation (Data Review Steps IIa and IIb) Process Table

Validation Stage	Validation Input	Description	Person Responsible for Validation
Data Review Step IIa			
Data Verification	Laboratory data reports	100 percent of data packages: The validator will verify data package completeness, review case narratives, evaluate sample delivery and condition, and evaluate preparation and analysis holding times (Worksheet #19).	TBD, LDC
Automated Data Review (ADR) with Manual Review	Laboratory data reports	100% of data packages: The ADR program will perform initial evaluation of sample- and batch-related QC results (see Attachment A, Table A.1). The validator will review and evaluate ADR outputs and complete the review of those items not able to be addressed by ADR.	TBD, LDC
Data Review Step IIb			
Peer Review	Data validation reports	100 percent of data validation reports: Peer review of reports to ensure all QC issues are identified and to approve application of qualifiers.	LDC
Senior Review	Data validation reports	100 percent of data validation reports: Review of LDC data validation reports to approve of all validation results and final qualifiers; overall evaluation of analytical performance against QAPP and WP requirements.	HGL Project Chemist
Overall Assessment	Project documentation (Worksheet #33)	Complete project data set and documentation: Determine whether the sampling plan was executed as specified (i.e., the number, location, and type of field samples were collected and analyzed as specified in the WP); evaluate whether sampling procedures were followed with respect to equipment and proper sampling support (e.g., techniques, equipment, decontamination, volume, temperature, preservatives).	HGL FTL

QAPP Worksheet #36
Validation (Data Review Steps IIa and IIb) Summary Table

Validation Stage	Matrix	Analytical Group	Concentration Level	Validation Criteria[1]	Data Validator
Data Review Step IIa					
1	Water and soil	All	Low	Package Completeness Holding Times: Worksheet #19 Narrative: Additional items noted for resolution or clarification	ADR; validator TBD (LDC)
2A and 2B	Water and soil	Explosives	Low	DQIs: Worksheets #12.1, #15.1, #15.2, and #28.1 Qualification: Attachment A, Table A.1	ADR; validator TBD (LDC)
2A and 2B	Water and soil	Metals	Low	DQIs: Worksheets #12.2, #12.3, #15.3, #15.4, and #28.2 Qualification: Attachment A, Table A.1	ADR; validator TBD (LDC)
Data Review Step IIb					
NA	Water and soil	All	Low	See Worksheet #37	LDC, HGL Project Chemist)
NA	Water and soil	All	Low	See Worksheet #37	HGL PM

[1] In **all** cases, the method-specific requirements as presented in this QAPP will supersede any conflicting requirements.

QAPP Worksheet #37
Data Usability Assessment (Step III)

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used: The data assessment team will perform the operations summarized in Worksheets #33, #34, and #35 to evaluate sampling team and laboratory compliance with the requirements with this QAPP and other project planning documents. ADR will be used to evaluate sample- and batch-specific QC elements. Evaluation activities will be documented in the QA reports listed in Worksheet #33 and will be used to assess the usability of project data in levels of detail ranging from an analyte- and sample-specific basis to the overall data set for the sampling event. A full description of the activities listed in this summary is presented in Attachment B.

Describe the evaluative procedures used to assess overall measurement error associated with the project: The assessment will include an evaluation of the QC elements relating to precision, accuracy, representativeness, comparability, completeness (both sample collection and analytical), and sensitivity (see Attachment B).

Identify the personnel responsible for performing the usability assessment: HGL PM, HGL Project Chemist, HGL Database Manager

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: Evaluation activities will be documented in the QA reports listed in Worksheet #33. An overall assessment of the impact of data usability issues will be presented in the project report. The usability assessment will evaluate the overall data set.

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ATTACHMENT A

DATA MANAGEMENT AND VALIDATION

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ATTACHMENT A
DATA MANAGEMENT AND VALIDATION

1.0 INTRODUCTION

Following sample collection and analysis, the data must be reviewed, reported, and validated. The procedures described in this appendix are conducted to ensure that the data were collected and obtained in accordance with this quality assurance project plan (QAPP), the applicable guidance documents, and good practices. The overall goal is to ensure that the data quality requirements of the project are met.

2.0 LABORATORY DATA MANAGEMENT REQUIREMENTS

The project laboratories are responsible for providing complete and correct data to HydroGeoLogic, Inc. (HGL) for all requested analyses. The QAPP addresses the project-specific requirements for analyses in Worksheets #12, #15, #24, and #28. Following analysis of the samples, the laboratory will perform a series of steps in order to deliver an acceptable final data report to HGL.

2.1 DATA REDUCTION

Data reduction is the process for collecting and transforming measurements, through mathematical and statistical formulas, into final reportable measurements. The calculations may be performed manually or electronically. Data reduction is performed by the analyst and consists of calculating concentrations in samples from the raw data. The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings, and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values. Calculations and data reduction steps for various methods are summarized in the respective laboratory standard operating procedures (SOPs) (see Attachment D) or program requirements.

Copies of all raw data and the calculations used to generate the final results, such as bound laboratory notebooks, strip-charts, chromatograms, spreadsheets, and computer record files, are retained on file as specified in this QAPP. Should HGL determine that the laboratory's data reduction processes require an in-depth review, these calculations and the associated raw data will be provided to HGL on request.

2.2 DATA REVIEW

Data review is performed to assess whether the quality control (QC) requirements are met. Project laboratories will perform data review on 100 percent of the data deliverables. No data may be released to HGL without the appropriate analyst and supervisory review performed and documented.

The individual analyst continually reviews the quality of data through evaluating the results of calibration checks, QC samples, and performance evaluation samples. The analyst performs data review during, immediately following, and after the completed analysis. The laboratory supervisor, analyst, or data specialist performs a secondary review of the data. The data reviewer is trained by the quality assurance (QA) manager or section leader to perform the data review.

The analytical laboratory data reviewer who has the initial responsibility for the correctness and completeness of the data will conduct the first level of review, which may contain multiple sublevels of all project related data. Data reduction, QA review, and reporting by the laboratory will be completed as follows:

- Raw data produced by the analyst are processed and reviewed for attainment of QC criteria as outlined in the SOPs, laboratory QA manual, and established U.S. Environmental Protection Agency (EPA) methods, as well as for overall reasonableness. These general QC criteria are modified by the requirements of this QAPP and the *U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories* (QSM), version 4.2.
- After entry into the laboratory information management system (LIMS), a computerized report is generated and sent to the laboratory data reviewer.
- The data reviewer will decide whether any sample reanalysis is required.
- Upon acceptance of the preliminary reports by the data reviewer, final reports will be generated.

The laboratory data reviewer will evaluate the quality of the work based on an established set of laboratory guidelines. This person will review the data package to ensure the following:

- Sample preparation information is correct and complete,
- Analysis information is correct and complete,
- The appropriate SOPs have been followed,
- Analytical results are correct and complete,
- QC samples are within project-specific control limits, and
- Special sample preparation and analytical requirements have been met.

Documentation is complete when all anomalies in the preparation and analysis have been documented.

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory QA director. The laboratory program administrator (PA) is responsible for assessing data quality and advising the project manager of any data that were rated “preliminary” or “unacceptable,” or other notations that would caution the data user of possible unreliability.

2.3 LABORATORY DOCUMENTATION

Analytical reports transmit final results, methods of analysis, levels of reporting, associated QC data, and method performance data. Level IV data reports, consisting of summary pages, full data including raw data, instrument printouts, and manually completed log sheets is the preferred deliverable format. The laboratory will submit the data report for each sample delivery group using a reporting format that presents the information required to support a Stage 2B validation as described in *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009), at a minimum. In addition, issues affecting the analytical process will be noted in the case narrative included in each report. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two or three significant figures.

Data are normally reported in units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight or activity per unit volume (e.g., micrograms per liter [µg/L] or milligrams per liter [mg/L]). Concentrations in solid or semisolid matrices are expressed in terms of weight or activity per unit weight of sample (e.g., micrograms per kilogram [µg/kg] or milligrams per kilogram [mg/kg]). Solid and semisolid matrices will also be reported on a dry weight basis. The sample-specific sensitivity limits (detection limits [DLs], limits of detection [LODs], and limits of quantitation [LOQs]) are reported adjusted for subsample size and percent moisture, as well as all appropriate concentration, dilution, and extraction factors.

If any analytical anomalies are encountered during the analyses (e.g., an out-of-control matrix duplicate), it will be documented in a case narrative and copies of the sample discrepancy reports or corrective action reports must be included in the laboratory data reports.

2.4 LABORATORY RECORD-KEEPING

At a minimum, the project laboratories will retain all data related to sample preparation, analysis, and general observations in appropriate hardbound laboratory notebooks or files. Laboratory notebook pages must be reviewed, signed, and dated by the author and receive an independent secondary review by a peer or supervisor who signs/initials and dates the data pages.

Corrections to notebook entries are made by drawing a single line through the erroneous entry and writing the correct entry next to the one that is crossed out. All corrections are initialed and dated by the individual performing the correction.

After delivering acceptable hard copy and/or electronic data deliverables, the laboratory will store the original project data for at least 5 years unless otherwise specified in the subcontract agreement.

2.5 LABORATORY ACCREDITATION

Project analytical data will be produced by the Denver, Colorado, facility of TestAmerica. QA analyses will be performed by GEL Laboratories of Charleston, South Carolina.

2.5.1 Department of Defense Requirements

This project requires that the analytical data be generated by a laboratory that has been accredited under the DoD Environmental Laboratory Accreditation Program (ELAP). This accreditation involves the successful completion of an on-site audit by an auditing firm contracted by the DoD and the evaluation of performance evaluation sample results. Project laboratories required to maintain current DoD ELAP accreditation for all analyses, matrices, and analytes applicable to this project throughout the duration of this work.

2.5.2 State Requirements

The South Carolina Department of Health and Environmental Control (SCDHEC) has an accreditation program for laboratories that conduct analysis on environmental samples. Project laboratories required to maintain current SCDHEC accreditation for all analyses, matrices, and analytes applicable to this project throughout the duration of this work.

2.5.3 Other Assessment and Audit Tasks

No subcontractor laboratory technical system audits are planned for this project; however, an audit may be performed at any time during this program at HGL's discretion or at client direction. In the event that laboratory performance does not meet QAPP requirements and/or significant data quality issues arise, HGL reserves the right to perform additional system/project audits at any time throughout the program.

3.0 SUBCONTRACTOR DATA MANAGEMENT REQUIREMENTS

Upon receipt of a laboratory data package and the associated electronic data deliverables (EDD), HGL will perform data management tasks required to ensure that all analyses were performed in accordance with project requirements. The data management requirements include conducting data verification, data evaluation, and data validation to determine the usability of the data for the original project objectives. Data verification, data evaluation, and data validation are each separate levels of review that can be performed by themselves or in conjunction with each other. Evaluation activities will be documented in the QA reports listed in Worksheet #33 and will be used to assess the usability of project data in levels of detail ranging from an analyte- and sample-specific basis to the overall data set for the sampling event (see Attachment B).

3.1 DATA VERIFICATION

Initially, laboratory deliverables are received at HGL in both .pdf (laboratory data report) and EDD formats, as discussed previously. HGL will perform data verification on every report

submitted by a laboratory. Upon receipt of the laboratory deliverables, a data management staff member will perform the following actions:

- The deliverable will be inspected to verify that results were received for each requested analysis for each sample. If a result is missing, the staff member will determine whether the laboratory submitted a deficiency report that accounts for the missing data.
- The data deliverable will be inspected for completeness based on the requirements specified in this plan. Inspection will verify only that all required report elements are present, not that the data within the report are complete.

3.2 ELECTRONIC DATA VERIFICATION

All analytical results are required to be submitted to HGL in a format that meets the requirements of the Staged Electronic Data Deliverable (SEDD). EDDs will also be required to support Stage 2A automated data review (ADR). Once HGL verifies that each EDD meets format requirements, it will be loaded into the project's electronic database management program as "unvalidated" for user access on the network. These analytical results will be considered preliminary until data validation is complete.

The EDDs will be compared to the pdf version of the laboratory data report by the HGL data management coordinator. HGL will perform this review on 10 percent of the electronic data results. If a discrepancy is identified, the laboratory will be required to correct the error.

3.3 DATA EVALUATION

Data evaluation is performed to assess whether the QC requirements for field duplicates, laboratory duplicates, equipment blanks, surrogates, matrix spikes (MSs)/matrix spike duplicates (MSDs), percent solids, method blanks, and laboratory control samples (LCSs) were met. Data evaluation will be performed on 100 percent of the laboratory deliverables generated during this program. This data evaluation procedure will be performed in conjunction with the data validation performed on each data report and described below.

The first stage of data evaluation will be performed using the latest version of the ADR software program. The ADR software must be able to import a SEDD deliverable from the laboratory and export a SEDD deliverable (with the appropriate data review qualifiers). Following ADR, an LDC chemist will evaluate ADR outputs and integrate those results into the manual review process in accordance with Appendix D of HGL's corporate data validation SOP.

3.4 DATA VALIDATION

Data validation is a systematic process to ensure that all chemical analytical information meet uniform requirements and to determine that the usability and defensibility of the data are adequate for their intended use. Validation of analytical results will be performed by a Laboratory Data Consultants (LDC) chemist and another LDC chemist will perform peer

review of each data validation report. All applicable analytical data packages will be validated to ensure compliance with specified analytical, QA/QC requirements, data reduction procedures, data reporting requirements, and required accuracy, precision, and completeness criteria. Each validation report will be subject to peer review. Once finalized, each report will be transmitted to HGL.

Data validation will be performed on 100 percent of the results for environmental samples. Validation will consist of a review of those elements that compose a Stage 2B data validation as described in *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). All data will be validated by ADR; ADR review will be supplemented by a manual review by an LDC chemist to ensure that the outputs from ADR are consistent with conventional technical approached to data validation and to evaluate QC elements not reviewed by ADR. The data will be validated against the acceptance criteria presented in Appendices F and G of the QSM, version 4.2 and other applicable guidance. Data validation guidelines are presented below in Table A.1, and data qualifiers are defined in Table A.2. The data validation guidelines are based on the requirements of the QSM, version 4.2, and the analytical methods. The qualification requirements and data qualifiers are based on the EPA National Functional Guidelines for data review. These guidelines were developed for the review of data generated using Contract Laboratory Program analytical methods, and the qualification guidelines presented in Table A.1 have been modified to accommodate differences between Contract Laboratory Program method requirements and the method requirements presented in the SW-846 methods and the QSM.

Upon completion, the data validator will provide a data validation report and will provide an annotated EDD that contains all final data result qualifiers. These data qualifiers will then be uploaded into the project database.

Table A.1
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
Data Verification to be conducted manually by an LDC chemist				
Case narrative	The case narrative should be reviewed to determine if additional issues affected the sample analyses that could have an impact on data quality or be brought to the attention of the project chemist to initiate corrective action.			
Chain of custody	Review the chain of custody against the laboratory sample summary to ensure no transcription errors have occurred and no samples have been misidentified.			
Sample temperature (grab samples only)	Evidence of frozen samples	J	UJ	All method results in affected sample or cooler
	12°C ≥ temperature > 6°C (explosives and mercury)	J	UJ	All method results in affected sample or cooler
	temperature > 12°C (explosives and mercury)	J	R	All method results in affected sample or cooler
Sample condition	Issues noted	Validator discretion	Validator discretion	All method results in affected sample
Data Validation Elements to be Evaluated by ADR with Manual Review				
Holding time[3]	Holding time exceeded	J	UJ	All method results in affected sample
	Holding time exceeded by greater than a factor of 2	J	R	All method results in affected sample
Analyte quantitation	Analyte concentration below calibrated range	J	Not applicable	Affected results in sample
	Analyte concentration above calibrated range, no corresponding diluted result	J	Not applicable	Affected results in sample
Method (preparation) blanks	Analyte detected in blank ≥ DL Multiply value by 10 for common lab contaminants, or by 5 for other analytes, to obtain action level	B (detected results below action level)	Not applicable	Affected analyte results in preparation batch

Table A.1 (continued)
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
Method (preparation) blanks (inorganic methods)	Negative drift with absolute value ≥ DL Same as laboratory blanks; convert to equivalent soil units if necessary Absolute value < LOD Absolute value ≥ LOD	 J J	 UJ R	Analyte results in preparation batch
Equipment blanks	Same as laboratory blanks	B (detected results below action level)	Not applicable	Affected analyte results in samples in the same sampling event (same day)
Surrogate recovery (organic methods)	recovery > UCL 10% < recovery < LCL recovery < 10% 1 or more mixed high and low (>10%)	J J J J	Not applicable UJ R UJ	All method results in affected sample
LCS recovery	recovery > UCL LCL > recovery > ME recovery < ME	J J J	Not applicable UJ R	Affected analyte results in the preparation batch
LCS/LCSD RPD	RPD > CL	J	Not applicable	Affected analyte results in the preparation batch
MS/MSD[3] (organic methods)	recovery > UCL recovery < LCL Precision > CL	J J J	Not applicable UJ Not applicable	Parent sample only
MS/MSD[3] (inorganic methods)	recovery > UCL 30% < recovery < LCL recovery < 30% Precision > CL	J J J J	Not applicable UJ R Not applicable	Affected analyte results in the preparation batch
MS/MSD (all methods)	*Manual Review*: 1) If an analyte concentration native in the sample is greater than 4x the concentration spiked, MS/MSD results are considered not to be applicable for that analyte and no qualification should be applied based on MS/MSD results. 2) MS/MSD discrepancies noted in samples requiring dilution are unlikely to be caused by matrix effects. 3) If, in the judgment of the reviewer, the spiked sample is not considered represented of the other samples in the preparation batch, only the parent sample is qualified. 4) If an MS/MSD from another SDG is reported as batch control, determine if that MS/MSD is from a project sample and applicable to the reported sample results or from a sample from a different project and the MS/MSD results are not applicable.			

Table A.1 (continued)
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
Laboratory replicate %RSD	%RSD ≤20% (use LOD as the nominal value for non-detected results)	J	UJ	Affected analyte results in the preparation batch
Field replicate %RSD	Same as laboratory replicate	Same as laboratory replicate	Same as laboratory replicate	Parent and replicate samples only
All triplicate results	*Manual Review*: 1) ADR is only able to evaluate the %RSD of triplicate results. For those results that are considered low-level (less than 5x LOQ), the reviewing chemist should verify that the results meet the absolute difference requirement. 2) If, in the judgment of the reviewer, the laboratory triplicate parent sample is not considered represented of the other samples in the preparation batch, only the parent sample is qualified.			
Completeness and compliance checks of instrument-related QC (all performed by manual review)				
Instrument tuning	Method tuning requirements	R	R	All sample analyses associated with affected tune
Initial calibration linearity	Method-specific criteria (Worksheet #24)	J	UJ	Affected analyte results associated with the initial calibration
Low-level calibration verification at LOQ (metals)	recovery >120% 80% > recovery ≥ 50% recovery <50%	J J J	Not applicable UJ R	Analyte results in the analytical batch: all non-detections and detections ≤10x LOQ; if associated CRDL standard results within 90-110%, then only detections ≤2x LOQ are affected
CCV %D (organic methods)	Method-specific criteria (Worksheet #24)	J	UJ	Affected analyte results associated with the continuing calibration

Table A.1 (continued)
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
ICV and CCV recoveries (inorganic methods)	%R above method-specific criteria (Worksheet #24)	J	Not applicable	Affected analyte results bracketed by the ICV or CCV
	%R less than method-specific criteria (Worksheet #24) but ≥75%	J	UJ	Affected analyte results bracketed by the ICV or CCV
	Recovery <75%	J	R	Affected analyte results bracketed by the ICV or CCV
Low-level ICV and CCV recoveries (inorganic methods)	%R above method-specific criteria (Worksheet #24)	J	Not applicable	Affected analyte results bracketed by the ICV or CCV; only affects non-detected results and results <10x the LOQ
	%R less than method-specific criteria (Worksheet #24) but ≥50%	J	UJ	
	Recovery <50%	J	R	
ICBs and CCBs (metals)	Positive results ≥DL: Same as method blanks; convert to equivalent soil units if necessary	B (detected results below action level)	Not applicable	ICB: Analyte results in analytical batch CCB: Analyte results bracketed by the CCB
	Negative drift with absolute value ≥DL Same as method blanks; convert to equivalent soil units if necessary Absolute value <LOD Absolute value ≥LOD	 J J	 UJ R	ICB: Analyte results in analytical batch CCB: Analyte results bracketed by the CCB

Table A.1 (continued)
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
ICS A (metals)	Spiked analyte >120% 79% > recovery ≥ 50% Spiked analyte <50%	J J J	Not applicable UJ R	Analyte results in the analytical batch
	Non-spiked analyte ≥LOD: multiply by 10 for action level; convert to equivalent soil units if necessary	J	Not applicable	Analyte results bracketed by the ICS A
	Non-spiked analyte ≥LOQ: multiply by 10 for action level; convert to equivalent soil units if necessary	R	Not applicable	Analyte results bracketed by the ICS A
	Non-spiked analyte with negative result with absolute value ≥LOD: multiply by 10 for action level; convert to equivalent soil units if necessary	J	UJ	Analyte results bracketed by the ICS A
	Non-spiked analyte with negative result with absolute value ≥LOQ: multiply by 10 for action level; convert to equivalent soil units if necessary	J	R	Analyte results bracketed by the ICS A
ICS AB (metals)	Spiked analyte >120% 79% > recovery > 50% Spiked analyte <50%	J J J	Not applicable UJ R	Analyte results bracketed by the ICS AB
Serial dilution (metals)	%D > 10% for analytes ≥50x LOQ	J	UJ	Affected analyte results in the preparation batch. If PDS results are in control, no qualification is necessary.
PDS (metals)[3] [*Only required if serial dilution results do not meet criteria or if analytes not present >50x LOQ in serial dilution parent sample*]	recovery >125% 75% > recovery ≥ 50% recovery <50%	J J J	Not applicable UJ R	Analyte results in the preparation batch

Table A.1 (continued)
Data Qualification Guidelines

Control Parameter	Exceedance of Control Limits	Qualification of Detected Results[1]	Qualification of Non-Detected Results[2]	Associated Results
Internal standards (metals)	Method response criteria (Worksheet #12) not met	J	R	Target analytes quantitated using affected IS in affected sample.
Additional Items to be Addressed during Manual Review				
Multiple results reported for an analyte in a single sample/method combination due to multiple dilution levels or reanalysis due to QC issue	NA; the validator will review the available data and associated QC results and determine the 'best' data point for each analyte reported for each sample	X	X	Applied to all results not selected as the 'best' data point.
Calculation and transcription verification	Errors or inconstancies noted	Validator judgment	Validator judgment	Results associated with the error; also notify HGL Project Manager or Senior Chemist
General data review	QC element not performed	Validator judgment	Validator judgment	Results associated with missing QC element

Notes:
[1] The priority of qualifiers for detected results is: X > R > B > J >no qualifier.
[2] The priority of qualifiers for non-detected results is: X > R > UJ > U.
[3] All project preparation and analytical methods have holding times greater than 72 hours and holding time compliance will be evaluated on the basis of elapsed calendar days.
[4] MS/MSD and post-digestion spike results for an analyte are not considered applicable if the concentration in the parent sample is >4x the spike concentration.
[5] When comparing triplicate results, the numerical value of non-detected results should be considered to be the LOD. Three results below the LOQ or a combination of results below the LOQ and non-detections are always considered to be in control.

CCB - continuing calibration blank
CCV - continuing calibration verification
CL - control limit
%D - percent difference
DL - detection limit
ICB - initial calibration blank
ICP-MS - inductively coupled plasma-mass spectrometry
ICS - interference check sample
IS - internal standard
LOD - limit of detection
LOQ - limit of quantitation
PDS - post-digestion spike
RPD - relative percent difference
%RSD - percent relative standard deviation
UCL - upper control limit

Table A.2
Data Qualifier Definitions

Qualifier	Definition
No qualifier	Confirmed identification. The analyte was positively identified at the reported concentration. The reported concentration is within the calibrated range of the instrument and the result is not affected by any deficiencies in the associated QC criteria.
B	Not detected substantially above that level reported in the associated field or laboratory blanks. The concentration is considered an artifact.
J	The analyte was detected at the reported concentration; the quantitation is an estimate.
R	The result is rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria.
U	Not detected. The associated number indicates the analyte LOD.
UJ	Not detected. The associated number indicates the analyte LOD, which may be inaccurate.
X	Excluded. The data point is associated with reanalyses or diluted analyses and is excluded because another result has been selected as the definitive result for the analyte.

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ATTACHMENT B

USABILITY ASSESSMENT

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ATTACHMENT B
USABILITY ASSESSMENT

1.0 INTRODUCTION

Assessment of the data usability is an important project component and will be performed as a preliminary step of the data interpretation phase. The assessment process summarized in Worksheet #37 is described in more detail in this attachment. The HydroGeoLogic, Inc. (HGL) personnel with primary responsibility for completing the data usability assessment process are the HGL project manager, the HGL project chemist, and the HGL database manager.

The data usability assessment is considered the final step in the data evaluation process and can be performed only on data of known and documented quality. As described in Worksheet #36, data generated for this project will undergo a formalized evaluation/validation process. Data usability goes beyond validation in that it evaluates the achievement of the data quality objectives (DQOs) based on the comparison of the project data quality indicator (DQIs) and individual study-specific work plans with the obtained results. The results of the data usability assessment, and particularly any changes to the DQOs necessitated by the data not meeting usability criteria, will be included in the final report.

2.0 INTERFACE WITH VALIDATION ACTIVITIES

Laboratory Data Consultants (LDC) will perform data validation, data quality evaluation (including authoring the project Quality Control Summary Report [QCSR]), and risk assessment. Prior to performing the usability assessment, LDC will perform the data verification, evaluation, and validation activities described in Attachment A (summarized in Worksheets #33 through #36). HGL will evaluate sampling team and laboratory compliance with the requirements with this quality assurance project plan (QAPP) and other project planning documents. HGL will perform senior review of LDC's data validation findings and HGL's data management team will incorporate the final data qualifiers into the project database. Once data validation is complete, the results of the validation will guide LDC's usability assessment. The usability assessment will examine the performance of the quality control elements relating to precision, accuracy, representativeness, comparability, completeness (both sample collection and analytical), and sensitivity. The assessment will also identify the existence and impact of any data gaps resulting from sampling incompleteness (e.g., due to insufficient water in a well) or from rejected data. The findings of the usability assessment will be reported in the QCSR.

3.0 USABILITY ASSESSMENT PROCEDURES

The assessment of data usability will primarily follow procedures described in appropriate U.S. Environmental Protection Agency (EPA) guidance documents, particularly *Guidance for*

Data Usability in Risk Assessment (Publication No. 9285.7-05FS, September 1992), and will be conducted according to the process outlined below.

3.1 REVIEW OF SAMPLING AND ANALYSIS PROGRAM

The first step of the data usability assessment will include a review of the sampling and analysis activities in comparison to the requirements of the project planning documents (work plan and QAPP) and to the project-specific DQIs. Specific limitations to the data, such as the effect of results that are qualified as estimated (J/UJ) or rejected (R), will be determined and documented in the database.

3.2 ACHIEVEMENT OF DQIS

The second part of data usability pertains to the achievement of the program-specific DQIs. The performance achieved for each data quality criterion will be evaluated against the expected and planned performance. In general, this comparison will follow from the DQIs used to define each DQO. This comparison is the most critical component of the assessment process. Any deviation from planned performance will be documented and evaluated to determine whether corrective action is advisable. Potential corrective actions will range from resampling and/or reanalysis of data, to qualification or exclusion of the data for use in the data interpretation. In the event that corrective action is not possible, the limitations, if any, of the data with regard to achieving the DQOs will be noted.

In conjunction with the review of performance against the DQI requirements, the investigators will need to make decisions for the use of qualified values, which are a consequence of the formalized evaluation/validation process. Data qualifiers will be applied to individual data results. Data usability decisions will be made based on the assessment of the usability of each of these results for the intended purpose. Evaluation will describe the uncertainty (such as bias and imprecision) of the qualified results. Multiple discrepancies in DQIs may require technical judgment to determine the overall effect on the usability of the associated data. Decisions about usability of qualified data for use in risk assessment will be based on the EPA guidance, which allows for the use of estimated values. Finally, data users may choose to determine final data usability qualifiers as a result of this overall examination and decision process.

3.3 ACHIEVEMENT OF DQOS

The third step in the data usability process concerns achievement of the DQOs. Once the dataset has been assessed to be of known quality, data limitations have been documented, and overall result applicability/usability for its intended purpose has been determined, the final data assessment can be initiated by considering the answers to the following questions:

- Are the data adequate to determine the extent to which hazardous substances have migrated or to what extent they were expected to migrate from potential hazardous substance source areas?
- Do the data collected adequately characterize the nature and extent of potential hazardous substance source areas at the site?

- Are the data statistically adequate to evaluate likely exposure concentrations on a per chemical and per medium basis?
- Do the data collected allow assessment of factors that may influence contaminant migration/distribution?
- Is the sample set sufficient to develop site-specific removal and disposal treatment methodologies?
- Have sufficient data been collected to evaluate how factors, including physical characteristics of the site and climate and water table fluctuations, affect contaminant fate and transport?
- Have sufficient data been collected to determine the toxicity, environmental fate, and other significant characteristics of each hazardous substance present?
- Is the dataset sufficient to evaluate the potential extent and risk of future releases of hazardous substances, which may remain as residual contamination at the source facility?

The study principal investigators, in conjunction with the project team, will need to formulate solutions if data gaps are found as a result of problems, biases, trends, etc., in the analytical data, or if conditions exist that were not anticipated in the development of the DQOs. It is particularly important that each data usability evaluation specifically address any limitations on the use of the data that may result from a failure to achieve the stipulated DQO. If the project scope changes, the DQOs will be expanded. The DQOs will address the specific action limits and measurable performance criteria, in order to make appropriate decisions on the analytical data.

3.4 QUALITY ASSURANCE SAMPLE EVALUATION

Quality assurance (QA) samples will not be required.

4.0 COMPLETENESS

Project-specific completeness goals account for all aspects of sample handling, from collection through data reporting. The level of completeness can be affected by loss or breakage of samples during transport, as well as external problems that prohibit collection of the sample.

The formula for sampling completeness is as follows:

$$\% \text{ Field Sampling Completeness} = \frac{\text{Number of data points collected}}{\text{Number of data points planned}} \text{ X } 100$$

The formula for analytical completeness is as follows:

$$\% \text{ Analytical Completeness} = \frac{\text{Number of usable results (not qualified R)}}{\text{Number of results reported}} \text{ X } 100$$

The ability to meet or exceed completeness objectives is dependent on field team performance, site conditions, the nature of samples submitted for analysis, and laboratory performance. The following table lists the completeness goals for this program. If the completeness goals are not met because of controllable circumstances, then the need for samples to be recollected and reanalyzed will be evaluated. If the completeness goals are not met because of uncontrollable circumstances, such as inaccessible sample points or matrix interferences, then the impact of the deficiency will be evaluated.

Task	Subtask	Completeness Goal
Sampling	Sample Collection	95%
Analytical Measurements	All Laboratory Analyses	95% of collected analytes (total)
		80% per target analyte

It should be noted that evaluation of completeness is a screening tool and that completeness alone does not determine whether a dataset is sufficient to meet project DQOs. The completeness determined for the investigations performed at each site can guide the data assessment process, but is only a component of this process. Datasets that do not meet the overall completeness goals may still be determined to be usable without resampling or reanalysis, and datasets that do meet completeness goals may still be determined to have significant data gaps at critical data points or for critical target analytes that will require resampling or reanalysis.

ATTACHMENT C

ANALYTICAL SOPS
(TestAmerica on CD-ROM)
GEL SOPs – Confidential Business Information
These documents are available for review upon request accompanied by a confidentiality agreement

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Title: Nitroaromatic and Nitroamine Explosive Compounds by High Performance Liquid Chromatography (HPLC) [SW-846 8330A & 8330B]

Approvals (Signature/Date):

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Health & Safety Manager / Coordinator — Date
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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the determination of nitroaromatic and nitroamine explosive residues by high performance liquid chromatography (HPLC) using dual columns and dual UV wavelengths. This includes analysis in water, soil, and sediment matrices. The instrumental analysis is based on EPA Methods 8330A and 8330B.

1.2 This SOP does not include the extraction procedures. For those details, please refer to DV-OP-0017 *Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from water samples by SW-846 3535A* and DV-OP-0018 *The Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples by SW-846 8330A and 8330B.*

1.3 On occasion, clients may request modifications to this SOP. Requests for modifications must be received in writing and will be communicated to the laboratory through method comments in the LIMS.

1.4 Application of 8330A versus 8330B

1.4.1 This procedure is for analysis by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the multi-increment field sampling process described in Appendix A of 8330B. If multi-increment or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires (see details in DV-OP-0018) may add little or no improvement in the overall precision of results.

1.4.2 For soil analysis, a larger sample size is used for 8330B (10 g) than is used for 8330A (2 g).

1.4.3 8330A only describes the cyano (CN) column for confirmation. 8330B gives the option of either cyano (CN) or pheny-hexyl columns for confirmation. Because it provides better sensitivity and resolution, TestAmerica Denver routinely confirms using the Phenomenex Luna Phenyl-Hexyl column for both methods.

1.4.4 8330B also added compounds to the potential analyte list. TestAmerica Denver offers all of the compounds shown in Appendix 1 of this SOP by both methods, except 3,5-dinitroaniline, which is only analyzed by 8330B.

1.5 Analytes, Matrix(s), and Reporting Limits

1.5.1 The list of analytes, CAS numbers, abbreviations and TA-Denver's standard reporting limits can be found in Appendix 1.

1.5.2 The working ranges of this method are as follows:

Analytes	8330A Soil (2g prep)	8330B Soil (10g prep)	Water
All Analytes except nitroglycerin and PETN	0.1 μg/g – 25 μg/g	0.04 μg/g – 10 μg/g	0.1 μg/L - 25 μg/L
Nitroglycerin and PETN	1.0 μg/g – 250 μg/g	0.40 μg/g – 100 μg/g	1.0 μg/L - 250 μg/L

2.0 Summary of Method

2.1 Instrument calibration is performed by external standardization using a minimum of five concentration levels.

2.2 An acetic acid and phosphate buffer in water / methanol gradient program is used for HPLC separation (see details in Section 7.8.10 and Appendix 4). Compounds are tentatively identified based on retention time and detection by the UV detector using the primary Phenomenex Ultracarb C18 column. Confirmation is performed by the UV detector using a Phenomenex Luna Phenyl-Hexyl column (see Appendix 4 for instrument conditions).

3.0 Definitions

3.1 Explosives: As used in this SOP, the term "explosives" refers specifically to the analytes listed in Appendix 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.2 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM) and in SOP QA-DV-003P.

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is analyzed immediately following a high-concentration sample. This potential is minimized by continuously flushing the needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

4.3 Co-elution of target analytes with non-target analytes can occur, resulting in false positives or biased high results.

4.4 Co-elution between target analytes can occur when high concentrations of individual compounds are present in samples, see Section 12.2.3.5 for details.

4.5 The inclusion of vegetation is not recommended given the nature of the detector and different uses the data will potentially support (USACE comment – Issue #306 TA Denver Audit Database).

4.6 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All samples are acidified prior to extraction to preserve tetryl. Working-level calibration standards are also prepared with acidified water to preserve and stabilize tetryl. All samples expected to contain tetryl should not be exposed to temperatures above room temperature. (Reference: EPA Method 8330A & 8330B, Section 4.3)

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual (RSM) and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and

health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately.

5.1.2 If a sample is expected to have an explosive concentration ≥2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

WARNING: Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have a moisture content of 25% or greater. Under no circumstances shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.1.3 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.2 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

MATERIAL [1]	HAZARDS	EXPOSURE LIMIT [2]	SIGNS AND SYMPTOMS OF EXPOSURE
Acetonitrile	Flammable Poison	40 ppm – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Glacial Acetic Acid	Corrosive Poison Flammable	10 ppm - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns.

MATERIAL [1]	HAZARDS	EXPOSURE LIMIT [2]	SIGNS AND SYMPTOMS OF EXPOSURE
	Liquid and Vapor		Contact with eyes may cause severe damage followed by loss of sight.
Methanol	Flammable Poison Irritant	200 ppm - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
Phosphoric Acid	Corrosive	1 ppm - TWA	Ingestion can cause severe burns to the throat, mouth, and stomach, abdominal pain and nausea. Severe exposures by ingestion can lead to shock, circulatory collapse, and death. Inhalation is not an expected hazard unless misted. Corrosive, contact with skin or eyes can cause redness, pain, severe burns, blurred vision, and permanent eye damage.
Sodium hydroxide	Corrosive Poison	2 mg/m^3	Effects from inhalation of dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, runny nose. Contact with skin can cause irritation or severe burns and scarring with greater exposures. Causes irritation of eyes and can cause burns that may result in permanent impairment of vision, even blindness with greater exposures.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 HPLC System

HPLC, equipped with a pump capable of achieving 6000 psi, a 100 µL loop injector, and a Diode Array Detector (DAD) or Multi-Wavelength Detector (MWD), Hewlett Packard Model 1100, or equivalent.

6.1.2 Primary Column: Reverse phase HPLC column, 15 cm x 4.6 mm (5 µm), Phenomenex Ultracarb ODS (20) or equivalent.

6.1.3 Confirmation Column: Phenomenex Luna Phenyl-Hexyl reverse phase HPLC column, 15 cm x 4.6 mm (3 µm) or equivalent.

6.1.4 Hewlett Packard HPLC Chem Station for instrument control.

6.2 Supplies

6.2.1 Glass vials, various sizes.

6.2.1.1 Amber glass, 8.0 mL, with Teflon-lined screw caps, for the storage of standards.

6.2.1.2 Crimp-top vial with caps for analysis, 1.8 mL.

6.2.2 Disposable pipettes, used for non-quantitative transfers only.

6.2.3 Volumetric flasks, various sizes.

6.2.4 Hamilton syringes, various sizes.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

7.1 Stock Standards

7.1.1 Stock standards are purchased as certified solutions or prepared from 100%, neat materials. Stock standard solutions are stored at -10 °C to -20 °C, or per vender instructions. All stock standards must be protected from light and should be brought to room temperature before using.

7.1.2 Stock standard solutions must be replaced after 1 year or sooner if comparison with check standards prepared from an independent source indicates a problem. Expiration times for all standards are measured from the time the standard is prepared or from the time that the standard ampoule is opened, if the standard is supplied in a sealed ampoule.

7.1.3 3,5-Dinitroaniline is purchased at a concentration of 20 μg/mL in acetonitrile, equivalent to our intermediate standard level. This standard is added directly to the working calibration standards (Section 7.5).

7.1.4 MNX is purchased as a pre-weighed neat standard and comes in powder form. A quantitative transfer is performed and the final concentration calculated for the high level MNX standard. The volume of this standard used for intermediate stock preparation will vary depending on the initial weight of MNX sent. This is the only known source of MNX and we do not currently have a second source for this compound.

7.2 Volume Measurements for all Standards Preparation

The volume of stock and intermediate standard solutions used in subsequent dilutions is measured using Hamilton syringes appropriate for the volume being measured and accurate to 2%. Standards are prepared either by (1) using a syringe to measure the standard solution and bringing to volume with the appropriate solvent in a Class A volumetric flask, or by (2) measuring the volumes of both the standard solution and the solvent using a calibrated syringe or Class A pipette and combining them in a vial.

7.3 High-Level Calibration Mix, Prepared from Stock Standards

This high level standards must be replaced every 1 year or sooner if comparison with check standards prepared from independent sources indicates a problem.

A solution is prepared to contain most standard analytes at a concentration of 100 μg/mL each in acetonitrile (see details in standards database instructions) with the exception of nitroglycerin and PETN, which are prepared at 1000 μg/mL. 3,5-

Dinitroaniline is purchased as a separate stock standard, and is not included in this mixture.

7.4 Intermediate Level Calibration Standard

Prepare a 20 μg/mL solution (nitroglycerin and PETN at 200 μg/mL) from the high-level calibration mix (see Section 7.3) by diluting 1.0 ± 0.02 mL to a final volume of 5.0 mL in acetonitrile. The shelf life of this material is 6 months.

7.5 Working Level Standards for Calibration Curve

Prepare calibration standards by diluting the intermediate standard solutions as shown in the table below using the 75%:25% (v/v) acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration and refrigerated if not used immediately. All volumes are measured using the appropriately sized Hamilton syringe.

7.5.1 On the primary (C18) column, 3,5-dinitroaniline must be calibrated using a separate set of calibration standards due to co-elutions with other target compounds. The 3,5-dinitroaniline calibration is made with the same volumes of intermediate 3,5-DNA stock and solvent as the full-list "Primary (C18) Column Calibration" in the following table.

7.5.2 On the confirmation (phenyl-hexyl) column, the intermediate full-list and intermediate 3,5-dinitroaniline stocks can be combined into the same calibration standards and follow the "Confirmation (Phenyl-Hexyl) Column Calibration" recipes in the following table.

Recommended Calibration Levels

Calibration Level	Final Concentration (μg/mL)		Primary (C18) Column Calibration		Confirmation (Phenyl-Hexyl) Column Calibration	
	Standard Analytes	***NG & PETN***	***Vol. Intermediate (μL)***	***Vol. Solvent (μL)***	***Vol. EACH Intermediate (μL)***	***Vol. Solvent (μL)***
8	2.5	25.0	125 ± 1	875 ± 9	125 ± 1	750 ± 9
7	1.0	10.0	50 ± 0.5	950 ± 10	50 ± 0.5	900 ± 10
6	0.7	7.0	35 ± 0.4	965 ± 10	35 ± 0.4	930 ± 10
5	0.4	4.0	20 ± 0.2	980 ± 10	20 ± 0.2	960 ± 10
4*	0.25	2.5	12.5 ± 0.1	988 ± 10	12.5 ± 0.1	975 ± 10
3	0.1	1.0	5 ± 0.05	995 ± 10	5 ± 0.05	990 ± 10
2	0.05	0.5	2.5 ± 0.02	998 ± 10	2.5 ± 0.02	995 ± 10
1	0.01	0.1	10 ± 0.1 μL of Level 7	990 ± 10	10 ± 0.1 μL of Level 7	990 ± 10
*** Level 4 concentration is used for the daily and continuing calibrations.**						

7.6 Extractions Standards

7.6.1 LCS Spike Solution

The LCS spike solution is prepared at a working level concentration of 10 μg/mL (nitroglycerin and PETN at 100 μg/mL) in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

This standard contains all explosives target compounds except 3,5-dinitroaniline, 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene.

7.6.2 3,5-Dinitroaniline LCS Solution

The 3,5-DNA LCS solution is prepared at a working level concentration of 10 μg/mL in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is used only for method 8330B and is added to separate LCS and MS/MSD samples as this compound cannot be completely resolved from tetryl and nitrobenzene on the primary column.

7.6.3 Diamino LCS Solution

The Diamino LCS solution is prepared at a working level concentration of 10 μg/mL in acetonitrile of 2,4-diamino-6-nitrotoluene and 2,6-diamino-4-nitrotoluene. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible. This standard is generally added to separate LCS and MS/MSD samples, although it can be spiked in addition to either the LCS Spike Solution or the 3,5-Dinitroaniline LCS Solution.

7.6.4 Working Level Surrogate (1,2-Dinitrobenzene) Solution

The 8330 surrogate solution is prepared at a working level concentration of 10 μg/mL in acetonitrile. This standard is stored in a freezer at –20°C to –10°C and given a six-month expiration date. The standard is allowed to come to room temperature before use and returned to the freezer as soon as possible.

7.7 Second Source Initial Calibration Verification Solution

The second source standard must be obtained from a different source than the standards used for initial calibration. This standard is used to verify the accuracy of the calibration standards.

NOTE: There is currently no second source available for MNX.

7.7.1 Working-Level Second Source Mix

Prepare a solution containing all compounds except 3,5-dinitroaniline at a concentration of 0.40 µg/mL (nitroglycerin and PETN at 4.0 µg/mL). A separate solution containing 3,5-dinitroaniline is prepared at a concentration of 0.40 µg/mL when analyzing on the primary (C18) column; the standards can be combined for analysis on the confirmation (phenyl-hexyl) column. These solutions are prepared using the 75%:25% (v/v)

acidic water:ACN solution (described in Section 7.8.7). These standards must be prepared fresh on the day of calibration. All volumes are measured using the appropriately sized Hamilton syringe.

7.8 Reagents

7.8.1 Reagent Water

For method blanks and laboratory control samples reagent water is generated by an ELGA water purification system. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.8.2 HPLC Grade Water

7.8.3 Acetonitrile, CH_3CN (ACN) - HPLC grade

7.8.4 Methanol - HPLC grade

7.8.5 Glacial Acetic Acid – Reagent Grade

7.8.6 85% Phosphoric acid, H_3PO_4 – Reagent Grade.

7.8.7 Acidified Water (75%) : Acetonitrile Solution (25%)

Take 250 mL of acetonitrile (ACN), and bring to 1.0 L with Elga or HPLC-grade water. Acidify the solution to a pH of approximately 3 by adding 20 drops (1 mL) of 85% phosphoric acid (H_3PO_4).

7.8.8 Acidified Calcium Chloride, $CaCl_2$ Solution, 5 g/L

Place 5 ± 0.05 g of reagent grade $CaCl_2$ into a one-liter volumetric flask containing approximately 500 mL of deionized water. Swirl the solution until the $CaCl_2$ is dissolved. Add approximately 1 mL of 85% H_3PO_4 to acidify the solution and bring to volume with deionized water.

7.8.9 Sodium Phosphate Buffer Stock

Slowly add 115.29 grams of 85% phosphoric acid (molecular weight = 97.9924 g/mol) to approximately 500 mL of water in a 1 L beaker. Place a stir bar in the beaker and the beaker in an ice bath on top of a magnetic stirrer. Slowly add 150 mL of 10 M (10 M = 10 N) sodium hydroxide, allowing time for the mixture to cool down between additions. Transfer to a 1 L volumetric flask and bring to volume with Elga or HPLC-grade water. The final pH of this solution should be 7.2.

7.8.10 Buffer Eluents for Analysis:

Make up the HPLC eluents for each column as described in Sections 7.8.10.1 and 7.8.10.2. The pH of the working eluents *must* be modified by the analyst by changing the volume of glacial acetic acid added to ensure compound resolution. This is particularly necessary when the column is replaced, to ensure that picric acid does not co-elute with any other target compound. Increasing the concentration (or volume added) of glacial acetic acid will result in greater retention of picric acid.

7.8.10.1 Working Eluent for Primary (C18) Column:

Combine 1 L of water, 1 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and 50 µL of Glacial Acetic acid to

adjust the pH of the buffer to approximately 7.0. Make fresh before each run.

Picric acid needs to elute after RDX, but before 1,3,5-trinitrobenzene.

7.8.10.2 Working Eluent for Confirmation (Phenyl-Hexyl) Column:

Combine 1 L of water, 2 mL of Sodium Phosphate Buffer Stock solution (Section 7.8.9), and 65 µL of Glacial Acetic acid to adjust the pH of the buffer to approximately 7.0. Make fresh before each run.

Picric acid needs to elute after 2,4-diamino-6-nitrotoluene and before HMX.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Aqueous Samples

Water samples should be collected in duplicate 500 mL amber glass bottles with Teflon-lined caps.

8.2 Soil and Sediment Samples

8.2.1 For method 8330A, soil samples should be collected in eight-ounce wide mouth jars with Teflon-lined caps. When sampling for DoD projects that must comply with the DoD QSM Version 3 requirements for drying and grinding the entire contents of a soil sample container, a separate container should be used to collect a soil sample for this analysis.

8.2.2 For method 8330B, it is not uncommon to receive samples of 1 kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Samples and sample extracts must be stored in amber glass containers at ≤ 6°C from the time of collection through analysis, except during drying.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See DV-OP-0018 for details. Once the sample is air dried, the sample can be stored at room temperature.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Water	Amber glass	1 Liter (2 x 500 mL)	Cool; ≤ 6°C	7 Days to Extraction 40 Days to Analysis	SW846 8330A
Soil	Glass / plastic	4 grams (8330A) / up to 1 kg (8330B)	Cool; ≤ 6°C	14 Days to Extraction 40 Days to Analysis	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each column on which the associated samples are analyzed. See QC Policy DV-QA-003P for further details.

9.3 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of reagent water for aqueous samples, and Ottawa sand for soil samples, with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

Acceptance Criteria: The MB must not contain any analyte of interest at or above one-half the RL or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Method blanks are evaluated on each column on which associated samples are analyzed, when confirmation

data are required. If there is a detection on either column in the MB, then detections for that target compound are suspect in associated samples.

Corrective Action: When the MB fails acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize, or eliminate the problem. All samples in the QC batch that have concentrations of affected target analytes greater than the RL, but less than 10 times the concentration in the MB must be re-prepared and reanalyzed.

If there are no target analytes greater than the RL, then the data may be reported with qualifiers if this is acceptable to the client.

If the MB acceptance criteria are not met and re-preparation and reanalysis are not possible, then the sample data associated with the unacceptable MB must be qualified. This nonconformance must be addressed in the project or case narrative and the client must be notified.

9.4 Laboratory Control Sample (LCS)

One LCS must be analyzed with each batch of samples. The LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. For water samples, the LCS is prepared by spiking the analytes of interest into reagent water. For soil samples, the LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: The LCS recovery for each spiked analyte must be within established control limits. Laboratory default control limits are calculated as ± 3 standard deviations around the mean of historical data, as described in SOP DV-QA-003P. Control limits are maintained in the LIMS.

In accordance with the NELAC 2003 Standard (Quality Systems, Appendix D), a marginal exceedance within ± 4 standard deviations is allowed for one of the analytes. This is based on the number of analytes typically spiked for this method, which is between 11 and 30. These acceptance criteria may be superseded by project-specific limits, as applicable.

Corrective Action: If recoveries for all spiked analytes are not within the acceptance limits, including the one allowed marginal exceedance, the analytical system is out of control and corrective action must occur. Generally this requires re-extraction and reanalysis of all associated samples. If the LCS is biased high and all associated samples are

ND, not detected, it may be possible to report results with an NCM (see requirements for individual programs).

9.5 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks, equipment blanks, or rinse blanks cannot be used for MS/MSD analysis.

NOTE: The MS/MSD must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out, or will exceed the linear range of the calibration standards.

Acceptance Criteria: The spike recoveries must fall within established control limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. Control limits are calculated as ± 3 standard deviations around the mean of historical data, as described in Policy DV-QA-003P. Control limits are maintained in the LIMS. Some federal programs require LCS limits to be used for MS/MSD evaluation (see SOP DV-QA-024P).

Corrective Action: If analyte recovery in the MS and/or MSD or the RPD between the MS and MSD fail acceptance criteria, but the recovery of the LCS is in control, then the method is considered to be in control and the samples in the batch do <u>not</u> require re-preparation and reanalysis, unless the results indicate that a spiking error may have occurred. The reasons for accepting the batch must be documented in the case narrative. If the recovery of the LCS also fails acceptance criteria, then the samples in the batch must be re-prepared and reanalyzed.

9.6 Sample Duplicate

Although not typically required for organic analyses, a duplicate sample may be required for project-specific quality control. In this case, a sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

Acceptance Criteria: The RPD between the sample and the sample duplicate results must be less than the established limit.

Corrective Action: Results for samples that do not meet acceptance limits, particularly if due to difficulties in subsampling, shall be discussed in the final report case narrative, after client notification and agreement.

9.7 Sample Replicates

Replicate analyses are not part of the laboratories standard quality control samples. In the event that replicate analyses are required for a given project, the lab will extract triplicate aliquots after grinding on the client designated sample. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The method suggests that the %RSD for the subsampling error is acceptable if it is <10%.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\overline{C}} \times 100\% \qquad \textit{Equation 1}$$

Where s is the standard deviation of the average concentration ($\overline{C}$) and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{n-1}} \qquad \textit{Equation 2}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.8 Grinding Blank (GB)

Refer to SOP DV-OP-0018 for details on how the grinding blanks for soils by method 8330B are prepared.

Acceptance Criteria: The grinding blank must not contain any analyte of interest at or above one-half of the RL or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Corrective Action: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank producing positive results for the same contaminant must be reprocessed and reanalyzed. If unground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.9 Grinding LCS (LCSSRM)

Refer to SOP DV-OP-0018 for details on how the grinding LCS for soils by method 8330B is prepared. The grinding LCS is spiked by an outside vendor, and then ground with the associated samples.

Acceptance Criteria: The grinding LCS recovery for each spiked analyte must be within established control limits. Control limits are maintained in the LIMS.

Corrective Action: Per the method, the entire client sample is ground initially. Therefore, it is not possible to re-grind client samples if the grinding LCS fails. Sample results will be reported with an NCM (see requirements for individual programs).

If the surrogate compound recovers below control limits, or every compound recovers outside of control limits, but at approximately the same percentage, this could be an indication of a bad extraction (post-grinding). Associated samples will be sent for re-extraction and re-analysis.

9.10 Sample QC Frequency

The following quality control samples are prepared with each batch of samples.

Quality Controls	Frequency
Method Blank (MB)	1 in 20 or fewer samples
Laboratory Control Sample (LCS)[1]	1 in 20 or fewer samples
Matrix Spike (MS)[2]	1 in 20 or fewer samples
MS Duplicate (MSD)[2]	1 in 20 or fewer samples
Surrogates	every sample[3]

[1] LCS Duplicate (LCSD) is performed if insufficient sample is available for the MS/MSD and it is requested by the client/project/contract.

[2] The sample for MS/MSD is randomly selected, unless specifically requested by a client. This is predetermined by the extraction lab.

[3] Analytical and QC samples (MB, LCS, MS/MSD)

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Extraction of Water Samples – *Please reference DV-OP-0017 for details*

Samples are extracted using a 500 mL initial volume and are concentrated to a 5 mL final volume.

10.4 Extraction of Soil Samples – *Please reference DV-OP-0018 for details*

10.4.1 Samples for method 8330A are extracted using a 2 g initial weight and delivered to the analytical group with a 10 mL final volume. Samples for method 8330B are extracted using a 10 g initial weight and delivered to the analytical group with a 20 mL final volume.

10.4.2 TALS prep batches for soils will show a final volume of 20 mL for 8330A extracts, and 40 mL for 8330B extracts. These final volumes include the 1:1 dilutions with the acidified calcium chloride done by the analyst. (See Section 10.5.2.)

10.5 HPLC Analysis

10.5.1 HPLC Startup: All electronic equipment should be allowed to warm up for 30 minutes. During this period, at least 15 void volumes of mobile phase are passed through the column. Continue until the detector's baseline has stabilized.

10.5.2 Prior to analysis, soil extracts (or a portion of the extract) must be diluted exactly 1:1 with the acidified calcium chloride solution that is described in section 7.8.8.

10.5.3 Analyze the samples using the chromatographic conditions given in Appendix 4. All positive measurements above the method detection limit observed on the primary C18 column are confirmed by injection of the sample extract onto the confirmation Phenyl-Hexyl column.

10.5.4 Analytes are introduced by direct injection of the extract. Samples, standards, and QC samples must be introduced using the same procedure.

10.5.5 It has been demonstrated that water samples with total concentrations of 16,000 μg/L can yield low recoveries due to saturation of the extraction cartridge. The client should be contacted to determine if re-extraction using a smaller sample aliquot size is required for samples with concentrations in this range. The low extraction recovery may meet the client's action limit, such that a re-extraction may not be necessary to prevent possible laboratory contamination.

10.5.6 Analytical Sequence

10.5.6.1 The analytical sequence starts with either an initial calibration or a Continuing Calibration Verification (CCV).

10.5.6.2 The CCV includes analyzing standards that contain all target analytes, and updating the retention time windows. If 3,5-dinitroaniline is not a target compound, it is not required to analyze a CCV for this analyte.

10.5.6.3 If there is a break in the analytical sequence greater than 12 hours since the analysis of a CCV standard, a new CCV

standard must be analyzed before proceeding with the sequence.

10.5.7 Retention Time Windows

10.5.7.1 Retention time windows must be determined for all analytes. Make an injection of all analytes of interest each day for a three-day period. Calculate the standard deviation of the three retention times for each analyte (relative retention times may also be used). The width of the retention time window for each analyte is defined as ± three times the standard deviation.

10.5.7.2 The chromatograms in Appendices 5 and 6 summarize the estimated retention times on both the C18 and Phenyl-Hexyl columns for many of the compounds analyzed using this method.

10.5.7.3 The center of the retention time window is the retention time from the last of the three standards. The centers of the windows are updated with the mid-point of the initial calibration, and each subsequent CCV. The widths of the windows will remain the same until new windows are generated following the installation of a new column.

10.5.7.4 If the retention time window, as calculated above, is less than ± 0.07 minutes, use ± 0.07 minutes as the retention time window. This allows for slight variations in retention times caused by sample matrix. The absolute retention time windows are closely monitored and adjusted based on each calibration verification standard. This minimizes the possibility of false positive and false negative qualitative identifications.

10.5.7.5 The laboratory must calculate new retention time windows each time a new column is installed. Until these standards have been run on the new column, the retention time windows from the old column may be used, but updated with the retention times from the new initial calibration.

10.5.8 Daily Retention Time Windows

The center of the retention time window is adjusted to the retention time of each analyte, as determined in each CCV.

Corrective Action:

If there are shifts in retention times for target compounds between CCVs that are outside the established retention time window (see Section 10.5.7), all samples analyzed after the last compliant standard must be reanalyzed unless the following conditions are met for any compound that elutes outside the retention time window:

- The retention time of that compound in the standard must be within the retention time range equal to twice the original window, as determined by the opening CCV of a bracket.

- No peak that would be reportable may be present on the sample chromatogram within an elution time range equal to three times the original retention time window.

10.6 Calibration Range and Dilutions

10.6.1 If the concentration of any analyte exceeds the working range as defined by the calibration standards, then the sample must be diluted and reanalyzed. Dilutions should target the most concentrated analyte in the upper half (between the CCV and highest standard) of the calibration range.

10.6.2 Samples that are analyzed immediately following a sample with an unusually high concentration of explosives must be evaluated for carryover. The potential for carryover is minimized in the analytical system by continuously flushing the HPLC needle with solvent. If contamination is suspected, the sample should be re-aliquoted and re-analyzed.

10.6.3 Guidance for Dilutions Due to Matrix Interference:

It may also be necessary to dilute samples because of matrix interferences. If the sample is initially run at a dilution and only minor matrix peaks are present, then the sample should be reanalyzed at a more concentrated dilution. Analyst judgment is required to determine the most concentrated dilution that will not result in instrument contamination. Ideally, the dilution chosen will make the response of the matrix interferences equal to approximately half the response of the mid-level calibration standard.

10.6.4 Reporting Dilutions

Some projects require reporting of multiple dilutions (check method comments in the LIMS). In other cases, the lowest dilution with no target compounds above the calibration range will be reported. In general, a maximum of two dilutions will be reported; one at the lowest dilution and one in which the most concentrated target analyte is in the upper half of the calibration range.

11.0 Instrument Calibration

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S005, “Calibration Curves” and under the public folder, Arizona Calibration Training.

11.2 Instrument QC

11.2.1 External calibration is used for this analysis. Prepare standards containing each analyte of interest at a minimum of five concentration levels. The low level standard should be at or below the reporting limit. The other standards define the working range of the detector. Recommended calibration levels are given in Appendix 2.

11.2.2 A new calibration curve must be generated after major changes to the system or when the continuing calibration criteria cannot be met. Major changes include a new column and any changes in instrument operating parameters (including solvent flows, replacement of a detector lamp, replacement of the flow cell windows, etc.).

11.2.3 With the exception noted in Section 11.2.4 below, it is NOT acceptable to remove points from the calibration curve for the purpose of meeting criteria, unless the points are the highest or lowest on the curve AND the reporting limit and/or linear range is adjusted accordingly. In any event, at least 5 points must be included in the calibration curve.

11.2.4 A level may be removed from the calibration if the reason can be clearly documented (i.e., a broken vial or an injection error). A minimum of five levels must remain in the calibration. The documentation must be retained with the initial calibration.

11.3 Initial Calibration

Calibrations are modeled either as average response factors or as calibration curves, using a systematic approach to selecting the optimum calibration function in order as follows. When calibration acceptance criteria cannot be met for a model, appropriate corrective action must be taken. This may include processing the data using another model, instrument maintenance and or re-preparation of standards followed by recalibration.

11.3.1 The following requirements must be met for any calibration to be used:

11.3.1.1 Response must increase with increasing concentration.

11.3.1.2 Calibration curves will not be forced through the origin.

11.3.1.3 The absolute value of the intercept of the curve at zero response should ideally be less than the MDL for the analyte. At a minimum the intercept must be less than ½ the on-column equivalent of the reporting limit.

11.3.2 Linear Calibration Using Average Calibration Factors

11.3.2.1 External standard calibration using average calibration factors involves the comparison of instrument response (e.g., peak area or peak height) from the target compounds in the sample to the responses of the target compounds in the calibration standards. The ratio of the detector response to the concentration of target analyte in the calibration standard is defined as the calibration factor (CF), as follows:

$$CF = \frac{R_x}{C_s} \qquad \textit{Equation 3}$$

Where: R_x = Response for analyte
C_s = Concentration in calibration standard, μg/mL

11.3.2.2 For each target analyte, calculate the average calibration factor ($\overline{CF}$) as follows:

$$\overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n} \qquad \textit{Equation 4}$$

Where: n = Number of calibration levels
CF_i = Calibration factor for the i^{th} level

11.3.2.3 The calibration relationship can be graphically represented as a line through the origin with a slope equal to the average calibration factor.

11.3.2.4 The relative standard deviation (RSD) is calculated as follows:

$$RSD = \frac{SD}{\overline{CF}} x100\% \qquad \textit{Equation 5}$$

Where SD is the standard deviation of the average CF, which is calculated as follows:

$$SD = \sqrt{\frac{\sum_{i=1}^{n}\left(CF_i - \overline{CF}\right)^2}{n-1}} \qquad \textit{Equation 6}$$

11.3.2.5 To calculate the concentration in an unknown sample extract, the equation is solved for concentration, resulting in the following equation:

$$C_{ex} = \frac{R_x}{\overline{CF}} \qquad \textit{Equation 7}$$

Where: C_{ex} = Extract analyte concentration, µg/mL
R_x = Response for analyte
$\overline{CF}$ = Average Calibration Factor

11.3.3 Average Calibration Factor Evaluation

Examine the residuals, i.e., the difference between the actual calibration points and the plotted line. Particular attention should be paid to the residuals for the highest points, and if the residual values are relatively large, a linear regression should be considered.

Acceptance Criteria: The RSD of the average response factor must be <20%. Also examine the residuals, especially for the high points versus the fitted function. If the residual values are large, a linear regression should be considered.

Corrective Action: If the RSD is > 20%, average response factor cannot be used and least-squares linear regression should be attempted.

11.3.4 Linear Calibration Using Least-Squares Regression

Calibration using least-squares linear regression produces a straight line that does not pass through the origin. The calibration relationship is constructed by performing a linear regression of the instrument response

(peak area or peak height) versus the concentration of the standards. The instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x).

The weighting used is the reciprocal of the concentration or the reciprocal of the square of the concentration. The regression produces the slope and intercept terms for a linear equation in the following:

$$R_x = m_1(C_s) + b \qquad \textit{Equation 8}$$

Where:

C_s	=	Concentration in calibration standard, µg/mL
R_x	=	Response for analyte
b	=	y - Intercept
m_1	=	Slope

To calculate the concentration in an unknown sample extract, the regression equation is solved for concentration, resulting in the following equations, where C_{ex} is the concentration of the target analyte in the unknown sample:

$$C_{ex} = \frac{[R_x - b]}{m_1} \qquad \textit{Equation 9}$$

Where:

C_{ex}	=	Extract analyte concentration, µg/mL
R_x	=	Response for analyte
b	=	y - Intercept
m_1	=	Slope

11.3.5 Evaluation of the Linear Least-Squares Regression Calibration Function:

With an unweighted linear regression, points at the lower end of the calibration curve have less weight in determining the curve than points at the high concentration end of the curve. For this reason, inverse weighting of the linear function is recommended to optimize the accuracy at low concentrations.

Note that the August 7, 1998 EPA memorandum “Clarification Regarding Use of SW-846 Methods”, Attachment 2, Page 9, includes the statement “The Agency further recommends the use of this for weighted regression over the use of an unweighted regression.”

Acceptance Criteria:

11.3.5.1 Examine the residuals, but with particular attention to the residuals at the bottom of the curve. If the intercept or the residuals are large, a second-order regression should be considered.

11.3.5.2 The linear regression must have a correlation coefficient (r) ≥ 0.995 (r^2 ≥ 0.990).

11.3.6 Non-linear Calibration Using a Second-Order Equation

When the instrument response does not follow a linear model over a sufficiently wide working range, or when the previously described

calibration approaches fail acceptance criteria, a non-linear, second-order calibration model may be employed. The second-order calibration uses the following equation:

$$R_x = m_2(C_s)^2 + m_1(C_s) + b \qquad \textit{Equation 10}$$

Where:
- C_s = Analyte concentration in calibration standard, µg/mL
- R_x = Response for analyte
- m_2 = Curvature
- m_1 = Slope
- b = y - Intercept

To calculate the concentration in an unknown sample extract, the roots of the quadratic equation are solved for:

$$C_{ex} = \frac{-m_1 \pm \sqrt{(m_1)^2 - 4(m_2)(b - R_x)}}{2m_2} \qquad \textit{Equation 11}$$

Where:
- C_{ex} = Extract analyte concentration, µg/mL
- R_x = Response for analyte
- m_2 = Curvature
- m_1 = Slope
- b = y - Intercept

11.3.7 Evaluation of Second-Order Regression Calibration:

A minimum of six points must be used for a second-order regression fit.

Acceptance Criteria:

11.3.7.1 Second-order regressions should be the last option, and note that some programs (e.g., South Carolina) do not allow the use of second-order regressions.

11.3.7.2 The coefficient of determination (COD, r^2) must be ≥ 0.99.

11.3.7.3 The response increases significantly with increasing standard concentration (i.e., the instrument response does not plateau at high concentrations).

11.3.7.4 The distribution of concentrations is adequate to characterize the curvature.

11.4 Calibration Verification

11.4.1 Initial Calibration Verification (ICV)

A second-source verification standard must be analyzed with each initial calibration. The calculated concentration of the analytes in this standard may not be greater than 20% different from the calibration standard.

11.4.2 Detection Limit Check (DLCK)

For analysis of 8330B samples, after the analysis of the initial calibration standards, re-inject the lowest calibration standard. The calculated concentration of the analytes in this standard should be ± 50%.

11.4.3 Continuing Calibration Verification (CCV)

The working calibration curve or RF must be verified by the analysis of a mid-point continuing calibration standard at the beginning of the analysis sequence, after every 10 samples, and at the end of the analysis sequence.

Acceptance Criteria:

Results are acceptable for any individual compound if the %D (percent difference between the standard and measured values of the CCV standard) is ≤ 20%.

According to SW-846 Method 8000B, the calibration verification is also acceptable if the average of the %D values for all the analytes is ≤ 15%. This average is calculated by summing all the absolute %D results in the calibration (including surrogates) and dividing by the number of analytes. However, TestAmerica Denver also requires that no single analyte result exceeds 30% D.

NOTE: In order to comply with DoD QSM requirements, the use of the grand mean is not acceptable (refer to policy DV-QA-024P). Results are acceptable for individual compounds if the %D is:

8330A		8330B	
QSM 3	%D ≤ 20%	QSM 3	%D ≤ 20%
QSM 4	%D ≤ 15%	QSM 4	%D ≤ 20%

Corrective Action:

If the percent difference for any analyte falls outside of ± 20%, corrective action must be taken. This may include back flushing the column, changing the guard cartridge, changing the frit on the front end of the column, or other minor instrument adjustments, followed by reanalyzing the standard. If the response for any analyte still varies by more than 20%, a new calibration curve must be prepared and analyzed. The column may also need to be replaced based on the chromatography.

Reported sample results must be bracketed by successful CCVs. When a CCV fails, all samples run since the last successful calibration verification must be reanalyzed. If the CCV recovery is >20% D and the associated samples are ND, the samples may be reported without reanalysis. Flag the data and document the decision in an NCM.

12.0 Calculations / Data Reduction

12.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S005, “Calibration Curves” and under the public folder, Arizona Calibration Training.

12.2 Qualitative Identification

12.2.1 Tentative identification occurs when a peak is found within the retention time window for an analyte, at a concentration above the method detection limit. The required quantitation level is defined as the LIMS test code reporting limit for standard reports, adjusted for initial weight and volume and any dilutions. A UV detector wavelength of 254 nm is used to quantify and report all analytes except PETN and Nitroglycerin that are quantified and reported using a UV detector wavelength of 215 nm.

12.2.2 Identification is confirmed if a peak is also detected within the retention time window on a dissimilar column (Section 12.3).

12.2.3 Sample Evaluation:

12.2.3.1 Analyst judgment weighs heavily in the evaluation of retention time shifts for client samples. The evaluation may be based on RT shifts of the surrogate standard. The chromatograms must be examined closely to ensure that false positive / negative results are not reported. In the absence of significant shifts of the surrogate, peaks within a ± 0.07 minute window must be considered positive results.

12.2.3.2 If the sample required significant dilution due to high levels of target peaks or interfering compounds, the surrogate peak may not be obvious. In this case, an adjustment of RTs due to matrix for target compounds cannot be done reliably, and ± 0.07 minutes (or the established RT window described in Section 10.5.7) from the most recent CCV will be used for all compounds.

12.2.3.3 The expected retention time for target analytes is updated with the retention times of each CCV. If sample matrix is causing significant retention time shifts between CCVs, samples may require dilution and reanalysis to minimize the matrix effects.

12.2.3.4 Method Blank Detections:

When a detection is observed in the method blank on either column, detections in associated samples for this target compound are suspect. If the associated samples are ND for this target compound (as determined by an ND result on either column), then the results will be reported with an NCM. If there is a detection for this target compound on both columns that is greater than the RL but less than 10x the detection in the MB, the sample and MB may be analyzed by LCMS for confirmation.

Water samples are difficult to analyze by LCMS due to the high concentration of $CaCl_2$ with which the samples are extracted. Dilution of the samples is required to preserve the integrity of the instrument. Therefore, low-level hits may not be able to be confirmed by LCMS.

12.2.3.5 Interferences:

2,4,6-Trinitrotoluene elutes closely with 4-amino-2,6-dinitrotoluene on the primary (C18) column. Because of this close elution, high levels of 2,4,6-trinitrotoluene can overlap the retention time window for, and thus mask the presence of, low levels of 4-amino-2,6-dinitrotoluene. Therefore, 4-amino-2,6-dinitrotoluene may be reported as a detection from the confirmation (phenyl-hexyl) column, even though no peak could be detected on the primary column. In this event, an NCM is necessary.

Other target compound interferences may be observed in samples. Analyst judgment will be necessary to evaluate sample chromatograms and potentially report additional detections without confirmation and/or analyze samples at dilutions. In this event, an NCM is necessary, documenting the decision.

12.3 Second-Column Confirmation

Detection of compounds on the primary column is confirmed using a second, dissimilar column. This column is calibrated using the same calibration levels as the primary column. The analysis on the second column must meet all of the instrument QC described in Section 11. Identification is confirmed if a peak is also present in the retention time window for that analyte on the confirmatory column. As specified in Method 8000, mass spectrometric confirmation may also be used.

The RPD between two results is calculated using the following equation:

$$\%RPD = \frac{\left|R_1 - R_2\right|}{\frac{1}{2}\left(R_1 + R_2\right)} \times 100\% \qquad \textit{Equation 12}$$

Where R_1 is the result for the first column and R_2 is the result for the second column.

Acceptance Criteria:

The RPD between confirmed results should agree within 40%; results will then be reported from the primary column.

Corrective Action:

If the RPD is >40% and there is visible positive interference, e.g., co-eluting peaks, elevated baseline, etc., for one column and not the other, then report the results from the column without the interference with the appropriate data qualifier flag, footnote, and/or narrative comment in the final report.

If the RPD is >40% and there is visible positive interference for both columns, then report the lower of the two results with the appropriate flag, footnote, and/or narrative comment in the final report.

12.4 Manual Integrations

Raw instrument data is automatically transferred to Chrom at the completion of each run for further processing. Review the chromatograms to ensure correct assigning of peaks and correct integration of each peak. If manual data manipulations are necessary, they must be justified and documented. See DV-QA-011P for requirements for manual integration.

12.5 % Difference Calculation for ICV / CCV Evaluation

The percent difference for the analysis of a CCV standard is calculated as follows:

$$\%\ \text{Difference} = \left(\frac{\text{Expected Value} - \text{Measured Value}}{\text{Expected Value}} \right) \times 100\% \qquad \textit{Equation 13}$$

12.6 Concentration in Aqueous Samples

The concentration of analyte in the original aqueous sample is calculated as follows:

$$\text{Concentration}, \mu\text{g/L} = \frac{C_{ex} V_t}{V_o} xDF \qquad \textit{Equation 14}$$

Where:
- C_{ex} = Extract analyte concentration, µg/mL
- V_t = Volume of total extract in mL (normally 5 mL)
- V_o = Volume of water extracted in liters (normally 0.5 L)
- DF = Dilution factor, as appropriate

12.7 Concentration in Soil Samples

The concentration of analyte in the original non-aqueous sample is calculated as follows:

$$\text{Concentration}, \mu\text{g/kg} = \frac{C_{ex} V_t}{W} \times DF \qquad \textit{Equation 15}$$

Where:
- C_{ex} = Concentration of analyte in the extract (µg/mL)
- V_t = Total volume of original extract in mL (normally 20 mL for 8330A or 40 mL for 8330B); this volume includes the extracted volume in ACN and the 1:1 dilution with $CaCl_2$ described in Section 10.2.2
- W = Weight (mass) of sample extracted in kg (normally 0.002 kg for 8330A or 0.010 kg for 8330B)
- DF = Dilution factor, as appropriate

12.8 Concentration of Ammonium Picrate

Ammonium picrate is requested by some clients as a target compound. This is the ammonium salt of picric acid. Chromatographically, there is no difference between these two compounds, therefore, upon request, the result for ammonium picrate (C_{AP}) is calculated based on the measured concentration of picric acid, as follows:

$$C_{AP} = Picric\ Acid\ Result \times \left(\frac{246.13\,(Molar\ Mass\ of\ \ Ammonium\ Picrate)}{229.11\,(Molar\ Mass\ of\ \ Picric\ Acid)} \right)$$

Equation 16

In TALS, this calculation is accomplished by opening the batch information in the analytical batch, and setting the calculation line to 1 (Yes).

12.9 LCS and CCV Percent Recovery

$$\text{Control Spike Recovery} = \frac{S_{SR}}{S_A} \times 100\% \qquad \textit{Equation 17}$$

Where S_{SR} = Calculated analyte concentration of spiked sample
S_A = Concentration of standard added

12.10 MS / MSD Percent Recovery Calculation

$$\text{Matrix Spike Recovery} = \frac{S_{SR} - S_R}{S_A} \times 100\% \qquad \textit{Equation 18}$$

Where S_{SR} = Calculated analyte concentration of spiked sample
S_R = Calculated analyte concentration of parent sample
S_A = Concentration of standard added

12.11 Relative Percent Difference Calculation for the MS/MSD

$$RPD = \frac{\left| MS_R - MSD_R \right|}{1/2(MS_R + MSD_R)} \times 100 \qquad \textit{Equation 19}$$

Where RPD = Relative percent difference
MS_R = Matrix spike result of analyte
MSD_R = Matrix spike duplicate result of analyte

12.12 Reporting limits are shown in Table 1. If samples require dilutions or smaller volumes than normally used, the MDLs and RLs will be correct based on the actual volume used and/or the dilution factor. Reporting limits for soil samples are adjusted for the actual weight of sample extracted. As samples are dried prior to subsampling for analysis percent moisture is not determined.

12.13 All results are subject to two levels of technical review. See SOP DV-QA-0020 for a more detailed description for data review and an example of this checklist.

13.0 Method Performance

13.1 Initial Method / Instrument Demonstration of Capability

13.1.1 An initial demonstration of capability for each method must be performed on each instrument prior to analyzing samples.

13.1.2 For the standard analyte list, the initial demonstration consists of the preparation and analysis of a method detection limit (MDL) study,

described in Section 13.2 as well as four QC check samples containing all of the standard analytes for the method

For the QC samples, the mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

13.1.3 For non-standard analytes an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is successful analysis of an extracted standard at the reporting limit and a single point calibration.

13.2 Method Detection Limit (MDL)

A valid method detection limit (MDL) study for each analyte of interest must be performed on each instrument prior to analyzing samples for the first time. Separate soil MDL studies are performed for 8330A using 2 g and 8330B using 10 g of Ottawa Sand. The procedure for determining detection limits is defined in Policy DV-QA-005P.

13.3 MDL Verification (MDLV)

13.3.1 Calculated MDLs are subject to verification by analyzing an MDLV standard prepared at 1-4 times the calculated MDL concentration. An MDLV standard is analyzed immediately after each MDL study and quarterly thereafter. This standard is subject to the entire preparation and analysis process. The calculated MDL is verified if the MDLV standard is detected under routine instrument conditions.

13.3.2 If the first MDLV is not detected, the MDLV standard will be re-prepared and analyzed at twice the original concentration. The lowest concentration that produces a detectable signal will then be reported as the MDL.

13.3.3 MDLs are verified at least annually unless program requirements stipulate a greater frequency (e.g., DoD).

13.4 Analyst Training and Qualification

13.4.1 The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See SOP DV-QA-0024 for details of training requirements.

13.4.2 Each analyst performing the method must complete an initial demonstration of capability (IDOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the IDOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. IDOCs are approved by the Quality Assurance Manager and the Technical Director. IDOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

14.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. When reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Expired Chemicals/Reagents/Standards – Contact Waste Coordinator

15.2.2 Flammable solvent waste – Waste Stream C

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

16.1.1 Method 3535A, Solid Phase Extraction (SPE), Revision 0, December 1996.

16.1.2 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

16.1.3 Method 8000C, Determinative Chromatographic Separations, Revision 3, March 2003.

16.1.4 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

16.1.5 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

16.1.6 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

17.0 Method Modifications:

17.1 Deviations from Method Source and Rationale

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life per 8330A	Shelf Life per 8330B
Stock standards	1,000,000 μg/L (1,000 ppm)	One year	One year
Intermediate standards	2.5 to 10,000 μg/L	Thirty days	One year

Standards	Concentration	Shelf Life per 8330A	Shelf Life per 8330B
Working standards	1 to 500 μg/L	Daily	Daily

This SOP describes the use of 100,000 μg/L high-level standards, which are assigned a one year shelf life based on TestAmerica's experience with these materials. Further, a 20,000 μg/L standard mix is characterized as an intermediate-level, and assigned a six month shelf life.

17.2 Acidic water (pH < 3) is added to the concentrated extract, dilutions, and all calibration and check standards in place of reagent water. This is to preserve any Tetryl present in the extract.

18.0 Attachments

Appendix 1. Analyte List

Appendix 2. Suggested Calibration Levels (μg/mL)

Appendix 3. Spike Levels

Appendix 4. Suggested Instrument Conditions

Appendix 5. Example Chromatogram from Primary Column – Ultracarb ODS (20)

Appendix 6. Example Chromatogram from Confirmation Column – Luna Phenyl-Hexyl

19.0 Revision History

- Revision 14, dated 30 April 2013
  - Updated Sections 9.1, 10.1 and 10.2
  - Annual Review
- Revision 13, dated 04 April 2012
  - Updated calibration section.
  - Updated standards section.
  - Replaced chromatograms in Appendices 5 and 6 with current chromatograms from Chrom.
  - Source method review.
- Revision 12.2, dated 15 February 2011
  - Added a comment to section 10.3 regarding saturation concentrations for the solid phase extraction cartridges.
  - Added section 11.1 referencing corporate SOP CA-Q-S005, "Calibration Curves".
- Revision 12.1, dated 19 November 2010
  - Added requirements for recording the calcium chloride lot number in section 10.3.8.
- Revision 12, dated 16 June 2010
  - Added Section 7.1.3 Standard information for MNX.
  - Added 5th dot to Section 9.18.3 – Reference to Corporate Calibration SOP
  - Added Section 11.8 – Calculation for the concentration of Ammonium Picrate.
  - Updated Appendix 5 Chromatogram to included MNX.

- Revision 11, dated 10 April 2009
  - The details on the extraction procedures have been removed from this SOP. These details can be found in DV-OP-0017 and DV-OP-0018
  - The table in Section 1.4 was revised to include 3,5-dinitroaniline
  - Section 6.2 was revised to include a 500 µL re-pipettor. The pipettor is used to perform the 2X dilution of the soil acetonitrile extracts with the calcium chloride solution.
  - Section 7.8.9 Eluents for Standard Analytes was revised to correct the confirmation column eluent. The eluent is made from methanol and reagent water. Acetonitrile is not used in this reagent.
  - Section 7.8.10 Eluents for Picric Acid was revised to describe more clearly exactly how this reagent is brought up to final volume.
  - Section 7.8.12 Working Eluent Confirmation Column was revised to correct the volume of primary stock solution and glacial acetic acid used in this reagent.
  - Section 9.8 *Method Blank* and Section 9.13 *Grinding Blank* were revised to reflect the laboratory's current practice of controlling method blanks to ½ the reporting limit, or 1/10 of the concentration found in the samples.
  - Section 9.18.3 was revised to state the intercept should be less than the MDL, but at least less than ½ the RL.
  - Section 10.3.1 was revised to state that all detections on the primary column above the method detection limit are confirmed.
  - Section 10.3.3 was revised to clarify that a sequence can either start with an ICAL or a CCV.
  - Section 12.1 *Initial Demonstration of Capability* was revised to eliminate the need for a QC check sample that contains all analytes to be processed through the drying and grinding procedure. The laboratory has performed PT samples that have gone through the grinding process described in method 8330B, but per the PT instructions the sample was not dried prior to grinding.
  - Appendix 1 was revised to remove the approximate retention times from the table. The retention times are updated from each CCV. See Sections 10.3.4 through 10.3.6 for details. This Appendix was also revised to indicate that 3,5-dinitroaniline is only spiked when specifically requested.
  - Appendix 4 was revised to correct the length of the primary column and the column parameters for both primary and confirmation column.
  - Appendix 5 *Organic Extractions Checklist* was removed and replaced with *Example Chromatogram from Primary Column*
  - Appendix 6 *Explosive Soil Extraction Checklist* was removed and replaced with *Example Chromatogram from Confirmation Column*
- Revision 10, dated 01 October 2008
  - Re-formatted SOP
  - Updated reference section to reflect the SW-846 update IV method 3535A.
  - Updated all reference to method 3535 to method 3535A.
  - Added 3,5-dinitroaniline as a spike compound for method 8330B
  - Revised the extraction of water samples so that the SPE cartridge is eluted directly into the extract storage vial.

- Added clarification and requirements for the storage of the working level LCS and surrogate standards.
- Revised section 9.13.1 to have the grinding blanks associated with the sample that is ground after the blank instead of before the blank in order to ensure that any contamination could be more easily traced.

- Changes from Previous Version
  - The type of SPE cartridge was changed in order to achieve better recoveries of picric acid.

Appendix 1. Analyte List

Compound	CAS #	Symbol	Standard Reporting Limits		
			Water (µg/L)	Soil, 2 g (mg/Kg)	Soil, 10 g (mg/Kg)
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2691-41-0	HMX	0.40	0.25	0.10
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	RDX	0.20	0.26	0.20
1,3,5-Trinitrobenzene	99-35-4	1,3,5-TNB	1.0	0.25	0.10
1,3-Dinitrobenzene	99-65-0	1,3-DNB	0.40	0.25	0.10
Methyl-2,4,6-trinitrophenyl nitramine	479-45-8	Tetryl	0.24	0.50	0.20
Nitrobenzene	98-95-3	NB	0.40	0.25	0.30
2,4,6-Trinitrotoluene	118-96-7	2,4,6-TNT	0.40	0.25	0.10
4-Amino-2,6-dinitrotoluene	19406-51-0	4-Am-DNT	0.20	0.25	0.10
2-Amino-4,6-dinitrotoluene	35572-78-2	2-Am-DNT	0.20	0.25	0.10
2,6-Dinitrotoluene	606-20-2	2,6-DNT	0.20	0.25	0.10
2,4-Dinitrotoluene	121-14-2	2,4-DNT	0.40	0.25	0.10
2-Nitrotoluene (o-Nitrotoluene)	88-72-2	2-NT	0.40	0.25	0.20
4-Nitrotoluene (p-Nitrotoluene)	99-99-0	4-NT	1.0	0.40	0.20
3-Nitrotoluene (m-Nitrotoluene)	99-08-1	3-NT	0.40	0.50	0.20
Nitroglycerin	55-63-0	NG	3.0	5.1	2.0
PETN	78-11-5	PETN	2.0	4.0	2.0
2,4-Diamino-6-nitrotoluene**	6629-29-4	2,4-DA-6-NT	1.0	2.0	1.0
2,6-Diamino-4-nitrotoluene**	59229-75-3	2,6-DA-4-NT	1.0	2.0	1.0
Picric Acid (2,4,6-Trinitrophenol)	88-89-1	PA	2.0	0.25	0.10
3,5-Dinitroaniline** (8330B only)	618-87-1	3,5-DNA	0.40	NA	0.10
Hexahydro-1-nitroso-3,5-dinitro-1,3,5-triazine	5755-27-1	MNX	2.0	0.25	0.10
1,2-Dinitrobenzene (surrogate)	528-29-0	1,2-DNB	NA	NA	NA

**Non-standard spike analytes, only spiked when specifically requested.

Appendix 2. Suggested Calibration Levels (μg/mL)

Compound	Level 1	Level 2	Level 3	Level 4*	Level 5	Level 6	Level 7	Level 8
HMX	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
RDX	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3,5-Trinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,3-Dinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Tetryl	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4,6-Trinitrobenzene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Amino-2,6-dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Amino-4,6-dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,4-Dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Dinitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
3-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
4-Nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Nitroglycerin	0.1	0.5	1.0	2.5	4	7	10.	25
PETN	0.1	0.5	1.0	2.5	4	7	10.	25
2,4-Diamino-6-ditrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
2,6-Diamino-4-nitrotoluene	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
Picric Acid	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5
1,2-Dinitrobenzene (surrogate)	0.01	0.05	0.10	0.25	0.4	0.7	1.0	2.5

* This level is used for the daily and continuing calibration standards.

Appendix 3. Spike Levels

LCS / MS / MSD Spike Levels					
Method and Matrix	Working Solution		Spike Amount	Final Concentrations	
	Standard Analytes	Nitroglycerin & PETN		Standard Analytes	Nitroglycerin & PETN
Water, Methods 8330A and 8330B	10 μg/mL	100 μg/mL	0.1 mL	2 μg/L	20 μg/L
Soil Method 8330A (2 g prep)	10 μg/mL	100 μg/mL	0.5 mL	2.5 mg/Kg	25 mg/Kg
Soil Method 8330B (10 g prep)	10 μg/mL	100 μg/mL	1.0 mL	1.0 mg/Kg	10 mg/Kg

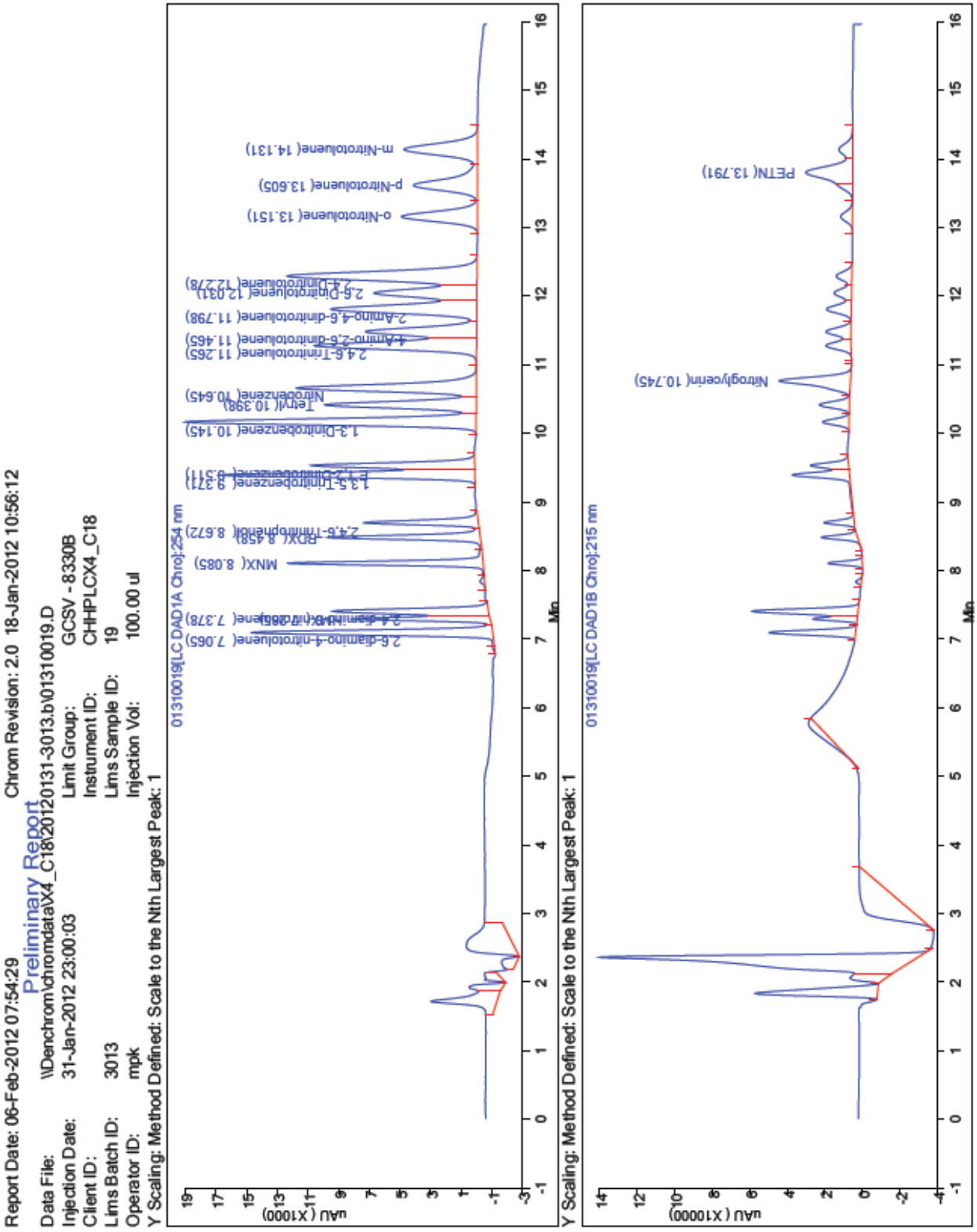
Surrogate Spike Levels			
Method and Matrix	Working Solution 1,2-DNB	Spike Amount	Final Concentration
Water, Methods 8330A and 8330B	10 μg/mL	0.1 mL	2 μg/L
Soil Method 8330A (2 g prep)	10 μg/mL	0.5 mL	2.5 mg/Kg
Soil Method 8330B (10 g prep)	10 μg/mL	1.0 mL	1.0 mg/Kg

Appendix 4. Suggested Instrument Conditions

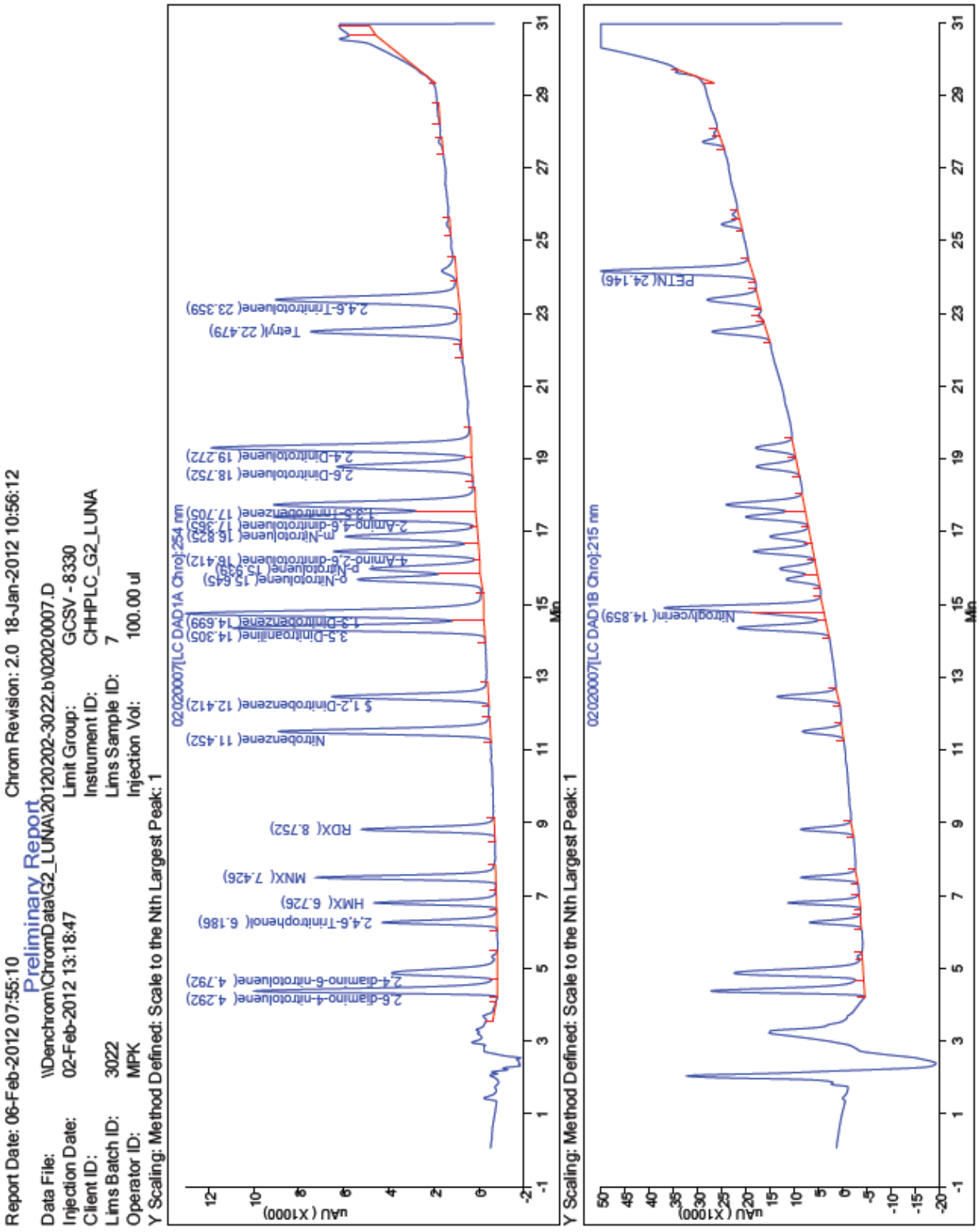
Instrument Conditions		
Column Types	Primary Column: Phenomenex C18 ODS (20), 15 cm x 4.6 mm i.d.	
	Confirmation Column: Phenomenex Luna Phenyl-Hexyl, 15 cm x 4.6 mm i.d.	
Detector - 1st Channel	uv 254 nm, 40 R 550 nm	
Detector - 2nd Channel	uv 215 nm, 40 R 450 nm	
General Parameters	Injection Volume: 100 μL	Temperature: 24.3°C Ambient

Suggested Column Parameters						
	Stop Time (min.)	**Post Time (min.)**	**Flow Rate (mL/min.)**	**Time (minutes)**	**% H_2O**	**% Methanol**
Gradient: Primary (C18) Column	16.0	3.0	1.0	0.0, 2.0, 5.76, 14.4, 15.0	90, 90, 40, 40, 90	10, 10, 60, 60, 10
Gradient: Confirmation (Phenyl-Hexyl) Column	26.0	4.0	0.8	0.0, 26.0, 30.0	50, 25, 50	50, 75, 50

Appendix 5. Example Chromatogram from Primary (C18) Column



Appendix 6. Example Chromatogram from Confirmation (Phenyl-Hexyl) Column



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Inductively Coupled Plasma Mass Spectrometry for Trace Element Analysis by SW-846 Method 6020A

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1.0 Scope and Application

1.1 This procedure describes multi-elemental analysis by inductively coupled plasma-mass spectrometry (ICP/MS) based on EPA Method 6020A.

1.2 Method 6020A lists twenty-three elements approved for analysis by ICP/MS (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, and Zn). This procedure has been developed for thirty-five elements (see Attachment 8), and additional elements may be included provided that the method performance criteria presented in Sections 9 and 13 are met. However, project approval may be required from the controlling agencies for compliance testing beyond the elements included in the promulgated methods.

1.3 The procedure is applicable to the analysis of acid digested waters, soils, and wastes. The preliminary acid digestion for aqueous samples is described in SOP DV-IP-0014, and the digestion procedure for soils is given in SOP DV-IP-0015.

2.0 Summary of Method

2.1 Aqueous samples, digestates, or leachates are nebulized into a spray chamber where a stream of argon carries the sample aerosol through the quartz torch and injects it into an R.F. plasma. There the sample is decomposed and desolvated.

2.2 The ions produced are entrained in the plasma gas and by means of a water-cooled, differentially pumped interface, introduced into a high-vacuum chamber that houses a quadrapole mass spectrometer capable of providing a resolution better than or equal to 0.9 amu (see Section 3) peak width at 10% of the peak height. The ions are sorted according to their mass-to-charge ratio and measured with a channel electron multiplier.

2.3 Interference must be assessed and valid corrections applied, or the data flagged to indicate problems. Interference correction must include compensation for background ions contributed by the plasma gas, reagents, and the constituents of the sample matrix. Recommended elemental equations, which correct for many of these interferences, are listed in Attachment 1. Use of the internal standard technique is required to compensate for suppressions and enhancements caused by sample matrices.

3.0 Definitions

3.1 **Atomic Mass Unit (amu)** – Obsolete term replaced by “unified atomic mass unit (u)” or “dalton (Da)”, which denotes a small unit of mass that is used to express atomic and molecular masses. It is defined to be 1/12 of the mass of one atom of carbon-12, or 1.66053886 X 10-27 kg.

3.2 **Dissolved Metals** - Those elements which pass through a 0.45-μm membrane filter (sample is acidified after filtration).

3.3 **Total Metals** - The concentration determined on an unfiltered sample following vigorous acid digestion.

3.4 **Total Recoverable Metals** - The concentration determined on an unfiltered sample following treatment with hot, dilute mineral acids.

3.5 **Instrument Detection Limit (IDL)** - See Section 12.3.

3.6 **Sensitivity** - The slope of the analytical curve (i.e., the functional relationship between raw instrument signal and the concentration).

3.7 **Tuning Solution** - This is a multi-element solution containing analytes which are representative of the entire mass range capable of being scanned by the instrument. It is used to optimize the sensitivity of the instrument and to verify the mass resolution meets method criteria.

3.8 **Initial Calibration Verification / Quality Control Standard (ICV)** - A multi-element standard of known concentrations prepared to verify instrument calibration. This solution must be an independent standard prepared near the mid-point of the calibration curve, and at a concentration other than that used for instrument calibration.

3.9 **Continuing Calibration Verification (CCV).** - A multi-element standard of known concentrations prepared to monitor and verify the instrument daily continuing performance.

3.10 **Interference Check Standard (ICS)** - A solution containing both interfering and analyte elements of know concentration that is used to verify background and interelement correction factors.

3.11 **Laboratory Control Sample / Laboratory Fortified Blank (LCS/LFB)** - A multi-element standard of known concentrations that is carried through the entire sample preparation and analysis procedure. This solution is used to verify the accuracy of the sample preparation.

3.12 **Reagent Blank** - High purity (> 18 megohm-cm) water containing the same acid matrix as the calibration standards that is carried through the entire digestion process.

3.13 **Calibration Blank** - High purity (> 18 megohm- cm) water acidified with the same acid concentrations present in the standards and samples. Also referred to as the Initial Calibration Blank (ICB) and Continuing Calibration Blank (CCB).

3.14 **Method Detection Limit (MDL)** - The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

3.15 **Low Level ICV (LLICV) / Continuing Calibration Verification (LLCCV)** - A multi-element standard of known concentrations prepared to monitor and verify the instrument daily continuing performance.

3.16 Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, "Quality Assurance Program," for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 Isobaric Interferences

Isobaric interferences in the ICPMS are caused by isotopes of different elements forming ions with the same nominal mass-to-charge ratio (m/z). Most interferences of this type are corrected for by the instrument software.

4.2 Isobaric Molecular and Doubly Charged Ion Interferences

4.2.1 Isobaric molecular interferences are caused by ions consisting of more than one atom or charge. Attachment 3 lists isobaric interferences which might possibly affect required analytes. When these interferences cannot be avoided by the use of another isotope with sufficient natural abundance, corrections must be applied and the data flagged to indicate the presence of interferences.

4.2.2 Chloride in samples can produce low recoveries for antimony and silver. If chloride interference is a concern, 1% HCl can be added during digestion, but calibration standards must be adjusted to include 1% HCl also.

4.3 Physical Interferences

4.3.1 Physical interferences are associated with the transport and nebulization process. Internal standards are used to compensate for these types of interferences.

4.3.2 Internal standards should be added at a level to give approximately 50,000 - 800,000 counts of raw signal intensity. The mass of the internal standard should ideally be within 50 amu of the mass of the measured analyte.

4.3.3 Matrix effects are monitored by comparing the internal standard intensity in the sample to the internal standard intensity of the calibration blank. When performing method 6020, the internal standard recoveries in samples can not fall below 70% of the intensity of the calibration standard. If they fall outside this window, a five-fold dilution (1:4) is performed on the sample to correct for matrix effects and the sample is reanalyzed.

4.3.4 Memory effects are dependent on the relative concentration differences between samples and/or standards which are analyzed sequentially. The rinse period between samples must be long enough to eliminate significant memory interference.

4.4 Polyatomic interferences

Polyatomic interferences are derived from the plasma gas, reagents or sample matrix. The Agilent 7500 is equipped with a collision cell to help filter out these interferences. Helium gas is used in this mode.

4.5 The use of hydrochloric and sulfuric acids should be minimized due to higher incidence of molecular-ion interferences with the presence of these acids. Excessive amounts of nitric acid can also lead to molecular interferences.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.2 The ICP plasma emits strong UV light and is harmful to vision. All analysts must avoid looking directly at the plasma. The RF Generator produces strong radio frequency waves, most of which are unshielded. People with pacemakers should not go near the instrument while in operation.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
1 – Always add acid to water to prevent violent reactions. 2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Inductively Coupled Plasma Mass Spectrometer (ICP/MS) capable of providing resolution, less than or equal to 0.9 amu at 10% peak height from 6-253 amu and 1.0 amu at 5% peak height from 6-253 amu with a data system that allows corrections for isobaric interferences and the application of the internal standard technique.

6.1.2 Agilent 7500 ICPMS

6.1.3 A four-channel peristaltic pump.

6.1.4 Autosampler with autosampler tubes.

6.2 Supplies

6.2.1 Argon gas: High purity grade (99.99%).

6.2.2 Appropriate water cooling device.

6.2.3 Calibrated automatic pipettes or Class A glass volumetric pipettes.

6.2.4 Glass beads, <1 mm diameter, acid washed.

6.3 Computer Software and Hardware

Please refer to the master list of documents and software located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and

Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Storage and Shelf-Life

7.1.1 All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. Standards stored at concentrations as received from the vendor and mid-level dilutions must be replaced prior to the expiration date assigned by the vendor. If no expiration date is provided, the stocks and mid-level standards may be stored for up to one year. They must be replaced sooner if verification from an independent source indicates a problem.

7.1.2 Working standards, i.e., all standards at concentrations ready to analyze on the ICP/MS (all except tuning mixes, ICSA and ICSAB mixes, which are received at ready-to-use concentrations), are prepared fresh daily.

7.2 Standards

7.2.1 Tuning Solution

The tuning solution is purchased as a custom multi-element mix. The elements and concentrations of the constituents are shown in Attachment 9.

Prepare the Tuning Solution as detailed below.

- Obtain a clean 1 L volumetric flask
- Place 500 mL of reagent water and 10 mL of conc. HNO_3 in the flask
- Pipet 1mL of the Tuning Solution Stock into the flask
- For the Agilent 7700 also add 20 uL of 500 mg/L Mg and 30 uL of 1000 mg/L Be
- Dilute to volume with acid diluent. Stopper and mix.

7.2.2 P/A factor solution

The P/A factor solution is purchased as a custom multi-element mix. Prepare the P/A Solution as detailed below.

- Add approximately 50 mL of acid diluent to a 100 mL volumetric flask
- Add 0.5 mL to 1.5 mL of the concentrated P/A solution. The sample amount can vary depending on instrument conditions
- Dilute to volume with acid diluent

7.2.3 Calibration Standards

Stock calibration standards are purchased as custom multi-element mixes or as single element solutions. Each day of analysis, the standards are diluted to working levels using acid diluent. The concentrations are given in Attachment 12.

Prepare the Working Calibration Standard as detailed below.

- Add approximately 50 mL of acid diluent to a 100 mL volumetric flask
- Pipet 0.5 mL each of CALSTD1, CALSTD2, CALSTD3 into the flask
- Pipet 0.5 mL of ICPMS-BRC-CALSTD-1
- Dilute to volume with acid diluent

7.2.4 Initial Calibration Verification (ICV) Standard

The ICV stock is from a source different than the source for the calibration standards. Each day of analysis, the ICV standards are prepared in acid diluent to the concentrations shown in Attachment 12.

Prepare the Working ICV as detailed below.

- Add approximately 30 mL of acid diluent to a 50 mL volumetric flask
- Pipet 0.1 mL each of ICP-MS ICV Sol. A, Sol. B, ICV salts and ICV BRC into the flask
- Dilute to volume with acid diluent

7.2.5 Continuing Calibration Verification (CCV) Standard

The CCV is prepared from the same source as the calibration standards. The CCV standards are prepared fresh each day of analysis in acid diluent. The concentration is shown in Attachment 12.

Prepare the Working CCV as detailed below.

- Dilute by 2X a known volume of the Working Calibration Standard in acid diluent

7.2.6 Reporting Limit (RL) Standards

The reporting limit standards are prepared fresh daily from the same stock as the calibration standards using acid diluent. The concentrations must be less than or equal to the reporting limits.

Prepare the standard Reporting Limit Standard as detailed below.

- Add approximately 5 mL of acid diluent to a 10 mL volumetric flask
- Pipet 0.1 mL of Calibration standard into the flask
- Pipet 0.09 mL of the 1 mg/L Sn and Zn standard into the flask
- Dilute to volume with acid diluent

Prepare the AFCEE Reporting Limit Standard as detailed below.

- Dilute the Reporting Limit Standard 5X in acid diluent

7.2.7 Daily Linear Range Standard

The Linear Range standard is prepared from the same stock as the calibration standards using acid diluent for the Agilent 7500 as detailed below.

- Add approximately 5 mL of acid diluent to a 10 mL volumetric flask
- Pipet 0.5 mL of the CALSTD-1, CALSTD-2 and CALSTD-3 standard into the flask
- Pipet 0.5 mL of the ICPMS-BRC-CALSTD 1 standard into the flask
- Dilute to volume with acid diluent
- The final concentration is 1000 ug/L.

Prepare the Daily Linear Range Standard for the Agilent 7700 as detailed below:

- Add approximately 250 mL of acid diluent to a 500 mL volumetric flask
- Pipet 1 mL each of the following 1000 ppm stock standards: As, Be, Cd, Co, Mo, Sb, Se, Tl, U, and V.
- Pipet 2.5 mL each of the following 1000 ppm stock standards: Ba, Cr, Cu, Ni, Pb, and Zn
- Pipet 5 mL of a 1000 ppm stock standard for Mn
- Pipet 0.1 mL of a 10,000 ppm stock standard for Th
- Dilute to volume with acid diluent

7.2.8 Post-Digestion Spiking Stock Solution

The spike stock solution is prepared from the same stock as the calibration standards using acid diluent. Spike concentrations are listed in Attachment 12.

Prepare the Spiking Stock as detailed below.

- Obtain a clean vial
- Pipet 1.0 mL of the ICPMS-SPK-A standard into the vial
- Pipet 1.0 mL of the TA-ICPMS-PDS-1 standard into the vial

7.2.9 Internal Standard Solution

The internal standard solution is prepared from individual 1000 ppm standards as detailed below.

- Add approximately 25 mL of acid diluent to a 250 mL volumetric flask
- Pipet 0.4 mL each of the Ho and In stock into the flask
- Pipet 1.2 mL of the Ge stock into the flask
- Pipet 1.5 mL of the Li^{6+} stock into the flask
- Pipet 0.75 mL of the Sc stock into the flask
- Dilute to volume with acid diluent

7.2.10 Interference Check Standard Solutions (ICSA / ICSAB)

The interference solutions are purchased as a custom multi-element mix.

7.2.10.1 Prepare the ICSA Solution as detailed below.

- Add approximately 25 mL of acid diluent to a 50 mL volumetric flask
- Pipet 5.0 mL of the 6020ICS-0A standard into the flask.

- Dilute to volume with acid diluent
- Stopper and shake to mix.

7.2.10.2 Prepare the ICSAB Solution for the Agilent 7500 as detailed below.

- Add approximately 5 mL of acid diluent to a 10 mL volumetric flask
- Pipet 1.0 mL of the 6020 ICS-0A standard into the flask
- Pipet 0.1 mL of the Spike Stock into the flask
- Dilute to volume with acid diluent

7.2.10.3 Prepare the ICSAB Solution for the Agilent 7700 as detailed below.

- Add approximately 50 mL of acid diluent to a 100 mL volumetric flask.
- Pipet 10.0 mL of the 6020 ICS-0A standard into the flask
- Pipet 0.5 mL each of the CALSTD1, CALSTD2, CALSTD3 and the ICPMS-BRC-CALSTD1 solutions into the flask
- Dilute to volume with acid diluent.

7.3 Low Level Initial Calibration Verification / Continuing Verification

Prepare the low level initial calibration verification and continuing verification standards as detailed below.

- Add approximately 5 mL of acid diluent to a 100 mL volumetric flask
- Pipet 1.0 mL of ICPMS-LLCCV-1
- Pipet 1.0 mL of ICPMS-LLCCV-2
- Dilute to volume with acid diluent

7.4 Reagents

7.4.1 **Reagent Water -** ASTM Type I or equivalent for the elements of interest, generated using an ion-exchange water polishing system capable of achieving 18.0 megohm-cm.

7.4.2 **Acid Diluent Agilent 7500, 5% HNO_3 -** Carefully dilute 50 mL of concentrated HNO_3 in 1.0 L of reagent water. This solution is used to dilute samples, and it is used for calibration blanks.

7.4.3 **Acid Diluent Agilent 7700, 2% HNO_3/0.5%HCl –** Carefully dilute 40 mL of concentrated HNO_3 and 10 mL of HCl in 2.0 L of reagent water. This solution is used to dilute samples, and it is used for calibration blanks.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Water	HDPE	50 mLs	HNO_3, pH < 2	180 Days	40 CFR Part 136.3
Soil	Glass	4 oz	Cool ≤ 6°C[1]	180 Days	N/A

[1] Although ICP analysis of soil does not require refrigeration of the samples, mercury analysis does require refrigeration. Samples which will be used to aliquot for both analyses must be refrigerated.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Method Blank (MB)

For aqueous and soil samples, the method blank consists of reagent water that has been processed in the same manner as the samples. For soil samples analyzed under the AFCEE and DoD QAPPs, the method blank consists of <1 mm glass beads that have been processed in the same manner as the samples. One method blank must be processed with each preparation batch.

Acceptance Criteria: Method blank results are acceptable if the concentration for each analyte of interest is less than ½ the reporting limit (RL). In the absence of project specific reporting

limits, if the blank is less than 10% of the lower limit of quantitation check sample concentration, less than 10% of the regulatory limit, or less than 10% of the lowest sample concentration for each analyte in a given preparation batch, whichever is greater, then the method blank is considered acceptable.

Corrective Action: If the method blank does not meet the acceptance criteria, the source of contamination should be investigated to determine if the problem can be minimized or eliminated. Samples associated with the contaminated blank shall be reprocessed for analysis or, under the following circumstances, may be reported as qualified (qualifier flags or narrative comments):

- The same analyte was not detected in the associated samples;
- The method blank concentration is less than 1/10 of the measured concentration of any sample in the batch;
- The method blank concentration is less than 1/10 the specified regulatory limit; or
- The analyte is a common laboratory contaminant (copper, zinc, iron, lead) less than 2 times the RL. Note that some programs do not recognize common lab contaminants or have a more stringent criterion (e.g., DoD allows common laboratory contaminants up to the RL.)

If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. This anomaly must be addressed in the project narrative and the client must be notified.

9.3 Laboratory Control Sample (LCS)

The LCS consists of reagent water that is spiked with the analytes of interest at the project specific action level or, when lacking specific action levels, at approximately mid-point of the linear dynamic range (summarized in Attachment 12). For soil samples analyzed under the AFCEE and DoD QAPPs, the LCS consists of <1 mm glass beads that have been spiked with the analytes of interest and processed in the same manner as the samples. One LCS must be processed for each preparation batch.

Acceptance Criteria: LCS control limits are based on three standard deviations of past laboratory results. These limits must not exceed 80-120% for Method 6020. The control limits are maintained in the LIMS system.

Corrective Action: If the LCS % recovery falls outside of the control limits for any analyte, that analyte is judged to be out of control. All associated samples must be reprocessed for analysis.

One possible exception is a recovery for a given element above the upper control limit with no detection for the same element in the samples.

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

The MS is prepared by taking a second aliquot of a selected sample and spiking it with the analytes of interest at same level as the LCS (summarized in Attachment 12). An MSD is prepared by taking a third aliquot of a selected sample and spiking it with the analytes of interest at same level as the LCS (summarized in Attachment 12). The MS and MSD are processed in the same manner as the samples. One MS/MSD pair must be processed for each preparation batch. However, some programs (e.g., AFCEE) require that matrix spikes can be performed only on project samples, and that the samples to be used are identified on the chain of custody form. The spike concentration should be the same level as the LCS.

Acceptance Criteria: Control limits are based on three standard deviations of past laboratory results. These limits are not to exceed 75-125% recovery, and 20% relative percent difference (RPD). The control limits are maintained in the LIMS system.

Corrective Action: If MS/MSD results do not meet the acceptance criteria and all other quality control criteria have been met, then a matrix interference is suspected. Failed matrix spikes are flagged automatically, and are discussed in the final report case narrative.

9.5 Interference Check Solutions (ICSA/ICSAB)

The interference check solution is prepared with known concentrations of interfering elements so a determination may be made as to the magnitude of the interference on analytes of interest as well as a test of any software corrections. The required elements and their concentrations are listed in Attachment 6. The interference check solutions must be analyzed at the beginning of every analytical run or once every 12 hours, whichever is more frequent. The results of solution "A" and solution "AB" should be monitored for possible interferences. See Attachment 6 for analyte concentrations.

NOTE: It may not be possible to obtain absolutely clean ICSA/ICSAB standards. If contamination can be confirmed by another method (e.g., ICPAES), acceptance criteria will be applied at that level and the data accepted.

Acceptance Criteria: The results for the trace elements (B portion) must be +/- 20% of the expected value.

Corrective Action: If the ICSAB results exceed the 20% limit, then the analysis sequence must be terminated. The problem must be investigated and fixed. The ICS and all affected samples must be re-analyzed.

9.6 Internal Standards Evaluation for Samples

The IS recovery in samples can not fall below 70% of the intensity of the calibration blank. If sample IS recoveries fall outside of these criteria, a five-fold (1:4) dilution must be performed, the dilution analyzed, and the same acceptance criteria applied.

9.7 Serial Dilution

One serial five-fold dilution should be analyzed per batch for each matrix. If the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 10 above the reporting limit after dilution), the serial dilution must agree to within 10% of the original analysis. If not, an interference effect is suspected, which must be described in an anomaly report and included in the final report narrative. Samples identified as blanks cannot be used for serial dilution.

9.8 Post-Digestion Spike Addition (PDS)

A PDS is performed for each batch. An analytical spike (minimum level of 10 times and a maximum of 100 times the lower limit of quantitation) added to a portion of a prepared sample, or its dilution, should be recovered to within 80-120% of the known value. If the PDS fails to meet this criterion, matrix interference should be suspected.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA department also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

10.3 Solid and aqueous samples must be digested prior to analysis by the appropriate method (see SOPs DV-IP-0014 and DV-IP-0015).

10.4 Sample Preparation

Solid and aqueous samples must be digested prior to analysis by the appropriate method (see SOPs DV-IP-0014 and DV-IP-0015).

10.5 Calibration

10.5.1 Instrument Start Up

Set up the instrument according to manufacturer's operating instructions. Allow the instrument to become thermally stable for at least 30 minutes

before tuning. . It is recommended that the instrument be flushed with the ICSA solution to help condition the cones. Allow the instrument time to rinse out all of the ICSA before tuning the instrument.

10.5.2 Oxide\Doubly Charge Performance Check

With the sample probe in the Tune solution verify that the oxides and doubly charged ions are less the 3% by running the Tune report.

10.5.3 Instrument Tuning / Mass Calibration

Tune the instrument with a solution containing elements representing all of the mass regions of interest. The relative standard deviations must be less than 5% after running the tuning solution a minimum of 4 times.

Mass calibration and resolution checks using the tuning solution must be completed at the beginning of every day.

Mass Calibration Check – The mass calibration results must be within 0.1 amu from the true value. If this criterion is not met, the mass calibration must be adjusted before running samples.

Mass Resolution Check - The resolution must be verified to be less than 0.9 amu full width at 10% peak height.

10.5.4 Initial Calibration

The ICP/MS is calibrated each day of operation using a blank and a single standard (see Section 7.2.2). At least three integrations are employed.

The validity of the calibration is determined by the subsequent calibration verifications, which are performed at concentrations as described in the next sections.

10.5.5 Low-Level Initial Calibration Verification (LLICV)

A low-level ICV standard at or below the reporting limit (see Section 7.3) is analyzed immediately after the initial calibration. This is a standard obtained from the same vendor used for calibration.

Acceptance Criteria: The ICV recovery must be within 70-130%. The ICV can be reanalyzed, but two consecutive successful results must be obtained or corrective action is taken.

Corrective Action: If the ICV results are outside of the acceptance limits, investigate the accuracy of the standards, correct as necessary, and recalibrate.

10.5.6 Mid-Level Second-Source Initial Calibration Verification (ICV)

A 40 µg/L ICV standard (see Section 7.2.4) is analyzed immediately after the initial calibration. This is a standard obtained from a different vendor than the standard used for calibration.

Acceptance Criteria: The ICV recovery must be within 90-110%. The ICV can be reanalyzed, but two consecutive successful results must be obtained or corrective action is taken.

Corrective Action: If the ICV results are outside of the acceptance limits, investigate the accuracy of the standards, correct as necessary, and recalibrate.

10.5.7 Calibration Blank

An initial calibration blank (ICB) is analyzed after the ICV. Continuing calibration blanks (CCBs) are analyzed after each continuing calibration verification.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. Client specific requirements take precedence. For example, DoD requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the calibration blank exceeds acceptance limits, then the possibility of instrument contamination should be examined, particularly the possibility of carry-over from high level samples. The blank can be reanalyzed, and if successful, analysis can continue. However, samples tested after high-level samples should be retested. If the reanalysis is not successful, then the analysis should be terminated. After the problem is corrected, recalibrate and reanalyze all samples tested since the last acceptable CCB.

10.5.8 Reporting Limit (RL) Verification Standard

Because the ICP calibration does not include multiple calibration levels, an independent standard is analyzed after the ICV to monitor the lab's ability to produce reliable results at RL-level concentrations. The RL verification standard (see Section 7.2.6) is analyzed after the daily ICB.

Acceptance Criteria: For project reporting limits at or above two times the MDL, the results should be within 50% of the expected value. Some programs may require

tighter control, in which case the RLs will need to be three or more times the MDL concentration.

Corrective Action: If the RL verification fails to meet acceptance limits, data for the associated samples must be assessed. For example, if the results are high, consider blank contamination, and if the results are low, consider MDL verifications. At a minimum, sample results must be qualified in the final report.

10.5.9 Lower Limit of Quantitation Check (LLQC)

The lower limit of quantitation check (LLQC) sample should be analyzed after establishing the lower laboratory reporting limits and on an as needed basis to demonstrate the desired detection capability. The difference between the LLQC and the RLSTD is that this standard is carried through the entire preparation and analytical procedure.

Acceptance Criteria: LLQC is verified when all analytes are detected within ± 30% of their true value.

Corrective Action: If the LLQC fails to meet acceptance limits, a single reanalysis may be attempted without modification to the instrument operating conditions. Otherwise, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

10.5.10 Low-Continuing Calibration Verification (LLCCV) Standard

A low-level CCV standard is analyzed after every set of ten samples and at the end of the analytical sequence.

Acceptance Criteria: The CCV recovery must be within 70-130%. In addition, the IS recovery must be within method limits: ≥70%. If CCV results are not within these limits, the CCV can be reanalyzed, but it must be successful twice in succession. If the calibration cannot be verified within these specified limits, the analysis of samples containing the affected analytes at similar concentrations cannot continue until the cause is determined and the LLCCV standard successfully analyzed. TestAmerica will not hold samples with concentrations greater than 10x the reporting limit to the 30% acceptance criteria.

Corrective Action: If the CCV fails acceptance criteria, then the analysis should be terminated. Recalibrate and

reanalyze all samples tested since the last acceptable CCV.

10.5.11 Mid-Continuing Calibration Verification (CCV) Standard

A 50 μg/L CCV standard is analyzed after every set of ten samples and at the end of the analytical sequence.

Acceptance Criteria: The CCV recovery must be within 90-110%. In addition, the IS recovery must ≥70%. If CCV results are not within these limits, the CCV can be reanalyzed, but it must be successful twice in succession or further corrective action must be taken.

Corrective Action: If the CCV fails acceptance criteria, then the analysis should be terminated. Recalibrate and reanalyze all samples tested since the last acceptable CCV.

10.6 Sample Analysis

10.6.1 Report the average of at least three integrations for all field and QC samples analyzed.

10.6.2 Flush the system with the rinse blank for at least 30 seconds between samples and standards during the analytical run.

10.6.3 All soil samples and associated QC samples are diluted 5X prior to analysis. This dilution is performed in an effort to reduce the impact of matrix interference on the performance of the ICPMS. The reported method detection limit has been corrected for the 5X dilution. The dilution factor on the report will be a 1X unless a subsequent dilution is required.

10.6.4 Masses which would affect the data quality must be monitored during the analytical run to determine the potential effects of matrix on a given element.

10.6.5 Dilute and reanalyze samples that are more concentrated than the linear range for an analyte or specific isotope of interest. No analyte may be reported from an analysis of a diluted sample in which the analyte concentration is less than 5 times the RL. (The sample should be diluted to the approximate midrange of the analytical curve.)

10.6.6 The analytical run sequence should be performed as follows to meet all quality control criteria:

Instrument initialization / Warm-Up
Tune instrument
Perform mass calibration
Perform resolution check
Validate tuning criteria

Calibration blank
Calibration standard
ICV
ICB
LLICV
RL verification standard
LLQC(as needed)
ICSA
ICSAB
LRA
CCV
CCB
LLCCV
10 Samples (which can include all sample types)
CCV
CCB
LLCCV
Reslope
CCV
CCB
LLCCV

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S-005 "Calibration Curves" and under the public folder, Arizona Calibration Training.

11.2 ICV percent recoveries are calculated according to the equation:

$$\%R = \left(\frac{\text{ICV Found Value}}{\text{ICV True Value}} \right) \times 100\%$$

11.3 CCV percent recoveries are calculated according to the equation:

$$\%R = \left(\frac{\text{CCV Found Value}}{\text{CCV True Value}} \right) \times 100\%$$

11.4 Matrix Spike Recoveries are calculated according to the following equation:

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

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike Added

NOTE: When the sample concentration is less than the detection limit, use SR = 0 for the purpose of calculating %R.

11.5 The relative percent difference (RPD) between sample duplicates is calculated according to the following equation:

$$RPD = \left[\frac{DU1 - DU2}{\frac{1}{2}(DU1 - DU2)} \right] \times 100$$

Where:

DU1 = Sample result
DU2 = Sample duplicate result

11.6 The final concentration for an aqueous sample is calculated as follows:

$$\text{Result } (\mu\text{g/L}) = \frac{C \times V1 \times D}{V2}$$

Where:

C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V1 = Final volume in liters after sample preparation
V2 = Initial volume of sample digested in liters

11.7 The concentration determined in digested solid samples when reported on a wet weight basis is as follows:

$$\text{Result } (\mu\text{g/kg}) = \frac{C \times V \times D}{W}$$

Where:

C = Concentration from instrument readout, ppb
D = Instrument dilution factor
V = Final volume in liters after sample preparation
W = Weight, in g, of wet sample digested

11.8 Documentation and Record Management

The following documentation comprises a completed ICPMS raw data package:

- Sample preparation bench sheet(s), to include the batch number, list of samples, preparation analyst and date, instrument analysis analyst and date, identification of reagents and standards used, and identification of all measuring equipment used (e.g., balances, thermometers, pipettes). This information is stored in the LIMS.

- Raw data (direct instrument printout).

- Data review checklist - See SOP DV-QA-0020.

- Standards Documentation to include source, lot, preparation date, and expiration date.

- Nonconformance summary (if applicable).

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. An initial method detection limit study is performed in accordance with Policy DV-QA-005P. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. For DoD, AFCEE, and DOE projects, an MDL verification is performed quarterly.

12.2 MDL Verification (MDLV)

Calculated MDLs from the annual studies are subject to quarterly verification by analyzing an MDLV standard.

12.2.1 Prepare an MDLV standard at 1-2 times the calculated MDL concentration.

12.2.2 Analyze the MDLV standard immediately after each MDL study and quarterly thereafter. This standard is subject to the entire preparation and analysis process.

12.2.3 The calculated MDL is verified if the MDLV standard is detected, nominally signal to noise ratio > 3, under routine instrument conditions.

12.2.4 If the first MDLV is not detected, re-prepare the MDLV standard at twice the original concentration and analyze. The lowest concentration that produces a detectable signal will then be reported as the MDL.

12.3 Instrument Detection Limit Study

Instrument detection limit (IDL) studies are conducted quarterly for each instrument and each wavelength used for analysis in accordance with Policy DV-QA-014.

12.3.1 Run seven reagent blank solutions.

12.3.2 Analyze the IDL standards on three non-consecutive days.

12.3.3 For each day, the standard deviations for the seven standards are calculated. The final IDL concentration is the average of the three daily standard deviation values.

12.4 Linear Dynamic Range (LDR)

Linear range standards (see Section 7.2.7 for preparation) must be analyzed quarterly.

Acceptance Criteria: The highest standard must produce a recovery within 90-110% of the expected value.

Correction Action: Samples producing results above the LDR must be diluted reanalyzed.

12.4.1 Linear Range Verification

The LDRs should be verified whenever, in the judgment of the analyst, a change in the analytical performance caused by either a change in instrument hardware or operating conditions would dictate the necessity to re-establish them.

Acceptance Criteria: The LDR verification standard must produce a result within 90-110% of the expected value.

Corrective Action: If this limit is not met, then a new LDR study is required.

Some programs (e.g., USACE) require verification of linear ranges in each analytical run. As described in 7.2.7, a lower concentration is used for the daily check than is used for the quarterly determination.

Acceptance Criteria: Results must be within 90-110% of the expected value.

Corrective Action: Samples producing results greater than the concentration of the daily check standard will be diluted and reanalyzed.

12.5 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going

proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.5.1 Four aliquots of the ICV are analyzed using the same instrumental conditions and procedures used to analyze samples. The analyst must employ ICV's from four distinct analytical sequences. Using these four ICV's demonstrates the analyst's ability to optimize and calibrate the instrument and to prepare analytical solutions. Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.5.2 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.5.3 Further details concerning demonstrations of proficiency are described in SOP# DV-QA-0024.

12.6 Training Requirements

12.6.1 The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

12.6.2 Each analyst performing the method must complete a demonstration of capability (DOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the DOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. DOCs are approved by the Quality Assurance Manager and the Technical Director. DOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually. Initial Demonstration of Capability

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and

Pollution Prevention", of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produce when this method is carried out:

14.2.1 Aqueous Acidic (Metals) - Corrosive - Waste Stream J

14.2.2 Expired reagents and standards – Contact the Waste Coordinator.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods For Evaluating Solid Waste, EPA SW-846, Update IV, Method 6020A: "Inductively Coupled Argon Plasma - Mass Spectrometry", Revision 1, February 2007.

15.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/20/2010

15.3 U.S.EPA Statement of Work for Inorganics Analysis, ILMO3.0.

16.0 Method Modifications:

Item	Method	Modification
1	EPA 6020A	Commercially available standards are purchased and verified at the laboratory rather than being prepared from the solid material. These verification records are kept on file with QA.
2	EPA 6020A	Milli-Q or Nanopure water is substituted when reagent water is called for. This water is tested to be free of contaminants by conductivity (18megOhm) and by the analysis of blanks.
3	EPA 6020A	Corrective action for a PDS failure will be limited to generating an NCM indicating the failed analyte and the recovery rather than diluting and reanalyzing the sample.
4	EPA 6020A	Internal standard recoveries are based on the intensities of the internal standards in the most recent calibration blank rather than the intensities of the internal standards in the initial calibration standard.

17.0 Attachments

Attachment 1: Recommended Elemental Equations
Attachment 2: Contributions of Contaminant Elements when Resolution and Measurement Schemes Vary
Attachment 3: Isobaric Molecular-Ion Interferences Which Could Affect the Analytes
Attachment 4: Changes in Isobaric Molecular-Ion Interferences with Changing Plasma Conditions
Attachment 5: Internal Standards and Corresponding Metals
Attachment 6: Interference Check Sample Components and Concentrations
Attachment 7: Sample Preservation and Holding Times
Attachment 8: Suggested Mass Choices
Attachment 9: Tuning Solution
Attachment 10: Suggested Tuning and Response Factor Criteria
Attachment 11: Summary of Quality Control Requirements
Attachment 12: Calibration, Calibration Verification, and Spike Concentrations
Attachment 13: ICP/MS Technical Data Review Checklist

18.0 Revision History

Revision 1, dated 15 July 2013

- Annual review
- Corrected formatting
- Added section 3.16
- Added reference to data review in section 10.7
- Added documentation information in section 11.8
- Added detail to note associated with section 14.2
- Updated reference in section 15.2
- Removed Attachment 13

Revision 0.3, dated 13 July 2012

- Revised standards preparation procedures in Section 7
- Added section 7.2.2
- Split acid diluent into two solutions depending upon instrument
- Updated standard mixes used to prepare standards; instrument specific mixes as needed
- Clarified requirements for preservation of soil samples for ICPMS only analysis, Section 8
- Revised list of common lab contaminants in method blank corrective action (Section 9.2)
- Added section 10.5.2: oxide/doubly charged performance check
- Updated Sections 9.2 and 10.5.7 to control method blanks and calibration blanks to ½ the RL
- Updated Sections 9.1, 10.1, 10.2 and 12.1 to reflect current practice.

Revision 0.2, dated 08 July 2011

- Added Section 4.4 on polyatomic interferences
- Added Instruments to Section 6.1
- Section 10.5.1 Added to condition cones with the ICSA solution

- Added Section 10.6.3 to reflect soil dilution practices
- Section 11.4 Corrected the RPD calculation
- Added section 11.1 referencing corporate SOP CA-Q-S-005 “Calibration Curves”
- Added section 12.2 “MDL Verification (MDLV)”
- Added Attachment 13 “ICP/MS Technical Data Review Checklist”

Revision 0.1, dated 18 June 2010

- Basic Annual Review

Revision 0, dated 19 June 2009

Attachment 1

Recommended Elemental Equations

Element	Isobaric Correction	Mathematical Equation
Al	none	(1.0000)(27M)
Sb	none	(1.0000)(121M)
As	ArCl, Se	(1.0000)(75M) - (3.1278)(77M) + (1.0177)(78M)
Ba	none	(1.0000)(135M)
Be	none	(1.0000)(9M)
Cd	MoO, Sn	(1.0000)(114M) - (0.0268)(118M) - (1.0000)(135M)
Ca	none	(1.0000)(44M)
Cr	none	(1.0000)(52M)
Co	none	(1.0000)(59M)
Cu	none	(1.0000)(65M)
Fe	none	(1.0000)(57M)
Pb	none	(1.0000)(208M) + (1.0000)(207M) + (1.0000)(206M)
Mg	none	(1.0000)(25M)
Mn	none	(1.0000)(55M)
Ni	none	(1.0000)(60M)
K	none	(1.0000)(39M)
Se	Ar2	(1.0000)(78M) - (1.1869)(76M)
Ag	none	(1.0000)(107M)
Na	none	(1.0000)(23M)
Tl	none	(1.0000)(205M)
V	ClO, Cr	(1.0000)(51M) - (3.1081)(53M) + (0.3524)(52M)
Zn	none	(1.0000)(66M)
6Li	Li (natural)	(1.0000)(6M) - (0.0813)(7M)
Sc	none	(1.0000)(45M)
Y	none	(1.0000)(89M)
Rh	none	(1.0000)(103M)
In	Sn	(1.0000)(115M) - (0.0149)(118M)
Tb	none	(1.0000)(159M)
Ho	none	(1.0000)(165M)
Bi	none	(1.0000)(209M)

Where M = Total ion count rate at the specified mass.

Attachment 2
Contributions of Contaminant Elements when Resolution and Measurement Schemes Vary

Concentrations listed are the approximate level (μg/L) measured when the interferent is present at 100 mg/L.

Analyte	Interferent Element	Peak Width at 10% of the Peak Height			
		1.0 amu Integration Width		0.8 amu Integration Width	
		0.9 amu	0.3 amu	0.9 amu	0.3 amu
^{121}Sb	^{120}Sn	820	5	10	1
^{121}Sb	^{122}Te	77	None	1	none
^{75}As	^{74}Se, ^{76}Se	910	4	3	none
^{9}Be	^{10}B	1,200	12	9	1
^{112}Cd	^{113}In	1,700	8	10	none
^{114}Cd	^{115}In	5,000	150	180	18
^{116}Cd	^{115}In	30	None	5	none
^{52}Cr	^{51}V	1.4	1.5	none	none
^{53}Cr	^{54}Fe	650	7	1	none
^{59}Co	^{58}Ni, ^{60}Ni	1,500	6	2	none
^{63}Cu	^{62}Ni, ^{64}Ni	190	1	none	none
^{63}Cu	^{64}Zn	4,000	14	9	none
^{65}Cu	^{64}Ni	1	1	none	none
^{65}Cu	^{64}Zn, ^{66}Zn	4,400	22	15	none
^{208}Pb	^{209}Bi	140	14	57	none
^{55}Mn	^{54}Fe, ^{56}Fe	900	8	4	none
^{58}Ni	^{59}Co	3,000	96	75	7
^{60}Ni	^{59}Co	9	4	10	5
^{62}Ni	^{63}Cu	8,500	690	4,500	16
^{107}Ag	^{106}Pd, ^{108}Pd	2,400	22	80	4
^{107}Ag	^{106}Cd, ^{108}Cd	130	3	5	2
^{109}Ag	^{108}Pd, ^{110}Pd	1,800	12	36	3
^{109}Ag	^{108}Cd, ^{110}Cd	1,600	10	37	3
^{51}V	^{52}Cr	2,100	45	410	1
^{64}Zn	^{65}Cu, ^{63}Cu	7,800	57	410	2
^{66}Zn	^{65}Cu	2	none	3	2

Attachment 3

Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences						
	Oxygen	Hydroxyl	Nitrogen	Chlorine	Sulfur	Carbon	Other
^{121}Sb	PdO		AgN			AgC	
^{123}Sb	AgO		AgN	SrCl	ZrS	CdC	
^{75}As	CoO	NiOH	NiN	ArCl	CaS	CuC	
^{138}Ba	SnO	SbOH					
^{137}Ba	SbO	SnOH		MoCl			
^{136}Ba	SnO	SnOH				SnC	
^{135}Ba	SnO	SnOH		MoCl			
^{134}Ba	SnO	SnOH	SnN	MoCl		SnC	
^{132}Ba	SnO, CdO	InOH	SnN	MoCl	MoS	SnC	
^{130}Ba	CdO	CdOH	SnN, CdN	MoCl	MoS	SnC	
^{9}Be							
^{114}Cd	MoO	MoOH	MoN	SeCl	SeS		
^{112}Cd	MoO, ZrO	MoOH	MoN	AsCl, SeCl	SeS	MoC	
^{111}Cd	MoO	MoOH	MoN	GeCl			
^{110}Cd	MoO, ZrO		MoN, ZrN	GeCl, AsCl	SeS	MoC	
^{113}Cd	MoO	MoOH		SeCl, AsCl			
^{116}Cd	MoO						
^{106}Cd	ZrO		MoN, ZrN		GeS	MoC, ZrC	
^{108}Cd	MoO, ZrO	ZrOH	MoN, ZrN	GeCl	SeS, GeS	MoC, ZrC	
^{52}Cr	ArO	ClOH				ArC	
^{53}Cr	ClO	ArOH	KN	NCl, OCl		KC	
^{50}Cr	SO		ArN		SO	ArC	Mo^{++}
^{54}Cr		ClOH	ArN, CaN			CaC	
^{59}Cr	CaO	CaOH	ScN	MgCl	AlS	TiC	Sn^{++}
^{63}Cu	TiO, PO_2	TiOH	TiN	SiCl, MgCl	PS	VC	ArNa
^{65}Cu	TiO	TiOH	VN	SiCl	SS, SO_2H	CrC	
^{208}Pb							
^{206}Pb							
^{207}Pb							
^{204}Pb							
^{55}Mn	KO	ArOH	KN		NaS	CaC	Cd^{++}

Attachment 3(cont.)
Isobaric Molecular-Ion Interferences Which Could Affect the Analytes

Analyte	Interferences						
	Oxygen	Hydroxyl	Nitrogen	Chlorine	Sulfur	Carbon	Other
^{202}Hg	WO						
^{200}Hg	WO	WOH	WN				
^{199}Hg	WO	WOH					
^{201}Hg		WOH					
^{198}Hg	WO	TaOH	WN			WC	
^{204}Hg							
^{196}Hg			WN				
^{58}Ni	CaO	KOH	CaN	NaCl	MgS	TiC	Cd^{++}, Sn^{++}
^{60}Ni	CaO	CaOH	TiN	MgCl, NaCl	SiS	TiC	Sn^{++}
^{62}Ni	TiO	ScOH	TiN	AlCl, MgCl	SiS	TiC, CrC	Sn^{++}
^{61}Ni	SeO	CaOH	TiN	MgCl	SiS	TiC	
^{64}Ni	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{80}Se	ZnO	CuOH	ZnN	ScCl, CaCl	TiS	ZnC	
^{78}Se	NiO	NiOH	ZnN	CaCl, KCl	TiS	ZnC	
^{82}Se	ZnO	CuOH	ZnN	TiCl, ScCl	TiS, CrS		
^{76}Se	NiO	CoOH	NiN	KCl	CaS	ZnC	
^{77}Se	NiO	CuN	CuN	CaCl, ArCl	ScS	CuC	
^{74}Se	NiO	NiN	NiN	ClCl, KCl	CaS	NiC	
^{107}Ag	ZrO	ZrOH		GeCl	AsS	MoC	
^{109}Ag		MoOH	MoN	GeCl	SeS	MoC	
^{205}Tl							
^{203}Tl		WOH					
^{51}V	ClO	SOH	ClN	ClO, ClN	FS	KC	
^{50}V	SO		ArN			ArC	Mo
^{64}Zn	TiO	TiOH	TiN, CrN	SiCl, AlCl	SS	CrC	
^{66}Zn	TiO	TiOH	CrN	PCl, SiCl	SS	FeC	
^{68}Zn	CrO	VOH	FeN	PCl	ArS	FeC	Ba^{++}
^{67}Zn	VO	TiOH, Cr	CrN	SCl	ClS	MnC	Ba^{++}
^{70}Zn	FeO	CrOH	GeN	ClCl	ArS	NiC	

NOTE: The information provided in this table does not indicate that all of the described interferences need to be tested. However, the table can be consulted for informational purposes if unusual samples are encountered.

Attachment 4
Changes in Isobaric Molecular-Ion Interferences with Changing Plasma Conditions**

	Molecular Interference	Nebulizer Flow Rate		
		High	Average	Low
Oxides	ScO/Sc	0.00326	0.00055	0.00116
	YO/Y	0.00568	0.00395	0.00353
	TbO/Tb	0.0156	0.00648	0.00614
	ClO, Cl	0.00725	0.00227	0.00233
Hydroxides	ScOH/Sc	0.00040	0.00011	0.00000
	YOH/Y	0.00078	0.00044	0.00048
	TbOH/Tb	0.00034	0.00008	0.00011
	ClOH/Cl	0.00048	0.00031	0.00029
Chlorine	ClO/Cl	0.00725	0.00227	0.00233
	ClOH/Cl	0.00048	0.00031	0.00029
	ArCl/Cl	0.00605	0.00091	0.00477

** Information for this table is being determined by the EPA.

Attachment 5
Internal Standards and Corresponding Metals

Method 200.8			
ICP-MS 004		ICP-MS-024	
Sc	Be	Li^6	Be
Ge	V, Cr, Co, Mn, Cu, Zn, As, Se, Ni	Ge	V, Cr, Co, Mn, Cu, Zn, As, Se, Ni
In	Mo, Ag, Cd, Sn, Sb, Ba	In	Mo, Ag, Cd, Sn, Sb, Ba
H	Tl, Pb, U	H	Tl, Pb, U

Attachment 6

Interference Check Sample Components and Concentrations
(ICSAB minors are suggested spike levels)

Interference Component	Solution A Concentration (mg/L)	Solution AB Concentration (mg/L)
Al	100.0	100.0
Ca	100.0	100.0
Fe	100.0	100.0
Mg	100.0	100.0
Na	100.0	100.0
P	100.0	100.0
K	100.0	100.0
S	100.0	100.0
C	200.0	200.0
Cl	1000.0	1000.0
Mo	2.0	2.0
Ti	2.0	2.0
As	0.0	0.1
Cd	0.0	0.1
Cr	0.0	0.1
Co	0.0	0.1
Cu	0.0	0.1
Mn	0.0	0.1
Ni	0.0	0.1
Se	0.0	0.1
Ag	0.0	0.1
V	0.0	0.1
Zn	0.0	0.1

Attachment 7

Sample Preservation and Holding Times

Measurement Parameter	Container (1)	Preservative (2)	Maximum Holding Time (3)
Waters:			
Metals (4)	P,G	HNO_3 to pH < 2	6 months
Soils/Sediments/Wastes:			
The preservation required for soil/sediment/waste samples is maintenance at 4°C (± 2°C) until digestion.			

Footnotes:
(1) Polyethylene (P) or glass (G).
(2) Sample preservation is performed by the sampler immediately upon sample collection.
(3) Samples must be analyzed as soon as possible after collection. The times listed are the maximum times that sample may be held before analysis and still considered valid. Holding times are calculated from the date when the sample was collected.
(4) Samples are filtered immediately on-site by the sampler before adding preservative for dissolved elements.

Attachment 8

Suggested Mass Choices

Boldface masses indicate the masses which must have the most impact on data quality and the elemental equations used to collect the data.

Mass	Element of Interest
"**27**"	Aluminum
121, "**123**"	Antimony
"75"	Arsenic
138, "137", 136, **135**, 134, 132, 130	Barium
"9"	Beryllium
114, 112, "111", 110, 113, 116, 106	Cadmium
42, 43, **44**, 46, 48	Calcium
"**52**", **53**, **50**, 54	Chromium
"**59**"	Cobalt
"**63**", **65**	Copper
56, **54**, **57**, 58	Iron
"**208**", "**207**", "**206**", 204	Lead
24, **25**, **26**	Magnesium
"**55**"	Manganese
58, "**60**", 62, **61**, 64	Nickel
39	Potassium
80, **78**, "**82**", **76**, **77**, 74	Selenium
"**107**", **109**	Silver
23	Sodium
"**205**", 203	Thallium
"**51**", **50**	Vanadium
64, "**66**", **68**, **67**, 70	Zinc
72	Germanium
139	Lanthanum
118	Tin
35, 37	Chlorine
"98", 96, 92, **97**, 94	Molybdenum

NOTE: It is strongly recommended that elements other than those of interest be monitored to indicate other potential molecular interferences which could affect the data quality.

Attachment 9: Tuning Solution

A tuning solution containing elements representing all of the mass regions of interest must be analyzed. Below are two groups of suggested solutions which cover a typical mass calibration range.

Method 6020

Element	Concentration (μg/L)
Mg	10
Rh	10
Ba	10
Be	10
U	10
Cs	10
Y	10
Pb	10
Li	10
Co	10
In	10
Tl	10

Attachment 10: Suggested Tuning and Response Factor Criteria

Minimum Response from Tuning Solution:

Be	>1,000
Mg	>2,000
Rh	>20,000
Pb	>10,000
Li	>2,000
Co	>20,000
In	>1,000
Tl	>1,000

Suggested Mass Calibration:

Be	9.0122
Mg	23.98
Rh	102.91
Pb	207.98
Li	7.016
Co	58.9332
In	114.904
Tl	204.9744

Attachment 11: Summary of Quality Control Requirements

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
LLQC	At the beginning of the run on an as needed basis	70 - 130% recovery. 6020 IS, ≥70% rec.	Terminate analysis; correct the problem; recalibrate.
LLICV	Beginning of every analytical run.	70 - 130% recovery. 6020 IS, ≥70% rec.	Terminate analysis; correct the problem; recalibrate.
ICV	Beginning of every analytical run.	90 - 110% recovery. 6020 IS, ≥70% rec.	Terminate analysis; correct the problem; recalibrate.
ICB/CB	Immediately after each ICV	The result is < ½ RL. 6020 IS, ≥70% rec.	Terminate analysis; correct the problem; recalibrate.
LLCCV	Beginning and end of run and every 10 samples OR every 2 hours, whichever is more frequent. Beginning and end of each lot.	70 - 130% recovery. 6020 IS, ≥70% rec.	See Section 10.5.10. Reanalyze twice in succession. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCV.
CCV	Beginning and end of run and every 10 samples OR every 2 hours, whichever is more frequent. Beginning and end of each lot.	90 - 110% recovery. 6020 IS, ≥70% rec.	Reanalyze twice in succession. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCV.

Attachment 11: Summary of Quality Control Requirements (Continued)

QC Parameter	Frequency*	Acceptance Criteria	Corrective Action
CCB	Immediately following each CCV.	The result must be < ½ RL. 6020 IS, ≥70% rec.	Reanalyze once. If acceptable, continue. If unacceptable, terminate analysis; correct the problem recalibrate the instrument, reverify calibration and rerun all samples since the last acceptable CCB.
ICSA	Beginning and every 12 hours.	Monitor for possible interferences.	See Section 9.5
ICSAB	Immediately following each ICSA.	Monitor for possible interferences.	See Section 9.5
Method Blank	One per lot of 20 field samples or fewer.	The result must be < ½ RL. Sample results greater than 10x the blank concentration or samples for which the contaminant is < RL, do not require redigestion or reanalysis.	Re-run once. If > ½ RL, redigest and reanalyze samples. Note exceptions under criteria section. See Section 9.2 for additional requirements.
Serial Dilution	One per batch of 20 field samples or fewer.	90 - 110% recovery	See Section 9.7 for additional requirements.
Post-Digestion Spike	One per batch of 20 field samples or fewer.	80-120% recovery	See Section 9.8.
Laboratory Control Sample	One per batch of 20 field samples or fewer.	80-120% recovery	See Section 9.3
Matrix Spike	One per lot of 20 field samples or fewer.	Must be within laboratory control limits	See Section 9.6 for additional requirements.

Attachment 12: Calibration, Calibration Verification, and Spike Concentrations

Element	Initial Calibration (µg/L)	LLICV / LLQC (µg/L)	ICV (µg/L)	LLCCV (µg/L)	CCV (µg/L)	LCS (µg/L)	MS/MSD (µg/L)
Aluminum	100	30	40	30	50	40	40
Antimony	100	2	40	3	50	40	40
Arsenic	100	5	40	5	50	40	40
Barium	100	1	40	1	50	40	40
Beryllium	100	1	40	1	50	40	40
Cadmium	100	1	40	1	50	40	40
Chromium	100	2	40	2	50	40	40
Cobalt	100	1	40	1	50	40	40
Copper	100	1	40	1	50	40	40
Lead	100	1	40	1	50	40	40
Manganese	100	1	40	1	50	40	40
Nickel	100	2	40	2	50	40	40
Silver	100	5	40	5	50	40	40
Thallium	100	1	40	1	50	40	40
Zinc	100	1	40	1	50	40	40

This procedure has been developed for thirty-five elements (See Attachment 8). Additional elements may be included in the calibration solution at the above levels. Levels may be adjusted to meet specific regulatory or client programs.

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Title: Mercury in Solids by Cold Vapor Atomic Absorption

[SW 7471B]

Approvals (Signature/Date):

Doug Gomez — 07-11-13
Technical Specialist — Date

Adam Alban — 12 July 13
Health & Safety Manager / Coordinator — Date

Margaret S. Sleevi — 7/12/13
Quality Assurance Manager — Date

William S. Cicero — 7/12/13
Laboratory Director — Date

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1.0 Scope and Application

1.1 This procedure describes the preparation and analysis of mercury (Hg, CAS # 7439-97-6) by Cold Vapor Atomic Absorption Spectroscopy (CVAA) using SW-846 Method 7471B.

1.2 Method 7471B is applicable to the preparation and analysis of mercury in soils, sediments, bottom deposits, and sludge-type materials. All matrices require sample preparation prior to analysis. This is not an appropriate procedure for the digestion of tissues or other organic matrices, which require the use of EPA 245.6 instead.

1.3 If sample preparation utilizing the Incremental Sampling Method is required, see SOP DV-OP-0013 for the procedure required prior to acid digestion for metals incorporating this procedure.

1.4 The routine reporting limit for mercury in solid matrices is 17 μg/kg.

2.0 Summary of Method

A representative portion of the sample is digested in aqua regia in the first digestion cycle and potassium permanganate in the second cycle. Mercury is reduced to its elemental state with stannous chloride 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. Absorption of light at 253.7nm is calibrated as a function of mercury concentration.

3.0 Definitions

3.1 **Total Mercury:** Inorganic forms of mercury are effectively dissolved by the acids used in the digestion. The potassium permanganate reagent breaks down organo-mercury compounds to inorganic forms that are detected by this procedure.

3.2 **Aqua Regia:** A 3:1 mixture of hydrochloric and nitric acids. This mixture is effective at dissolving metals in the solid form.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Potassium permanganate “suitable for mercury determination” is specified because of the potential for mercury contamination in the reagent. In addition, potassium permanganate crystals will absorb mercury vapors from the air. Reagent bottles must be kept tightly closed to avoid contamination.

4.3 Potassium permanganate, in addition to breaking down organic compounds, also eliminates possible interferences from sulfide. Concentrations as high as 20 ppm of sulfide as sodium sulfide do not interfere with the recovery of inorganic mercury from reagent water.

4.4 Copper has also been reported to interfere; however, copper concentrations as high as 10 ppm had no effect on the recovery of mercury from spiked samples.

4.5 Chlorides can cause a positive interference. Samples 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 at 253.7 nm. Care must be taken to ensure that free chlorine is absent before the mercury is reduced and swept into the cell. This is accomplished by adding excess hydroxylamine reagent (25 mL) and purging the sample headspace before stannous chloride is added. Both inorganic and organic mercury spikes have been quantitatively recovered from seawater using this technique.

NOTE: Sufficient addition of permanganate is apparent when the purple color persists at least 15 minutes. Some samples may require dilution prior to digestion due to extremely high concentrations of chloride.

4.6 Interference from certain volatile organic materials that absorb at the wavelength used for the method may also occur. If suspected, a preliminary run without stannous chloride can determine if this type of interference is present. While the possibility of absorption from certain organic substances present in the sample does exist, this problem is not routinely encountered. This is mentioned only to caution the analyst of the possibility. If this condition is found to exist, the mercury concentration in the sample can be determined by subtracting the result of the sample run without the reducing reagent (stannous chloride) from that obtained with the reducing reagent.

4.7 Samples containing high concentrations of oxidizable organic materials, as evidenced by high COD levels, may not be completely oxidized by this procedure. When this occurs, the recovery of mercury will be low. The problem can be lessened by reducing the volume of original sample used. Alternatively, EPA Method 245.6 can be used.

4.8 The most common interference is laboratory contamination which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately. It is recommended that a disposable face shield be worn when making up aqua regia

5.3.2 Potassium permanganate is a strong oxidizing agent. It is incompatible and must be stored separately from hydroxylamine hydrochloride and stannous chloride, the reducing agents used in this procedure, and from acids.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Mercury Nitrate Solutions	Corrosive Poison	0.1 mg/m^3 Ceiling (Mercury Compounds)	Extremely toxic. Causes irritation to the respiratory tract. Causes irritation. Symptoms include redness and pain. May cause burns. May cause sensitization. Can be absorbed through the skin with symptoms to parallel ingestion. May affect the central nervous system. Causes irritation and burns to eyes. Symptoms include redness, pain, and blurred vision; may cause serious and permanent eye damage.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Hydroxylamine hydrochloride	Corrosive Poison	No OSHA PEL listed for this compound	Direct contact with skin or eyes causes irritation. May cause skin sensitization, an allergic reaction. Inhalation or ingestion may cause methemoglobinemia and resulting cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), and labored breathing.
Potassium Permanganate	Oxidizer	5 mg/m^3 for Mn compounds	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Dry crystals and concentrated solutions are caustic causing redness, pain, severe burns, brown stains in the contact area and possible hardening of outer skin layer. Diluted solutions are only mildly irritating to the skin. Eye contact with crystals (dusts) and concentrated solutions causes severe irritation, redness, and blurred vision and can cause severe damage, possibly permanent.

1 – Always add acid to water to prevent violent reactions.
2 – Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Digestion Block, with adjustable heating, capable of maintaining a sample temperature of 90-95°C.

6.1.2 Mercury Autoanalyzers:

CETAC Mercury Analyzer with Autosampler and Auto-Diluter

6.2 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

6.3 Supplies

6.3.1 Disposable digestion tubes with caps, accuracy verified to ±3% gravimetrically prior to use

6.3.2 Disposable glass tubes, 16mm x 100mm

6.3.3 Argon, 99.999% purity

6.3.4 Calibrated automatic pipettes or Class A glass volumetric pipettes (see SOP No. DV-QA-0008 for details on calibrating mechanical pipettes)

6.3.5 Class A volumetric flasks.

6.3.6 Thermometer, non-mercury column, accurate to ±1°C at 95 °C (see SOP No. DV-QA-0001 for calibration details).

6.3.7 Glass beads, <1 mm diameter, acid washed.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 **Reagent water:** Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.2 **Nitric acid (HNO_3):** concentrated, trace metal grade or better.

7.3 **Hydrochloric acid (HCl):** concentrated, trace metal grade or better.

7.4 **Aqua Regia:** Add 600ml concentrated HCL and 200ml concentrated HNO_3 to a 1 liter container. Aqua regia will be prepared immediately before use

7.5 **Calibration Blank, Initial Calibration Blank (ICB), Continuing Calibration Blank (CCB), and Method Blank (MB), 1% HNO_3:**

7.5.1 Add 0.5 L of concentrated HNO_3 to a 50-L carboy partially filled with reagent water.

7.5.2 Dilute to 50 L with reagent water.

7.6 **Stannous Chloride Solution ($SnCl_2$), Hg grade, 10% (w/v) per manufacturer's instructions. (CETAC Only)**

7.6.1 Place approximately 100 mL of deionized water into a 2-L volumetric flask.

7.6.2 Slowly add 200 mL of concentrated HCl to the flask and swirl to mix.

7.6.3 Add 200 grams of $SnCl_2$ to the flask.

7.6.4 Mix the contents of the flask until the reagent is completely dissolved.

7.6.5 Bring to volume (2-L) with deionized water.

7.7 **Sodium chloride-hydroxylamine hydrochloride solution (Hg grade):**

Add 12 g of sodium chloride and 12 g of hydroxylamine hydrochloride (Hg grade) to every 100 mL of reagent water.

NOTE: Hydroxylamine sulfate may be used in place of hydroxylamine hydrochloride.

7.8 Potassium permanganate, 5% solution (w/v):

Dissolve 5 g of potassium permanganate (reagent grade, "suitable for mercury determination") for every 100 mL of reagent water.

7.9 Purchased Mercury Stock Solutions

Primary Mercury Calibration Standard Solution, 1,000 mg/L

7.10 Calibration Working Standard Solution, 10 mg/L

7.10.1 Add approximately 90 mL of 1% HNO_3 to a 100 mL Class A volumetric flask.

7.10.2 Pipet 1.00 mL of the 1000 mg/L primary mercury calibration standard solution into the flask.

7.10.3 Dilute to the mark on the flask with 1% HNO_3.

7.10.4 Stopper the flask and shake to mix.

7.10.5 Transfer the solution to a 125-mL Nalgene bottle.

7.10.6 Document the preparation of the solution in the Reagent Module in the LIMS.

7.10.7 Prepare this solution fresh monthly or more often if necessary.

7.11 Daily Calibration Working Solution (100 μg/L)

7.11.1 Add approximately 90 mL of 1% HNO_3 to a 100-mL volumetric flask.

7.11.2 Add 1.00 mL of the 10 mg/L Calibration Working Standard (see section 7.10).

7.11.3 Bring the solution to a final volume of 100.0 mL.

7.11.4 Stopper and mix thoroughly.

7.11.5 Document the preparation in the Reagent Module in the LIMS.

7.11.6 Prepare this solution each day prior to calibration.

7.12 Initial Calibration (ICAL) Standards

The initial calibration standards are prepared directly in the digestion tubes as follow:

ICAL	Daily Cal Working Std (mL)	1% HNO_3 (mL)	Final Conc (µg/L)
Blank	0.0	5.0	0.0
Std 1	0.1	4.9	0.20
Std 2	0.25	4.75	0.50
Std 3	0.5	4.5	1.0
Std 4	1.0	4.0	2.0
Std 5	2.5	2.5	5.0
Std 6	5.0	0.0	10.

7.13 Second-Source Initial Calibration Verification (ICV) Daily Intermediate Standard, approximately 400 µg/L.

Add 400 uL of the 100 mg/L ICV Standard to a 100-mL volumetric flask partially filled with 1% HNO_3 and dilute to the mark. Record this information in the Reagent Module in the LIMS.

7.14 Second-Source Initial Calibration Verification (ICV) Daily Working Standard, approximately 4.00 µg/L.

Add 0.5 mL of the 400 µg/L ICV Daily Intermediate Standard (see section 7.13) to a soil digestion tube and add 4.5 mL of 1% HNO_3. Record this information in the Reagent Module in the LIMS.

7.15 Continuing Calibration Verification (CCV) Standards, 5 µg/L

7.15.1 The CCVs are prepared exactly as the 5.0 µg/L ICAL standard shown above (see section 7.12).

7.15.2 Prepare sufficient volume of the standard for analysis of a CCV after every 10 samples.

7.16 Laboratory Control Standard (LCS), 417 µg/kg

7.16.1 The LCS is prepared in an empty digestion tube for which 0.6 g of glass beads are used.

7.16.2 Add 2.5 mL of the 100 µg/L Daily Calibration Working Standard (see section 7.11) to a digestion tube. See Section 10.4.4 for additional detail.

7.16.3 This is equivalent to a 5.0 µg/L ICAL standard, which is the concentration that appears on the raw data printout from the instruments.

7.17 Matrix Spike and Matrix Spike Duplicate (MS/MSD), 417 µg/kg

MS/MSD pairs are spiked in the same manner as the LCS (see section 7.16) and prepared in the same manner as the samples, using 0.6 g of sample.

7.18 Reporting Limit (CRA) Check Standard, 17 µg/kg

7.18.1 Add 0.1 mL of 100 µg/L Daily Calibration Working Standard (see section 7.11) and 4.9 mL of reagent water to a digestion tube.

7.18.2 This is equivalent to a 0.2 µg/L ICAL standard, which is the concentration that appears on the raw data printout from the instruments.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Soil	Glass	3 grams	Cool $\leq 6^{o}C$	28 Days	N/A

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as

appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Preparation Batch

A group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, an LCS, and a matrix spike/matrix spike duplicate pair (MS/MSD). As discussed in the following sections, special program or project requirements can include additional requirements. Always refer to special project instructions for details before proceeding with the analysis.

9.3 Method Blank (MB)

The MB consists of an empty vessel or <1-mm glass beads (for DoD and AFCEE projects) containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. At least one method blank (MB) must be processed with each preparation batch.

Acceptance Criteria: The result for the method blank must be less than the project-specific data quality objectives. In the absence of project-specific data quality objectives, the blank must be less than the ½ the reporting limit or less than 10% of the mercury concentration found in the associated samples, whichever is higher.

Corrective Action: All samples associated with an unacceptable method blank must be re-prepared and reanalyzed. If mercury was not detected in the samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

9.4 Laboratory Control Sample (LCS), 417 µg/kg

The preparation of the LCS is described in Section 7.16. The LCS is spiked at the project-specific action level, or when lacking project-specific action levels, between the low and midlevel standards. At least one aqueous LCS must be processed with each preparation batch. The LCS must be carried through the entire analytical procedure.

Acceptance Criteria: Maximum control limits for LCS recoveries are 80-120%. In-house control limits based on three standard deviations of the mean of historical results are used as long as they are at least as tight as 80-120% (see Policy QA-003 for further details on establishing control limits).

Corrective Action: If LCS recoveries are outside established control limits, the system is out of control and corrective action must

occur. If recoveries are above control limits and mercury is not detected in samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative. In other circumstances, the entire batch must be re-prepared and reanalyzed.

9.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD), 417µg/kg

One MS/MSD pair must be processed for each preparation batch. Some programs may require the use of sample duplicates in place of or in addition to MS/MSDs. In addition, some programs will allow spikes to be reported only for project-related samples. Samples identified as field blanks cannot be used for MS/MSD analysis. MS/MSD is spiked at the same levels as the corresponding LCS.

Acceptance Criteria: Control limits are statistically determined based on three standard deviations of the mean of the laboratory's historical data. The MS/MSD recovery must fall within 80-120%; the relative percent difference (RPD) between the MS and MSD cannot exceed 20%.

Corrective Action: If analyte recovery or RPD fails acceptance criteria, the LCS recovery must be in control for the data to be reported. If there is no evidence of analytical problems and all other QC criteria are met, then qualified results may be reported and the situation must be described in the final report case narrative. In other circumstances, the batch must be re-prepared and reanalyzed.

If the native analyte concentration in the MS/MSD exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated). If the reporting software does not have the ability to report NC, then the actual recovery must be reported and narrated as follows: "Results outside of limits do not necessarily reflect poor method performance in the matrix due to high analyte concentrations in the sample relative to the spike level."

9.6 Serial Dilution

Some programs (e.g., DoD and AFCEE programs) require that a fivefold (1+4) dilution must be included in each analytical batch for each sample matrix.

Acceptance Criteria: The results must be within 10% of the expected value, assuming that the sample concentration is at least 25x the MDL concentration.

Corrective Action: If the result fails the acceptance criteria, all associated sample results must be qualified.

9.7 Post-Digestion Spikes

Some programs require the inclusion of a post-digestion spike in each analytical batch. The post-digestion spike is prepared by adding 0.5 mL of the 100 µg/L Daily Calibration Working Solution to 10 mL of filtered sample digestate. Post-digestion spikes are performed as an additional check for matrix interference.

Acceptance Criteria: The percent recovery limits for the post-digestion spike are 85 to 115%.

Corrective Action: If the result fails the acceptance criteria, all associated sample results must be qualified.

9.8 Method of Standard Addition (MSA)

The method of standard additions is an option for the analysis of samples shown to have significant matrix effects, e.g., unacceptably low MS/MSD recoveries or under certain conditions for TCLP analysis (see Attachment 3 for details).

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

10.3.1 All calibration and calibration verification standards (ICV, ICB, CCV, CCB), as well as the field samples, are processed through the digestion procedure. Prepare digestion tubes containing volumes of standards required for each tube as listed in section 7.

10.3.2 Weigh a 0.5 – 0.6 g aliquot of a well homogenized sample and place in a sample digestion tube. (See No. DV-QA-0023 for additional information on subsampling.)

10.4 Digestion of 3 g sample aliquot obtained utilizing previously prepared Incremental Sampling Method soil aliquot

10.4.1 Five 0.6 g samples and QC are digested in five individual digestion tubes and combined into one after adding the sodium chloride-hydroxylamine hydrochloride.

10.4.2 Prepare an MB, LCS, MS, and MSD for each batch. The MB is either an empty digestion tube or is prepared by placing 0.6 g of glass beads in a digestion tube, depending on client requirements. The LCS is prepared by adding 2.5 mL of the 100 μg/L Daily Calibration Working Solution to a digestion tube. The MS is prepared by adding 2.5 mL of the 100 μg/L Daily Calibration Working Solution to a digestion tube containing a second aliquot of the chosen sample. The MSD is prepared in the same manner as the MS using a third aliquot of the chosen sample.

NOTE: The spike must be added after the sample aliquot but before the addition of reagents.

10.4.3 Add 5.0 mL of aqua regia to each tube.

10.4.4 Add 5.0 mL of reagent water to all un-spiked field samples and the method blanks. Add 2.5 mL of reagent water to the LCS, MS and MSD.

10.4.5 Heat for 2 minutes at 95+/-3 ° C. Record the start and stop times and the temperature on the bench sheet.

10.4.6 Allow the samples and standards to cool at room temperature.

10.4.7 Add 19 mL of reagent water.

10.4.8 Add 15 mL of 5% potassium permanganate solution. A purple color must persist for at least 15 minutes. If the color does not persist, the sample must be re-prepared using less sample.

NOTE: It is important that equal volumes of the potassium permanganate solution are added to all solutions in the batch. Unequal volumes used with the automated method will result in dilution errors. Unequal volumes used with the manual method will result in differing purging efficiencies.

10.4.9 Cap the samples and standards and heat for 30 minutes on the digestion block at 95 +/-3°C. Record the start and stop times and the temperature on the bench sheet. The analyst will verify that a purple color persists or a black precipitate is present after the thirty minutes of heating. If this is not true, the digestion must be repeated using more potassium permanganate or less sample.

10.4.10 Allow the samples and standards to cool at room temperature.

10.4.11 Add 6 mL of sodium chloride-hydroxylamine hydrochloride solution to reduce the excess permanganate. Add additional 1%HNO_3 to bring the final volume to 50 mL.

NOTE: The sample volume must be verified before mixing. Due to the limited headspace left in the digestion tube it is likely that the sample will react with the sodium chloride-hydroxylamine hydrochloride solution possibly causing some loss.

10.4.12 For aliquots taken by the Incremental Sampling Method combine the 5 individual sample cups for each sample and QC into one marked 250ml container.

10.5 Calibration

10.5.1 All calibration standards are digested together with samples, as described in Section 10.1, prior to analysis. Preparation of calibration materials is described in Section 7.

10.5.2 Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (approximately 30 minutes of warm-up is required).

10.5.3 Detailed information regarding calibration models and calculations can be found in Corporate SOP No. CA-Q-S-005, Calibration Curves (General).

10.5.4 Initial Calibration (ICAL)

10.5.4.1 Calibration must be performed daily (every 24 hours) and each time the instrument is set up. The instrument calibration date and time must be included in the raw data.

10.5.4.2 Calibrate using six standards and a blank.

NOTE: It is generally not acceptable to reject calibration points for this method.

10.5.4.3 The calibration curve must have a correlation coefficient of ≥ 0.995 or the instrument shall be stopped and recalibrated prior to running samples. Sample results cannot be reported from a curve with an unacceptable correlation coefficient.

10.5.4.4 Record the counts for the 10 ppb standard in the instrument maintenance log.

10.5.5 Initial and Continuing Calibration Blanks

10.5.5.1 An initial calibration blank (ICB) is tested immediately after the daily ICAL standards.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. Client specific requirements take precedence. For example, DoD requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the blank acceptance limit is exceeded, the analysis should be terminated, the source of contamination identified, and the instrument recalibrated.

10.5.5.2 Continuing calibration blanks (CCBs) are run after every 10 samples and at the end of the run.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Common lab contaminants such as sodium must be less than the RL. Client specific requirements take precedence. For example, DoD requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the blank acceptance limit is exceeded, the analysis should be terminated, the source of contamination identified, and the instrument recalibrated.

10.5.6 Initial Calibration Verification (ICV), approximately 4.0 µg/L

The accuracy of the calibration standards is verified by testing a second source standard (ICV).

Acceptance Criteria: The ICV recovery must be within 90-110%.

Corrective Action: If the ICV acceptance limit is exceeded, the analysis should be terminated, the accuracy of the calibration standards checked, and the instrument recalibrated.

10.5.7 Reporting Limit Check Standard (CRA), 0.2 µg/L

The accuracy of results at the reporting limit is verified by testing a standard in every analytical run that is prepared at the reporting limit concentration.

Acceptance Criteria: The results for this standard must be within 50% of the expected value (20% for some programs).

Corrective Action: If the RL check acceptance limit is exceeded, the analysis should be terminated, the instrument operation checked, the instrument recalibrated, and associated samples reanalyzed.

10.5.8 Continuing Calibration Verification (CCV), 5.0 μg/L

Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard after every 10 samples and at the end of the run.

Acceptance Criteria: The CCV recovery must be within 80-120%.

Correction Action: Sample results may be reported only when bracketed by valid CCV pairs. If a CCV fails, the analysis must be terminated, the problem corrected, the instrument recalibrated, the calibration verified, and the affected samples reanalyzed. If the cause of the CCV failure was not directly related to the instrument, the associated samples must be reanalyzed.

10.6 Sample Analysis

NOTE: Because of differences between various makes and models of CVAA instrumentation, detailed push-button operating instructions are not provided here. Refer to the specific instrument operating manual for detailed autosampler setup and operation protocols.

NOTE: The injection of samples and the addition of stannous chloride are done automatically by the instrument. Refer to the specific instrument manual for details.

10.6.1 Set up the instrument and autosampler according to the manufacturer's instructions.

10.6.2 Allow the samples to cool to room temperature prior to analysis or a decrease in the response signal can occur.

10.6.3 Aliquot each sample and calibration standard into a disposable test tube for analysis.

10.6.4 Analyze the standards and samples according to the manufacturer's instructions.

10.6.5 All measurements must fall within the defined calibration range to be valid. Dilute and reanalyze all samples for mercury concentrations that exceed the highest calibration standard.

NOTE: The instrument auto-dilutes samples. Any samples that require greater than a 10x dilutions MUST be diluted manually.

10.6.6 If the sample results are negative and the absolute value is greater than the reporting limit, the sample must be reanalyzed.

10.6.7 Baseline correction is acceptable as long as it is performed after every sample or after the CCV and CCB. Re-sloping is acceptable as long as it is immediately preceded and followed by a compliant CCV and CCB.

10.6.8 The analytical sequence listed below must be followed. Refer to Quality Control Section 9.0 and Table I (Appendix A) for quality control limits.

Instrument Calibration
ICV
ICB
CRA
Maximum of 10 samples
CCV
CCB
Repeat sequence of 10 samples between CCV/CCB pairs as required to complete run
CCV
CCB

NOTE: Samples included in the count between CCVs include the method blank, LCS, MS, MSD, and field samples.

10.6.9 Guidelines are provided in the appendices on procedures to minimize contamination of samples and standards, preventive maintenance and troubleshooting.

11.0 Calculations / Data Reduction

11.1 Accuracy

$$\textbf{ICV / CCV, LCS \% Recovery} = \frac{\text{observed concentration}}{\text{known concentration}} \times 100$$

$$\textbf{MS \% Recovery} = \frac{\text{(spiked sample) - (unspiked sample)}}{\text{spiked concentration}} \times 100$$

11.2 Precision (RPD)

$$\text{Matrix Duplicate (MD)} = \frac{|\text{orig. sample value - dup. sample value}|}{[(\text{orig. sample value + dup. sample value})/2]} \times 100$$

11.3 Concentration:

$$\text{mg/kg or mg/L} = \frac{C \times V \times D}{W}$$

Where:
C = sample concentration in extract (ppm)
V = Volume of extract (mL)
D = Dilution Factor
W = Weight/Volume of sample aliquot extracted (grams or mLs)

NOTE: All dry weight corrections are made in LIMS at the time the final report is prepared.

11.4 Documentation and Record Management

The following documentation comprises a complete CVAA raw data package:

- Sample preparation bench sheet(s), to include the batch number, list of samples, preparation analyst and date, instrument analysis analyst and date, identification of reagents and standards used, and identification of all measuring equipment used (e.g., balances, thermometers, pipettes). This information is stored in the LIMS.
- Raw data (direct instrument printout).
- Data review checklist - See SOP DV-QA-0020.
- Standards Documentation to include source, lot, preparation date, and expiration date. This information is stored in the LIMS.
- Nonconformance summary (if applicable).

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. An initial method detection limit study is performed in accordance with Policy DV-QA-005P. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. For Texas TRRP, DoD, AFCEE, and DOE projects, an MDL verification is performed quarterly.

12.2 Demonstration of Capabilities

12.2.1 All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually.

12.2.2 IDOCs and on-going proficiency demonstrations are conducted as follows. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample is typically the LCS spike level. The results of the IDOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. IDOCs are approved by the Quality Assurance Manager and the Technical Director. IDOC records are maintained by the QA staff in the central training files.

12.3 Training Requirements

12.3.1 The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

14.0 Waste Management

All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Corporate Safety Manual, and HS-001, "Waste Management Program."

14.1 The following waste streams are produced when this method is carried out:

14.1.1 Aqueous Acidic (Metals) - Corrosive - (J)

14.1.2 Expired reagents and standards – Contact the Waste Coordinator.

NOTE: Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of these materials.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Update IV, February 2007, Method 7471B (Mercury).

15.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/20/2010.

15.3 U.S.EPA Statement of Work for Inorganic Analysis, ILMO3.0

16.0 Method Modifications:

Item	Method	Modification
1	7471B	An additional QC analysis, RL verification, is added
2	7471B	Methods 7470A and 7471B state that working standards "should be prepared fresh daily." The laboratory frequently prepares up to three batches of mercury samples, including digested calibration standards, each day. The third batch is typically prepared and digested late in the day, and then is analyzed the morning of the next day. The laboratory had developed the following information

Item	Method	Modification
		demonstrating that analysis within 24 hours, but on the second calendar day from preparation produces reliable results and is acceptable to the EPA: • Successful proficiency testing (PT) results for samples that were prepared and analyzed within 24 hours, but on successive days • Successful analysis of true NIST mercury standards within every analytical batch; and • A written comment from the EPA MICE Hotline stating that, with the supporting lab data, their opinion was that the laboratory's practice is "within the letter of the method as written."
3	Chapter 1, SW846	Chapter 1 of SW-846 specifies the use of reagent water with a purity equivalent of ASTM Type II water. This SOP specifies the use of a Millipore DI system or equivalent to produce reagent water. This SOP requires that reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.
4	7471B	7471B uses reagent water for the method blank. TestAmerica Denver is currently using glass beads.
5	7471B	Section 11.1 requires 50 mL of reagent water to be added to the sample with 15 mL of Potassium permanganate. TestAmerica Denver utilizes digestion tubes which do no allow for 50 mL of reagent water. 19 mL of reagent water is currently being added.

17.0 Attachments

Attachment 1: Mercury Preparation & Analysis Flowchart
Attachment 2: Summary of Quality Control Requirements
Attachment 3: MSA Guidance
Attachment 4: Instrument Maintenance

18.0 Revision History

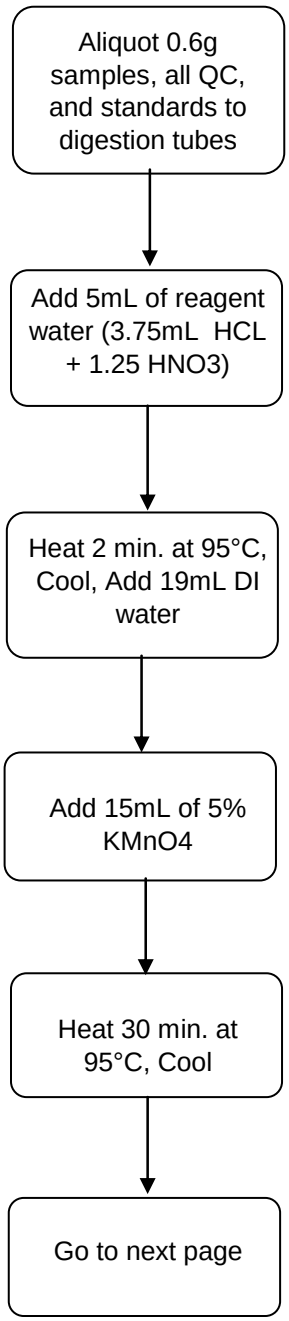
- Revision 2 dated 15 July 2013
  - Updated Sections 9.1, 10.1, 10.2, 12.1 to reflect current practice
  - Formatting and grammatical changes throughout
  - Updated sections 7.6, 7.16.2 & 10.4.8 to reflect current practice
  - Changed or added CRA to Reporting limit standard in sections 7.18, 10.5.7, 10.6.8 and Attachment 2
  - Removed Attachment 3 and renumbered attachments
  - Changed references to Standards Log Database to Reagent Module in the LIMS
  - Corrected references date for section 15.2
  - Added Texas TRRP to section 12.1
- Revision 1.2 dated 13 July 2012
  - Updated Sections 7.6 and 7.7 for using Hg grade reagents
  - Updated Sections 10.4.11 to bring samples to 50 mL with 1% HNO3
  - Added Section 10.5.4.4 to record the counts of the 10 ppb high standard
  - Updated Section 10.5.5 to control the calibration blanks to ½ the RL
  - Updated Sections 9.1, 10.1, 10.2, 12.1 to reflect current practice

- Formatting and grammatical changes throughout
- Updated sections 7.6, 7.16.2 & 10.4.8 to reflect current practice
- Changed or added CRA to Reporting limit standard in sections 7.18, 10.5.7, 10.6.8 and Attachment 2

- Revision 1.1 dated 03 February 2012
  - Annual technical review
  - Changed references of Multi-Incremental Sampling to Incremental Sampling Method throughout document
  - Section 1.3 Added statement for Incremental Sampling Method
  - Added introductory statement to section 7.0 regarding reagent purity
  - Updated section 9.5 and Attachment 2 for Method Blank criteria
  - Section 10.2.12 Added Incremental Sampling Method combination procedure
  - Section 10.2.13 Added Incremental Sampling Method final volume
  - Added dilution note to Section 10.3.5
  - Updated section 12.0 to reflect current laboratory practice
- Revision 1.0, dated 31 August 2011
  - Added a note to section 10.1.3 for the addition of the LCS/MS spike before reagents.
  - Updated Section 5.1.1 to include using a face shield when making up aqua regia
  - Added Section 7.4 for how to make aqua regia
  - Removed previous Section 7.6 (FIMS information)
  - Updated Section 7.13 ICV daily intermediate standard level to 400ug/l
  - Updated Section 7.14 ICV daily working standard level to 4ug/l
  - Updated Section 10.2.3 ICV level to 4ug/l
  - Changed run order for ICV and ICB in section 10.3.8
  - Changed section 10.1.4 to say 5ml of aqua regia
- Revision 0.8, dated 25 April 2011
  - Removed all references to the FIMS Hg Analyzer
  - Sections 6.1 and 6.3 were updated to reflect the use of digestion blocks from water baths
- Revision 0.7, data 07 February 2011
  - Updated supplies list for implementation of calibrated digestion tube
  - Updated Section 10 to incorporate use of calibrated tube for digestion.
  - Updated Section 6 to include reference to the Master List of Documents, Software and Hardware.
- Revision 0.6, dated 01 September 2010
  - Annual Technical Review
  - Removed comment about Standards Log in Section 7
  - Updated Section 11.4 for new LIMS
  - Removed example prep sheet (Attachment 3)
- Revision 0.5, dated 07 August 2009
  - Removed Reagent Blank from Section 7.4
  - Changed table heading in section 7.12 to say 1% HNO_3 from reagent blank
  - Changed Section 7.13 and 7.14 to use 1% HNO_3 from reagent blank

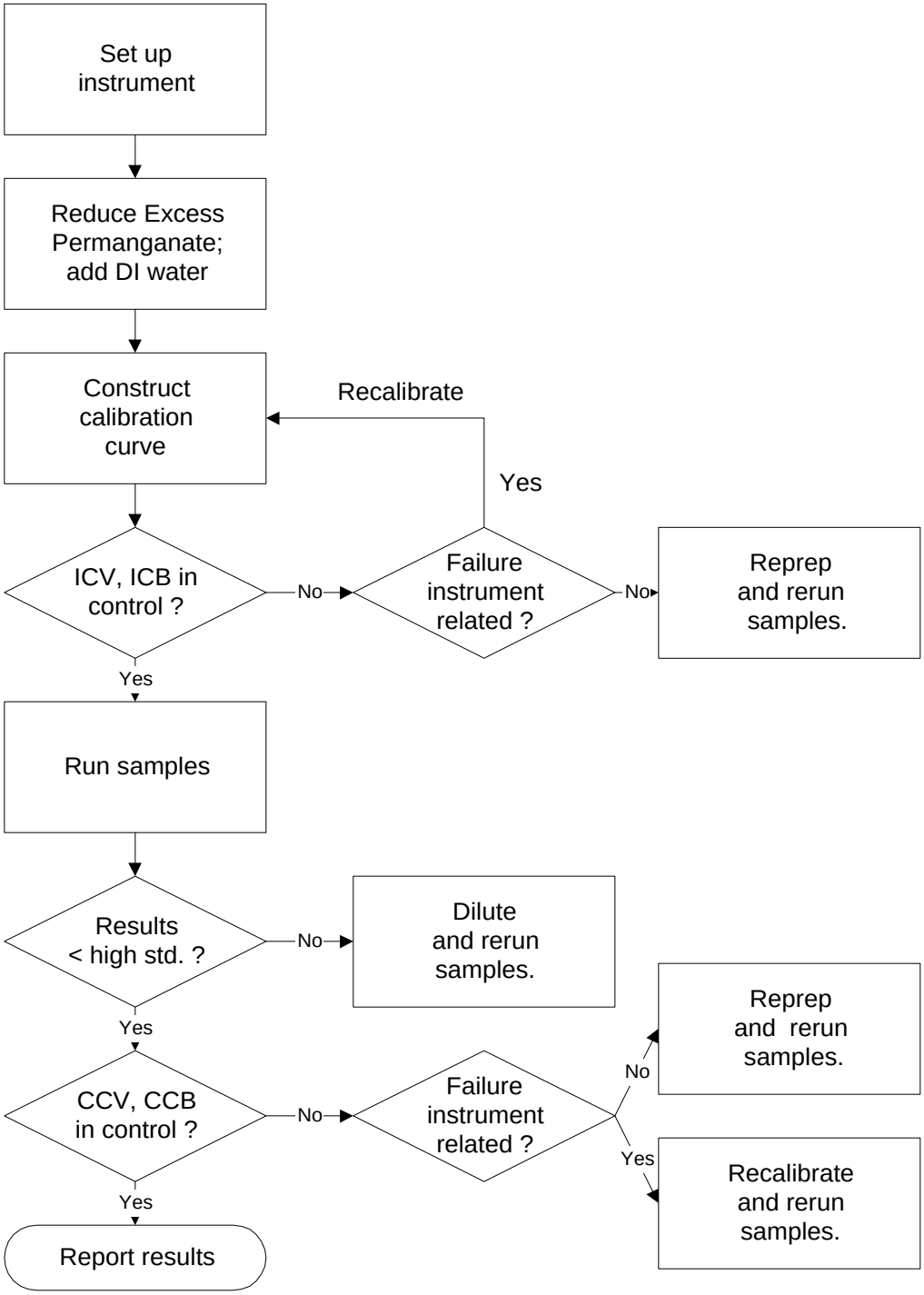
Attachment 1

Mercury Preparation & Analysis Flowchart



Attachment 1

Mercury Preparation & Analysis Flowchart (continued)



Attachment 2

Summary of Quality Control Requirements

QC PARAMETER	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
ICB	Immediately following ICAL	Absolute value < ½ RL (2x MDL for DoD)	Terminate analysis; correct the problem; recalibrate or re-prepare and reanalyze batch.
ICV	Following ICB	90- 110% recovery	Terminate analysis; correct the problem; recalibrate or re-prepare and reanalyze batch.
RL Check Standard (CRA)	Following the ICV	50-150% recovery (80-120% for DoD)	Terminate analysis; correct the problem; recalibrate or re-prepare and reanalyze batch.
CCV	Every 10 samples and at the end of the run	80 - 120 % recovery.	Terminate analysis; correct the problem; recalibrate and rerun all samples not bracketed by acceptable CCVs or re-prepare and reanalyze batch.
CCB	Immediately following each CCV	Absolute value < ½ RL (2x MDL for DoD)	Terminate analysis; correct the problem; recalibrate and rerun all samples not bracketed by acceptable CCVs or re-prepare and reanalyze batch.
Method Blank	One per sample preparation batch of up to 20 samples.	Project specific or ≤1/2 RL Sample results greater than 10% the blank concentration are acceptable. Samples for which the contaminant is < RL do not require redigestion	Redigest and reanalyze samples. Note exceptions under criteria section.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Recovery must be within statistical control limits, not to exceed 80 - 120%	Terminate analysis; correct the problem; redigest and reanalyze all samples associated with the failed LCS.
Matrix Spike	One per sample preparation batch of up to 20 samples.	Recovery must be within statistical control limits, not to exceed 75-125%	In the absence of client specific requirements, flag the data; no flag required if the sample level is > 4x the spike added.
Matrix Spike Duplicate	See Matrix Spike	Recovery within statistical control limits, not to exceed 75-125 % recovery or in-house control limits; RPD ≤ 20%	See Corrective Action for Matrix Spike.

Attachment 3

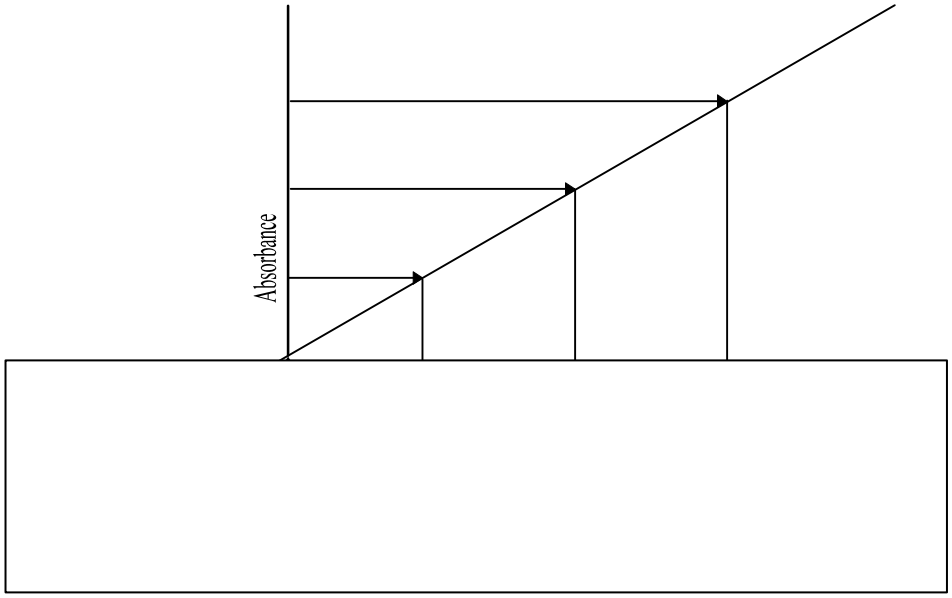
MSA Guidance

Method of Standard Addition

Four equal volume aliquots of sample are measured and known amounts of standards are added to three aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked aliquots should be the same (i.e., the volume of the spike added should be negligible in relation to the volume of sample).

To determine the concentration of analyte in the sample, the absorbance (or response) of each solution is determined and a linear regression performed. On the vertical axis the absorbance (or response) is plotted versus the concentrations of the standards on the horizontal axis using 0 as the concentration of the unspiked aliquot. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the point of interception of the horizontal axis is the concentration of the unknown. Calculate the correlation coefficient (r) and the x-intercept (where y=0) of the curve. The concentration in the digestate is equal to the negative x-intercept.

Figure 1



For the method of standard additions to be correctly applied, the following limitations must be taken into consideration.

- The plot of the sample and standards must be linear over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.
- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

Attachment 4

Instrument Maintenance

A maintenance log is used to record when maintenance is performed on instruments. When an instrument problem occurs, record the date, time and instrument number, then identify the problem and corrective action in the maintenance log. When the instrument is returned to service, record the return to service, the date, and any tests performed to verify proper operation.

The following preventative maintenance procedures are <u>required</u> to ensure that that the instrument is fully operational.

Cold Vapor Atomic Absorption

Daily	Monthly	Annually
Change rinse solution.	Check Hg lamp intensity.	Change Hg lamp.
Optimize light path.		Check liquid/gas separator.
Check argon flow.		
Check tubing. Replace as needed.		
Check drain.		
Check condition of dryer		

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Title: Mercury in Water by Cold Vapor Atomic Absorption (CVAA) [SW 7470A]

Approvals (Signature/Date):

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Technical Specialist — Date

Adam Alban 11 July 13
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1.0 Scope and Application

1.1 This procedure describes the preparation and analysis of mercury (Hg, CAS # 7439-97-6) by Cold Vapor Atomic Absorption Spectroscopy (CVAA) using SW-846 Method 7470A.

1.2 Method 7470 is applicable to the preparation and analysis of mercury in ground water, aqueous samples, wastes, wipes, TCLP, EP and other leachates/extracts.

1.3 All matrices require sample preparation prior to analysis.

1.4 The reporting limit is 0.0002 mg/L (0.2 μg/L), except for TCLP leachates that have a 0.002 mg/L (2 μg/L) reporting limit.

2.0 Summary of Method

This SOP describes a technique for the determination of mercury in solution. The procedure is a physical method based on the absorption of radiation at 253.7 nm by mercury vapor. A representative portion of the sample is digested in sulfuric and nitric acids. Organic mercury compounds are oxidized with potassium permanganate and potassium persulfate and the mercury reduced to its elemental state with stannous chloride 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 is measured as a function of mercury concentration. Concentration of the analyte in the sample is determined by comparison of the sample absorbance to the calibration curve (absorbance vs. concentration).

3.0 Definitions

3.1 Dissolved Metals: Those elements that pass through a 0.45-μm membrane. (Sample is acidified after filtration).

3.2 Total Metals: The concentration determined on an unfiltered sample following digestion.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Potassium permanganate, which is used to breakdown organic mercury compounds, also eliminates possible interferences from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of inorganic mercury from reagent water.

4.3 Copper also has been reported to interfere; however, copper concentrations as high as 10 mg/L had no effect on the recovery of mercury from spiked samples.

4.4 Chlorides can cause a positive interference. Seawaters, brines, and industrial effluents high in chlorides will require dilution. During the oxidation step, chlorides

are converted to free chlorine, which also absorbs radiation at 253.7 nm. Care must be taken to ensure that free chlorine is absent before the mercury is reduced and swept into the cell. Both inorganic and organic mercury spikes have been quantitatively recovered from seawater using this technique.

4.5 Interference from certain volatile organic materials that absorb at the wavelength used for the method may also occur. If suspected, a preliminary run without stannous chloride can determine if this type of interference is present. While the possibility of absorption from certain organic substances present in the sample does exist, this problem is not routinely encountered. This is mentioned only to caution the analyst of the possibility. If this condition is found to exist, the mercury concentration in the sample can be determined by subtracting the result of the sample run without the reducing reagent (stannous chloride) from that obtained with the reducing reagent.

4.6 Samples containing high concentrations of oxidizable organic materials, as evidenced by high COD levels, may not be completely oxidized by this procedure. When this occurs, the recovery of mercury will be low. The problem can be eliminated by reducing the volume of original sample used.

4.7 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Corporate Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.3.2 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.3.3 Potassium permanganate is a strong oxidizing agent. It is incompatible

and must be stored separately from hydroxylamine hydrochloride and stannous chloride, the reducing agents used in this procedure, and from acids.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Mercury (1,000 ppm in Reagent)	Oxidizer Corrosive Poison	0.1 mg/m^3 Ceiling (Mercury Compounds)	Extremely toxic. Causes irritation to the respiratory tract. Causes irritation. Symptoms include redness and pain. May cause burns. May cause sensitization. Can be absorbed through the skin with symptoms to parallel ingestion. May affect the central nervous system. Causes irritation and burns to eyes. Symptoms include redness, pain, and blurred vision; may cause serious and permanent eye damage.
Sulfuric Acid	Corrosive Oxidizer Dehydrator Poison Carcinogen	1 mg/m^3-TWA	Inhalation produces damaging effects on the mucous membranes and upper respiratory tract. Symptoms may include irritation of the nose and throat, and labored breathing. Symptoms of redness, pain, and severe burn can occur. Contact can cause blurred vision, redness, pain and severe tissue burns. Can cause blindness.
Hydrochloric Acid	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Potassium Permanganate	Oxidizer	5 mg/m^3 for Mn Compounds	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Dry crystals and concentrated solutions are caustic causing redness, pain, severe burns, brown stains in the contact area and possible hardening of outer skin layer. Diluted solutions are only mildly irritating to the skin. Eye contact with crystals (dusts) and concentrated solutions causes severe irritation, redness, and blurred vision and can cause severe damage, possibly permanent.
Potassium Persulfate	Oxidizer	None	Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. Causes irritation to skin and eyes. Symptoms include redness, itching, and pain. May cause dermatitis, burns, and moderate skin necrosis.
1 – Always add acid to water to prevent violent reactions. 2 – Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

6.1.1 Digestion Block, with adjustable heating, capable of maintaining a sample temperature of 90-95°C.

6.1.2 Mercury Auto-analyzers:

- CETAC Mercury Analyzer with Autosampler and Auto-Diluter

6.2 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on G:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

6.3 Supplies

6.1.3 Disposable 50 mL digestion tubes with caps. Accuracy verified to ±3% gravimetrically prior to use (by lot).

6.1.4 Disposable glass test tubes, 16 mm x 100 mm

6.1.5 Argon, 99.999% purity

6.1.6 Calibrated automatic pipettes or Class A glass volumetric pipettes (see SOP No. DV-QA-0008 for details on calibrating mechanical pipettes).

6.1.7 Class A volumetric flasks.

6.1.8 Thermometer, non-mercury column, accurate to ±1°C at 95 °C (see SOP No. DV-QA-0001 for calibration details).

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 **Reagent water:** Must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.

7.2 **Nitric acid (HNO_3):** concentrated, trace metal grade or better.

7.3 **Hydrochloric acid (HCl):** concentrated, trace metal grade or better.

7.4 Sulfuric acid (H_2SO_4): concentrated, trace metal grade or better.

7.5 Calibration Blank, Initial Calibration Blank (ICB), Continuing Calibration Blank (CCB), and Method Blank (MB), 1% HNO_3:

Add 0.5 L of concentrated HNO_3 to a 50-liter carboy partially filled with reagent water. Dilute to 50 L with reagent water.

7.6 Stannous Chloride Solution, Hg grade, 10% (w/v) per manufacturer's (CETAC) instructions

7.6.1 Place approximately 100 mL of deionized water in a 2-L volumetric flask

7.6.2 Slowly add 200 mL of concentrated HCl to the flask and swirl to mix.

7.6.3 Add 200 grams of $SnCl_2$ to the flask.

7.6.4 Mix the contents of the flask until the reagent is completely dissolved.

7.6.5 Bring to volume (2-L) with deionized water.

7.7 Sodium chloride-hydroxylamine hydrochloride solution (Hg grade):

Add 12 g of sodium chloride and 12 g of hydroxylamine hydrochloride (Hg grade) to every 100 mL of reagent water.

NOTE: Hydroxylamine sulfate may be used in place of hydroxylamine hydrochloride.

7.8 Potassium permanganate ($KMnO_4$), 5% solution (w/v):

Dissolve 5 g of potassium permanganate (reagent grade, "suitable for mercury determination") for every 100 mL of reagent water.

7.9 Potassium persulfate ($K_2S_2O_8$), 5% solution (w/v):

Dissolve 5 g of potassium persulfate, reagent grade, for every 100 mL of reagent water.

7.10 Purchased Mercury Stock Solutions

7.10.1 Primary Mercury Calibration Standard Solution, 1,000 mg/L

7.10.2 Second-source Mercury Standard (different vendor than primary calibration standard), 100 mg/L.

7.11 Calibration Working Standard Solution, 10 mg/L.

7.11.1 Add approximately 90 mL of 1% HNO_3 to a 100 mL Class A volumetric flask.

7.11.2 Pipet 1.00 mL of the 1000 mg/L primary mercury calibration standard

solution (see Section 7.10.1) into the flask.

7.11.3 Dilute to the mark on the flask with 1% HNO_3.

7.11.4 Stopper the flask and shake to mix.

7.11.5 Transfer the solution to a 125 mL Nalgene bottle.

7.11.6 Document the preparation of the solution in the Reagent Module in the LIMS.

7.11.7 Prepare this solution fresh monthly or more often if necessary.

7.12 Daily Calibration Working Solution, 100 µg/L

7.12.1 Add approximately 90 mL of 1% HNO_3 to a 100 mL Class A volumetric flask.

7.12.2 Pipet 1.00 mL of the 10 mg/L Calibration Working Standard solution (see Section 7.11) into the flask.

7.12.3 Dilute to the mark on the flask with 1% HNO_3 (final volume of 100.0 mL).

7.12.4 Stopper the flask and shake to mix.

7.12.5 Transfer the solution to a 125 mL Nalgene bottle.

7.12.6 Document the preparation of the solution in the Reagent Module in the LIMS.

7.13 Daily Initial Calibration (ICAL)Standards.

7.13.1 To each of six volumetric flasks, add approximately 80 mL of 1% HNO_3.

7.13.2 For each calibration level, add the amount of Daily Calibration Working Solution to the flask as indicated in the following table and bring the solution to a final volume of 100.0 mL. The final concentration for each calibration level is listed in the following table:

Daily ICAL Standards

Calibration Level	Volume of Daily Calibration Working Solution (100 µg/L) (mL)	Final Hg Concentration (µg/L)
1	0.20	0.2
2	0.50	0.5
3	1.0	1.0
4	2.0	2.0
5	5.0	5.0
6	10.0	10.0

7.13.3 Stopper each flask and mix thoroughly.

7.13.4 Document the preparation of the solution in the Reagent Module of the LIMS.

7.13.5 Prepare the calibration solutions each day prior to calibration.

7.14 Continuing Calibration Verification Standard, 5.0 µg/L.

7.14.1 The CCV is prepared exactly as the 5.0 µg/L calibration standard, and from the same source. Refer to Section 7.13.

7.14.2 Prepare sufficient volume of the standard for analysis of a CCV after every 10 samples.

7.15 Second-Source Initial Calibration Verification (ICV) Intermediate Standard, 400 µg/L.

Add 0.4 mL of the 100 mg/L ICV stock standard (see Section 17.10.2) to a 100 mL volumetric flask partially filled with 1%HNO_3 and dilute to the mark. Record this information in the Reagent Module in the LIMS.

7.16 Second-Source Initial Calibration Verification (ICV) Working Standard, 4.00 µg /L.

Add 1.0 mL of the 400 µg/L ICV intermediate standard (see Section 7.15) to a 100 mL volumetric flask partially filled with 1%HNO_3 and dilute to the mark. Record this information in the Reagent Module in the LIMS.

7.17 Laboratory Control Sample (LCS), 5 µg/L

The LCS is prepared by adding 1.5 mL of the 100 µg/L Daily Calibration Working Standard to 30 mL of reagent blank in a digestion tube.

7.18 Matrix Spike and Matrix Spike Duplicate (MS/MSD), 5 µg/L

7.18.1 The MS is prepared by adding 1.5 mL of the 100 µg/L Daily Calibration Working Solution to a digestion tube containing a second 30-mL aliquot of the selected sample.

7.18.2 The MSD is prepared in the same manner as the MS using a third aliquot of the selected sample.

7.19 Reporting Limit (CRA) Check Standard, 0.2 µg/L

The 0.2 µg/L calibration standard is analyzed as a sample to verify the reporting limit. Denoted as CRA in the run sequence.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent

on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Water	HDPE	50 mL	HNO_3, pH < 2	28 Days	40 CFR Part 136.3

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 **Sample QC** - The following quality control samples are prepared with each batch of samples.

9.2.1 Preparation Batch

A group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank (MB), a laboratory control sample (LCS), and a matrix spike/matrix spike duplicate (MS/MSD) pair. As discussed in the

following sections, special program or project requirements can include additional requirements. Always refer to special project instructions for details before proceeding with the analysis.

9.2.2 Method Blank (MB)

The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. At least one method blank must be processed with each preparation batch.

Acceptance Criteria: The result for the method blank must be less than the project-specific data quality objectives. In the absence of project-specific data quality objectives, the blank must be less than ½ the reporting limit or less than 10% of the mercury concentration found in the associated samples, whichever is higher.

Corrective Action: All samples associated with an unacceptable method blank must be re-prepared and reanalyzed. If mercury was not detected in the samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

9.2.3 Laboratory Control Sample (LCS)

The LCS is a blank to which a known concentration of the target analyte has been added. At least one aqueous LCS must be processed with each preparation batch. The LCS must be carried through the entire analytical procedure.

Acceptance Criteria: Maximum control limits for LCS recoveries for Method 7470A are 80-120%. In-house control limits based on three standard deviations of the mean of past results are used as long as they are at least as tight as the limits in the methods (see TestAmerica Denver Policy DV-QA-003P for further details on establishing control limits).

Corrective Action: If LCS recoveries are outside established control limits, the system is out of control and corrective action must occur. If recoveries are above the upper control limit and mercury is not detected in samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative. In other circumstances, the entire batch must be re-prepared and reanalyzed.

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

A matrix spike (MS) is a second aliquot of a selected field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a third aliquot of the same sample (spiked exactly as the MS) prepared and analyzed along with the sample and matrix spike. One MS/MSD pair must be processed for each preparation batch. Some programs may require the use of sample duplicates in place of or in addition to MS/MSDs. In addition, some programs will allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for MS/MSD analysis. Spiking levels are provided in Attachment 1).

Acceptance Criteria: Control limits are statistically determined based on three standard deviations of the mean of the laboratory's historical data. The recoveries for the MS and MSD must fall within 75-125%. The relative percent difference between the MS and MSD cannot exceed 20%.

Corrective Action: If analyte recoveries or the RPD between duplicates fall outside the acceptance range, then LCS recovery must be in control for the data to be reported. If there is no evidence of analytical problems and all other QC criteria are met, then qualified results may be reported and the situation must be described in the final report case narrative. In other circumstances, the batch must be re-prepared and reanalyzed.

If the native analyte concentration in the MS/MSD sample exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated). If the reporting software does not have the ability to report NC, then the actual recovery must be reported and narrated as follows: "Results outside of limits do not necessarily reflect poor method performance in the matrix due to high analyte concentrations in the sample relative to the spike level."

9.2.5 Serial Dilution

Some programs (e.g., DoD programs) require that a fivefold (1+4) dilution must be included in each analytical batch for each sample matrix.

Acceptance Criteria: The results must be within 10% of the expected value, assuming that the sample concentration is at least 25x the MDL concentration.

Corrective Action: If the control limit is not met, all associated

sample results must be qualified.

9.2.6 Post-Digestion Spikes

Some programs require the inclusion of a post-digestion spike in each analytical batch. The post-digestion spike is prepared by adding 0.25 mL of the 100 µg/L Daily Calibration Working Solution to 6.6 mL of filtered sample digestate. Post-digestion spikes are performed as an additional check for matrix interference.

Acceptance Criteria: The percent recovery limits for the post-digestion spike are 85 to 115%.

Corrective Action: If the acceptance criteria are not met, all associated sample results must be qualified.

9.2.7 Method of Standard Addition (MSA)

The method of standard additions is an option for the analysis of samples shown to have significant matrix effects, e.g., unacceptably low MS/MSD recoveries or under certain conditions for TCLP analysis (see Attachment 3)

9.3 Instrument QC

9.3.1 Initial Calibration (ICAL)

9.3.1.1 Detailed information regarding calibration models and calculations can be found in Corporate SOP No. CA-Q-S-005, *Calibration Curves (General).*

9.3.1.2 Calibration must be performed daily (every 24 hours) and each time the instrument is set up. The instrument calibration date and time must be included in the raw data.

9.3.1.3 Calibrate using six standards and a blank. The concentration levels are listed in Attachment 1.

NOTE: It is generally not acceptable to reject calibration points for this method.

9.3.1.4 The calibration curve must have a correlation coefficient of ≥ 0.995 or the instrument shall be stopped and recalibrated prior to running samples. Sample results cannot be reported from a curve with an unacceptable correlation coefficient.

9.3.1.5 Record the number of counts for the 10 ppb standard in the instrument maintenance log.

9.3.2 Initial and Continuing Calibration Blanks

9.3.2.1 An initial calibration blank is tested immediately after the daily

ICAL standards.

Acceptance Criteria: Absolute values for the calibration blanks must be less than ½ the standard RL. Client specific requirements take precedence. For example, DoD requires control of blanks to a concentration less than or equal to the LOD.

Corrective Action: If the blank acceptance limit is exceeded, the analysis should be terminated, the source of contamination identified, and the instrument recalibrated.

9.3.2.2 Continuing calibration blanks are run after every 10 samples and at the end of the run.

Acceptance Criteria: The absolute value of the blank result must be less than ½ the reporting limit. Some programs require that blanks be less than 2x the MDL or less than the LOD (refer to special project requirements).

Corrective Action: If the blank acceptance limit is exceeded, the analysis should be terminated, the source of contamination identified, and the instrument recalibrated.

9.3.3 Initial Calibration Verification (ICV), 4 µg/L

The accuracy of the calibration standards is verified by testing a second source standard (ICV).

Acceptance Criteria: The ICV result must be within 10% of the true value.

Corrective Action: If the ICV acceptance limit is exceeded, the analysis should be terminated, the accuracy of the calibration standards checked, and the instrument recalibrated.

9.3.4 Reporting Limit Check Standard (CRA), 0.2 µg/L

The accuracy of results at the reporting limit is verified by testing a standard in every analytical run that is prepared at the reporting limit concentration.

Acceptance Criteria: The results for this standard must be within 50% of the expected value (20% for USACE and DoD projects).

Corrective Action: If the RL check acceptance limit is exceeded, the analysis should be terminated, the instrument operation checked, and the instrument recalibrated.

9.3.5 Continuing Calibration Verification (CCV), 5.0 µg/L

Calibration accuracy is monitored throughout the analytical run through the analysis of a known standard after every 10 samples and at the end of the run. The CCV must be a mid-range standard at a concentration other than that of the ICV.

Acceptance Criteria: The CCV result must fall within 20% of the true value.

Correction Action: Sample results may be reported only when bracketed by valid CCV pairs. If a mid-run CCV fails, the CCV may be re-analyzed once without modification to the instrument's operating conditions. If the re-analyzed CCV is found to be in control, the CCV analysis must be repeated with successful results or the analysis must be terminated, the problem corrected, the instrument recalibrated, the calibration verified and the affected samples reanalyzed. If the cause of the CCV failure was not directly instrument related, the associated samples must be re-prepared and reanalyzed.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Sample Preparation

10.3.1 All calibration and calibration verification standards (ICV, ICB, CCV,

CCB), as well as the field samples, are processed through the digestion procedure.

10.3.2 Transfer 30.0 mL of well mixed sample and 30.0 mL of each calibration and calibration verification standard to a clean sample digestion tube. The calibration standards are prepared in duplicate to ensure sufficient volume to complete the analytical sequence. Additional aliquots of CCV and CCB solution may have to be prepared for larger sample runs to ensure that CCV and CCB samples bracket every 10 samples in the analytical sequence.

10.3.3 Prepare an MB, LCS, MS, and MSD for each batch.

10.3.3.1 The MB consists of 30.0 mL of 1% HNO_3.

10.3.3.2 The LCS is prepared by adding 1.5 mL of the 100 µg/L Daily Calibration Working Solution to 30 mL of 1% HNO_3 in a digestion tube.

10.3.3.3 The MS is prepared by adding 1.5 mL of the 100 µg/L Daily Calibration Working Solution to a digestion tube containing a second 30-mL aliquot of the selected sample.

10.3.3.4 The MSD is prepared in the same manner as the MS using a third aliquot of the selected sample.

10.3.4 Add 1.5 mL of concentrated H_2SO_4 and 0.75 mL of concentrated HNO_3 to the samples in the digestion tubes, mixing after each addition.

10.3.5 Add 4.5 mL of 5% potassium permanganate solution to each sample. For samples high in organic materials or chlorides, dilute the sample until the purple color persists for at least 15 minutes.

10.3.6 Add 2.4 mL of potassium persulfate solution, cap the vial, and heat for two hours at 90 - 95°C. Record the start and stop times and the temperature on the bench sheet. Verify that a purple color persists or a black precipitate is present after the two hours of heating. If this is not true, repeat the digestion using a smaller aliquot of sample.

10.3.7 Allow the samples and standards to cool at room temperature.

10.4 Calibration

10.4.1 All calibration standards are digested together with samples, as described in Section 10.3, prior to analysis.

10.4.2 Set up the instrument with the operating parameters recommended by the manufacturer. Allow the instrument to become thermally stable before beginning calibration (approximately 30 minutes of warm-up is required).

10.5 Sample Analysis

NOTE: Because of differences between various makes and models of CVAA instrumentation, detailed push-button operating instructions are not provided here. Refer to the specific instrument-operating manual for detailed autosampler setup and operation protocols.

NOTE: The injection of samples and the addition of stannous chloride are done automatically by the instrument. Refer to the specific instrument manual for details.

10.5.1 When ready to begin analysis, add 1.8 mL of sodium chloride-hydroxylamine hydrochloride solution to the samples to reduce the excess permanganate. The permanganate has been reduced when no purple color remains.

10.5.2 Add additional 1% HNO_3 to the samples, QC samples and calibration standards to bring the final volume of each sample to 45 mL.

10.5.3 Aliquot each sample and calibration standard into a disposable test tube for analysis.

10.5.4 All measurements must fall within the defined calibration range to be valid. Dilute and reanalyze all samples for analytes that exceed the highest calibration standard.

NOTE: The instrument auto-dilutes samples. Any samples that require greater than 10x dilutions MUST be diluted manually.

10.5.5 If the sample results are negative and the absolute value is greater than the reporting limit, the sample must be diluted and reanalyzed.

10.5.6 The samples must be allowed to cool to room temperature prior to analysis or a decrease in the response signal can occur.

10.5.7 Baseline correction is acceptable as long as it is performed after every sample or after the CCV and CCB. Re-sloping is acceptable as long as it is immediately preceded and followed by a compliant CCV and CCB.

10.5.8 The following analytical sequence must be used for Method 7470A. Refer to Quality Control Section 9.0 and Attachment 2 for quality control criteria to apply to Method 7470A.

Instrument Calibration
ICV
ICB
CRA
Maximum of 10 samples
CCV
CCB

Repeat sequence of 10 samples between CCV/CCB pairs as required to complete the run.
CCV
CCB

NOTE: Samples included in the count between CCVs include the method blank, LCS, MS, MSD, and field samples.

10.5.9 For TCLP samples, full four-point MSA will be required if all of the following conditions are met:

- Recovery of the analyte in the matrix spike is <50%;
- The concentration of the analyte does not exceed the regulatory level; and
- The concentration of the analyte is within 20% of the regulatory level.
- The reporting and matrix spike levels for TCLP analyses are detailed in Attachment 1. Attachment 3 provides guidance on performing MSA analyses. For TCLP mercury determinations, MSA spikes must be added prior to sample preparation.

10.5.10 To facilitate the early identification of QC failures and samples requiring rerun, it is strongly recommended that sample data be reviewed periodically throughout the run.

10.5.11 See Attachment 5 for guidelines for minimizing contamination of samples and standards. See Attachments 4 and 6 for guidance on troubleshooting and preventive maintenance.

11.0 Calculations / Data Reduction

11.1 Detailed calibration equations can be found in the corporate SOP CA-Q-S-005 "Calibration Curves" and under the public folder, Arizona Calibration Training.

11.2 Accuracy

$$\textbf{ICV / CCV, LCS \% Recovery} = \frac{\text{observed concentration}}{\text{known concentration}} \times 100$$

$$\textbf{MS \% Recovery} = \frac{\text{(spiked sample) - (unspiked sample)}}{\text{spiked concentration}} \times 100$$

11.3 Precision (RPD)

$$\textbf{Matrix Duplicate (MD)} = \frac{|\text{orig. sample value - dup. sample value}|}{[(\text{orig. sample value + dup. sample value})/2]} \times 100$$

11.4 Concentration = Hg concentration $(\mu g/L) = C \times D$

Where:

C = Concentration (μg/L) from instrument readout
D = Instrument dilution factor

11.5 Appropriate factors must be applied to sample values if dilutions are performed.

11.6 Sample results should be reported with up to three significant figures in accordance with the TestAmerica significant figure policy (DV-QA-004P).

11.7 Documentation and Record Management

The following documentation comprises a completed CVAA raw data package:

- Sample preparation bench sheet(s), to include the batch number, list of samples, preparation analyst and date, instrument analysis analyst and date, identification of reagents and standards used, and identification of all measuring equipment used (e.g., balances, thermometers, pipettes). This information is stored in the LIMS.
- Raw data (direct instrument printout).
- Data review checklist - See SOP DV-QA-0020.
- Standards Documentation to include source, lot, preparation date, and expiration date.
- Nonconformance summary (if applicable).

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. An initial method detection limit study is performed in accordance with Policy DV-QA-005P. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency. For Texas TRRP, DoD, AFCEE, and DOE projects, an MDL verification is performed quarterly.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Further details concerning demonstrations of proficiency are described in SOP# DV-QA-0024.

12.3 Training Requirements

12.3.1 The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability).

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Corporate Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Aqueous Acidic (Metals) - Corrosive - Waste Stream J

14.2.2 Expired reagents and standards – Contact the Waste Coordinator.

NOTE: Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of these materials.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update II, Revision I, September 1994, Method 7470A (Mercury).

15.2 Department of Defense Quality Systems Manual for Environmental Laboratories, Final Version 4.2, 10/25/2010.

15.3 U.S.EPA Statement of Work for Inorganics Analysis, ILMO3.0.

16.0 Method Modifications:

Item	Method	Modification
1	EPA 7470A	Chapter 1 of SW846 specifies the use of reagent water with a purity equivalent to ASTM Type II water. This SOP specifies the use of a Millipore DI system or equivalent to produce reagent water. This SOP requires that reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks.
2	EPA 7470A	This SOP allows for the use of reduced sample volumes to decrease waste generation. Reagent levels are adjusted to maintain the same ratios as stated in the source methods. According to a letter from Robert Booth of EPA EMSL-Cinn to David Payne of EPA Region V, "Reduction in sample size and appropriate corresponding reduction in sample volume is not considered a significant change in the methodology."
3	EPA 7470A	Methods 7470A and 7471A state that working mercury standards "should be prepared fresh daily." The laboratory frequently prepares up to three batches of mercury samples, including digested calibration standards, each day. The third batch is typically prepared and digested late in the day, and then is analyzed the morning of the next day. The laboratory has developed the following information demonstrating that analysis within 24 hours, but on the second calendar day from preparation produces reliable results and is acceptable to the EPA: • Successful proficiency testing PT results for samples that were prepared and analyzed within 24 hours, but on successive days (e.g., ERA WP-66); • Successful analysis of true NIST mercury standards within every analytical batch; and • A written comment from the EPA MICE Hotline stating that, with the supporting lab data, their opinion was that the laboratory's practice is "within the letter of the method as written."
4	EPA 7470A	Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above ½ the reporting limit.

17.0 Attachments

Figure 1: Aqueous Sample Preparation Flow Chart
Figure 2: CVAA Mercury Analysis Flow Chart
Attachment 1: Mercury Reporting Limits, Calibration Levels, QC Standard and Spiking Levels
Attachment 2: Summary of Quality Control Requirements
Attachment 3: MSA Guidance

Attachment 4: Troubleshooting Guide
Attachment 5: Contamination Control Guidelines
Attachment 6: Preventative Maintenance

18.0 Revision History

- Revision 2 dated July 15, 2013
  - Annual review
  - Changes section 7.6 and 12 to reflect current practices
  - Remove reference to Standards Log to Reagent Module in the LIMS in section 7.11.6, 7.12.6, 7.13.4, 7.15 & 7.16.
  - Changed "RL" to "CRA" in sections 7.19, 9.3.4, 10.5.8
  - Added CRA (RL Standard) to Attachment 2
  - Removed Attachment 3 and re-number subsequent attachments
  - Clarified first bullet point under 10.5.9
  - Corrected references date for section 15.2
  - Added Texas TRRP to section 12.1
- Revision 1.2 dated July 13, 2012
  - Updated Sections 7.6 and 7.7 to state Hg reagents are used
  - Updated Sections 9.3.2.1 and 9.3.2.2 to control calibration blanks to ½ RL
  - Added Section 9.3.1.5 to record the counts for the 10 ppb high standard
  - Updated Sections 10.5.2 to bring samples to a final volume of 45 mL with 1% HNO_3
  - Formatting and grammatical changes

- Revision 1.1 dated February 03, 2012
  - Annual technical review
  - Added introductory statement to section 7.0 regarding reagent purity
  - Updated Section 9.1.2 and Attachment 2 for Method Blank acceptance criteria
  - Added dilution note to Section 10.3.4
  - Updated section 12.0 to reflect current laboratory practice
  - Removed Leeman instrument and replaced Nitrogen with Argon for Attachment 7

- Revision 1.0 dated 23 August 2011
  - Updated Section 7.15 ICV Intermediate Standard to 400ug/l
  - Updated Section 7.16 ICV Working Standard level to 4ug/l
  - Updated Section 9.2.3 ICV true value to 4ug/l
  - Updated Section 10.3.8 ICV and ICB run order

- Revision 0.5 dated 25 April 2011
  - Removed all references to the FIMS Analyzer
  - Sections 6.1 and 6.3 were updated to reflect the use of digestion blocks from water baths.
  - The reagent amounts were updated to reflect using a 30ml aliquot from 10ml.
  - Section 10.3.2 was updated to show a final volume of 40ml.

- Revision 0.4 dated 07 February 2011
  - Revised section 10 to reflect use of calibrated digestion tubes and calibration standard volumes
  - Revised supplies list
  - Revised section 6.2 to include reference to Master List of Documents, Software

and Hardware
    - Added section 11.1 to reference corporate SOP CA-Q-S-005 “Calibration Curves”

- Revision 0.3 dated 01 September 2010
    - Section 7.0: Removed note about standards log with the change in LIMS systems
    - Section 12.2 added section about MDLV verifications
    - Updated Section 11.6 for new LIMS
    - Removed Attachments 3a and 3b
    - Annual Technical Review

- Revision 0.2 dated 07 August 2009
    - Sections 7.17 and 7.18 were updated to use 1% HNO3 from reagent blank.
    - Sections 10.1.3.1 and 10.1.3.2 were updated to use 1% HNO3 from reagent blank.
    - Changed SOP name DV-QA-003P from QC Policy to Quality Assurance Program.

- Revision 0.1, dated 16 February 2008
    - Section 9.1.2: Changed control limit to 10% to match soil SOP
    - Section 9.2.2: Changed the stated control limits for special projects from ½ the RL to 2x the MDL
    - Deleted section 12.2 for IDL requirements
    - Section 12.3: Noted that LCSs will be used for verification

Figure 1

Aqueous Sample Preparation Flow Chart

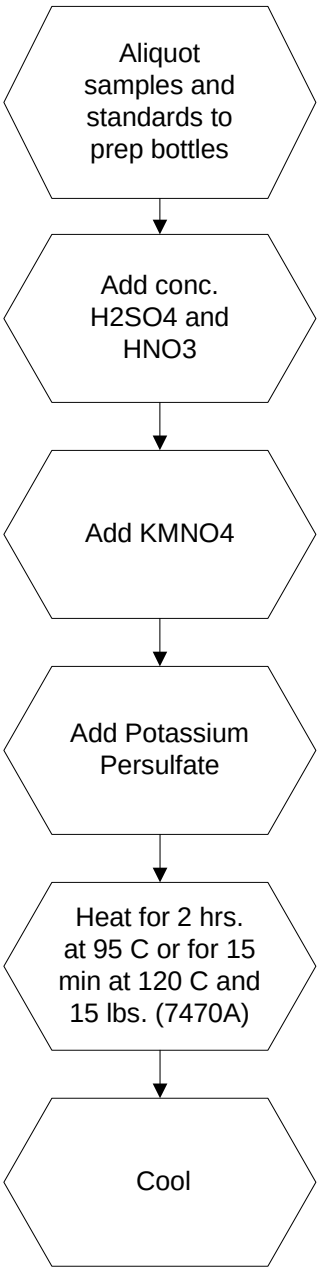
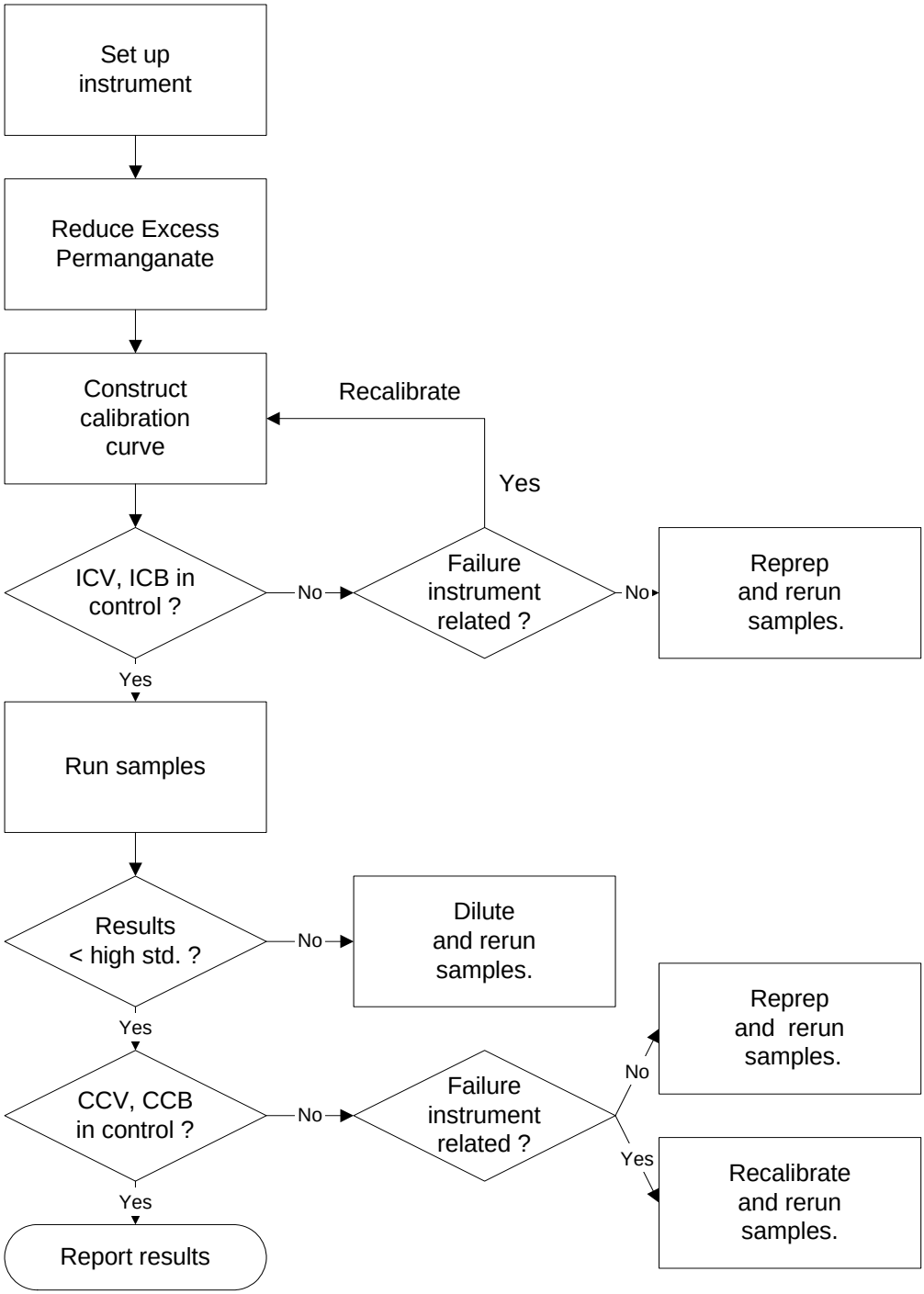


Figure 2

CVAA Mercury Analysis Flow Chart



Attachment 1

Mercury Reporting Limits, Calibration Levels, QC Standard and Spiking Levels (µg/L)

Standard Aqueous RL	0.2
TCLP RL	0.2
Std 0	0
Std 1	0.2
Std 2	0.5
Std 3	1.0
Std 4	2.0
Std 5	5.0
Std 6	10.0
ICV	4.0
LCS/CCV	5.0
Aqueous MS	5.0
TCLP MS	5.0

Attachment 2

Summary of Quality Control Requirements

QC Parameter	Frequency *	Acceptance Criteria	Corrective Action
ICV	Beginning of every analytical run.	90 - 110% recovery	Terminate analysis; Correct the problem; Recalibrate or reprep batch (see Section 9.3.3).
RL Check Standard (CRA)	Following the ICV	50-150% recovery (80-120% for DoD)	Terminate analysis; correct the problem; recalibrate or re-prepare and reanalyze batch.
ICB	Beginning of every analytical run, immediately following the ICAL.	Absolute value must be < ½ RL, 2x the MDL for DoD	Terminate analysis; Correct the problem; Recalibrate or reprep batch (see Section 9.3.2).
CCV	Every 10 samples and at the end of the run.	80 - 120% recovery	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCV or reprep batch (see Section 9.3.5).
CCB	Immediately following each CCV.	Absolute value must be < ½ RL, 2x the MDL for DoD	Terminate analysis; Correct the problem; Recalibrate and rerun all samples not bracketed by acceptable CCB or reprep batch (see Section 9.3.2).
Method Blank	One per sample preparation batch of up to 20 samples.	Project specific or ½ RL Sample results greater than 10x the blank concentration are acceptable.	Re-digest and reanalyze samples. Note exceptions under criteria section. See Section 9.2.2 for additional requirements.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	In-house 3 standard deviation control limits, not to exceed 80-120% recovery.	Terminate analysis; Correct the problem; Re-digest and reanalyze all samples associated with the LCS (see Section 9.2.3).
Matrix Spike	One per 10 samples preparation batch of up to 20 samples.	In-house 3 standard deviation control limits, not to exceed 75-125% recovery	In the absence of client-specific requirements, flag the data (see Section 9.2.4).
Matrix Spike Duplicate	See Matrix Spike	In-house 3 standard deviation control limits, not to exceed 20% RPD	See Corrective Action for Matrix Spike.

Attachment 3

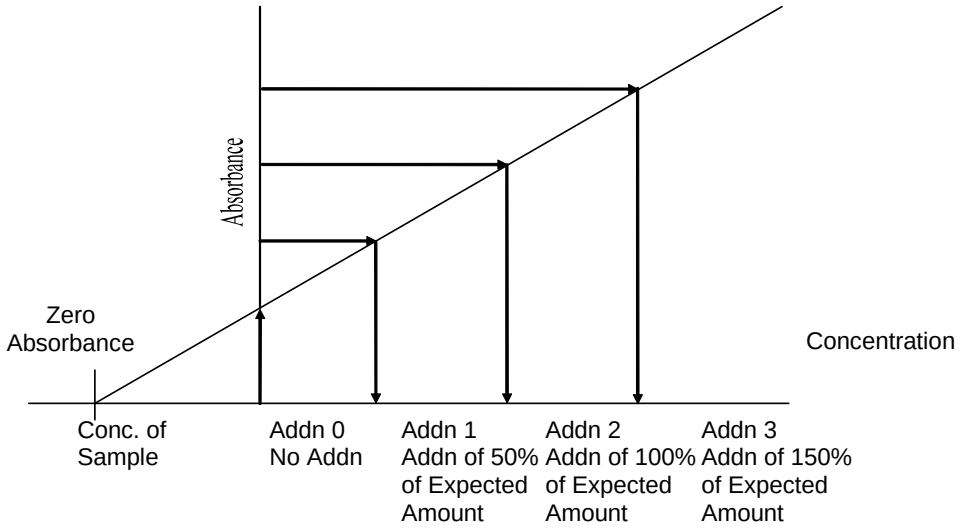
MSA Guidance

Method of Standard Addition (MSA)

Four equal volume aliquots of sample are measured and known amounts of standards are added to three of the aliquots. The fourth aliquot is the unknown and no standard is added to it. The concentration of standard added to the first aliquot should be 50% of the expected concentration. The concentration of standard added to the second aliquot should be 100% of the expected concentration, and the concentration of standard added to the third aliquot should be 150% of the expected concentration. The volume of the unspiked and spiked aliquots should be the same (i.e., the volume of the spike added should be negligible in relation to the volume of sample).

To determine the concentration of an analyte in the sample, the absorbance (or response) of each solution is determined and a linear regression performed. The absorbance (or response) is plotted on the vertical axis versus the concentrations of the standards on the horizontal axis using 0 as the concentration of the unspiked aliquot. An example plot is shown in Figure 1. When the resulting line is extrapolated back to zero absorbance, the point of interception of the horizontal axis is the concentration of the unknown. The correlation coefficient (r) and the x-intercept (where y=0) of the curve are calculated. The concentration in the digestate is equal to the negative x-intercept.

Figure 1



For the method of standard additions to be correctly applied, the following limitations must be taken into consideration.

- The plot of the sample and standards must be linear over the concentration range of concern. For best results, the slope of the curve should be similar to that of a plot of the aqueous standard curve.

- The effect of the interference should not vary as the ratio of the standard added to the sample matrix changes.

Attachment 4

Troubleshooting Guide

Problem	Possible Cause
Poor or No Absorbance or Sensitivity Check failed	Incorrect wavelength Dirty windows Window loose Etched or dirty optics Bad lamp Not enough or no sample introduced Empty sample cup Incorrectly made standards Gas leak
Erratic Readings	Source lamp not aligned properly Lamp not pre-warmed Injection tip partially clogged Contaminated reagents Contaminated glassware Drying tube saturated Bad lamp Injection tip hitting outside of tube Injection tip coated or not set properly Leak in sample tubing Power fluctuations Air bubbles in tubing
Standards reading twice or half normal absorbance or concentration	Incorrect standard used Incorrect dilution performed Dirty cell
Background Correction Light Blinking	Background screen or attenuator faulty

Attachment 5

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

- All work areas used to prepare standards and spikes should be cleaned before and after each use.
- All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Powdered gloves should not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes.
- Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.
- Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- If an unusually high sample is analyzed, segregate the glassware and soak with sulfuric acid prior to routine cleaning.

Attachment 6

Preventative Maintenance

A maintenance log is used to record when maintenance is performed on instruments. When an instrument problem occurs, record the date, time, and instrument number; describe the problem; and explain the corrective action in the maintenance log.

The following procedures are required to ensure that that the instrument is fully operational:

Cold Vapor Atomic Absorption (CETAC Analyzers)

Daily	Monthly	Annually
Change rinse solution.	Check Hg lamp intensity.	Change Hg lamp.
Optimize light path.		Check liquid/gas separator.
Check argon flow.		
Check tubing. Replace as needed.		
Check drain.		
Check condition of dryer		

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Title: Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples [SW-846 8330A & 8330B]

Approvals (Signature/Date):

Susan H. Oster 12/20/12
Susan Oster Date
Technical Specialist

Adam W. Alban 24Dec12
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12/24/12
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Laboratory Director

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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the extraction of nitroaromatic and nitroamine explosive residues from soil samples. This procedure is based on SW-846 8330A and 8330B, but can also be performed on samples for analysis by method SW-846 8321A.

1.2 This procedure does not describe the analysis of the extracts. For those details, see the following SOPs:

1.2.1 DV-LC-0002 "*Analysis of Nitroaromatic and Nitroamine Explosive Compounds by HPLC"*

1.2.2 DV-LC-0010 "*Analysis of Nitroaromatic and Nitroamine Explosives Compounds by APCI/LC/MS"*

1.2.3 DV-LC-0028 *"Analysis of Nitroaromatic and Nitroamine Explosive Compounds by APCI/LC/MS/MS"*.

1.2.4 DV-LC-0025 *"Analysis of Picric Acid by LC/MS/MS"*

1.3 Application of 8330A versus 8330B

1.3.1 This procedure is for extraction by either Method 8330A or 8330B. The most important differences in the two source methods are the more rigorous sample collection and preparation measures in 8330B, which are designed to produce more representative results. The more rigorous 8330B process is specifically intended to complement the incremental field sampling process described in Appendix A of method 8330B. If incremental or equivalent systematic sampling processes are not employed in the field, then the extra laboratory homogenization and subsampling effort 8330B requires may add little or no improvement in the overall precision of results.

1.3.2 A larger sample size is used for 8330B (10 g) than is used for 8330A (2 g).

2.0 Summary of Method

2.1 Solid samples are air dried and sieved. Soil agglomerates are broken with a mortar and pestle, sieve shaker, or mechanical grinder. For samples requiring the more rigorous homogenization techniques found in method 8330B, the analyst employs either a ring and puck grinder or a ball mill grinder. The samples are extracted with a 0.1% acetic acid in acetonitrile mixture on a shaker table.

3.0 Definitions

3.1 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM).

3.2 **Explosives:** As used in this SOP, the term "explosives" refers specifically to the analytes listed in Table 1. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.3 **TALS:** TestAmerica Laboratory Information Management System

3.4 **ISM:** Incremental Sampling Methodology - This is a requirement of method 8330B and describes the technique used to take a 10g aliquot from a sample in at least 30 increments.

3.5 **Extraction Holding Time**: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.6 **Preparation Batch**: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.7 **Grinding Batch:** A grinding batch is up to 20 samples processed through the same grinding procedure within a three day time span due to the expiration of the grinding LCS. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.**

3.8 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client.

3.9 **Quality Assurance Summary (QAS)**: Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.10 **Aliquot**: A part that is a definite fraction of a whole; as in “take an aliquot of a sample for testing or analysis.” In the context of this SOP, “aliquot” is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is extracted immediately following a high-concentration sample.

4.3 The inclusion of vegetation is not recommended given the nature of the detector and different uses the data will potentially support (USACE comment – Issue #306 Audit Database).

4.4 Samples from an ammunition plant or depot usually contain analytes that were deposited via water and leaching and therefore are more uniformly dispersed.

Therefore, as per SW-846 8330B Section 11.1.4.2, ring and puck or ball mill grinding is not necessary.

4.5 Samples from firing ranges and impact zones can contain particles of explosives at a variety of sizes, shapes, and compositions. Therefore the entire sample must be processed through a ring and puck or ball mill prior to removal of the subsample for analysis. Samples collected at the firing point can contain nitrocellulose fibers. These fibers present a special problem in the grinding step. In order to get the fibers to release the target analytes they must be very finely ground. For these samples only the ring and puck should be used. Samples collected at the impact areas usually only contain crystalline residues and can usually be ground satisfactorily with a ball mill as the nitro-cellulose fibers are not present in these areas. The client needs to be consulted when selecting a grinding mechanism.

4.6 Excessive headspace in the ball mill cans may cause loss of target compounds in the grinding LCS. It is important to use cans that are of the appropriate size and fill the cans with grinding stones to minimize headspace.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile or latex gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately. When tightening caps on 40mL glass vials, cut resistant gloves must be worn.

5.1.2 **WARNING**: Soil samples with explosive concentrations greater than 2% cannot be accepted by the laboratory unless they have moisture content of 25% or greater. Under no circumstances shall a soil sample with an explosive concentration greater than 10% be accepted by the laboratory.

5.1.2.1 If a sample is expected to have an explosive concentration ≥2% (but less than 10%), the EH&S Coordinator and Group Leader shall be notified before any work is performed. Additional safety precautions may be implemented as required due to high concentrations of explosives.

5.1.2.2 Soil samples with high concentrations (between 2 and 10%) of explosives should not be ground using a mortar and pestle. Visual observation of a soil samples is important prior to grinding samples. Any samples containing metal fragments, powders, waxy appearing pieces, or other suspicious material should be brought to the

attention of the Group Leader and the EH&S Coordinator before proceeding with the procedure. Bypassing the grinding step and proceeding to solvent dilution is an alternative for samples that are determined to be unsafe to grind.

5.1.3 Anyone working in the grinding room needs to be enrolled in the Hearing Conservation Program. See SOP DV-HS-0010 for details. Personnel operating the grinding equipment are required to wear ear plugs when the equipment is turned on.

5.1.4 Operations involving handling samples outside of sealed containers are conducted in ventilation hoods to avoid exposure to dust. Dust masks are available for use, but are optional.

5.1.5 Operations involving the grinding of radioactive samples can be particularly hazardous due to the increased potential for exposure from airborne dust. If a sample is labeled as a "CAT 1", "CAT 2", "CAT 3" or "CAT 4" sample, and requires grinding thru the ring and puck or ball mill, contact the RSO immediately.

5.2 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
ACETONITRILE	Flammable Poison	40 PPM – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
METHANOL	Flammable Poison Irritant	200 PPM - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.
ACETIC ACID, GLACIAL	Corrosive Poison Flammable Liquid and Vapor	10 PPM - TWA	Inhalation of concentrated vapors may cause serious damage to the lining of the nose, throat, and lungs. Breathing difficulties may occur. Can cause serious damage to skin, including redness, pain, and burns. Contact with eyes may cause severe damage followed by loss of sight.
(1) ALWAYS ADD ACID TO WATER TO PREVENT VIOLENT REACTIONS. (2) EXPOSURE LIMIT REFERS TO THE OSHA REGULATORY EXPOSURE LIMIT.			

6.0 Equipment and Supplies

6.1 Equipment

- Balance, capable of measuring ± 0.01 g. Calibration checked per SOP DV-QA-0014
- Orbital shaker table, capable of maintaining 150 rpm for 18 hours.
- Pipettor with disposable 1.0 mL tips, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008.
- Bottle-top pipettor, able to dispense 8 to 20mL, accurate to ± 2%, calibration checked daily in accordance with SOP DV-QA-0008. If the pipettor does not have a digital display, then the calibration check should be performed whenever the pipette is adjusted.
- Ring and Puck - for the grinding of soils per method 8330B

  The grinding bowl and puck are cleaned after each use by washing with soap and water, with a plastic brush, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% acetonitrile solution in acetone. A final wipe down of the bowl and puck while still wet with solvent is done with a Kimwipe (TNT in particular is reported to be prone to adhering to steel surface). In addition, sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.10.1 for details).
- Ball Mill - for the grinding of soils per method 8330B

  Ceramic grinding stones are cleaned after each use by rinsing with hot tap water, washing with soap and water, rinsing with hot tap water, rinsing with DI water, and then rinsing with a 10% solution of acetonitrile in acetone. The stones are allowed to dry then tumbled in a clean can with clean baked Ottowa Sand for 3 hours. The stones are then removed from the can, rinsed with hot tap water, rinsed with DI water, and then rinsed with 10% acetonitrile in acetone. The stones are allowed to dry again before use. In addition, sand blanks are used to monitor potential carry-over for each batch of samples (see Section 9.10.2 for details)

  Paint Cans – disposable, 1 gallon, ½ gallon, or 1 pint in size. Cans and lids are cleaned prior to use by rinsing with 10% acetonitrile in acetone and wiping with a Kim-wipe while still wet.

  Spacer Cans – cans or PVC pipe that is filled with sand or other material used to prevent sample cans from “walking” off of the mill.
- Trays – “baker’s rack” type of stack for the air drying of soils per method 8330B
- Sieves, 10 and 30 mesh – Sieves are cleaned after each use by washing with soap and water, (be careful not to damage the mesh with brushes), rinsing with hot tap water, rinsing with DI water. Prior to use, the sieves are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe. Sieves are allowed to dry in a hood prior to use.
- Receiver pans and lids – Receiver pans are cleaned after each use by washing with soap and water, rinsing with hot tap water, rinsing with DI water. Prior to use,

the receiver pans are rinsed with a 10% acetonitrile in acetone and wiped dry with a Kim Wipe.

- Sieve shaker – used to facilitate the sieving of large sample volumes.
- Mortar and pestle – cleaned after each use by washing with soap and water, rinsing with hot tap water, and then rinsing with DI water. Prior to use, the mortars and pestles are rinsed with 10% acetonitrile in acetone and wiped with a Kim Wipe and allowed to dry in a hood prior to use.
- Mechanical Grinder – Humbolt Manufacturing Part Number H-4199. Used in place of a mortar and pestle to quickly reduce cakes of dry soil. The grinder reduces soil agglomerates and sieves the soil through a 10 mesh sieve. The mechanical grinder is used to break up soil agglomerates, but it is not an alternative to Ring and Puck or Ball Mill grinding. The mechanical grinder is cleaned after each sample by removing the hopper. The hopper is washed with soap and water, rinsed with tap water, rinsed with DI water, and then rinsed with 90:10 Acetone:Acetonitrile. The Hopper is then wiped dried with a laboratory tissue. The hammers and body of the grinder are cleaned after each sample by rinsing with DI water and wiping dry with a laboratory tissue.

6.2 Supplies

- Glass vials, various sizes.

  Amber glass, 40 mL, with Teflon-lined screw caps for the sonication of soil samples.

  Amber glass, 8.0 mL, with Teflon-lined screw caps, for the storage of final extracts.
- Aluminum foil and aluminum dishes.
- Parchment paper
- 0.2-μm PTFE syringe filters and disposable syringes.
- Wooden spatulas – used to lay samples out to dry.
- Plastic square-ended disposable spoons – used to aliquot samples.

7.0 Reagents and Standards

7.1 Ottawa Sand – baked at 400°C for at least 4 hours.

7.2 Acetonitrile, CH3CN - HPLC grade (ACN). Each lot is tested per CA-Q-S-001 DV-1.

7.3 Soil Extraction Solvent – approximately 0.1% acetic acid in acetonitrile – Open a new 4-liter bottle of acetonitrile and add 4 mL of acetic acid, then cap and mix. This reagent is given a 1 year expiration date.

7.4 Standards

Please reference SOP DV-OP-00020 for information regarding the surrogate and spike standards used in this procedure.

7.5 Grinding LCS Bulk Material

A standard is purchased in a matrix of -20/+70 Sieved Soil that contains the compounds at the concentrations listed in Table 2. This standard comes packaged in 500g containers. This standard is stored in a refrigerator at 0°C to 4°C and is given a 1 year expiration date. After grinding the ground LCS is stored refrigerated and has a three day expiration date.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Soil samples to be extracted by method 8330A for analysis by either method 8330A or method 8321A should be collected in eight-ounce wide mouth jars with Teflon-lined caps. When sampling for DoD projects that must comply with DoD QSM, version 3 or 4 requirements for drying and sieving the entire contents of a soil sample container, a separate container should be used to collect a soil sample for this analysis.

8.2 For soil samples to be extracted by method 8330B for analysis by either method 8330B or method 8321A, it is not uncommon to receive samples of 1kg or more. Samples may be shipped in wide mouth jars or clean plastic bags.

8.3 Sample extracts must be stored in amber glass containers at 4 ± 2 °C.

8.4 Soil and sediment samples should be air dried at ambient temperature until dry enough to sieve. See Section 10.1 for details. Once the sample is air dried, the sample can be stored at room temperature.

8.5 All soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction begins.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time	Reference
Soils	Glass/ plastic	4 grams (8330A)/up to 1 Kg (8330B)	Cool 4 ± 2°C	14 Days	SW846 8330A/B

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the Method Comments and any QAS to determine specific QC requirements that apply.

The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Control Program.

Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client,

and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via special instructions in the LIMS.

Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 11.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument. See QC Policy DV-QA-003P for further details.

Grinding Batches – A grinding batch is up to 20 samples processed through the same grinding procedure within a three day time span due to the expiration of the grinding LCS. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.**

9.4 Method Blank (MB)

A method blank (MB) must be prepared and analyzed with each batch of samples. The MB consists of Ottawa sand with surrogates added. The MB is created at the time of extraction after the samples have been dried, sieved, and ground and is then carried through all extraction and analysis steps. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

Acceptance Criteria: The result for the method blank must be less than the reporting limit for the analytes of interest or less than 10% of the analyte concentration found in the associated samples, whichever is higher. Note that some programs (e.g., AFCEE, DoD) require that the maximum blank concentration must be less than ½ of the reporting limit or less than 10% of the lowest sample concentration.

Corrective Action: If target analytes in the blank exceed the acceptance limits, the associated samples must be re-extracted and re-analyzed. If the analytes detected in the method blank were not detected in the samples, then the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

If the MB acceptance criteria are not met and re-preparation and reanalysis are not possible, then the sample data associated with the unacceptable MB must be qualified. This nonconformance must be addressed in the project or case narrative and the client must be notified.

9.5 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

One LCS must be analyzed with each batch of samples. The LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. The LCS is prepared by spiking the analytes of interest into Ottawa sand. The LCS is created at the time of sample extraction after the samples have been dried, sieved, and ground. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: The recovery results for the LCS must fall within the established control limits. Control limits are set at ± 3 standard deviations around the historical mean. Where required, project-specific limits may be used in place of historical limits. Current control limits are maintained in the LIMS.

When there are more than 11 analytes in the LCS, then NELAC allows a specified number of results to fall beyond the LCS control limit (3 standard deviations), but within the marginal exceedance limits (ME) limits, which are set at ±4 standard deviations around the mean of the historical data. The number of marginal exeedances is based on the number of analytes in the LCS, as shown in the following table.

# of Analytes in LCS	# of Allowed MEs
> 90	5
71 – 90	4
51 – 70	3
31 – 50	2
11 – 30	1
< 11	0

If more analytes exceed the LCS control limits than is allowed, or if any analyte exceeds the ME limits, the LCS fails and corrective action is necessary. Marginal exceedances must be random. If the same analyte repeatedly fails the LCS

control limits, it is an indication of a systematic problem. The source of the error must be identified and corrective action taken.

Corrective Action: If LCS recoveries are outside of the established control limits, the system is out of control and corrective action must occur. If recoveries are above the upper control limit and the analytes of interest are not detected in the samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative. In other circumstances, the entire batch must be re-prepared and re-analyzed.

9.6 Matrix Spike Sample (MS) and Matrix Spike Duplicate (MSD)

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. The soil matrix spikes are created at the time of extraction. Spikes and surrogate compounds are added after the sample has been dried, sieved, and ground. One MS/MSD pair must be processed for each preparation batch. The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.

If insufficient sample volume is available for MS/MSD, an NCM must be written. For SW-846 methods a LCS/LCSD will be required in this case with the exception of work done under the AFCEE and DoD programs which allows precision to be calculated using LCSs from different batches over the duration of the project.

Acceptance Criteria: The spike recoveries must fall within established control limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. Control limits are calculated as $\pm$ 3 standard deviations around the mean of historical data, as described in Policy DV-QA-003P. Control limits are maintained in the LIMS. Some federal programs require LCS limits to be used for MS/MSD evaluation (see SOP DV-QA-024P).

Corrective Action: If analyte recovery in the MS and/or MSD or the RPD between the MS and MSD fail acceptance criteria, but the recovery of the LCS is in control, then the method is considered to be in control and the samples in the batch do not require re-preparation and reanalysis, unless the results indicate that a spiking error may have occurred. The reasons for accepting the batch must be documented in the case narrative. If the recovery of the LCS also fails acceptance criteria, then the samples in the batch must be re-prepared and reanalyzed.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, DU, TRL, MS, and MSD) is spiked with surrogate compounds.

Acceptance Criteria: The recovery of each surrogate must fall within established statistical limits, which are set at $\pm$ 3 standard deviations around the historical mean.

Corrective Action: If surrogate recoveries in the method blank are outside the established limits, verify calculations, standard solutions, and acceptable instrument performance. High surrogate recoveries in the blank might be acceptable if the surrogate recoveries for the field samples and other QC samples in the batch are acceptable. Low surrogate recoveries in the blank require re-preparation and reanalysis of the associated samples, unless sample surrogate recoveries are acceptable and targeted compounds are not detected.

If surrogate recoveries fail, verify calculations, standard solutions, and acceptable instrument performance. High recoveries may be due to a co-eluting matrix interference, which can be confirmed by examining the sample chromatogram. Low recoveries may be due to adsorption by the sample matrix (i.e., clay particles, peat or organic material in the sample). Recalculate the data and/or reanalyze the extract if the checks reveal a problem.

If matrix interference is not obvious from the initial analysis, it is necessary to re-prepare / reanalyze a sample only once to demonstrate that poor surrogate recovery is due to a matrix effect, as long as it can be shown that the analytical system was in control.

9.8 Sample Duplicate (DU)

A duplicate sample is required after ring and puck or ball mill grinding is performed. A duplicate sample is also required for method 8330B, even if grinding is not performed. A sample duplicate is a second aliquot of one of the samples in the batch. Field blanks cannot be used for duplicate testing. The results for duplicates are reported separately, and cannot be averaged when reporting results. Sample duplicate results are used to evaluate the precision of the method. As such, results should be greater than or equal to the RL for a valid statistical comparison.

Acceptance Criteria: The RPD between the sample and the sample duplicate results must be less than the established limit.

Corrective Action: Results for samples that do not meet acceptance limits, particularly if due to difficulties in subsampling, shall be discussed in the final report case narrative, after client notification and agreement.

9.9 Sample Triplicates (TRL)

A triplicate sample is required after ring and puck or ball mill grinding is performed. A duplicate sample is also required for method 8330B, even if grinding is not performed. The lab will determine the %RSD as defined below. Results for the %RSD as well as the individual replicate results will be reported to the client. The method suggests that the %RSD for the subsampling error is acceptable if it is <10%.

The percent relative standard deviation (%RSD) is calculated as follows:

$$\%RSD = \frac{s}{\bar{C}} \times 100\%$$

Where s is the standard deviation of the average concentration and is calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{n-1}}$$

In the event that the laboratory is requested to perform the evaluation of field replicate precision, three field replicates designated by the client will be processed through the entire homogenization and extraction steps. The %RSD for these replicates will be calculated as indicated above and reported to the client.

9.10 Grinding Blank (GB)

9.10.1 Ring and Puck Grinding Blanks

Before each sample is processed through the ring and puck mill, the ring and puck will be cleaned per Section 6.1. Then approximately 200g of Ottawa Sand will be ground. This ground sand will be saved and labeled with the sample ID of the next sample ground with the suffix "blank". After a batch of samples has been processed through the ring and puck, a composite will be generated using sub-aliquots from all blanks ground before the samples. These aliquots are equal portions from each blank, combined to create a 10 g composite sample. This composite is extracted and analyzed in the same manner as the field samples.

Acceptance Criteria: The grinding blank must not contain any analyte of interest at or above the RL or one-half of the RL for DoD projects or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.

Corrective Action: If the composite grinding blank results are greater than the acceptance limits, then the individual grinding blanks will be extracted and analyzed to determine when the contamination occurred and exactly which samples were affected. Samples associated with a contaminated grinding blank producing positive results for the same contaminant, must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.10.2 Ball Mill Grinding Blanks

With every batch of samples processed with the ball mill, approximately 200g of clean Ottowa Sand will also be processed in the same manner. This ground sand will then be extracted and analyzed in the same manner as the field samples.

Acceptance Criteria: The grinding blank must be less than the reporting limit for the analytes of interest or less than 10% of the analyte concentration found in the associated samples, whichever is higher. Note that some programs (e.g., AFCEE, DoD) require that the maximum blank concentration must be less than ½ of the reporting limit or less than 10% of the lowest sample concentration.

Corrective Action: If grinding blank results are greater than the acceptance limits, then any samples producing positive results for the same contaminant must be reprocessed and reanalyzed. If un-ground sample is not available, then the potential carry-over between samples must be described in a non-conformance memo and discussed in the final report case narrative.

9.11 Grinding LCS (LCSSRM)

One Grinding LCS must be ground and analyzed with each batch of samples that are processed through the ring and puck or ball mill grinder. The Grinding LCS must contain specified analytes of interest and must be carried through the entire analytical procedure. The Grinding LCS is prepared by grinding a 500g aliquot of the Grinding LCS Bulk Material described in Section 7.5 without having air-dried the material before hand. The Grinding LCS must be ground using the same grinding apparatus (ring and puck or ball mill) as the samples were ground. The Grinding LCS is used to monitor the effects of the grinding process on the analytes of interest. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: The recovery results for the LCS must fall within the established control limits. Control limits are set at ± 3 standard deviations around the historical mean. Where required, project-specific limits may be used in place of historical limits. Current control limits are maintained in the LIMS. If enough data is not available to set historical limits, the limits from the manufacturer or the standard will be used.

Corrective Action: If the Grinding LCS fails the acceptance criteria, samples associated with the Grinding LCS must be reprocessed and reanalyzed. If un-ground sample is not available, then the results of the grinding LCS must be described in a non-conformance memo and discussed in the final report case narrative.

10.0 Procedure

- One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using a Nonconformance Memo and is approved by a Technical Specialist and QA Manager. If contractually required, the client shall be notified. The Nonconformance Memo shall be filed in the project file.

- Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

10.1 Dry the Samples – Refer to the Flowchart in Appendix 1 and the batching instructions in Appendix 3

10.1.1 Check the Method Comments to see if the samples are for a project with the Department of Defense (DoD), Air Force Center of Environmental Excellence (AFCEE), or Army Corp of Engineers (USACE), If yes, then the entire contents of the sample container must be dried. Check TALS to make sure the client sent more than one container if additional tests are being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified.

10.1.2 If the sample is logged for method 8330B, then the entire contents of the sample container must be dried. Check each sample to make sure the client sent more than one container if additional tests are being requested. If additional tests are logged and the client only sent one container, the Project Manager should be notified

10.1.3 If the samples do not fall under the descriptions given in Section 10.1.1 or Section 10.1.2 then only a portion of the sample container needs to be dried. In these cases, lay out at least 20 g to dry.

10.1.4 Depending on the sample size, the samples are laid out in aluminum pans, or on large trays lined with aluminum foil to dry. Some clients may request metals analysis on the dried samples. In those cases, samples are laid out on parchment paper.

10.1.5 Spread the samples out in a thin layer to facilitate drying. Use a disposable wooden spatula to break up any clumps and agglomerates.

10.1.6 The tray or pan that the sample is laid out into is labeled with the sample ID. A second analyst checks to make sure that the labels on the tray or pan match the labels on the client sample container to ensure samples are not accidently mixed up. This check is documented on the Extraction Review Checklist in WI-DV-0009.

10.1.7 Place the samples in a hood or well ventilated area at room temperature. Document on the Extraction Review Checklist the date and time the samples were laid out to dry. If the samples are very wet, a fan can be used to help facilitate the drying process, but care should be taken so that the air flow is not strong enough to cause cross-contamination between samples. An electronic temperature recording device records the temperature of the room and the data is downloaded weekly.

10.1.8 When the samples appear to be dry enough that they can be sieved without caking, proceed to Section 10.2.

10.2 Sieve the Samples - Refer to the Flowchart in Appendix 2.

10.2.1 If the client requirements specify a particular sieve size, those instructions take precedence.

10.2.2 If the sample is logged for prep method "8330_P_2g" then a 30 mesh sieve should be used.

10.2.3 If the sample is logged for prep method "8330_Sonc_10g" then a 10 mesh sieve should be used.

10.2.4 Some clients will request metals analyses to be performed on the sieved sample. In those cases, a stainless steel sieve should be used. Brass sieves should be avoided.

10.2.5 Clean the sieves prior to use following the instructions in Section 6.1.

10.2.6 Some samples may require the use of a mortar and pestle or a mechanical grinder to break up dried clumps. Refer to Section 6.1 on how to clean and rinse the mortar and pestles and the mechanical grinder before use.

10.2.7 Sieve the entire dried sample through the appropriate sized sieve. Care must be exercised not to eliminate soil agglomerates during this step. The soil can be broken into small pieces with a gloved hand or another instrument (a wooden spatula for example). If a gloved hand is used, care should be taken to change out gloves in between samples so not to cross- contaminate samples.

10.2.8 Remove large rocks, vegetation, and twigs that do not pass through the sieve. Mosses and other types of fine vegetation should be physically shredded while sieving to release trapped soil and residues. The only materials that should be eliminated by sieving are rocks and vegetation. All soil must be broken up to pass through the sieve.

10.2.9 Place any soil that does not pass through the sieve into a clean mortar. Break up soil agglomerates using the pestle. Or as an alternative use the mechanical grinder. Be sure to break up all soil so that it can pass through the sieve. Only extraneous material such as rocks and vegetation should be removed with the sieve. Describe all extraneous material that did not pass through the sieve in an NCM.

NOTE: Some clients may request the portion of the sample that did not pass through the sieve to be saved and weighed. Check Method Comments before discarding any sample material.

10.2.10 Collect all of the material that passes through the sieve on a clean piece of foil or parchment paper.

10.2.11 An automatic sieve shaker can be used to help facilitate the sieving of samples. A receiver pan is placed under a sieve and the sample is added to the sieve with 1 or 2 small grinding stones. Then a lid or another receiver pan for a second sample is placed on top. The stack is then clamped inside the sieve shaker for no more than 30 minutes. Inspect the samples to ensure that only extraneous material such as rocks and vegetation should be removed with the sieve. If needed use a mortar and pestle to break up soil agglomerates. Describe all extraneous material that did not pass through the sieve in an NCM.

10.3 Grind the Samples - Refer to the Flowchart in Appendix 2.

10.3.1 If the samples are not logged with a pre-prep method of "8330_P RingPuck" or "8330_P_BM" skip this section and proceed to Section 10.4.

10.3.2 Ball Mill Grinding

10.3.2.1 If the sample is logged for ball mill grinding, prepare a paint can for each sample. See Section 6.1 on how to clean the cans and the grinding stones. Select a can that is large enough that the sample alone would occupy ½ of the can's volume. Prepare the paint can by filling the can full with grinding stones of various sizes, leaving only 1 inch of space at the top. After the stones have been placed in the can, transfer the sample into the labeled can. The sample will fill in the spaces around the grinding stones. If needed, the sample can be split between multiple cans and recombined after grinding. The entire sample must be ground. It is important to fill the can. Add additional stones if needed. Seal the lid by pounding it in place with a rubber mallet and placing duct tape over the top of the lid to secure it.

NOTE: It is critical that the can has minimal headspace, yet enough stones to grind the sample completely. Excess headspace may result in loss of target compounds, especially in the grinding LCS media.

10.3.2.2 Prepare a grinding blank per Section 9.10.2 with every batch. The grinding blank will be analyzed in addition to the normal extraction blank (method blank).

10.3.2.3 Prepare a grinding LCS per Section 9.11 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS.

10.3.2.4 Place the paint cans on the ball mill. To prevent the samples from falling off of the mill, place a spacer can on the ball mill to the right of the cans on each row. Start the ball mill. Document the start time on the benchsheet. The samples should be ground for at least 8 hours. Remove the paint can and in a fume hood open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed. If the sample is not at the correct consistency of flour, either seal the can and return it to the ball mill for further grinding, or transfer the sample to a ring and puck dish to finish the grinding.

NOTE: If the can is re-sealed to be placed back on the ball mill, care must be taken that the lid was not damaged when the can was opened and that the lid still seals well. It may be necessary to use a new lid if the first lid was damaged.

NOTE: The Grinding LCS (LCSSRM) should not be ground for more than 8 hours.

NOTE: A grinding batch will consist of no more than 20 samples that have been ground within three days of each other. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.** A grinding batch must have one Grinding LCS, and at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank.

10.3.3 Ring and Puck Grinding

10.3.3.1 See Section 6.1 on how to clean the ring and puck dish.

10.3.3.2 If the sample is logged for ring and puck grinding, a grinding blank per Section 9.10.1 consisting of baked Ottawa sand will be processed through the ring and puck dish before each sample. These individual blanks will be composited into one grinding blank for the associated samples and will be analyzed in addition to the normal extraction blank.

NOTE: When preparing the grinding blanks, it is not necessary to do five 60-second grinds. One 60-second grind of the Ottawa sand is sufficient.

10.3.3.3 After a grinding blank has been processed through a ring and puck dish, that blank is labeled as the blank associated to the next sample processed through that same dish. It is not necessary to clean the ring and puck dish after the blank.

10.3.3.4 Prepare a grinding LCS per Section 9.11 with every batch. The grinding LCS will be analyzed in addition to the normal extraction LCS.

NOTE: A grinding batch will consist of no more than 20 samples that have been ground within three days of each other. The grinding batch is opened with a grinding LCS and a grinding blank and must be closed after 20 samples or after 3 days, whichever is sooner**.** A grinding batch must have one Grinding LCS, and at least one Grinding Blank. If more than one Grinding Blank is prepared, it must be very clear on the benchsheet which individual sample blanks were used to build each Grinding Blank.

10.3.3.5 In a hood, transfer the sample into a clean ring and puck dish. Do not overfill the dish (approximately 300g of sample can fit in one dish). If needed, grind the sample in 300g or smaller increments and recombine after all sample has been ground. The entire sample must be ground. Place the dish securely in the holder and close the door on the machine. Grind the sample in five

60-second periods with a one minute cooling time between grinds for a total of 5 minutes of grinding. Remove the dish and in a fume hood, open the lid and inspect the sample. It should be the consistency of flour. The consistency of the material is checked by pinching some between fingers of a gloved hand and feeling for grit and by looking for any un-ground fibers. If grit is detected or if fibers are observed, additional grinding is needed.

NOTE: During the one-minute cooling time, the dish should be placed in a shallow ice water bath to facilitate cooling. Be sure the bath is shallow enough so that water does not get inside the dish.

10.4 Aliquot the Samples

10.4.1 All aliquots should be taken using a square-ended disposable plastic spoon. This is done to ensure that finer sample material does not fall off of the sampling tool, as can happen if a spatula was used instead. This is particularly necessary when samples are not ground to a consistent grain size using the ring and puck or ball mill grinders.

10.4.2 **2 Gram Aliquot – Extraction Method "8330_P_2g"** – Remove the cap from a labeled 40mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1cm. Use a disposable plastic square-ended spoon to build a 2.0g to 2.2g aliquot by taking at least five small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create a LCS and a method blank by placing 2.0g to 2.2g of baked Ottawa sand in labeled vials.

10.4.3 **10 Gram Aliquot – Extraction Method "8330_Sonc_10g"** – Remove the cap from a labeled 40mL amber vial and place the vial on a balance and tare. Spread the entire sample out to a thickness no greater than 1cm. Use a disposable plastic square-ended spoon to build a 10g to 11g aliquot by taking at least thirty small portions from random locations through the entire thickness of the sample. Record the exact sample weights on the benchsheet and cap the vial with a Teflon™ lined lid. Save the remaining soil for possible re-extraction. Create a LCS and a method blank by placing 10g to 11g of baked Ottowa sand in labeled vials. If the samples were ground create a grinding blank per Section 9.10 by taking approximately equal scoops from each individual grinding blanks. Aliquot the grinding LCS as you would a sample.

10.5 Add Surrogate, Spikes, and Solvent to the Samples

10.5.1 Refer to WI-DV-009 for the correct surrogate and spike standards to use and the correct volume.

10.5.2 The surrogate standards are kept in a freezer, but should be allowed to come to room temperature before use. Record the ID of the standard used on the benchsheet.

10.5.3 The spike standards are kept in a freezer. Only a small aliquot of the standard should be removed from the freezer and allowed to come to room temperature before use. Any remaining standard that has come to room temperature will be disposed.

10.5.4 The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-009.

10.5.5 Only one batch should be surrogated at a time to ensure the correct standards are used.

10.5.6 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard to each sample and each QC sample.

10.5.7 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard to each LCS and MS/MSD.

NOTE: Do not add the spike standard to the grinding LCS. The grinding LCS is created using the material described in Section 7.5 and already contains the analytes of interest.

10.6 Add Extraction Solvent

10.6.1 2 Gram Extraction – Extraction Method "8330_P_2g"

10.6.1.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 10mL with the soil extraction solvent described in Section 7.3. Use either a 10mL Class A graduated cylinder or a bottle top pump that has been calibration checked.

Example: If 0.5mL of surrogate standard was added to a sample, add exactly 9.5mL of the soil extraction solvent.

Example: If 0.5mL of surrogate standard and 0.5mL of spike standard was added to a LCS, add exactly 9mL of the soil extraction solvent.

10.6.1.2 Proceed to Section 10.7

10.6.2 10 Gram Extraction – Extraction Method "8330_Sonc_10g"

10.6.2.1 Taking into account the volume of surrogate and spike standard added to each sample, bring the extract volume up to 20mL with the soil extraction solvent described in Section 7.3. Use either a 25mL Class A graduated cylinder or a bottle top pump that ahs been calibration checked.

Example: If 1mL of surrogate standard was added to a sample, add exactly 19mL of the soil extraction solvent.

Example: If 1mL of surrogate standard and 1mL of spike standard was added to a LCS, add exactly 18mL of the soil extraction solvent.

10.7 Extract the Samples

10.7.1 Cap vial with a Teflon-lined cap, vigorously hand shake the vial for one minute, or until all material is well mixed, and place it in a box. Place the box on the platform shaker so that the vials are lying on their side. Set the platform shaker at 150rpm and allow the samples to be shaken for at least 18 hours. Record the start time on the benchsheet.

10.7.2 After the 18 hour extraction, remove the vials from the shaker table and record the stop time on the benchsheet.

10.7.3 If needed, centrifuge the vial at 2500 rpm to help separate the solids from the extract. Remove approximately 5 mL of the supernatant solution. Filter the supernatant solution using a 0.2-μm PTFE syringe discarding the first mL into the waste. Filter the remaining supernatant into a labeled 8-mL amber vial.

10.7.4 Submit the extract for analysis to the appropriate analytical lab.

11.0 Method Performance

11.1 Initial Demonstration of Capability

11.1.1 An initial demonstration of capability must be performed prior to analyzing samples.

11.1.2 For the standard analyte list, the initial demonstration consists of the preparation and analysis of a QC check sample containing all of the standard analytes for the method, as well as a method detection limit (MDL) study (described in Section 11.2 below).

11.1.3 Four aliquots of the QC check sample are analyzed with the same procedures used to analyze samples, including sample preparation through the drying and grinding process for 8330B soils.

11.1.4 The mean recovery and standard deviation are calculated for each analyte of interest. These results are compared with the established or project-specific acceptance criteria. All four results must meet acceptance criteria before the method can be used to analyze samples.

11.1.5 For non-standard analytes an MDL study must be performed and calibration curve generated before analyzing any samples, unless lesser requirements are previously agreed to with the client. In any event, the minimum initial demonstration required is successful analysis of an extracted standard at the reporting limit and a single point calibration.

11.2 Method Detection Limit (MDL)

A valid method detection limit (MDL) study for each analyte of interest must be performed prior to analyzing samples for the first time and annually thereafter. Separate soil MDL studies are performed for 8330A using 2 g and 8330B using 10 g of Ottawa sand. Separate soil MDL studies are performed for explosive method 8321A using 2 g of Ottowa sand and 8321A using 10 g of Ottowa sand. A MDL study for picric acid by method 8321A is performed using 10 g of Ottowa sand. A MDL study for explosives by 8321 LC/MS/MS is performed using 10 g of Ottowa sand. The procedure for determining detection limits is defined in Policy DV-QA-005P.

11.3 Analyst Training and Qualification

11.3.1 The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See SOP DV-QA-0024 for details of training requirements.

11.3.2 Each analyst performing the method must complete an initial demonstration of capability (IDOC) by successfully preparing and/or analyzing four consecutive LCSs, or a blind performance evaluation (PE) sample, or other acceptable QC samples. The results of the IDOC study are summarized in the NELAC format, as described in SOP DV-QA-0024. IDOCs are approved by the Quality Assurance Manager and the Technical Director.

11.3.3 IDOC records are maintained by the QA staff in the central training files. Analysts who continue to perform the method must successfully complete a demonstration of capability annually.

12.0 Pollution Control

Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

13.0 Waste Management

13.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Environmental Health and Safety Manual, and DV-HS-001P, “Waste Management Program.”

13.2 The following waste streams are produced when this method is carried out:

- Expired Chemicals/Reagents/Standards – Contact Waste Coordinator
- Flammable solvent waste – Waste Stream C
- Solid sample waste - Waste Stream D
- Waste soil sample vials - Waste Stream A

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

14.0 References / Cross-References

14.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

14.2 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

14.3 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

14.4 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

14.5 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

15.0 Method Modifications:

15.1 Deviations from Method Source and Rationale

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life
Stock standards	1,000,000 µg/L (1,000 ppm)	One year
Intermediate standards	2.5 to 1,000 µg/L	Thirty days
Working standards	1 to 500 µg/L	Daily

This SOP assigns a six-month shelf life to the working level standard based on TestAmerica's experience with these materials. The standards are stored in a freezer.

15.2 This SOP describes air drying soil samples until the sample is dry enough to pass through a sieve. One source method (SW 8330B) describes air drying to a "constant weight." If this issue is a concern for a client's project needs, the laboratory may be able to perform a separate % moisture determination for the client at 105 degrees C. However, sample results are calculated using the air dried sample as described in this procedure.

16.0 Attachments

Table 1. Analyte List
Table 2. Grinding LCS Bulk Material
Appendix 1 Flowchart for Drying Explosive Soils
Appendix 2 Flowchart for Grinding and Sieving Soils
Appendix 3 Instructions for Batching in TALS

17.0 Revision History

- Revision 4, dated 30 October 2012
  - Annual Technical Review
  - Section 4.6 was added to document the adverse affect headspace in the ball mill can has on the grinding LCS.
  - Section 6.1 and Section 10 were revised to include the description of the Spacer Can in the Ball Mill apparatus.
  - Section 6.1 and Section 10 were revised to include the Mechanical Grinder used as an alternative to mortar and pestle.
  - Section 9.6 was revised to state that LCSDs are not required for DoD or AFCEE work.
  - Section 10 was revised to reference the Explosive Review Checklist in WI-DV-0009.
  - Section 10.3.2 was revised to instruct the analyst to eliminate as much headspace as possible during the Ball Mill grinding step.
  - Appendix 3 was revised to give more detail on the steps taken to ensure all pre-ground ISM aliquots are taken before the sample is ground. It was also revised to include the use of the Explosive Extraction Checklist in WI-DV-0009.

- Revision 3, dated 10 October 2011
  - The procedure was revised to have the extraction performed by shaker table instead of cooled sonication bath. This was done to increase lab capacity and to create a more rugged extraction.
  - Section 5 was revised to include the requirement that analysts wear cut-resistant gloves when tightening vial caps.
  - Section 7.2 was revised to include the lot approval process for acetonitrile.
  - Sections 7.5 and 9.3 were revised to mandate a 3 day expiration date on the Grinding LCS after it has been ground.
  - Section 9.8 and 9.9 were revised to require a duplicate and triplicate whenever method 8330B is performed, not just when samples are ground.
  - Section 10.2.2 and 10.2.3 were revised to have the analyst use the prep method instead of the pre-prep method to determine sieve size. This is a simpler determination and matches the flow chart in Appendix 2.
  - Section 10.7.3 was revised to change the speed of the centrifuge to prevent the breakage of the extract vials.

- Revision 2, dated 11 January 2011
  - Details about the surrogate and spike standards used in this procedure have been moved to SOP DV-OP-0020.
  - Revised Section 9 to state that duplicates and triplicates are required when ring and puck or ball mill grinding is performed.
  - Revised the procedure to include instructions and details for the laboratory's new LIMS.
  - Revised Section 4 to give more details on the grinding of samples.
  - The procedure was revised to state that samples should be ground on the ball mill for only 8 hours. At that time, the samples should be inspected and only ground longer if required.
  - Added detail in Section 10.1 about the electronic temperature monitoring device that records the temperature of the drying room.
  - Revised the flowcharts to be flowcharts only and not worksheets. All data is now recorded in TALs benchsheets.

- Added instructions in Appendix 3 on how to batch samples in TALSs
- Added the option to use an automatic sieve shaker.

- Revision 1, dated 14 August 2009
  - This SOP was revised to include the addition of a Grinding LCS whenever samples are ground through the ring and puck or mall mill grinder. This was done to meet the requirements of method 8330B.
  - Section 9.6 “Initial Performance Studies” was revised to more clearly describe the laboratories procedures for MDLs and IDOCs.
  - Section 9.8 “Method Blank” was revised to correct the acceptance criteria for method blanks for DoD samples.
  - Section 9.9 “Laboratory Control Sample” was revised to give more details about marginal exceedances.
  - This SOP was revised to give additional requirements on sealing the ball mill cans. Duct tape will be used to ensure the lids are secure. Lids that have been opened will be inspected before being re-sealed. Damaged lids will be discarded.
  - Section 5 was revised to give warning about the hazards of grinding potential radioactive samples. Any CAT1 or higher sample cannot be ground without RSO approval.

- Revision 0, dated 06 March 2009
  - This SOP was written to consolidate procedures that used to be documented in several different SOPs. This was done to ensure the analysts had a clear and easy-to-follow procedure at the bench.

Table 1. Analyte List

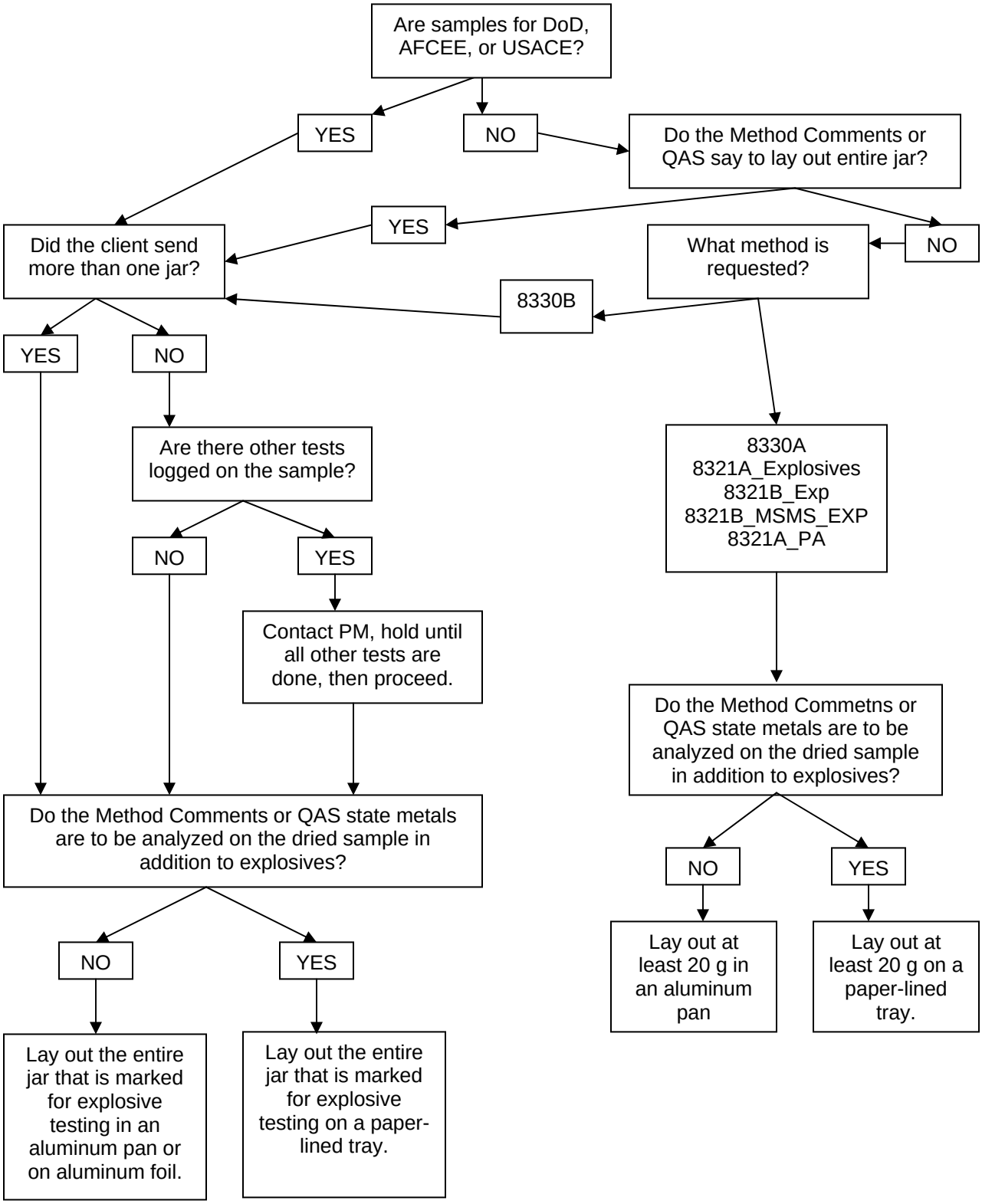
Compound	CAS #	Symbol
Octahydro-1,3,5,7-tetranitro-1,3,5,7,-tetrazocine	2691-41-0	HMX
Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	RDX
1,3,5-Trinitrobenzene	99-35-4	1,3,5-TNB
1,3-Dinitrobenzene	99-65-0	1,3-DNB
Methyl-2,4,6-trinitrophenyl nitramine	479-45-8	Tetryl
Nitrobenzene	98-95-3	NB
2,4,6-Trinitrobenzene	118-96-7	2,4,6-TNT
4-Amino-2,6-dinitrotoluene	19406-51-0	4-Am-DNT
2-Amino-4,6-dinitrotoluene	35572-78-2	2-Am-DNT
2,6-Dinitrotoluene	606-20-2	2,6-DNT
2,4-Dinitrotoluene	121-14-2	2,4-DNT
2-Nitrotoluene	88-72-2	2-NT
4-Nitrotoluene	99-99-0	4-NT
3-Nitrotoluene	99-08-1	3-NT
Nitroglycerin	55-63-0	NG
PETN	78-11-5	PETN
2,4-Diamino-6-nitrotoluene**	6629-29-4	--
2,6-Diamino-4-nitrotoluene**	59229-75-3	--
Picric Acid	88-89-1	PA
3,5-Dinitroaniline	618-87-1	3,5-DNA
1,2-Dinitrobenzene (8330 surrogate)	528-29-0	1,2-DNB
Nitrobenzene-d5 (8321 surrogate)	--	NB-d5

** Compounds are only analyzed and spiked upon request.

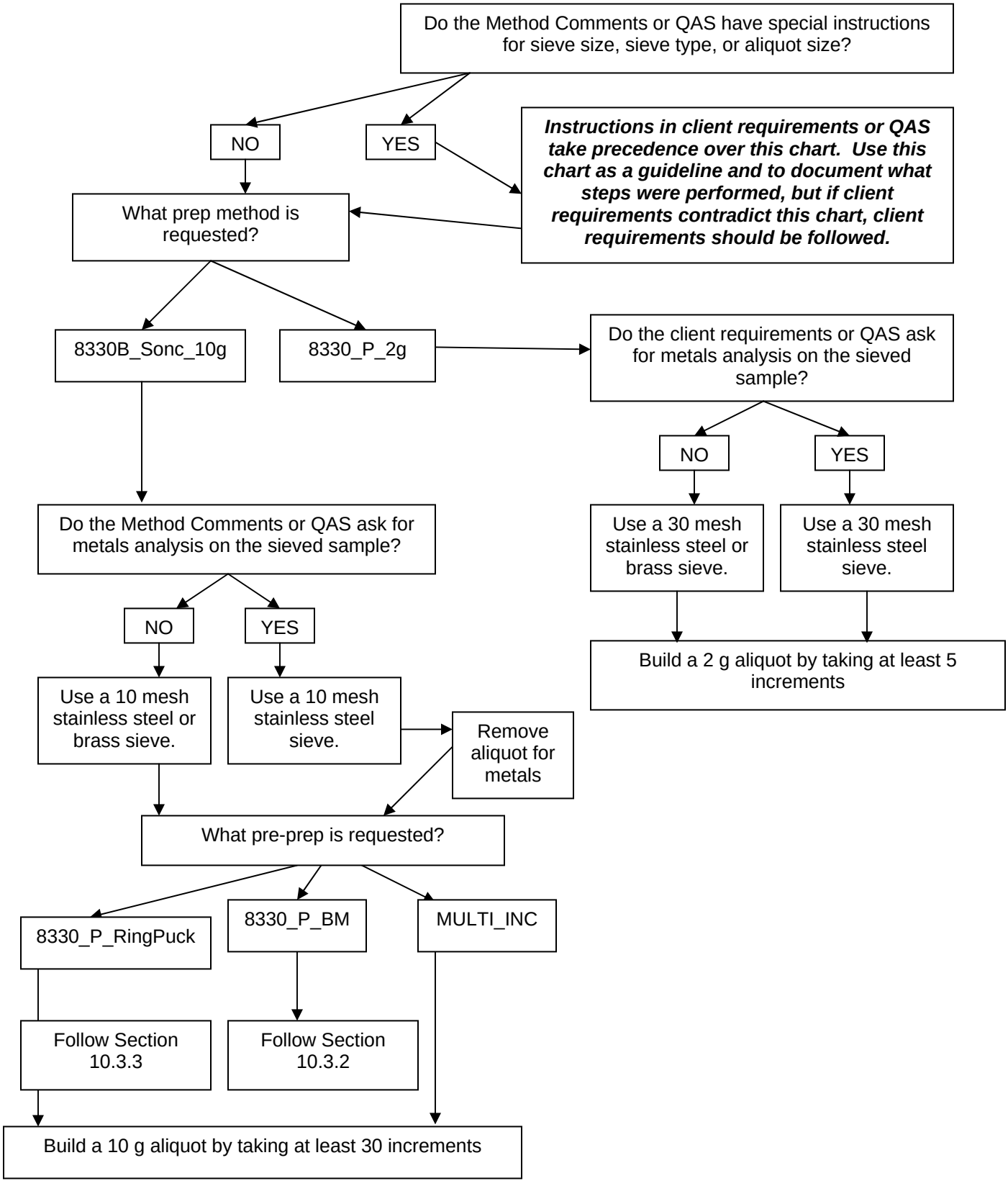
Table 2. Grinding LCS Bulk Material

Compound	Concentration (µg/Kg)
4-Amino-2,6-dinitrotoluene	600
2-Amino-4,6-dinitrotoluene	600
1,3-Dinitrobenzene	600
2,4-Dinitrotoluene	600
2,6-Dinitrotoluene	600
HMX (Octahydro-1,3,5,7-TNTC)	600
1,3,5-Trinitrobenzene	600
Nitrobenzene	600
2-Nitrotoluene	600
3-Nitrotoluene	600
4-Nitrotoluene	600
RDX (Hexahydro-1,3,5-TNTriaz)	600
Tetryl (Methyl-2,4,6-TNPN)	600
Nitroglycerin (Trinitroglycerin)	600
Pentaerythritol tetranitrate (PETN)	600
2,4,6-Trinitrotoluene	600

Appendix 1 – Flowchart and Worksheet for Drying Explosive Soils



Appendix 2 – Flowchart and Worksheet for Grinding and Sieving Explosive Soils



Appendix 3

How to Batch:

8330_P_BM (Dry, Sieve, Ball Mill, MIS)
8330_P_RingPuck (Dry, Sieve, Ring & Puck, MIS)
MULTI_INC (Dry, Sieve, MIS)
Dry_Sample (Dry, Sieve, 2g prep)
Dry_Grind (Dry, Sieve, 2g Prep)

Overview

These five pre-prep methods can be logged in for not just for samples for explosives by 8330A or 8330B and 8321A or 8321B, but also for samples for metals analysis, or perchlorate, or any other method where the client is asking the lab to dry, sieve, and possibly grind the sample before extraction or digestion.

If one sample is logged in for 8330B and 6010B and 6020B and 7471A and all of these methods have the pre-prep of MULTI_INC, the sample will show up on the backlog 4 times, (once for each analytical method). This would happen if the client wants us to dry, sieve, and perform ISM for each of these methods.

If one sample is logged in for 8330B with a pre-prep of 8330_P_RingPuck and the same sample is logged in for method 6010B with a pre-prep of MULTI_INC, that means that the client wants us to dry, sieve the sample, perform ISM for method 6010B, then ring and puck and perform ISM for 8330B.

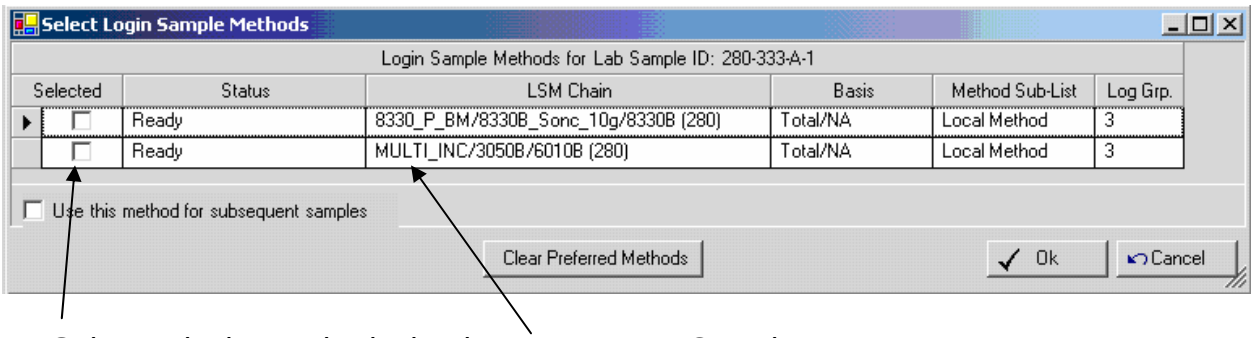
We will use a different status to indicate where the samples are.

- A status of “Batched” means the samples have been laid out to dry.
- A status of “Scheduled” on 8330_P_BM and 8330_P_RingPuck means the samples have been laid out to dry, but possibly need ISM performed before grinding.
- A status of “1st Level Review” means the samples have been sieved.
- A status of “2nd Level Review” on methods MULTI_INC, Dry_Sample, or Dry_Grind means that the aliquots have been taken and someone has checked your work.
- A status of “2nd Level Review” on 8330_P_BM or 8330_P_Ring Puck means samples have completed the grinding.

Steps for Samples logged for <u>both</u> MULTI_INC and Ring & Puck or Ball Mill

1. Run the Dry/Sieve/Grind/MIS backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for MULTI_INC for metals and 8330_P_BM for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the MULTI_INC method.
   NOTE: Do not put samples in the same batch that require different sieve sizes.

3. Scan your samples into the batch. A window will appear called “Select Login Sample Methods”.



4. Select only the methods that have MULTI_INC as the pre-prep.
    a. You can only batch ISM samples under a MULTI_INC batch.
    b. You can only batch ring and puck samples under a 8330_P_RingPuck batch.
    c. You can only batch ball mill samples under a 8330_P_BM batch.
    d. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch.
5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample. Also label the tray “Grinding Needed” if the sample is logged for Ball Mill or Ring and Puck.
8. Start an Explosive Review Checklist.
9. Set the Ball Mill or Ring and Puck Methods to “Scheduled” in the backlog. Do not batch them at this time.
10. Sieve the samples and take the required ISM aliquots. Place the ISM aliquots on the tray with the sample so a 2nd analyst can perform a label check. Document these steps on the Explosive Review Checklist.
11. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
12. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
13. Have a 2nd analyst review the MULTI_INC batch to ensure all required ISM aliquots have been performed. Transfer all data from the Explosive Review Checklist to the batch notes and take the MULTI_INC batch to 2nd level review.
14. Now the samples are ready to be ground by Ball Mill or Ring and Puck.
15. As the samples are ground, add them to the 8330_P_BM or 8330_P_RingPuck batch. The grinding batch is opened with the grinding LCS and must be closed after 20 samples or 3 days, whichever is sooner. The grinding LCS must be extracted within 3 days of being ground.
16. As you add samples to the 8330_P_BM or 8330_P_RingPuck batch, watch the LSM window to ensure that all MULTI_INC methods are at 2nd level review. If there are MULTI_INC methods that are not at 2nd level review, perform ISM on the sample for the requested methods before grinding the sample.

17. Transfer the data from the Explosive Review Checklist to the Batch Notes.
18. Take the samples to 2nd level review.
19. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for Ring & Puck or Ball Mill <u>only</u>. No MULTI_INC methods logged.

1. Run the Dry/Sieve/Grind/MIS backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for MULTI_INC for metals and 8330_P_BM for explosives, you can easily see that the sample needs both preps.
2. Pull the samples from the walk-in cooler and take custody of the samples. Take note of what shelf the sample came from.
3. Lay the samples out on parchment or foil. Label each tray with the sample ID and the grinding method (Ball Mill or Ring & Puck)
4. Print out an Explosive Review Checklist. Document the date and time the samples were laid out to dry. Document if the samples were laid out on parchment or foil. Document that a label check was performed.
5. Set the samples to Scheduled in the backlog to show that they are laid out to dry.
6. Once the samples are dry enough to sieve, sieve the samples and document what sieve size on the Explosive Review Checklist.
7. As the samples are ground, add them to the 8330_P_BM or 8330_P_RingPuck batch. There can only be 20 field samples in each batch, and the grinding LCS must be extracted within 3 days of being ground.
8. As you add samples to the 8330_P_BM or 8330_P_RingPuck batch, watch the LSM window to ensure that the samples do NOT require any non-ground aliquots.
9. Transfer the data from the Explosive Review Checklist to the Batch Notes.
10. Take the samples to 2nd level review.
11. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

Steps for Samples logged for <u>only</u> MULTI_INC, Dry_Grind, or Dry_Sample. No grinding methods logged.

1. Run the Dry/Sieve/Grind/MIS backlog. This backlog will only have samples that are logged in for these five pre-preps. This backlog is sorted by sample ID so that if a sample is logged in for MULTI_INC for metals and 8330_P_BM for explosives, you can easily see that the sample needs both preps.
2. Batch the samples under the pre-prep method logged. Do not put samples in the same batch that are logged for different pre-prep methods. Do not put samples in the same batch that require different sieve sizes.
3. Scan your samples into the batch. If your samples are logged in for more than one of these three methods, a window will appear called “Select Login Sample Methods”.
4. Select only the methods that have MULTI_INC as the pre-prep.
    a. You can only batch ISM samples under a MULTI_INC batch.

b. You can batch “Dry_Grind” and “Dry Sample” samples under the same batch. If the LSM window shows methods with pre-preps of 8330_P_RingPuck or 8330_P_BM batch, then stop and follow the instructions above under the header “Steps for Samples logged for both MULTI_INC and Ring & Puck or Ball Mill”.

5. Save the batch and print the benchsheet.
6. Print labels. Print one label for each method logged on each sample. Write on the label the analytical method.
7. Lay out the samples to dry. Place all of the labels on the sample tray for the sample.
8. Start an Explosive Review Checklist.
9. Sieve the samples and take the required aliquots. Place the aliquots on the tray with the sample so a 2nd analyst can perform a label check. Document these steps on the Explosive Review Checklist.
10. The Notes field in the Worksheets tab can be used to document if there was rocks or vegetation that did not go thru the sieve. Write NCMs for any samples that contained rocks or vegetation that was removed from the sample.
11. In the Worksheet tab, you can record the weight of the sample before and after drying and the weight of the sample that went through the sieve and the weight of the sample that did not go through the sieve. These measurements are not normally required, so they only need to be performed if client requested.
12. Have a 2nd analyst review the batch to ensure all required aliquots have been performed. Transfer all data from the Explosive Review Checklist to the batch notes and take the batch to 2nd level review.
13. Return all empty containers to the walk-in refrigerator using ICOC. Any left-over dried and ground material is stored in the walk-in refrigerator on the same shelf as the original client containers.

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Title: ACID DIGESTION OF SOLIDS
[Method EPA 3050B]

Approvals (Signature/Date):

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Doug Gomer Date
Technical Specialist

Adam W. Alban 01 March 13
Adam Alban Date
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3/1/13
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1.0 Scope and Application

1.1 This is a strong acid digestion procedure for the preparation of sediments, sludge, soils, and other types of solid materials by EPA Method 3050B for analysis by inductively coupled plasma atomic emission spectroscopy (ICP) or inductively coupled plasma-mass spectrometry (ICP/MS).

1.2 Method 3050B is designed to determine the concentration of "environmentally available" metals, and is not a true "total metals" digestion (see discussion below). The procedure is used primarily for hazardous waste characterization and other Resource Conservation and Recovery Act (RCRA) compliance testing.

1.3 The elements approved for Method 3050B are shown in Table I. The source method also mentions that other elements may be prepared by the method if the quality control requirements are met. The complete list of elements routinely included in this procedure by TestAmerica Denver is shown in Table II.

1.4 If sample preparation utilizing the Incremental Sampling Method is required, see SOP DV-OP-0013 for the procedure required prior to acid digestion for metals incorporating this procedure.

2.0 Summary of Method

A representative 1 to 2 gram portion of sample is digested with two cycles of nitric acid additions, followed by hydrogen peroxide digestion. For ICP analysis, the sample is also refluxed with hydrochloric acid. The resulting solution is filtered and diluted to 100 mL with reagent water. For the Incremental Sampling Method, 10g of sample is used and brought to a final volume of 500ml.

3.0 Definitions

3.1 Total Metals: Although Method 3050B is often referred to as a "total metals" digestion, it is important to understand that there are many compounds formed from these elements that are not efficiently dissolved using this digestion procedure. It is more accurately termed a strong acid digestion procedure. The limitations are discussed further in Section 4 (Interferences) below. The method itself states, "This method is not a total digestion technique for most samples." There are a variety of total digestion procedures used for metal assay, geochemical analysis, etc., that involve more vigorous digestions than 3050B.

3.2 Preparation Batch: A group of up to 20 samples that are of the same matrix and are processed together using the same lots of reagents and standards. The minimum QC elements in a batch are outlined in Section 9.

3.3 Other quality control terminology used in this procedure is based on SW-846, and is defined in the glossary section of the TestAmerica Denver Quality Assurance Manual (QAM).

4.0 Interferences

4.1 There are common compounds formed by the elements of interest (e.g., barium sulfate, beryllium oxide, silicon dioxide, crystalline silicates, titanium dioxide, etc.) that are not efficiently dissolved using this EPA approved procedure.

4.2 Silicon or silica are occasionally requested as part of the Method 3050B digestion. However, this digestion will include only acid-soluble silicon, and will not dissolve crystalline silica. The analysis is for silicon, but the final result is sometimes expressed as silica rather than silicon.

4.3 Antimony and silver have poor solubility in dilute nitric acid solution. Therefore it is strongly recommended that these elements are determined by the ICP procedure that includes HCl as the final digestion acid. See Section 11.7.8 of this SOP.

4.4 Potential sources of trace metals contamination include metallic or metal-containing labware (e.g., talc gloves which contain high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.5 The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Attachment 1 for additional contamination control guidelines.

4.6 Boron and silica from the glassware will dissolve into the sample solution during and following sample processing. For critical low level determinations of boron and silica, only quartz and/or plastic labware should be used.

4.7 Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents, and other matrix materials may not be digested using these methods if they are not soluble in acids. If physical interferences are present, they should be documented.

4.8 Allowing samples to boil or go dry during digestion may result in the loss of volatile metals or conversion of metals to insoluble forms. For example, antimony is easily lost by volatilization from hydrochloric media. If this occurs the sample must be re-prepared.

4.9 Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.10 Samples Requiring Additional Digestion Reagents

A few examples of types of samples that might require additional digestion reagents follow. It is very important to note situations where samples are not behaving normally. However, do not assume that adding additional reagents will be acceptable for the project, even if it is obvious that the digestion will be incomplete without it. The situation must be discussed with the project manager and documented in a Nonconformance Memo (NCM), whether or not the variations suggested in the following examples are approved.

4.10.1 Samples with high organic content may require additional nitric acid and/or hydrogen peroxide for a thorough digestion, but these oxidizing reagents should be added very carefully to avoid violent reactions.

4.10.2 Samples with high concentrations of metal in the elemental form or refractory oxides may require additional hydrochloric acid for a thorough digestion. As an example, blasting sand used to remove paint from the hull of ships typically consists of 30% cupric oxide. Following 3050B exactly will produce results as low as 0.1% without additional hydrochloric acid, and increasing the volume of hydrochloric acid can produce results approaching the true copper concentration.

4.10.3 Highly alkaline materials may require larger volumes of acid than specified in this procedure.

4.10.4 If the use of extra digestion reagents is approved, the same volume of reagents must be added to all field samples and QC samples in the batch. Usually the method blank results will not be elevated. To ensure that the QC sample results accurately reflect sample results, the QC samples must be treated exactly like the samples.

5.0 Safety

5.1 Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document.

5.2 This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile or latex gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.3 Specific Safety Concerns or Requirements

5.3.1 Samples that contain high concentrations of carbonates or organic material or samples that are at elevated pH can react violently when acids are added.

5.3.2 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.4 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Hydrogen Peroxide, H_2O_2	Oxidizer Corrosive Poison	1 ppm TWA 1.4 mg/m^3 TWA 75 ppm IDLH	Contact with other materials may cause fire. Eye contact may result in permanent eye damage. Causes eye and skin burns. Corrosive: May cause severe respiratory tract irritation. Harmful if swallowed, may cause digestive tract irritation or burns.
Nitric Acid, HNO_3	Corrosive Oxidizer Poison	2 ppm-TWA 4 ppm-STEL	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hydrochloric Acid, HCl	Corrosive Poison	5 ppm-Ceiling	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Top-loading balance capable of accurately weighing to the nearest 0.01 grams.

NOTE: Balances are serviced annually and the accuracy checked daily using 3 standard masses. See SOP DV-QA-0014 for details.

6.2 Digestion "Hot Block" or equivalent heating device capable of maintaining a temperature of 90-95°C. The Hot Block temperature must be monitored separately for each unit. The temperature of each Hot Block is checked by placing a calibrated thermometer through a cap on a digestion tube that is filled approximately to the middle of the tube with water. The temperature is recorded on the preparation benchsheet.

6.3 Thermometers (non-mercury liquid filled or digital) that cover a temperature range including 80-110°C with 1°C increments clearly visible.

NOTE: Thermometers are calibrated before use and periodically as described in SOP DV-QA-0001.

6.4 Hot Block plastic digestion tubes, 50ml and 125 mL, disposable. The volumetric markings on the tubes are checked for each lot received to ensure accuracy of at least ± 3%. The documentation is kept on file in the Metals area.

6.5 Ribbed plastic cover, similar to a watch glass, for the digestion tubes; disposable.

6.6 Ahlstrom grade 55 filter paper, Fisher Q8 filter paper (acid washed), or equivalent.

6.7 Disposable plastic funnels.

6.8 Disposable wooden spatula for subsampling.

6.9 Centrifuge, capable of at least 2,000 rpm.

6.10 Graduated cylinder, 100 mL and 500 mL, capable of ± 3% accuracy.

6.11 Calibrated automatic pipettes with corresponding pipette tips or Class A glass volumetric pipettes.

NOTE: Mechanical pipettes are calibrated before use and monthly as described in SOP DV-QA-0008.

6.12 Class A volumetric flasks.

6.13 pH indicator strips (pH range 0 – 6).

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Reagent water – Millipore DI system or equivalent, 10-18.2 megohm-cm. See SOP DV-QA-0026 for daily water monitoring procedure.

7.2 Nitric acid (HNO_3), concentrated, trace metal grade or better.

7.3 Nitric acid (HNO_3), 5%

Add 5 mL of concentrated HNO_3 to approximately 900 mL of reagent water and dilute to 1 liter.

7.4 Hydrochloric acid (HCl), concentrated, trace metal grade or better.

7.5 30% Hydrogen peroxide (H_2O_2), reagent grade.

7.6 Glass beads, ≤ 1 mm diameter, washed with aqua regia (for AFCEE and DoD projects)

7.7 Standards

7.7.1 All standards must be NIST traceable. Unless purchased directly from NIST, the accuracy of each standard is verified before use, as described in SOP DV-QA-0015.

7.7.2 Storage and Shelf Life of Metal Standards

7.7.2.1 Standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. They are stored at room temperature.

7.7.2.2 Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.7.3 LCS and MS Spike Solution for ICP

7.7.3.1 ICP spike solutions are purchased as custom-made solutions from a commercial vendor at ready-to-use concentrations. No further dilutions are needed. Spikes are prepared as follows:

- Routine ICP: Add 1.0 mL of spike
- AFCEE/DoD ICP: Add 1.0 mL of spike to 1.0 g of glass beads

The resulting spike concentrations for each element are given in Table II.

7.7.3.2 ICP/MS spike solutions are also purchased as custom-made solutions from a commercial vendor at ready-to-use concentrations. No further dilutions are needed. 1.0 mL of spike solution is added to samples. The concentrations of the elements in the stock standard and the resulting concentrations in samples are shown in Table III.

7.7.4 If a non-routine element is required that is not contained in the custom-made solution, single-element solutions from a commercial vendor may also be used.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sample holding time for metals included under the scope of this SOP is 180 days from the date of collection to the date of analysis.

8.2 Soil samples do not require chemical preservation, but are stored at 4 ± 2 °C until the time of analysis.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Soils	Glass	3 grams	Cool 4 ± 2°C	180 Days	N/A

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. The process of establishing control limits, and the use of control charts are described more completely in DV-QA-003P, *QualityAssurance Program*. Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents.

9.3 Initial Demonstration of Capability

An initial demonstration of capability must be performed by analysts before digesting samples using this procedure. See Section 13 of this SOP for further details.

9.4 Minimum QC Elements in a Preparation Batch

Each preparation batch must contain a method blank (MB), a laboratory control sample (LCS), and a matrix spike/matrix spike duplicate (MS/MSD) pair. Note that some programs require an unspiked duplicate sample in place of or in addition to the duplicate matrix spike. Be sure to check special instructions in the laboratory LIMS. If clients specify specific samples for MS and MSD, the batch may contain multiple MS/MSD pairs.

9.5 Sample Count

Laboratory generated QC samples (method blanks, LCS, MS/MSD) are not counted towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.

9.6 Method Blank (MB) One method blank must be processed with each preparation batch. The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. Soil method blanks are prepared by taking 5 mL or 5 g of reagent water

through the procedure described in Section 11.

The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false positive data.

Acceptance Criteria: Criteria for the acceptance of blanks are contained within the individual analytical method SOPs.

Corrective Action: If the method blank does not meet the criteria contained within the analytical method SOPs, the blank and all associated samples in the batch must be re-digested and reanalyzed.

9.7 Laboratory Control Sample (LCS)

9.7.1 One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire analytical procedure.

9.7.2 The spike solution described in Section 7.7.3 is used to prepare LCSs as follows:

- Routine ICP: Add 1.0 mL of spike
- AFCEE/DoD ICP: Add 1.0 mL of spike to 1.0 g of glass beads
- ICP/MS: Add 1.0 mL of spike

The resulting spike concentrations for each element are given in Table 2 and Table 3.
Incremental Sampling Method LCS's are spiked with 5ml of spike.

9.7.3 The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: Criteria for the acceptance of LCS results are contained within the individual analytical method SOPs.

Corrective Action: When LCS results fail to meet control limits, the LCS and all associated samples in the batch must be re-prepared and reanalyzed.

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

9.8.1 One MS/MSD pair must be processed for each preparation batch. A matrix spike (MS) is a second aliquot of a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a third aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Samples identified as field blanks cannot be used for MS/MSD analysis.

9.8.2 The spike solution described in Section 7.7.3 is also used to prepare matrix spikes, as follows:

- ICP: Add 1.0 mL of spike
- ICP/MS: Add 1.0 mL of spike

The resulting spike concentrations for each element are given in Tables II through IV.

Incremental Sampling Method MS/MSD's are spiked with 5ml of spike.

9.8.3 The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process.

Note: The spike must be added after the sample aliquot but before any reagents.

Acceptance Criteria:	Criteria for the acceptance of MS and MSD recoveries and the relative percent difference (RPD) between the MS and MSD results are contained within the individual analytical method SOPs.
Corrective Action:	If any analyte recovery or RPD falls outside the established acceptance range, the recovery of that analyte must be in control for the LCS. If the recovery for the LCS is also outside of established limits, corrective action must be taken. Corrective action will include re-preparation and reanalysis of the batch. Corrective action when MS results alone fail to meet control limits does not include repreparation of samples unless the results indicate that a spiking error may have occurred.

10.0 Calibration

Not applicable. This SOP addresses sample preparation only for subsequent ICP or ICP/MS analysis. Calibration of the measurement system is covered in the SOPs for the determinative methods.

11.0 Procedure

11.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is approved by the supervisor and then automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA department also receives NCMs by e-mail for tracking and trending purposes. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

11.2 Sample Custody

11.2.1 Custody of samples is transferred from the Sample Control group to the Metals group, which is documented using the internal program, Sample Transfer Utility (see SOP DV-QA-0003 for details).

11.2.2 Proper sample identification is extremely important in any preparation procedure. Labeling of digestion tubes and bottles must be done in a manner to ensure connection with the proper sample.

11.3 Subsampling

11.3.1 It is not acceptable to simply collect 1.0 g off of the top of the sample. Samples must be mixed and incrementally subsampled to obtain a representative subsample. At a minimum, mix by stirring with a disposable wooden spatula. If there is insufficient room in the sample container to allow for proper mixing,

refer to SOP DV-QA-0023, “Subsampling” for directions.

11.3.2 Select at least three incremental subsamples from different locations in the original sample to obtain a final subsample weight of 1.0 to 1.2 g in a digestion tube, and record the exact weight to the nearest 0.01 g. A 2.0-g sample size may also be used if needed to meet the reporting limits.

11.3.3 Measure additional aliquots for QC samples required in the batch and spike as required (see Section 9 for details).

11.4 Digestion of 10g sample aliquot obtained utilizing previously prepared Incremental Sampling Method soil aliquot

11.4.1 The Method 3050B digestion reagents are increased 5x to maintain the same chemistry as is used for a 1-2 gram subsample. 10g of sample is digested in 125ml tubes.

11.5 Initial Digestion Cycle with 1:1 Nitric Acid

11.5.1 Add approximately 5mL of reagent water to each digestion tube.

11.5.2 Add 5 mL of concentrated HNO_3, and mix the sample.

11.5.3 Place a ribbed cover on each tube.

11.5.4 Heat samples to 95°C, and reflux for 15 minutes without boiling.

NOTE: **DO NOT ALLOW SAMPLE TO BOIL OR GO DRY** during any part of the digestion. Doing so will result in the loss of analyte and the sample must be re-prepared.

11.5.5 Allow sample to cool before proceeding with the next step.

11.5.6 Record the start time, starting temperature, end time, and ending temperature in LIMS.

11.6 Second Digestion Cycle Using Concentrated Nitric Acid

11.6.1 Add 5 mL of concentrated HNO_3, and replace the ribbed cover.

11.6.2 Reflux at 95°C for 30 minutes. Add reagent water as needed to ensure that the volume of solution is not reduced to less than 5 mL.

11.6.3 If brown fumes are observed, this means that material in the sample is actively being oxidized. There may not be enough HNO_3 acid to complete the oxidation, and there could be violent reaction of the sample with peroxide in the third digestion step. For that reason, it is necessary to repeat the previous two steps until no more fumes are evolved.

11.6.4 Allow the sample to evaporate to 5 mL, while ensuring that no portion of the bottom of the beaker is allowed to go dry. Alternatively, heat at 95^{o}C for 2 hours.

11.6.5 Allow the samples to thoroughly cool before proceeding.

11.7 Third Digestion Cycle Using Hydrogen Peroxide

11.7.1 Add 2 mL of reagent water to each tube.

11.7.2 Add 3 mL of 30 % H_2O_2 a few drops at a time. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence.

11.7.3 Replace the ribbed cover and heat sample until effervescence subsides.

11.7.4 Allow the sample to cool.

11.7.5 Continue adding 30% H_2O_2 in 1-mL increments with warming until effervescence is minimal or sample appearance is unchanged.

NOTE: Do not add more than a total of 10 mL of 30 % H_2O_2.

11.7.6 Continue heating at 95^{o}C until the volume is reduced to approximately 5 mL. Alternatively the sample may be heated for 2 hours.

11.7.7 Allow the sample to cool

11.7.8 If samples will be analyzed by ICP, continue on with the fourth digestion step using HCl in step 11.7.8. If the samples will be analyzed by ICP/MS, skip the HCl digestion step and go to step 11.9.

11.8 Fourth Digestion Cycle for ICP Using Concentrated Hydrochloric Acid

11.8.1 If the sample is being prepared for ICP analysis, add 10 mL of concentrated HCl to the sample in the digestion tube, and cover with ribbed cover.

11.8.2 Reflux for an additional 15 minutes without boiling.

11.8.3 Allow the sample to cool.

11.9 Separating Undigested Solids from the Digestion Solution

11.9.1 Filter sample through filter paper into a measured 125ml bottle whose accuracy is documented to be better than $\pm$ 3%.

NOTE: In place of filtering, the samples, after dilution and mixing, may be centrifuged or allowed to settle by gravity overnight to remove insoluble material.

11.9.2 For samples digested by the incremental Sampling Method use a 500mL poly bottle that has been marked by pouring out 500mL of DI water from a graduated cylinder.

11.9.3 Wash the digestion tube and ribbed cover with reagent water to ensure quantitative transfer of all of the digestion solution.

11.9.4 Rinse beaker and filter paper with reagent water to ensure complete sample transfer.

11.9.5 Re-volume sample to 100 mL with reagent water. This must be done volumetrically, rather than by weight. Record the final volume in TAL's. For Multi-Incremental samples the final volume is 500ml.

11.10 Documentation and Record Management

11.10.1 The following information must be recorded for each preparation batch. This information is entered into the LIMS system

- Batch number,
- List of samples,
- Initial sample weight and final digestion volume,
    - Preparation analyst and date,
    - Matrix,

- Preparation type,
- Identification of reagents and standards used, and
- Identification of all measuring and test equipment used (e.g., balances, thermometers, pipettes).

11.11 Antimony for Analysis by ICP-MS

11.11.1 Weigh 1.0 to 1.2g soil sample using sub sampling in digestion vessel.

11.11.2 Add 5-mL of reagent water to the blank, LCS/LCSD and samples.

11.11.3 Spike LCS/LCSD, MS, MSD with 1.0 mL 200.8 CAL-2.

11.11.4 Add 2.5-mL conc. HNO_3 and 2.5 mLs conc. HCI to each sample and QC.

11.11.5 Cover with a watch glass and reflux on hot block set at 95° C (covered container of water) for 15 minutes.

11.11.6 Filter through Ahlstrom 55 into 100-mL vessel while still hot.

11.11.7 Rinse with hot 1.25mls (~95° C) conc. HCI.

11.11.8 Rinse 3X with hot (95° C) reagent water (5mL rinses.)

11.11.9 Place the filter paper and soil residue back into the original sample digestion vessel. Add 2.5 mLs conc. HCI, cover and reflux on hot block for 20 minutes or until paper dissolves.

11.11.10 Filter through Ahlstrom 55 adding to the original filtrate. Rinse 3X with reagent water. (5mL rinses.)

11.11.11 Bring to final volume of 100 mL with reagent water.

12.0 Calculations / Data Reduction

Not applicable. Calculations of final results are described in the determinative analytical SOPs.

13.0 Method Performance

13.1 Method Detection Limit (MDL)

An MDL must be determined for each analyte/matrix prior to the analysis of any samples. See the SOPs for the determinative analysis methods for details.

13.2 Initial Demonstration Study

This requires the analysis of four QC check samples. The QC check sample is a well-characterized, laboratory-generated sample used to monitor method performance, which should contain all the analytes of interest. Typically this is the LCS. The results of the initial demonstration study must be acceptable before analysis of samples may begin. The results of the initial demonstration study may be used to extend a method for the analysis of other elements provided all acceptance criteria are met.

13.2.1 Four aliquots of the check sample (LCS) are prepared and analyzed using the procedures detailed in this SOP and the determinative SOPs.

13.2.2 Calculations and acceptance criteria for QC check samples are given in the determinative SOPs for ICP/MS and ICP (DV-MT-0002 and DV-MT-0012, respectively).

13.3 Training Qualification:

13.3.1 The group leader or supervisor has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

15.2 The following waste streams are produced when this method is carried out:

15.2.1 Aqueous Acidic (Metals) - Corrosive – Waste Stream J

15.2.2 Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of these materials.

16.0 References

16.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Final Update III, December 1996; Method 3050B.

17.0 Method Modifications:

Item	Method	Modification
1	3050B	Chapter 1 of SW-846 states that the method blank should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit.
2	3050B	Section 7.5 digestion for Sb was modified to add less HCL to limit the interference on the ICPMS instrument.

18.0 Figures, Tables, and Attachments

Figure 1: Soil Sample Preparation Flowchart
Figure 2: Soil Sample Preparation Flowchart for Antimony by ICP-MS
Table 1: Method 3050B Approved Analyte List for ICP/ICP-MS
Table 2: Soil LCS and MS/MSD Spikes for ICP
Table 3: Soil LCS and MS/MSD Spikes for ICP-MS

Attachment 1: Contamination Control Guidelines
Attachment 2: Work Instruction: Preparation of Soil Samples for ICP and ICP-MS

19.0 Revision History

- Revision 5 dated 04 March 2013
  - Section 7.7.3.1 Added DoD to the glass beads requirement
  - Section 11.11.2 Added that 5ml of water is added to the samples
  - Section 11.11.3 Changed spike name to 200.8 Cal-2
  - Updated spike level to 1.0ml in Table 3
  - Updated work instructions to current revision.

- Revision 4 dated 3 February 2012
  - Changed references of Multi-Incremental Sampling to Incremental Sampling Method throughout document
  - Section 2.0 Added reference to Incremental Sampling Method
  - Section 6.4 Added 50ml digestion tubes
  - Added introductory statement to section 7.0 regarding reagent purity
  - Section 7.1 Updated acceptable criteria for the reagent water
  - Section 9.7.2 Added LCS Incremental Sampling Method spike amounts
  - Section 9.8.2 Added MS/MSD Incremental Sampling Method spike amounts
  - Section 11.4 Updated sample amount for Incremental Sampling Method to 1 10g aliquot
  - Section 11.9 Added Incremental Sampling Method final volume

- Revision 3.5, dated 24 August 2011
  - A note has been added to section 9.8.3 for the addition of the LCS/MS spike before reagents.

- Revision 3.4, dated 01 September 2010
  - Annual Technical Review
  - Updated documentation in section 11.10 to reference new LIMS.
  - Updated Section 11.11 and Figure 2 to reference current HCL amount used. Added method modification to digestion in Section 17.
  - Added Bismuth to Table 2
  - Updated Figure 2
  - Removed Example prep sheets (Attachments 2 – 4)
  - Updated work instruction WI-DV-015 (Attachment 5 now Attachment 2)

- Revision 3.3, dated 17 August 2009
  - Sections 11.3.2 and 11.11.1: Updated amount of sample used to range from 1.0 to 1.2g.

- Revision 3.2, dated 28 April 2009
    - Sec 6.6: Updated filter paper from Whatman No. 541 to Ahlstrom grade 55.
    - Sec 7.6: Added glass beads to DoD projects.
    - Sec 7.7.3.1: Removed ICPMS spike from this section.
    - Sec 7.7.3.2: Updated spike volume to 1.0ml for ICPMS.
    - Table 3: Updated ICPMS spike level to 1.0ml.

- Revision 3.1, dated 28 May 2008
    - The spiking amount for LCS, MS and MSD was changed from 0.2 mL to 1.0 mL for ICP-MS.

- Revision 3, dated 12 October 2007
    - Integration for TestAmerica and STL operations.
    - Added reference to SOP DV-OP-0015 for Multi-Incremental Subsampling Preparation of Soil Aliquots
    - Removed references to Graphite Furnace Atomic Absorption Analysis

- Revision 2.3, dated 11 November 2005
    - Section 6.3: Replaced the specification to use a mercury thermometer with a non-mercury thermometer.
    - Section 6.4: The Hot Block digestion tube volume was changed from 60 mL to 125 mL.
    - Section 6.6: Whatman No. 41 filters were changed to Whatman 541, or Fisher Q8 (acid washed) filters.
    - Section 6.14: This section, which specified HDPE plastic bottles for storing digested samples, was removed. The digests are stored in the Hot Block tubes.
    - Section 7.7.3.2: The volume of spike solution used for ICP/MS samples was changed from 1.0 mL to 0.2 mL.
    - Section 9.7.2: Added the volume of spike used for ICP-MS, i.e., 0.2 mL.
    - Item 9.8.2: Added the volume of spike used for ICP-MS, i.e., 0.2 mL.
    - Section 11.7.8: Added information concerning the use of HCL for Sb analysis.
    - The Safety Section 5 and the Waste Management section 15 were updated to current STL Corporate requirements.
    - Added examples of preparation bench sheets as Attachments 2, 3, 4, and 5.

Figure 1.

Soil Sample Preparation Flowchart
(Page 1)

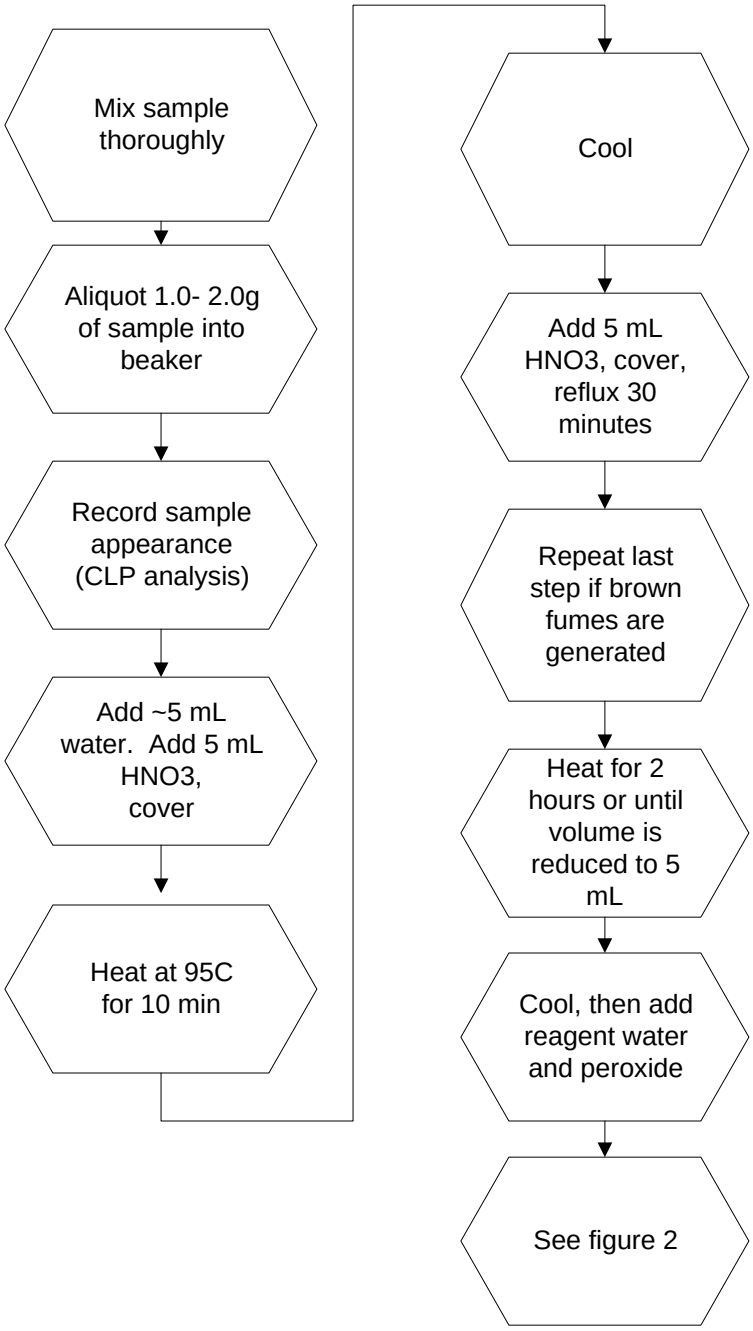

Figure 1. (continued)

Soil Sample Preparation Flowchart
(Page 2)

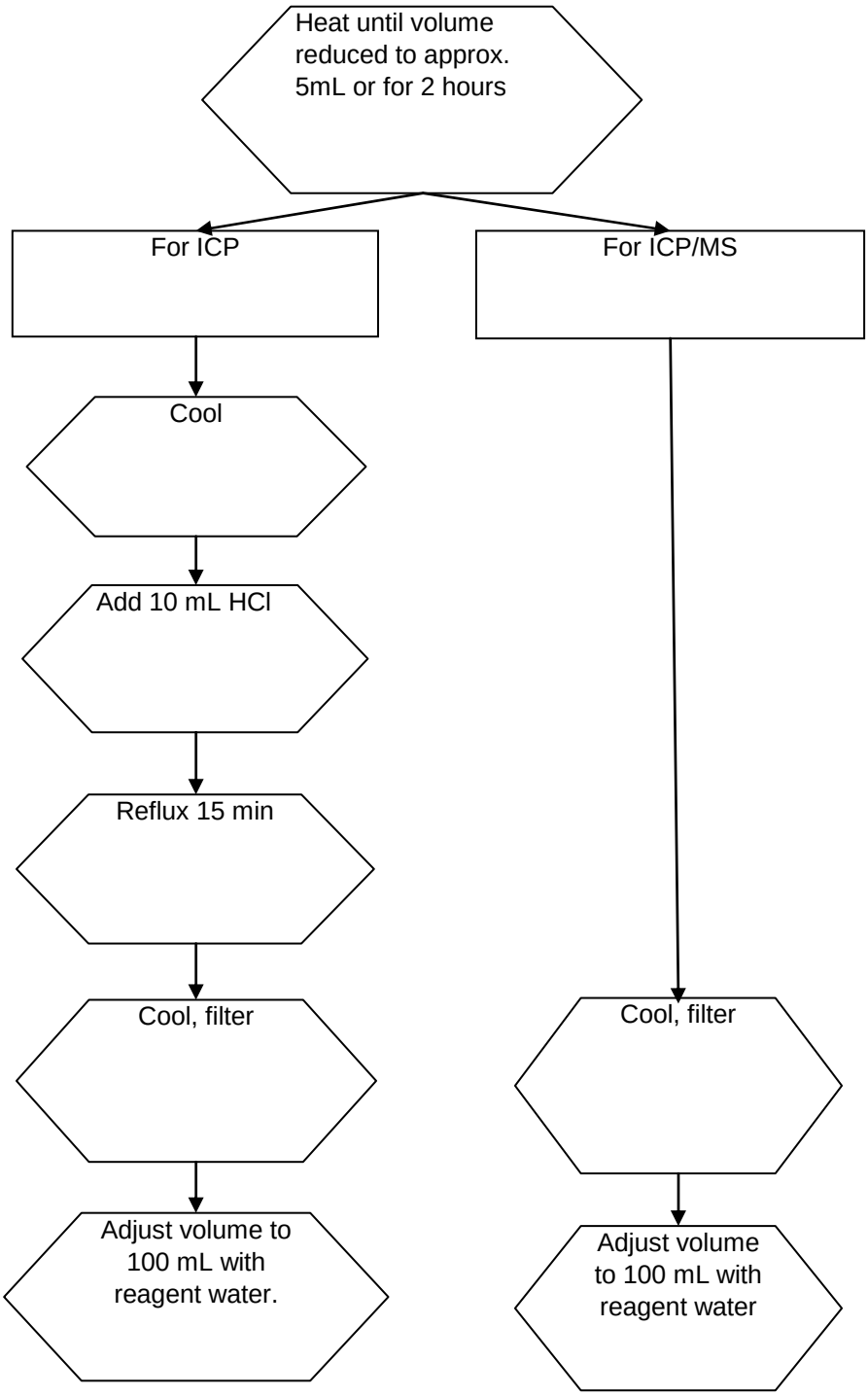

Figure 2

Soil Sample Preparation Flowchart for "Hot" Antimony by ICP-MS

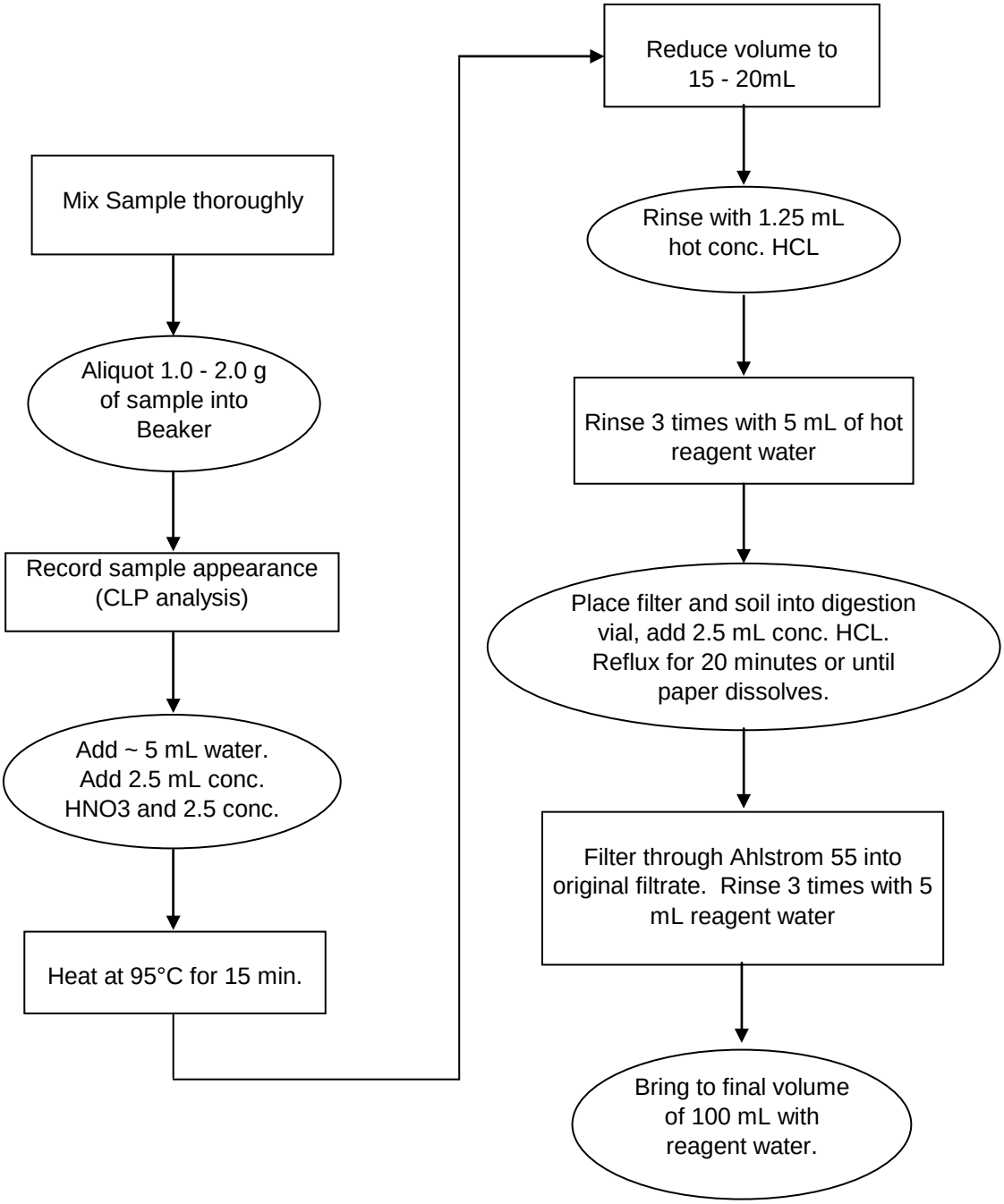

Table 1.

Method 3050B Approved Analyte List for ICP/ICP-MS

ELEMENT	Symbol	CAS Number
Aluminum	Al	7429-90-5
Antimony	Sb	7440-36-0
Arsenic	As	7440-38-2
Barium	Ba	7440-39-3
Beryllium	Be	7440-41-7
Cadmium	Cd	7440-43-9
Calcium	Ca	7440-70-2
Chromium	Cr	7440-47-3
Cobalt	Co	7440-48-4
Copper	Cu	7440-50-8
Iron	Fe	7439-89-6
Lead	Pb	7439-92-1
Magnesium	Mg	7439-95-4
Manganese	Mn	7439-96-5
Molybdenum	Mo	7439-98-7
Nickel	Ni	7440-02-0
Potassium	K	7440-09-7
Selenium	Se	7782-49-2
Silver	Ag	7440-22-4
Sodium	Na	7440-23-5
Thallium	Tl	7440-28-0
Vanadium	V	7440-62-2
Zinc	Zn	7440-66-6

Table 2.

Soil LCS and MS/MSD Spikes for ICP

ELEMENT	Stock Standard (mg/L)	Sample Spike (mg/kg)	Final Digested Solution (mg/L)
Aluminum	200	200	2.0
Antimony	50	50	0.5
Arsenic	100	100	1.0
Barium	200	200	2.0
Beryllium	5	5	0.050
Bismuth	200	200	2
Boron	100	100	1.0
Cadmium	10	10	0.1
Calcium	5000	5000	50.
Chromium	20	20	0.20
Cobalt	50	50	0.50
Copper	25	25	0.25
Iron	100	100	1.0
Lead	50	50	0.50
Lithium	100	100	1.0
Magnesium	5000	5000	50.
Manganese	50	50	0.50
Molybdenum	100	100	1.0
Nickel	50	50	0.50
Phosphorous	1000	1000	10.
Potassium	5000	5000	50.
Selenium	200	200	2.0
Silica	1000	1000	10.
Silver	5	5	0.050
Sodium	5000	5000	50.
Strontium	100	100	1.0
Thallium	200	200	2.0
Thorium	100	100	1.0
Tin	200	200	2.0
Titanium	100	100	1.0
Uranium	200	200	2.0
Vanadium	50	50	0.50
Zinc	50	50	0.50
Zirconium	50	50	0.5

NOTE: Final soil spike concentration based on the addition of 1.0 mL stock standard to 1.0 g of sample, which is then digested to produce a 100 mL final volume.

Table 3.

Soil LCS and MS/MSD Spikes for ICP-MS

ELEMENT	Stock Standard (mg/L)	Sample Spike (mg/kg)	Final Digested Solution (µg/L)
Aluminum	20	20	200
Antimony	20	20	200
Arsenic	20	20	200
Barium	20	20	200
Beryllium	20	20	200
Cadmium	20	20	200
Chromium	20	20	200
Cobalt	20	20	200
Copper	20	20	200
Lead	20	20	200
Manganese	20	20	200
Molybdenum	20	20	200
Nickel	20	20	200
Selenium	20	20	200
Silver	20	20	200
Thallium	20	20	200
Tin	20	20	200
Titanium	20	20	200
Uranium	20	20	200
Vanadium	20	20	200
Zinc	20	20	200

NOTE: Final soil spike concentration based on the addition of 1.0 mL stock standard to 1.0 g of sample, which is then digested to produce a 100 mL final volume.

Attachment 1

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

- All work areas used to prepare standards and spikes should be cleaned before and after each use.
- All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.
- Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.
- Powdered or Latex Gloves should not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes.
- Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.
- Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

- Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.
- Improper cleaning of glassware can cause contamination.
- Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

Attachment 2

Work Instruction: Preparation of Soil Samples for ICP and ICP-MS

TAL DENVER WORK INSTRUCTION	WI-DV-015	A	9/20/10	Page 1 of 1

TITLE:	**Preparation of Soil Samples for ICP and ICP-MS** **COPY#**
AUTHOR:	Richard Clinkscales
QA REVIEW:	**DATE:**
SOP REFERENCE:	DV-IP-0015 *Acid Digestion of Soil Samples by SW-846 Method 3050B for ICP and ICP-MS*

Metals in Soils by ICP-MS 6020 and ICP 6010 – Method 3050B

1. Open container and mix with tongue depressor to homogenize samples.
2. Weigh a representative 1.0 g to 1.2g of the sample into the digestion tube. Record the weight.
3. Weigh additional aliquots for QC samples into their respective digestion tubes.
4. Add 5 mL of reagent water into each digestion tube and swirl to mix.

For ICP-MS

5. Spike LCS, LCSD, MS, and MSD with 1.0 mL of the ICP-MS spike solutions for each QC sample.

For ICP

5 Spike LCS, LCSD, MS, and MSD with 1.0 mL of the ICP spike solutions for each QC sample.
6. Add 5 mL of concentrated HNO_3 into each digestion tube, swirl to mix and cover with a watch glass.
7. Heat at 95 ºC for 15 minutes. **DO NOT ALLOW SAMPLE TO GO DRY**.
8. Remove from the HotBlock and let cool.
9. Add 5 mL of concentrated HNO_3 into each digestion tube, swirl to mix and cover with a watch glass.
10. Heat at 95 ºC for 2 hours. Add reagent water as needed to keep the volume to at least 5 mL.
11. Remove from the HotBlock and let cool completely.
12. Add 2 mL of reagent water to each tube.
13. Slowly add 3 mL of H_2O_2 to each tube and cover with a watch glass.
14. Heat sample at 95° C for 2 hours. Remove from the HotBlock and cool.

For ICP-MS

15. Skip to Step 18.

For ICP

15 Add 10 mL of concentrated HCl to each digestion tube and cover with a watch glass.
16. Heat sample for 15 minutes.
17. Remove from the HotBlock and allow to cool.
18. Filter the sample and re-volume to 100 mL with reagent water.

Antimony in Soils by ICP-MS 6020 – Method 3050B

1. Open container and mix with tongue depressor to homogenize samples.
2. Weigh a representative 1.0g to 1.2g of the sample into the digestion tube. Record the weight.
3. Weigh additional aliquots for QC samples into their respective digestion tubes.
4. Add 5 mL of reagent water into the blank and LCS/LCSD.
5. Add 2.5 mL of conc. HNO_3 and 2.5 mL conc, HCl into each digestion tube and cover with a watch glass.
6. Heat at 95 ºC for 15 minutes. **DO NOT ALLOW SAMPLE TO GO DRY**.
7. Filter while the digestion tube is still hot. Rinse with 1.25 mL of hot HCl.
8. Rinse 3X with 5 mL of hot reagent water.
9. Place the filter paper and residue back into the original digestion tube and add 2.5 mL of conc. HCl. Heat for 20 minutes or until the filter paper dissolves.
10. Remove from the HotBlock and let cool completely.
11. Filter the sample and re-volume to 100 mL with reagent water.

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Title: Solid Phase Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Water Samples [SW-846 3535A]

Approvals (Signature/Date):

Susan M. Oster May 18, 2013
Susan Oster Date
Technical Specialist

Adam Walban 20 May 13
Adam Alban Date
Health & Safety Manager / Coordinator

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1.0 Scope and Application

1.1 This standard operating procedure (SOP) describes the extraction of nitroaromatic and nitroamine explosive residues by solid phase extraction (SPE). This procedure is based on SW-846 method 3535A.

1.2 This procedure does not describe the analysis of the extracts. For those details, see the following SOPs:

1.2.1 DV-LC-0002 "*Analysis of Nitroaromatic and Nitroamine Explosive Compounds by HPLC"*

1.2.2 DV-LC-0010 "*Analysis of Nitroaromatic and Nitroamine Explosives Compounds by APCI/LC/MS"*

1.2.3 DV-LC-0028 *"Analysis of Nitroaromatic and Nitroamine Explosive Compounds by APCI/LC/MS/MS"*.

1.2.4 DV-LC-0025 *"Analysis of Picric Acid by LC/MS/MS"*

2.0 Summary of Method

2.1 Aqueous samples undergo solid phase extraction (SPE). For samples that are to be analyzed by method 8330A or 8330B, 25g of NaCl is added to a 500mL sample aliquot and extracted. For samples that are to be analyzed by method 8321A LC/MS or 8321B LC/MS/MS, a 1000mL aliquot is acidified and extracted. The analytes are absorbed onto the sorbent material in the SPE cartridge, and then eluted with 2.5 mL of acetonitrile. The concentrated extract is diluted 1:1 with an aqueous solution of calcium chloride prior to analysis by method 8330A or 8330B or with a dilute acetic acid solution prior to analysis by method 8321A or 8321B.

3.0 Definitions

3.1 Definition of terms used in this SOP may be found in the Glossary section of the TestAmerica Denver Quality Assurance Manual (QAM).

3.2 **Explosives:** As used in this SOP, the term "explosives" refers specifically to the analytes listed in the Tables. These include compounds that can be readily detonated with heat, shock, or ignition, such as nitroglycerin, RDX, and TNT. It also includes production by-products and degradation products of true explosives.

3.3 SPE: Solid Phase Extraction

3.4 LIMS: Laboratory Information Management System

4.0 Interferences

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, causing misinterpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by running method blanks.

4.2 Contamination by carryover can occur when a low-concentration sample is analyzed immediately following a high-concentration sample.

4.3 The extraction of high-level samples can cause contamination in the extractions lab, especially on the solid-phase manifold. If water samples appear to have a red tint or if the extracts appear to be multi-phasic, the project manager and client should be contacted and care should be taken to minimize cross-contamination.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual (CW-E-M-001), Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; non-disposable gloves must be cleaned immediately.

5.2 Primary Materials Used

The following is a list of materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not contain all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagent and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

MATERIAL (1)	HAZARDS	EXPOSURE LIMIT (2)	SIGNS AND SYMPTOMS OF EXPOSURE
ACETONITRILE	Flammable Poison	40 PPM – TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
METHANOL	FLAMMABLE Poison IRRITANT	200 PPM - TWA	A slight irritant to the mucous membranes. Toxic effects are exerted upon the nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness, and dizziness. Methyl alcohol is a defatting agent and may cause the skin to be become dry and cracked. Skin absorption can occur, symptoms may parallel inhalation exposure. Irritant to the eyes.

MATERIAL [1]	HAZARDS	EXPOSURE LIMIT [2]	SIGNS AND SYMPTOMS OF EXPOSURE
PHOSPHORIC ACID	CORROSIVE	1 PPM - TWA	Ingestion can cause severe burns to the throat, mouth, and stomach, abdominal pain and nausea. Severe exposures by ingestion can lead to shock, circulatory collapse, and death. Inhalation is not an expected hazard unless misted. Corrosive, contact with skin or eyes can cause redness, pain, severe burns, blurred vision, and permanent eye damage.
(1) ALWAYS ADD ACID TO WATER TO PREVENT VIOLENT REACTIONS. (2) EXPOSURE LIMIT REFERS TO THE OSHA REGULATORY EXPOSURE LIMIT.			

6.0 Equipment and Supplies

6.1 Equipment

- Vacuum manifold for SPE cartridges. Capable of maintaining approximately 66 cm (26") of Hg. After each use, the valves and tube caps are removed from the manifold, disassembled and placed in a jar with acetonitrile. The jar is placed into a sonication bath for a minimum of 30 minutes. The jar used to sonicate the valves should be replaced at least weekly to avoid contamination.
- Nitrogen evaporation apparatus (N-EVAP) for the concentration of some water extracts.
- Balance capable of measuring ± 0.1 g. Calibration checked per SOP DV-QA-0014. Used to measure the initial sample mass and volume.
- Pipettor with disposable 1.0 mL tips. Calibration checked per SOP DV-QA-0008. Used to add surrogate and spike standards to samples.
- Pipettor with disposable 0.1 mL tips. Calibration checked per SOP DV-QA-0008. Used to add surrogate and spike solution to samples.
- Pipettor capable of dispensing 5 to 50 mL. Calibration checked per SOP DV-QA-0008. Used to calibrate vials to hold 5mL for the final volume determination for water extracts.

6.2 Supplies

- pH paper, wide range.
- Volumetric Flasks and Graduated Cylinders, glass, Class A, various sizes
- Amber Glass Vials, 8.0 mL, with Teflon-lined screw caps. For the storage of final extracts. Vials used to store the final extracts are calibrated to hold a volume of 5 mL by using a calibrated pipette to deliver 5 mL of acetonitrile into the vial, and marking the meniscus with a fine-tipped permanent marker. This volume is accurate to ± 2%.
- Disposable pipettes, used for non-quantitative transfers only.
- SPE Cartridges for method 8330A and 8330B (PoraPak RDX 6cc tubes, Waters part no. WAT047220)
- SPE Cartridges for method 8321A and 8321B (Strata SDB-L 500mg packed into 6mL tubes, Phenomenex part no. 8B-S014-HCH)

- SPE tubing – Teflon tubing with weights attached to one end. Tubes are cleaned before each use with acetonitrile.
- Miscellaneous laboratory apparatus (beakers, test tubes, volumetric flasks, pipettes etc.). These should be disposable where possible, or marked and segregated for high-level versus low-level use.
- Glass fiber filter paper, Ahlstrom, catalog number 1510-0900 or equivalent.

6.3 Computer Software and Hardware

6.3.1 Please refer to the master list of documents and software located on G:\QA\Read\Master List of Documents\Master List of Documents and Software.xls or current revision for the current software to be used for data processing.

7.0 Reagents and Standards

7.1 Reagent Water – TestAmerica Denver has three ELGA Analytical water purification systems. The water coming from the ELGA system should be 18-18.2 Mohm-cm. The performance of the water polishing system is checked daily and recorded per SOP DV-QA-0026.

7.2 Acetonitrile, CH3CN - HPLC grade (ACN).

7.3 6M HCl Solution – Used to acidify 8321A or 8321B samples prior to extraction to facilitate the extraction of picric acid from the samples. Place approximately 250mL of HPLC grade water into a 1000mL Class A volumetric flask. Using a Class A graduated cylinder, measure 250mL of concentrated (12M) HCl and carefully add it to the water in the volumetric flask. Dilute up to 1000mL with HPLC grade water.

7.4 Phosphoric acid, 85% H3PO4 – Purchased ready to use. Used to make up the CaCl2 Solution in Section 7.5**.**

7.5 Calcium Chloride, CaCl2 Solution, 5 g/L - Used to bring the 8330A and 8330B extracts up to volume.

Place 5 ± 0.05g of reagent grade CaCl2 into a one-liter volumetric flask containing approximately 500mL of reagent water. Swirl the solution until the CaCl2 is dissolved. Add approximately 1 mL of 85% H3PO4 to acidify the solution and make up to volume with reagent water.

7.6 0.1% Acetic Acid – Used to bring the 8321A or 8321B extracts up to volume.

Using a calibrated pipette, add 1mL of concentrated acetic acid to a 1000mL Class A volumetric flask containing reagent water. Make up to volume with reagent water.

7.7 Baked Sodium Chloride – Added to 8330A or 8330B samples to facilitate the extraction of picric acid.

Bake in 400 °C oven for at least 4 hours.

7.8 Standards

Please reference SOP DV-OP-0020 and WI-DV-009 for information regarding the surrogate and spike standards used in this procedure.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 For method 8321, water samples should be collected in duplicate one-liter amber glass bottles with Teflon-lined caps. For method 8330, water samples should be collected in duplicate 500mL amber glass bottles with Teflon-lined caps.

8.2 Samples and sample extracts must be stored in amber glass containers at 4 ± 2 °C from the time of collection through analysis.

8.3 All water samples must be extracted within 7 days of collection and analyzed within 40 days after extraction begins.

Method	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
8321A	Amber glass	1 Liter	Cool 4 ± 2°C	7 Days	SW-846 8330B
8330	Amber glass	500mL	Cool 4 ± 2°C	7 Days	SW-846 8330B

[1] Exclusive of Analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is

described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

At least one method blank must be processed with each preparation batch. The method blank consists of reagent water, which is free of any of the analyte(s) of interest. The method blank is processed and analyzed just as if it were a field sample.

Acceptance Criteria: The result for the method blank must be less than 1/2 the reporting limit for the analyte(s) of interest or less than 10% of the analyte concentration found in the associated samples, whichever is higher.

Corrective Action: If target analytes in the blank exceed the acceptance limits, an acceptable method blank must be re-prepared and reanalyzed. If the analyte was <u>not</u> detected in the samples, then the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative.

9.5 Laboratory Control Sample (LCS)

At least one LCS must be processed with each preparation batch. The LCS consists of reagent water to which the analyte(s) of interest are added at known concentration. The LCS is carried through the entire analytical procedure just as if it were a sample.

Acceptance Criteria: The recovery results for the LCS must fall within the established control limits. Control limits are set at $\pm$ 3 standard deviations around the historical mean. Where required, project-specific limits may be used in place of historical limits. Current control limits are maintained in the LIMS.

When there are more than 11 analytes in the LCS, then NELAC allows a specified number of results to fall beyond the LCS control limit (3 standard deviations), but within the marginal exceedance (ME) limits, which are set at $\pm$ 4 standard deviations around the mean of historical data. The number of marginal exceedances is based on the number of analytes in the LCS, as shown in the following table:

# of Analytes in LCS	# of Allowed MEs
> 90	5
71 – 90	4
51 – 70	3
31 – 50	2
11 – 30	1
< 11	0

If more analytes exceed the LCS control limits than is allowed, or if any analyte exceeds the ME limits, the LCS fails and corrective action is necessary. Marginal exceedances must be random. If the same analyte repeatedly fails the LCS control limits, it is an indication of a systematic problem. The source of the error must be identified and corrective action taken.

Corrective Action: If LCS recoveries are outside of the established control limits, the system is out of control and corrective action must occur. If recoveries are above the upper control limit and the analyte(s) of interest is not detected in samples, the data may be reported with qualifiers (check project requirements to be sure this is allowed) and it must be addressed in the project narrative. In other circumstances, the entire batch must be re-prepared and reanalyzed.

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

One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

Corrective Action: If analyte recovery or RPD falls outside the acceptance range, but the associated LCS recovery is in control, and all other QC criteria (e.g., continuing calibration verification) are met, then there is no evidence of analytical problems, and qualified results may be reported. The situation must be described in an NCM and in the final report case narrative. In other circumstances, the batch must be re-prepared and reanalyzed.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

Acceptance Criteria: The recovery of each surrogate must fall within established statistical limits, which are set at $\pm$ 3 standard deviations around the historical mean.

Corrective Action: If surrogate recoveries in the method blank are outside the established limits, verify calculations, standard solutions, and acceptable instrument performance. High surrogate recoveries in the blank might be acceptable if the surrogate recoveries for the field samples and other QC samples in the batch are acceptable. Low surrogate recoveries in the blank require re-preparation and reanalysis of the associated samples, unless sample surrogate recoveries are acceptable and targeted compounds are not detected.

If surrogate recoveries fail, verify calculations, standard solutions, and acceptable instrument performance. High recoveries may be due to a co-eluting matrix interference, which can be confirmed by examining the sample chromatogram. Low recoveries may be due to adsorption by the sample matrix (i.e., clay particles, peat or organic material in the sample). Recalculate the data and/or reanalyze the extract if the checks reveal a problem.

If matrix interference is not obvious from the initial analysis, it is necessary to re-prepare / reanalyze a sample only once to demonstrate that poor surrogate recovery is due to a matrix effect, as long as it can be shown that the analytical system was in control.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.1 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.2 **Clean the SPE manifold and tubing -** Pull acetonitrile, followed by water from the ELGA system, through each tube and each port on the vacuum manifold.

10.3 **Precondition the SPE cartridge –**Fill each cartridge two times with acetonitrile (12mL total) and draw it through the column using a vacuum manifold. Empty the in-process tank into waste stream C.

NOTE: For method 8321A and 8321B be sure to use the Strata SDB-L cartridges. For method 8330A and 8330B be sure to use the PoraPak RDX cartridges.

10.4 **Condition the SPE cartridge -** Fill the cartridge four times with reagent water and draw the water through the cartridge. Fill the cartridge a fifth time and close the valve to prevent the water from dripping through. Cap each cartridge using clean and dry caps.

10.5 **Prepare MBs and LCSs –** For every MB and LCS sample by method 8330A and 8330B, place 500mL of reagent water in a disposable 500mL Boston round bottom bottle. For every MB and LCS sample by method 8321A and 8321B, place 1000mL of reagent water in a disposable 1000mL Boston round bottom bottle.

10.6 **Inspect the water sample for the presence of sediment**. The sample must be free of particulate matter before it is introduced into the SPE extraction cartridge. Particulate matter

will obstruct the media and cause the analysis to fail. If the samples are particulate free, proceed to Section 10.9. If the samples have sediment that has settled to the bottom of the sample container, but otherwise is clear, proceed to Section 10.7. If the samples have suspended solids, proceed to Section 10.8

10.7 Aliquot Samples with Significant Solids Whenever possible, the sample should be extracted directly from the original sample container. This will allow the sample container to be rinsed. If the original sample container contains a significant amount of solids that have settled to the bottom of the container and these solids would clog the solid phase cartridge, then the sample cannot be extracted in the original sample container and will have to be aliquoted at this time.

10.7.1 Gravimetrically - Place a disposable amber glass bottle on a balance and tare. Then carefully pour the sample from the original container into the tared bottle, making sure that if any sediment is present, it is not transferred to the beaker. For method 8330A and 8330B the nominal volume is 500mL. For method 8321A or 8321B the nominal volume is 1000mL. Attempt to aliquot at least the nominal volume, but no more than 20% higher than the nominal volume. Record the balance readout as the actual initial sample volume in mL on the benchsheet. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. Write a NCM to document that the rinse of the original sample container could not be performed. If there is any indication that the density of the sample is not 1g/mL, measure the density of the sample using a calibrated pipette and refer to Section 11. Proceed to Section 10.11

10.7.2 Volumetrically - For each sample, rinse a Class A graduated cylinder (500mL for 8330, 1000mL for 8321) once with acetonitrile and twice with reagent water. Carefully pour the sample from the original container into the graduated cylinder, making sure that if any sediment is present, it is not transferred to the graduated cylinder. Record the volume to the nearest 10 mL. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. Transfer the sample from the graduated cylinder into a disposable amber glass bottle. Rinse the graduated cylinder with reagent water and add the rinse to the beaker as well. Write a NCM to document that the rinse of the original sample container could not be performed. Place the original sample bottle beside the new bottle so a second analyst can check that the correct sample was aliquotted. Proceed to Section 10.11

10.8 Filter Samples with Suspended Solids. If the sample contains a significant amount of suspended solids that will likely clog the solid phase cartridge, then the sample can be vacuum filtered though glass fiber filter paper to separate the solids from the water. Rinse a filter flask and a Büchner funnel lined with filter paper once with acetonitrile and twice with water. Under vacuum, filter the sample. Do not rinse the original sample container as this will incorrectly raise the initial volume of the sample. If there is no sediment remaining in the original sample container, return the sample to the original sample container. Whenever possible, the sample should be extracted directly from the original sample container. This will allow the sample container to be rinsed. If the original sample container contains sediment, the sample can be extracted in the filter flask. Write an NCM stating that the sample had to be filtered to remove suspended solids.

10.9 Aliquot 8330 Samples received in 1L ambers - Whenever possible, the sample should be extracted directly from the original sample container. This will allow the sample container to be rinsed at the end of the procedure. If the original sample container is a 1000mL container and the requested method is 8330A or 8330B, then a 500mL aliquot should be transferred to a new disposable 500mL amber bottle. Write a NCM to document that the rinse of the original sample container could not be performed. Follow the procedures in Section 10.11 to aliquot either gravimetrically or volumetrically.

10.10 Aliquot Samples - It is the laboratory's standard procedure to aliquot samples gravimetrically. Check the Method Comments to see if volumetric aliquotting is required. .

- **Aliquot Gravimetrically -** Weigh the full sample bottle (either the original container or the filter flask) to the nearest gram using a top loading balance, and record the weight on the benchsheet. After the extraction, weigh the empty sample bottle, and record the weight. Subtract the empty bottle weight from the full bottle weight and record the difference as the sample volume in mL. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. If there is any indication that the density of the sample is not 1g/mL, measure the density of the sample using a calibrated pipette and refer to Section 11. Proceed to Section 10.11.

- **Aliquot Volumetrically -** The surrogate and spike standards should be added to the samples before volumetric aliquotting unless the samples contained significant sediment or was received in the improper container. For each sample, rinse a Class A graduated cylinder (500mL for 8330, 1000mL for 8321) once with acetonitrile and twice with reagent water. Carefully pour the sample from the original container into the graduated cylinder, making sure that if any sediment is present, it is not transferred to the graduated cylinder. Record the volume to the nearest 10 mL. If the initial volume is less than the nominal volume by 20% or more, prepare an NCM. Transfer the sample back to the original sample container. Rinse the graduated cylinders with reagent water and add the rinse to the sample. If sediment was present in the original sample container the sample can be transferred from the graduated cylinder into a new amber glass bottle. Write a NCM to document that the rinse of the original sample container could not be performed. Place the original sample bottle beside the new sample bottle so a second analyst can check that the correct sample was aliquotted. Proceed to Section 10.11

10.11 Add Surrogate Standards to Sample Containers - Add surrogate standard to each field sample and QC sample using a calibrated pipette. Reference WI-DV-009 to determine the correct surrogate standard and the correct volume to be used. The surrogate standard should be added to the sample in the original sample container unless the sample had significant sediment, was received in the improper container, or aliquoted volumetrically. Record the ID of the standard and the pipette used on the bench sheet.

10.12 Add Spike Standards to Sample Containers - Add spike standard to each LCS, MS, and MSD sample using a calibrated pipette. Reference WI-DV-009 to determine the correct spike standard and the correct volume of standard to be used. The spike standard should be added to the MS and MSD samples in the original sample containers unless the sample had significant sediment or was received in the improper container. Record the ID of the standard and the pipette used on the bench sheet.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-

009. Also at this time the witness checks the sample labels to ensure samples are correctly identified.

10.13 Acidify or Salt the Samples –

10.13.1 For methods 8321A and 8321B add 1.0 mL of 6M HCl to every field sample and QC samples. This is done to facilitate the extraction of picric acid.

10.13.2 For methods 8330A and 8330B add 25g of baked Sodium Chloride to every field sample and QC samples. This is done to facilitate the extraction of picric acid.

10.14 Connect the Tubing - Using the tubing that has been rinsed with acetonitrile, connect the cartridge to the sample container. If the extraction is being performed directly from the sample container care should be taken if there are solids that have settled to the bottom of the bottle. Clip the tubing so that the end is not resting on the bottom, but suspended above the solids.

10.15 Load the Sample onto the Cartridge –

- Begin drawing the sample through the cartridge at a rate of approximately 10 mL/minute. The solution should come out of the cartridge as individual drops. If the sample comes out of the cartridge in a stream instead of drops, the elution rate is too fast.
- Do not let the extraction tube go completely dry.
- A cartridge is considered clogged if a flow rate of 4 mL/min cannot be achieved. If the cartridge clogs during sample loading, a second cartridge can be used for the sample and then extracts are combined. Alternatively, measure the amount of sample successfully extracted, and use that volume for the extraction constant. If this approach is used, then the surrogate and spike volumes must be corrected for the new initial volume. See Section 11 on how to calculate the actual surrogate and spike volumes.
- As the sample level drops, rinse the walls of the sample container with reagent water. If a clip was used to keep the end of the line off of the bottom of the sample bottle and away from solids, lower it at this point in an attempt to extract the entire sample. After all of the sample and the water used to rinse the container has gone through the line, close the valve and remove the line and the cap from the cartridge. It is important not to let the cartridge go dry, but to leave water in the cartridge.

10.16 Wash the Cartridge - After all samples have passed through the cartridge and valves have been closed and all lines and caps have been removed from the cartridges, rinse each cartridge two times with the reagent water by filling the cartridges with the water and opening the valves and drawing it through with the vacuum. Do not allow the cartridge to go dry, but do not leave any solution remaining above the glass frit that sits on top of the column packing.

10.17 Elute the Cartridge –

- Turn off the vacuum and remove the manifold lid. Rinse the needles on the underside of the manifold lid with acetonitrile and wipe it with a clean laboratory tissue. Place the lid on a clean lab tissue. Place the vial holder inside the manifold and place 8mL

amber vials that have been calibrated to 5mL inside the manifold on top of the vial holder. Replace the manifold lid and be sure that each valve needle is positioned inside a vial.

- Using a serological pipette or a bottle-top re-pipettor, add 2.5mL of acetonitrile to each cartridge. Turn on the vacuum pump while the valves on the manifold are still closed, then quickly open and close each valve to create a vacuum in the cartridges. Turn off the vacuum pump and break the vacuum in the manifold. Open the valves to allow the acetonitrile to slowly drip gravimetrically (approximately one drop in 5 seconds).
- After the solution has stopped dripping, reapply the vacuum to ensure that the last portion of solvent is collected. This is a very important step.
- If two cartridges were used, transfer all extracts into one collection vial and evaporate down to approximately 2.5mL using a N-Evap. Continue to the next step.

10.18 Bring the extract up to the 5mL final volume -

- For method 8330A and 8330B, add the calcium chloride solution to adjust the volume of the collected extract to the mark on the calibrated vial.
- For method 8321A, add the 0.1% acetic acid to adjust the volume of the collected extract to the mark on the calibrated vial.

11.0 Calculations Data Reduction

11.1 Volume of Surrogate or Spike Extracted = (VSA) x (VE) ÷ (VI)

Where:

V_{SA} = Volume of Spike or Surrogate originally added.
V_E = Volume of Sample that was extracted through the cartridge
V_I = Volume of Sample that was originally spiked

Example: 0.1mL of surrogate standard was added to a 253mL sample. During the extraction, the cartridge clogged and only 233mL of sample was actually extracted.
0.1mL x 233mL ÷ 253mL = 0.092mL
Therefore the initial volume on the benchsheet should be entered as 233mL and the volume of surrogate should be entered as 0.092mL.

11.2 Initial Volume

$$InitialVolume(mL) = \frac{FullBottle(g) - EmptyBottle(g)}{Density(g/mL)}$$

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

Before analyzing samples, the laboratory must establish a method detection limit (MDL). The laboratory also operates under programs that require instrument detection limits (IDLs). See DV-QA-005P, “Determination of Method Detection Limits”, for more information on the method detection limit studies.

12.2 Demonstration of Capabilities

In initial demonstration of capability (IDOC) must be performed by each analyst. On-going proficiency must be documented by each analyst on an annual basis. See DV-QA-0024, "Employee Training", for more information on the IDOCs

12.3 Training Requirements

The group/team leader has the responsibility to ensure that this procedure is performed by an analyst who has been properly trained in its use and who has the required experience. Further details concerning the training program are described in SOP DV-QA-0024.

13.0 Pollution Control

13.1 Solid phase extraction used for water samples greatly reduces the amount of solvent used compared to liquid/liquid extraction.

13.2 Standards and reagents are prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in the Corporate Environmental Health and Safety Manual, and DV-HS-001P, "Waste Management Program."

14.2 The following waste streams are produced when this method is carried out:

- Expired Chemicals/Reagents/Standards – Contact Waste Coordinator
- Flammable solvent waste – Waste Stream C
- Aqueous sample waste - Waste Stream X

NOTE: Radioactive and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.2 Method 3535A, Solid-Phase Extraction (SPE), Revision 1, February 2007.

15.3 Method 8330, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 0, September 1994.

15.4 Method 8000B, Determinative Chromatographic Separations, Revision 2, December 1996.

15.5 Method 8330A, Nitroaromatics and Nitramines by High Performance Liquid Chromatography, Revision 1, January 1998.

15.6 Method 8330B, Nitroaromatics, Nitramines, and Nitrate Esters by High Performance Liquid Chromatography, Revision 2, October 2006.

16.0 Method Modifications:

16.1 Deviations from Method Source and Rationale

Method 8330 prescribes the shelf life for standards as follows:

Standards	Concentration	Shelf Life
Stock standards	1,000,000 µg/L (1,000 ppm)	One year
Intermediate standards	2.5 to 1,000 µg/L	Thirty days
Working standards	1 to 500 µg/L	Daily

This SOP describes the use of 1,000µg/L and 500µg/L standards, which are assigned a six-month shelf life based on TestAmerica's experience with these materials.

16.2 Acidic water (pH < 3) is added to the concentrated extract, dilutions, and all calibration and check standards in place of reagent water. This is to preserve any Tetryl present in the extract.

16.3 Deviations from Solid-Phase Extraction method 3535A include extracting a 500 mL volume of sample versus 1-liter, solvents used are acetonitrile and ELGA System reagent water rather than methanol and methylene chloride, a concentration step is not required in this procedure, and various volumes have been adjusted for optimum performance.

17.0 Attachments

None

18.0 Revision History

18.1 Revision 3 dated May 30, 2013

- Annual Technical Review
- Corrected formatting and grammatical errors.
- Section 6.1 was revised to give more detail on the cleaning of the valves and tube caps. The valves and tube caps should be sonicated in a jar of acetonitrile for at least 30 minutes before use. The jar uses should be replaced at least weekly.
- Section 6.2 was revised to remove alumunimum foil and dishes as part of the supply list. These items are not used in the procedure.
- The procedure was revised to define reagent water as water coming from the ELGA purification system. The option for bottled HPLC water was removed. This was done to ensure consistency in the procedure and to reduce the cost and environmental impact of bottled water (shipping, empty bottle waste).
- Sections 10.6, 10.8, 10.9, and 10.10 were revised to instruct analysts to use disposable amber bottles instead of solvent-rinsed beakers. This was done to reduce the chance of cross-contamination and to reduce solvent usage and waste.

18.2 Revision 2.1 dated May 25, 2012

- Annual Technical Review
- Corrected formatting and grammatical errors.
- Updated Section 6.1 to incorporate the addition of 0.1mL tips used to add surrogate and spike standards to samples.
- Revised Section 7.3 to state that 6M HCl Solution is added prior to extraction, when extracting for method 8321A or 8321B.

- Revised Section 7.7 to state that baked Sodium Chloride is used when extracting for method 8330A or 8330B.
- Updated Section 10.3 to more accurately describe the rinsing of all tubes and ports on the vacuum manifold.
- The instructions for aliquotting samples was moved to be before the instructions on surrogating and spiking the samples to match actual lab practice
- Updated Section 10.16 to include a reference to the Calculation Data Reduction Equation found in Section 11.
- Revised Section 11 to include a detailed equation, with example, on how to calculate the actual surrogate and spike volumes of samples when the extraction cannot be completed after use of a second cartridge.

18.3 Revision 2 dated April 29, 2011

- Revised Section 2.1 to incorporate the addition of NaCl instead of 6M HCL for method 8330A and 8330B.
- Updated Section 6.2 and 10.4 to incorporate a change to the cartridges used for method 8330A and 8330B.
- Added section NaCl to Section 7.
- Revised Section 7.1 to state that reagent water from the ELGA purification system should be 18 to 18.2 Mohm-cm.
- Updated note in section 10.12 to reference WI-DV-0009 for information about surrogate and spike standards.
- Added sections 10.14.1 and 10.14.2 to direct analysts to add hydrochloric acid when extracting for method 8321A or 8321B and to add sodium chloride when extracting for method 8330A or 8330B.
- Removed the Attachments describing the working level surrogate and spike standards. This information is now in DV-OP-0020

18.4 Revision 1 dated February 18, 2010

- Revised Section 7.3 to more accurately describe the preparation of the 6M Hydrochloric Acid solution.
- Revised Section 7 to and Tables 1 through 2 to change the concentrations of the LCS and surrogate standards and the volumes of the standards used in the extractions.
- Revised Section 10 to more accurately describe the requirement to rinse all sample containers and how to properly aliquot samples volumetrically.
- Added section 6.3.

18.5 Revision 0.1, dated January 22, 2010

- Basic Annual Review
- Added section 6.3

18.6 Revision 0, dated January 12, 2009

- This SOP was written to replace the sections of SOPs DV-LC-0002, DV-LC-0010, DV-LC-0025, and DV-LC-0028 that described the extraction of water samples.
- For method 8330, the addition of calcium chloride solution to the SPE cartridge before the acetonitrile elution was eliminated. This was done to make the extraction more like the method 8321 extraction. Four LCSs were performed to determine this change did not have an effect on recoveries.
- The 8321 Water LCS solution was changed to contain picric acid at a concentration of 0.05ug/mL.

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Title: Acid digestion of Aqueous Samples for Analysis by ICP- MS [SW-846 3005A, 3020A, 3050B and EPA Method 200.8.]

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1.0 Scope and Application

1.1 This procedure describes the preparation of aqueous samples for the analysis of metals by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) using EPA Method 200.8, and SW-846 Methods 3005A, 3020A, and 3050B.

1.2 Aqueous samples also include TCLP & SPLP Leachates, aqueous equipment rinse blanks for soil sampling. In some cases, where the associated soil samples require the SW-846 Method 3050B, Section 7.5, optional treatment to improve solubility and recovery of Sb, Ag, and Sn. The client may require that the aqueous equipment blank receive the same treatment. Refer to section 10.13 for this prep.

1.3 The applicability of each of these preparation protocols to specific analytes is detailed in Table 1. Additional elements may be analyzed following digestion by these protocols, provided that the method performance criteria specified in Section 12.0 of this SOP are met.

1.4 This SOP provides procedures applicable to the preparation of dissolved, total recoverable, potentially dissolved, and total metallic elements in ground water, aqueous samples, aqueous sludges, aqueous wastes, aqueous air sampling media, and leachates/extracts. This SOP is not applicable to samples that contain or consist of oil or other immiscible organic solvents.

NOTE: Samples that are known to be immiscible with water, e.g., contain or consist of oil or other immiscible organic solvents should be logged with a waste matrix and prepared using method 3052 TestAmerica Denver SOP: DV-IP-0017.

1.5 SW-846 Method 3005A is used to prepare surface and groundwater samples for total recoverable and dissolved metals determination by ICP-MS.

1.6 EPA Method 200.8 Section 11.2 is used to prepare surface water, and domestic and industrial waste samples for total recoverable and dissolved metals.

1.7 SW-846 Method 3020A is used to prepare aqueous samples, TCLP leachates, SPLP Leachates and aqueous wastes that contain suspended solids for total metals analysis by ICP-MS. All matrices require digestion prior to analysis with the exception of analyses for dissolved metals in filtered and acidified aqueous samples. Although digestion is not specifically required by the method, some clients and regulators do require digestion of dissolved samples and this must be clarified before project initiation.

1.8 The following table lists the sample preparation methods that are covered in this SOP and the specific section of this SOP for each preparation method. Prepared samples are analyzed by inductively-coupled plasma-mass spectrometry (ICP-MS).

PREPARATION METHOD	SOP SECTION	DETERMINATIVE METHOD	SOP #
Method 6020 – 3020A	10.10	ICP-MS	DV-MT-0002
Method 6020 – 3005A	10.11	ICP-MS	DV-MT-0002
Method 200.8 – 200.8 Total Rec.	10.12	ICP-MS	DV-MT-0002
Method 200.8 – Dissolved	10.12	ICP-MS	DV-MT-0002
Method 3050B-Special Sb Prep	10.13	ICP-MS	DV-MT-0002

2.0 Summary of Method

2.1 Method 3005A, Acid Digestion of Waters for Total Recoverable or Dissolved Metals.

This preparation method is used for total recoverable and dissolved metals analysis by ICP-MS method 6020. A representative aliquot of sample is heated with nitric acid and substantially reduced in volume. The digestate is diluted to volume and then filtered (if necessary).

2.2 Method 3020A, Acid Digestion of Aqueous Samples and TCLP/SPLP Leachates for Total Metals.

This preparation method is used for total metals analysis by ICP-MS method 6020. A representative aliquot of sample is refluxed with nitric acid. This step is repeated until the digestate is light in color or until its color has stabilized. The digestate is diluted to volume and then filtered (if necessary).

2.3 Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry

This preparation method is used for metals analysis by ICP-MS method 200.8. A representative aliquot of sample is refluxed with nitric and hydrochloric acids. The digestate is diluted to volume and then filtered (if necessary).

3.0 Definitions

Additional definitions of terms used in this SOP may be found in the glossary of the QAM.

- Dissolved Metals: The concentration of metals determined in a sample after the sample is filtered through a 0.45-μm membrane (Method 3005A). (The sample is acidified after filtration).

- Total Metals: The concentration of metals determined in an unfiltered sample following digestion (Method 3020A).

- Total Recoverable Metals: The concentration of metals determined in an unfiltered sample following treatment with hot, dilute mineral acid (Method 200.8)-(Method 3005 A).

- Potentially Dissolved Metals: An acidified sample is filtered between 8- 96 hours following acidification and the filtrate is digested using Method 3005A.

- Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, "Quality Assurance Program," for definitions of general analytical and QA/QC terms.

4.0 Interferences

4.1 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination include the following: metallic or metal-containing labware (e.g., latex gloves coated with talc, which contains high levels of zinc), containers, impure reagents, dirty glassware, improper sample transfers, dirty work areas, atmospheric inputs such as dirt and dust, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.2 The entire work area, including the bench top and fume hood, should be thoroughly cleaned on a routine schedule in order to minimize the potential for environmental contamination. Refer to Appendix A for additional contamination control guidelines.

4.3 Physical interference effects may contribute to inaccuracies in the determinations of trace elements. Oils, solvents, and other matrices may not be digested using these methods if they are not soluble in acids. If physical interferences are present, they should be documented.

4.4 Visual interferences or anomalies (such as foaming, emulsions, precipitates, etc.) must be documented.

4.5 Allowing samples to boil or go dry during digestion may result in the loss of volatile metals. If this occurs, the sample must be re-prepared.

4.6 Specific analytical interferences are discussed in the ICP-MS determinative method SOP, i.e., DV-MT-0002.

5.0 Safety

Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, and this document.

5.1 Specific Safety Concerns

5.1.1 Samples that contain high concentrations of carbonates or organic material, or samples that are at elevated pH can react violently when acids are added.

5.1.2 The digestion solution must be cooled sufficiently before adding hydrogen

peroxide (H2O2) to avoid a reaction and possible violent effervescence, or boiling over of the digestion solution.

5.1.3 Care must be taken when handling the digestion tubes. The tubes may become very hot during the digestion procedure. Allow the tubes to cool before attempting to touch the sample digestate.

5.1.4 Eye protection that satisfies ANSI Z87.1, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated must be removed and discarded; non-disposable gloves must be cleaned immediately.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating.

NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.

A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Hydrogen Peroxide	Oxidizer Corrosive	1 ppm (TWA)	Vapors are corrosive and irritating to the respiratory tract. Vapors are very corrosive and irritating to the eyes and skin.
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage

Material [1]	Hazards	Exposure Limit [2]	Signs and Symptoms of Exposure
Hydrochloric Acid	Corrosive Poison	5 ppm (Ceiling)	Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death. Can cause redness, pain, and severe skin burns. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

6.1 Instrumentation

- Digestion block, with adjustable heating, capable of maintaining a sample temperature of 85 - 95 °C.
- Thermometer that covers a temperature range of at least 80 - 110 °C.
- Centrifugation equipment (if desired method of removing particulate material is centrifugation).

6.2 Supplies

- Disposable digestion tubes, with volume accuracy verified to ± 3% gravimetrically prior to use.
- Watch glasses, ribbed or equivalent, or disposable digestion tube covers.
- Whatman GD/XP - PVDF membrane, 0.45-micron syringe filters, No. 6973-2504, for trace metal analysis, or equivalent. When used to filter any sample in a preparation batch or analytical batch, filters of the same type are also used to filter the method blank and the LCS in the batch. Acceptable results for the QC samples demonstrate that the filters neither add or subtract analytes.
- Syringes or equivalent filtration apparatus.
- Graduated cylinder or equivalent capable of measuring 50 mL to ±3% accuracy.
- Repipetors or suitable reagent dispensers.
- Calibrated automatic pipettes with pipette tips or Class A glass volumetric pipettes.
- Class A volumetric flasks.

- pH indicator strips (pH range 0 - 6).
- Plastic digestate storage bottles.

7.0 Reagents and Standards

7.1 Reagent water must be produced by a Millipore DI system or equivalent. Reagent water must be free of the analytes of interest as demonstrated through the analysis of method blanks as defined in the determinative method SOP, DV-MT-0002.

7.2 Laboratory control sample (LCS), and matrix spike and matrix spike duplicate (MS/MSD) spike solutions are purchased as custom TestAmerica Denver solutions. Standards are logged into the Standards Log database and are assigned unique identification numbers that can be used to access traceability information. The Standards Log identification numbers are recorded on the metals prep bench sheet.

7.2.1 All standards must be stored in FEP fluorocarbon or previously unused polyethylene or polypropylene bottles. These plastic bottles may be stored in a glass jar.

7.2.2 Stock standard solutions must be replaced prior to the expiration date provided by the manufacturer. If no expiration date is provided, the stock solutions may be used for up to one year and must be replaced sooner if verification from an independent source indicates a problem.

7.2.3 See Table 2 for the list of spiking levels. A volume of 0.1 mL of working spike solution is added to the 50-mL final sample volume.

7.3 Nitric Acid (HNO_3), concentrated, trace-metal grade or better.

NOTE: When preparing diluted acids, always add acid to water. If the water is added to the acid, the sudden increase in temperature may cause splashing.

7.4 Nitric Acid, 1:1

Dilute concentrated HNO_3 with an equal volume of reagent water.

7.5 30% Hydrogen Peroxide (H2O2), ultra pure grade.

7.6 Hydrochloric Acid (HCl), concentrated, trace metal grade or better.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time [1]	Reference
Waters	HDPE Or Glass	500 mLs	HNO_3, pH < 2;	180 Days	40 CFR Part 136.3
Soils	Glass	4 oz	Cool 4 $\pm$ 2°C	180 Days	N/A

[1] Inclusive of digestion and analysis.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS login, sample or method comments and/or program QAS to determine specific QC requirements that apply.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, Quality Assurance Program.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), AFCEE, etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Table 4 provides a summary of quality control requirements, including type, frequency, acceptance criteria, and corrective action.

9.3 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See

Section 12.1 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.4 Preparation Batch

A preparation batch is a group of up to 20 samples that are of the same matrix and are processed together using the same procedures and reagents. The preparation batch must contain a method blank, an LCS, a matrix spike (MS), and a matrix spike duplicate (MSD). In some cases, at client request, it may be appropriate to process a matrix spike and sample duplicate in place of the MS/MSD. If clients specify samples for the MS/MSD pair, then the batch may contain multiple MS/MSD pairs to accommodate client requests. Clients may also request a duplicate LCS (LCSD). In cases where the client has not provided sufficient sample to prepare an MS and MSD, an LCS and LCSD will be prepared instead.

9.5 Sample Count

Laboratory-generated QC samples (method blanks, LCSs) are not included in the sample count for determining the size of a preparation batch. The MS and MSD are usually not included in the sample count.

NOTE: For samples prepared under any AFCEE QAPP, all MSs and MSDs are included in the sample count.

9.6 Method Blank (MB)

The method blank consists of reagent water containing all reagents specific to the method that is carried through the entire analytical procedure, including preparation and analysis. When samples are filtered in the laboratory for determination of dissolved metals, then the blank is filtered using a filter of the same type that was used for the samples. The method blank is used to identify any system and process interferences or contamination of the analytical system that may lead to the reporting of elevated analyte concentrations or false-positive data.

Acceptance Criteria: The method blank should not contain any analyte of interest at or above ½ the reporting limit (RL) or at or above 10% of the measured concentration of that analyte in associated samples, whichever is higher. In other words, the sample result must be a minimum of 10 times higher than the blank contamination level. An exception is made for common laboratory contaminants (see section 16.1.1).

Corrective Action: If the method blank does not meet the criteria, the blank and all associated samples in the batch must be re-digested and reanalyzed.

9.7 Laboratory Control Sample (LCS)

One aqueous LCS must be processed with each preparation batch. The LCS must contain all analytes of interest and must be carried through the entire

analytical procedure. When samples are filtered in the laboratory for determination of dissolved metals, then the LCS is filtered using a filter of the same type that was used for the samples. The LCS is used to monitor the accuracy of the analytical process. On-going monitoring of the LCS results provides evidence that the laboratory is performing the method within acceptable accuracy and precision guidelines.

Acceptance Criteria: LCS recovery control limits are set at ± 3 standard deviations about the historical mean. These limits must not be wider than 85 - 115 % recovery for Method 200.8, or 80 - 120 % for Method 6020. The control limits are maintained in the LIMS system.

Corrective Action: If the LCS % recovery falls outside of the control limits for any analyte, that analyte is judged to be out of control. All associated samples must be reprocessed for analysis. One possible exception is a recovery for a given element above the upper control limit with no detection for the same element in the samples. This latter case must be explained in the case narrative.

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

A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked identically as the MS) prepared and analyzed along with the sample and matrix spike. Some client-specific data quality objectives (DQOs) may require the use of sample duplicates in place of or in addition to MS/MSDs. One MS/MSD pair must be processed for each preparation batch. Some client programs require a 10 % MS/MSD analysis frequency. If insufficient sample is available to process an MS/MSD pair, then a second LCS must be processed. The LCS pair is then evaluated according to the MS/MSD criteria.

The MS/MSD results are used to determine the effect of a matrix on the precision and accuracy of the analytical process. Samples identified as field blanks, equipment blanks, or rinse blanks cannot be used for MS/MSD analysis.

Acceptance Criteria: The recovery for each analyte must fall within established limits. The relative percent difference (RPD) between the MS and MSD must be less than or equal to the established RPD limit. If any analyte recovery or relative percent difference (RPD) between the MS and MSD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS.

Corrective Action: If the recovery of the LCS is outside limits, then corrective action must be taken. Corrective action will include re-preparation and reanalysis of the batch. If MS results fail to meet control limits, but the LCS results are within limits, then samples do not require re-preparation and reanalysis unless the results indicate that a spiking error may have occurred.

9.9 Quality Assurance Summaries

Certain clients may require specific project or program QC that may supersede the SOP requirements. Quality Assurance Summaries (QASs) are developed to address these requirements.

10.0 Procedure

Sample Preparation

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

10.3 All samples are to be checked out of Sample Control with the Internal Chain of Custody in the LIMS properly completed.

10.4 Proper sample identification is extremely important in any preparation procedure. Labeling of beakers, digestion tubes, and bottles must be done in a manner to ensure connection with the proper sample.

10.5 Samples are typically logged in as either waters or soils. Wastes such as organic liquids or sludges and tissues (animal/vegetable) are usually logged in with solid test codes. When initiating sample preparation, examine the sample to see if the sample matches the matrix designation. If the sample is logged in as aqueous, but it appears to be more like a waste (biphasic, oil, sludge-like, organic liquid, lots of sediment, etc.), then contact the project manager and the laboratory group leader for further instructions. Samples determined to be immiscible in water must be logged as a waste matrix and prepared using method 3052, TestAmerica SOP: DV-IP-0017.

10.6 If possible, prepare all the samples of a project at the same time to minimize the QC required and streamline the flow of the project through the lab, data review, and reporting groups.

10.7 Guidelines are provided in Appendix A on procedures to minimize contamination of samples and standards.

10.8 Aqueous Sample Preparation Setup

The following setup procedure must be followed for all aqueous samples prior to performing the specific digestion procedure:

10.8.1 Sample pH is verified during sample receipt. When a sample is received with improper/insufficient preservation, the sample is delivered with notification of the deficiency.

10.8.1.1 Measure the sample pH with pH paper using a separate aliquot of sample.

10.8.1.2 If the pH>2 for a sample requiring acidic preservation, add 1-2mls of conc. HNO3 to the sample. Replace the lid and mix.

10.8.1.3 Recheck the pH of the sample. If the pH<2, record the sample in the Metals preservation logbook. If the pH>2, repeat 10.8.1.2 until pH<2 or 5mls has been added. If the sample still has a pH greater than 2 do not add any additional acid and create an NCM. Add the sample to the Metals preservation logbook

10.8.1.4 Allow the sample to sit for 8-16 hours following acidification.

10.8.1.5 After 8-16 hours, recheck the pH of the sample. If the pH<2, proceed with the appropriate digestion procedure. Note the date/time of this pH recheck in the Metals preservation logbook.

10.8.1.6 If after 8-16 hours the pH>2, repeat steps 10.8.1.2 through 10.8.1.5 until the pH remains <2 following the 8-16 hour period or 5mls of HNO3 has been added.

Note: Acid must be added at least 24 hours before analysis.

10.8.2 Select the unfiltered fraction for a total or total recoverable analysis or the filtered fraction for a dissolved analysis. For SPLP select the proper sample leachates.

NOTE: Samples requiring dissolved metals determination are either filtered and preserved in the field or are filtered and preserved by the laboratory as soon as possible after receiving the samples. When filtered in the laboratory, the filtration and preservation are recorded in the Laboratory Sample Filtration and Preservation Logbook, including the preservative type and lot number. Filter acceptability is demonstrated by using filters of the same type to filter samples and batch QC samples when preparation batches include samples that were filtered in the laboratory. The results of the analysis of the batch QC samples are used to demonstrate that the filtration process neither adds nor subtracts target analytes from samples.

10.8.3 Mix the sample by shaking the container.

10.8.4 Measure and transfer 50 mL of the sample into a digestion tube. When using calibrated digestion tubes, pour the sample into the tube to the 50-mL mark. Record the lot number of the digestion tubes in the LIMS.

10.8.5 Measure two extra aliquots of the sample that is selected for the MS/MSD analysis. Spike each aliquot with 0.1 mL of each spiking solution (see Table 2). Record the standards and pipette identifications in the LIMS.

10.8.6 Measure and transfer 50 mL of reagent water into a digestion tube for the method blank. If a determination of dissolved metals is requested, use filtered reagent water for the method blank.

10.8.7 Measure and transfer 50 mL of reagent water into a digestion tube for the LCS and add 0.1 mL of spiking solution (see Table 2). Record the standards and pipette identifications in the LIMS. If determination of dissolved metals is requested (preparation method 3005A), and one or more samples were filtered in the laboratory, then filter the LCS using a filter of the same type that was used to filter the sample(s).

10.9 Proceed to the appropriate Section of this SOP for the desired preparation method as follows:

Preparation Method*	SOP Section	Analytical Method
3020A Total Metals	10.10	Method 6020
3005A Total Recoverable	10.11	Method 6020
3005A Dissolved Metals	10.11	Method 6020
200.8 Total Recoverable Metals	10.12	Method 200.8
200.8 Dissolved Metals	10.14	Method 200.8
3050B Special Sb prep	10.15	Method 3050B

10.10 Method 3020A - Preparation for Total Metals Analysis by ICP-MS Method 6020

10.10.1 To the sample in a digestion tube, add 1.5 mL of concentrated HNO_3.

10.10.2 Heat at 90 - 95 °C until the volume is reduced to approximately 5 mL. Record the start time and the Hot Block temperature in the LIMS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared and reanalyzed.

10.10.3 Allow the digestion tube to cool in a fume hood.

10.10.4 Add 1.5 mL of concentrated HNO3. Cover and reflux gently.

10.10.5 Continue heating, adding additional acid as necessary in 1-2 mL increments to ensure a complete digestion. Record the start and stop times and the Hot Block temperature in the LIMS.

NOTE: Digestion is complete when the digestate is light in color and does not change in appearance with continued refluxing.

10.10.6 Evaporate to low volume, approximately 3 - 5 mL.

10.10.7 Allow the digestion tube to cool, then add about 10 mL of reagent water.

10.10.8 Replace the cover and continue warming for 10 to 15 minutes to allow additional solubilization of any residue to occur. Record the stop time in the LIMS.

10.10.9 Allow the sample to cool and rinse the watch glass into the digestion tube with reagent water.

10.10.10 Re-Volume to 50 mL with reagent water, cap and mix thoroughly.

10.10.11 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0018.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0018 for additional details.

10.11 Method 3005A - Preparation for Total Recoverable and Dissolved Metals Analysis by ICP-MS Method 6020

10.11.1 To the sample in a digestion tube, add 2.0 mL of concentrated HNO3.

10.11.2 Heat the sample to 90 - 95 °C and cautiously evaporate to a low volume of 15 - 20 mL, while ensuring that no portion of the sample container is allowed to go dry. Record the start and stop times and the Hot Block temperature in the LIMS.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be re-prepared.

10.11.3 Allow the sample to cool in a fume hood.

10.11.4 Rinse the digestion tube with reagent water.

10.11.5 Re-Volume to 50 mL with reagent water, cap and mix thoroughly.

10.11.6 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0018.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0018 for additional details.

10.12 Method 200.8 - Preparation for Total Recoverable/Potentially Dissolved/Dissolved Metals Analysis by ICP-MS

10.12.1 To the sample, add 0.5 mL of concentrated HNO3 and 0.25 mL of concentrated HCl.

10.12.2 Adjust the digestion block to 85 ºC so that the temperature of the solution in a covered container rises to approximately 90 - 95 ºC. Record temperature on bench sheet.

10.12.3 Heat the sample until it evaporates to approximately 10 mL, while ensuring that no portion of the bottom of the digestion tube is allowed to go dry.

CAUTION: DO NOT ALLOW SAMPLE TO BOIL OR GO DRY. Doing so will result in the loss of analyte and the sample must be reprepared.

10.12.4 Cover the sample and gently reflux for an additional 30 minutes. Avoid vigorous boiling to prevent the loss of the HCl-H2O azeotrope. Record the start and stop times and the Hot Block temperature in the LIMS.

10.12.5 Allow the sample to cool in a fume hood.

10.12.6 Rinse the watch glass or cover into the container and re-volume to 25 mL with reagent water. Cap and mix thoroughly.

10.12.7 The sample is now ready for ICP-MS analysis. Refer to SOP DV-MT-0002.

NOTE: If insoluble materials are present in a sample digestate, the ICP-MS analyst may filter the sample prior to analysis. Refer to SOP DV-MT-0002 for additional details.

10.13 Method 3050B – Special Prep for Sb, Sn and Ag for Analysis by ICP-MS Method 6020

10.13.1 To 25 mL of sample in a digestion tube, add 2.5 mL of HNO_3 and 2.5 mL of HCl.

10.13.2 Heat at 90-95 °C until the sample has reduced to a volume of 10-15 mL ensuring that no portion of the sample container is allowed to go dry.

Record the start and stop times and the Hot Block temperature in the LIMS.

10.13.3 Remove the sample from the Hot Block and allow it to cool in a fume hood.

10.13.4 Add 1.0 mL of HCl to the digestion tube and cover with a ribbed watch glass.

10.13.5 Replace the watch glass and heat the sample for 15 minutes.

Record the start and stop times and the Hot Block temperature in The LIMS.

10.13.6 Remove the sample from the Hot Block and allow it to cool in a fume hood.

10.13.7 Re-volume to 100 mL with reagent water, cap and mix thoroughly.

10.14 Calibration

The digestion block temperature must be maintained between 90 and 95 °C. The temperature must be monitored continuously while in use and must be recorded on the metals preparation bench sheet. The temperature must be monitored by measuring the temperature of reagent water contained in a digestion tube that is placed in each digestion block. The thermometer used and the start and end time temperatures are recorded in LIMS. The thermometer is calibrated in accordance with SOP DV-QA-0001, Thermometer Calibration.

11.0 Calculations / Data Reduction

Not applicable. See the determinative method SOP, DV-MT-0002, for data analysis and applicable calculations.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The

concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

13.1 This method allows for the proportional reduction of sample and reagent volumes to decrease waste generation.

13.2 Standards and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards and reagents requiring disposal.

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, “Waste Management and Pollution Prevention”, of the Corporate Safety Manual, and DV-HS-001P, “Waste Management Program.”

14.2 The following waste streams are produce when this method is carried out:

14.2.1 Expired Chemicals/Reagents/Standards: Contact Waste Coordinator

14.2.2 Acidic waste from sample digests: Waste Stream J.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, EPA Office of Solid Waste, January 2005.

15.1.1 Method 3005A, Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy, Revision 1, July 1992.

15.1.2 Method 3020A, Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by GFAA Spectroscopy, Revision 1, July 1992.

15.1.3 Method 6020, Inductively Coupled Plasma - Mass Spectrometry, Revision 0, September 1994.

15.1.4 Method 3050B, Acid Digestion of Sediments, sludges and soils, Rev. 2, Dec. 1996.

15.2 Methods for the Chemical Analysis of Water and Waste (MCAWW), 1983.

15.3 Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectroscopy, Revision 5.4, May 1994.

16.0 Miscellaneous Modifications:

16.1 Modifications and Interpretations Applicable to SW-846 Reference Methods

16.1.1 Chapter 1 of SW-846 states that the method blanks should not contain any analyte of interest at or above the MDL. This SOP states that the method blank must not contain any analyte of interest at or above the reporting limit. Common lab contaminants are allowed up to two times the reporting limit in the blank following consultation with the client.

16.1.2 The referenced methods, as well as Table 3-1 of SW-846, refer to the use of a 100-mL aliquot for digestion. This SOP requires the use of a 50-mL sample size to reduce waste generation. The use of reduced sample volumes is supported in EPA's document "Response to Public Comments Background Document, Promulgation of the Second Update to SW-846, Third Edition", dated November 3, 1994. This document stated, "...flexibility to alter digestion volumes is addressed and 'allowed' by the table (3-1) and is also inherently allowed by specific digestion methods. Table 3-1 is only to be used as guidance when collecting samples..."

EMSL-Ci has also taken the stance that "reduction in sample size and appropriate corresponding reduction in sample volume is not considered a significant change in the methodology." Additionally, in written correspondence from the Office of Solid Waste, Oliver Fordham stated. " As a 'representative sample' can be assured, scaling causes no loss of precision and accuracy in the analysis."

16.2 Modifications Specific to Method 3005A

An additional 1.0 mL of HNO3 was included to replace the 5.0 mL of HCl. HCl was eliminated to reduce interferences from chloride.

16.3 Modifications and Interpretations Specific to Method 3020A

16.3.1 Section 10.10.6 of this SOP requires that the sample be reduced to a volume of 3 -5 mL. Section 7.2 of Method 3020A states that the volume should be reduced to 3 mL, but also states that no portion of the bottom of the digestion tube should go dry. The volume required by this SOP is a closer approximation of the volume required to provide an adequate covering of the bottom of the digestion tube so as to prevent the loss of critical analytes through volatilization.

16.3.2 The scope of 3020A has been expanded to include silver, based on comparison studies with 7760A. Method 3020A consistently demonstrated improved accuracy and precision over Method 7760A in the matrices tested (reagent water, surface water, and TCLP leachate) up to a concentration of 1 ppm silver.

16.4 Documentation and Records Management

The following documentation is contained within the LIMS system for each batch

- Batch number, Job and sample numbers, preparation date, and analyst name;
- Matrix, and prep type;
- Initial sample volume and final volume;
- Reagent manufacturer and lot number;
- Digestion tube lot information;
- Identification number for each standard used
- Calibrated measuring equipment used (thermometers, balances, pipettes, etc.).

17.0 Attachments

Figure 1.Method 3020A - Section 10.10

Figure 2.Method 3005A - Section 10.11

Figure 3.Method 200.8 - Section 10.12

Figure 4.Prep for Sb, Sn and Ag, Method 6020 - Section 10.13

Table 1.Approved Preparation Method Analytes

Table 2.ICP-MS Matrix Spike and Aqueous Laboratory Control Sample Levels

Table 3.TCLP Reporting Limits, Regulatory Limits, and Matrix Spike Levels

Table 4.Summary of Quality Control Requirements

Appendix A.Contamination Control Guidelines

Appendix B. Work Instruction WI-DV-017: Preparation of Water Samples for ICP-MS

18.0 Revision History

- Revision 5, Dated 30 September 2013
  - Reference to SOP DV-IP-0017 for preparation of organic waste
  - Formatting updates
  - Updated section 9, 12 & 14 to include more detail
  - Annual review
  - Updated sections 10.8.1.2 - 10.8.1.4 to removed reference to amount of HNO3 acid added.
  - Added to Section 10.8.1.6 that a maximum of 5mls of HNO3 can be added.
- Revision 4, Dated 28 September 2012
  - Annual review
  - Section 9.6 Updated method blank control limits to ½ the reporting limit.
  - Updated appendix B with revised Work Instruction.
- Revision 3.5, dated 23 September 2011
  - Annual Technical Review
  - Removed reference to Supplemental Metals Prep Sheets in Sections 10.10.8 and 10.13.5.1
  - Removed reference to Clouseau in Section 10.8.1.2
  - Removed references to LIMS codes in Appendix B
- Revision 3.4, dated 01 September 2010
  - Annual Technical Review
  - Removed all references to Supplemental Metals Prep Sheets
  - Removed all references to old LIMS prep codes
  - Updated Section 16.4 for new LIMS
  - Removed example prep sheets (Appendix A & B)
  - Updated Work Instruction Appendix D (now Appendix B)
- Revision 3.3, dated 24 August 2009
  - Updated temperature range in section 6.1.
  - Updated starting temperature in section 10.12.2
  - Added to section 10.12.4 to cover the samples
- Revision 3.2, dated 19 June 2009
  - Basic annual review
  - Updated some section references
  - Removed section 10.13.5 through 10.13.10

- Updated Figure 4

- Revision 3.1, dated 13 June 2008
  - Added requirement to wait 24 hours after the addition of acid to samples.
- Revision 3, dated 03 March 2008
  - Integration for TestAmerica and STL operations.
- Modifications from Previous Revision of the SOP
  - Eliminated sample preparation methods for GFAA analysis from the SOP, because GFAA analysis is no longer performed at STL Denver. The title of the SOP and scope was changed accordingly.
  - Added dissolved metals to Section 1.4.
  - Added note to Section 1 to clarify that samples that consist of or contain oil or immiscible organic solvents are subcontracted to other laboratories.
  - Deleted the GFAA sample prep methods from Section 2 and reformatted the section.
  - In Section 6.5, clarified that filter media is checked by using the media to filter batch QC samples.
  - Added Section 9.1 to summarize the laboratory QC program and reference QA-024 for QA requirements that apply to federal programs.
  - Added note following Section 11.8.2 to explain filtration and preservation of samples for dissolved metals.
  - In Sections 11.10, 11.11, 11.12, and 11.13, deleted final steps for filtering the digestate solution. This step, if needed, is performed by the ICP-MS analyst prior to analysis at the instrument.
  - Revised Supplemental Metals Prep Sheet to change annotation for filtering samples for dissolved metals. The current version of the prep sheet is included as Appendix B.
  - Revised Figures 1, 2, 3, and 4 to indicate that the pH of the sample is checked at the time it is received by the laboratory.

Figure 1:

Total Metals by 6020, Method 3020A- Section 10.10

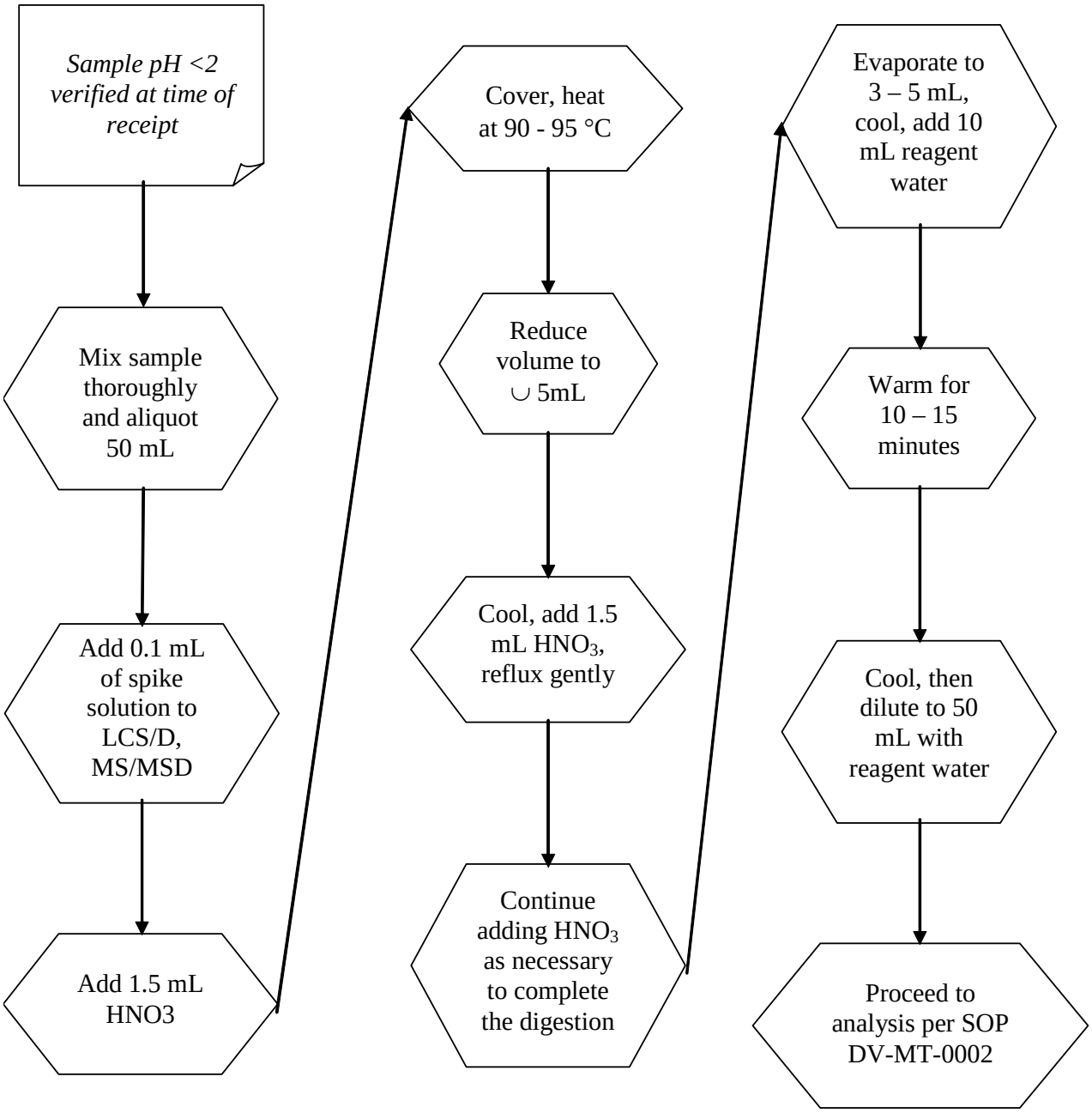

Figure 2.

Dissolved or Total Recoverable Metals by 6020, Method 3005A Section 10.11

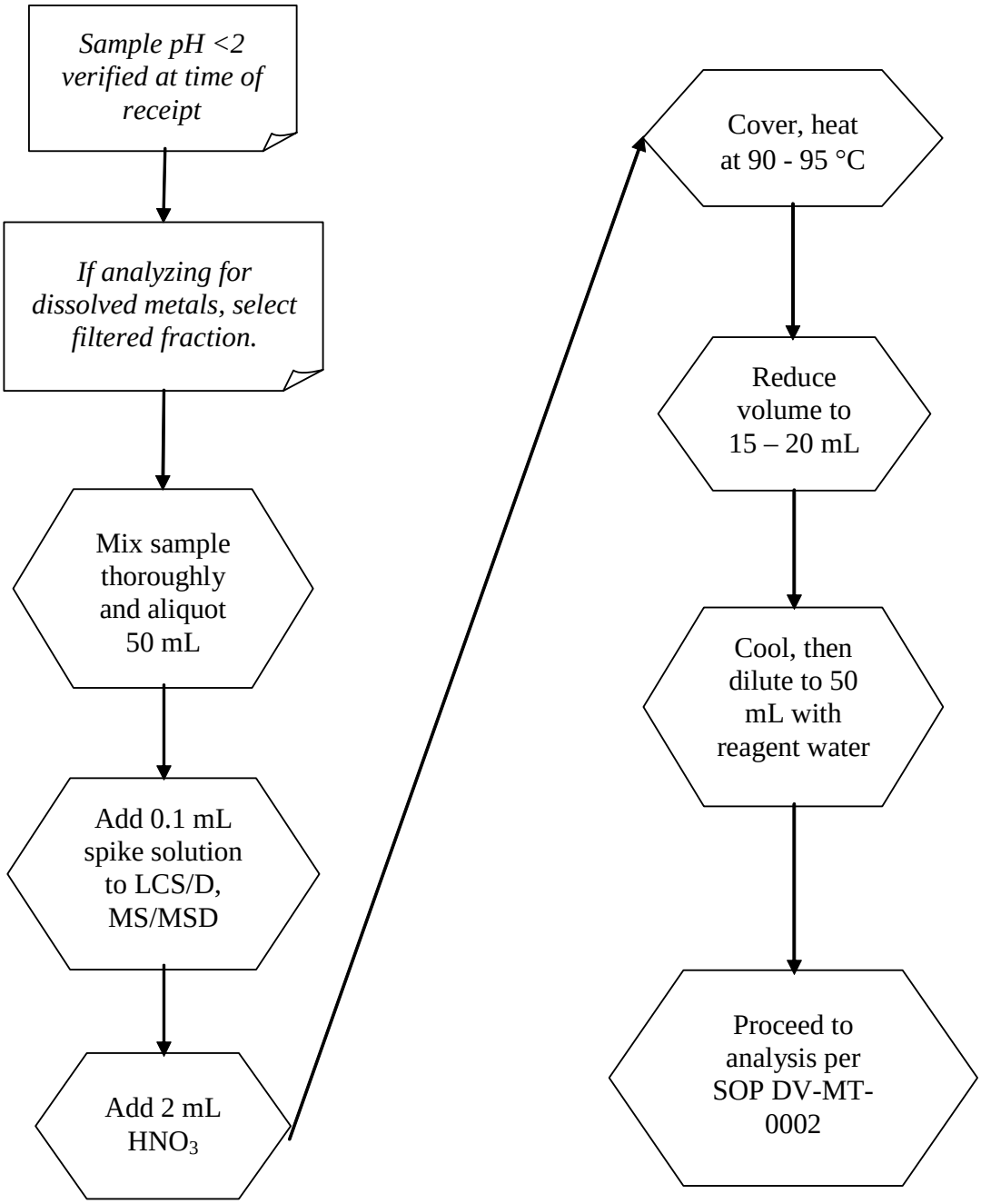

Figure 3.

Total Recoverable Metals, Method 200.8- Section 10.12

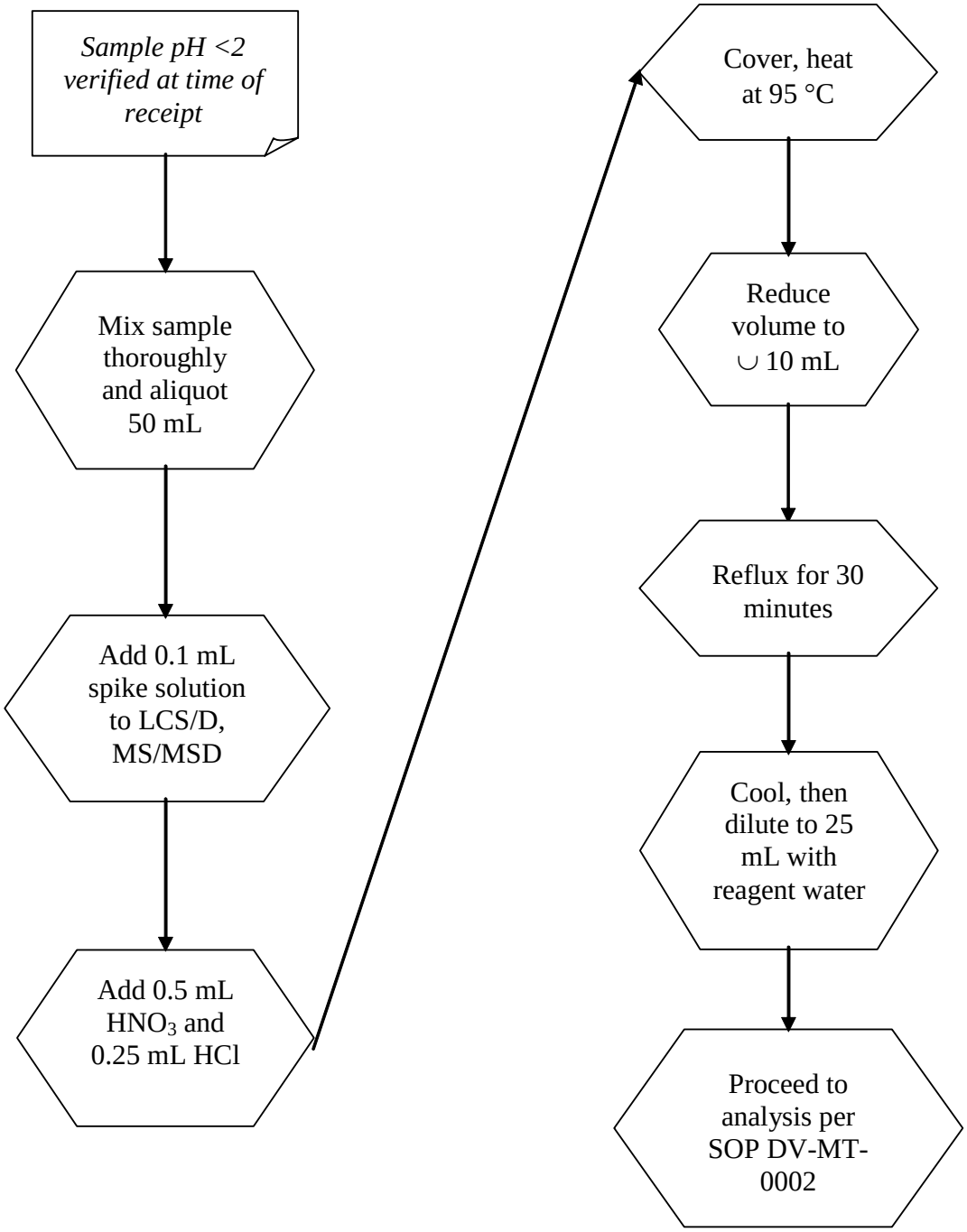

Figure 4

Prep for Sb, Sn and Ag, Method 6020- Section 10.13

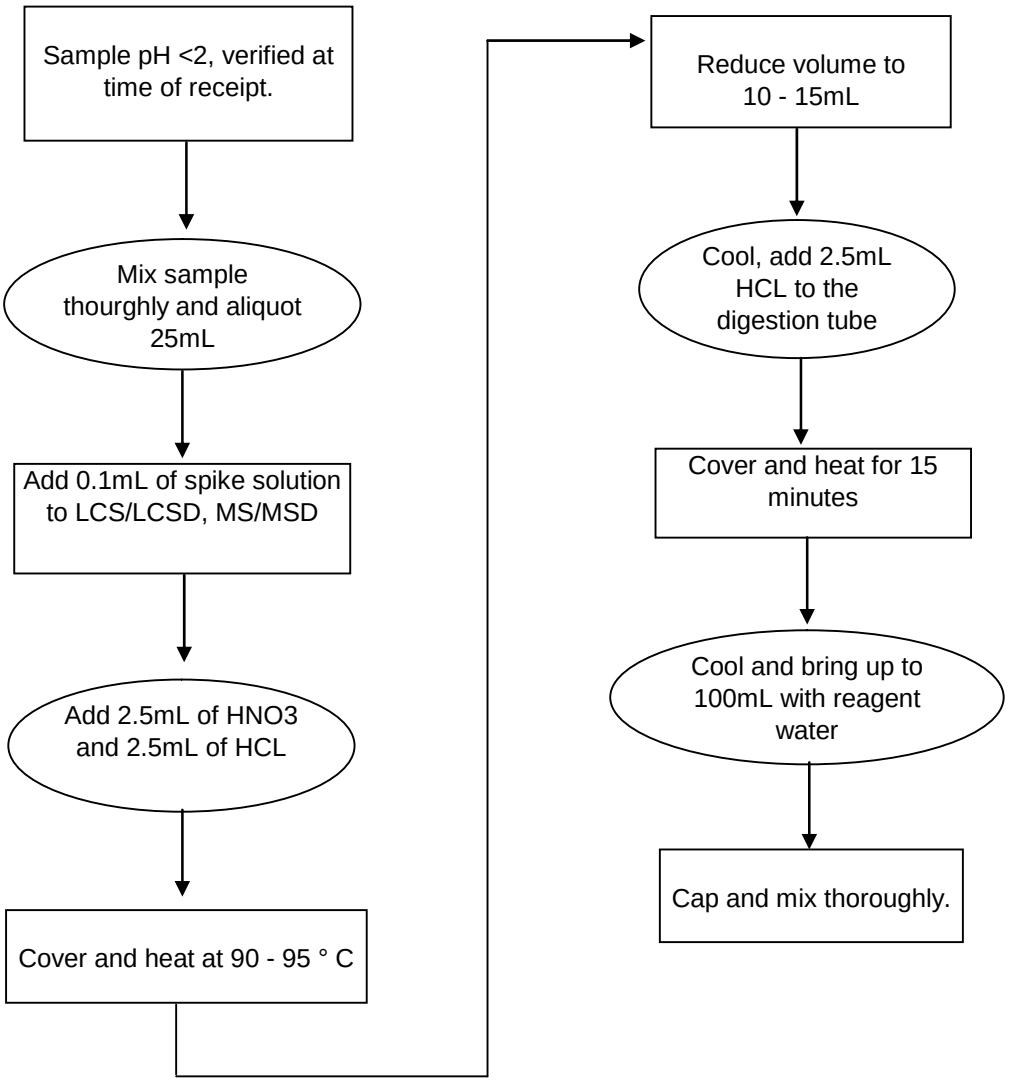

Table 1.

Approved Preparation Method Analytes

Element	Symbol	CAS Number	3005A	3020A	200.8
Aluminum	Al	7429-90-5	X		X
Antimony	Sb	7440-36-0	X		X
Arsenic	As	7440-38-2	X		X
Barium	Ba	7440-39-3	X		X
Beryllium	Be	7440-41-7	X	X	X
Cadmium	Cd	7440-43-9	X	X	X
Chromium	Cr	7440-47-3	X	X	X
Cobalt	Co	7440-48-4	X	X	X
Copper	Cu	7440-50-8	X		X
Lead	Pb	7439-92-1	X	X	X
Manganese	Mn	7439-96-5	X		X
Molybdenum	Mo	7439-98-7	X	X	X
Nickel	Ni	7440-02-0	X		X
Selenium	Se	7782-49-2	X		X
Silver	Ag	7440-22-4	X	X	X
Thallium	Tl	7440-28-0	X	X	X
Thorium	Th	7440-29-1			X
Uranium	U	7440-61-1			X
Vanadium	V	7440-62-2	X	X	X
Zinc	Zn	7440-66-6	X		X

X - Designates that the preparation method is approved for an element.

NOTE: Additional elements may be analyzed following digestion by these protocols, provided that the method performance criteria specified in Section 13.0 of this SOP are met.

Table 2.

ICP-MS Matrix Spike and Aqueous Laboratory Control Sample Levels

Element	Working LCS/MS Standard (mg/L)	Aqueous LCS/ MS Level* (μg/L)
Aluminum	20	40
Antimony	20	40
Arsenic	20	40
Barium	20	40
Beryllium	20	40
Cadmium	20	40
Chromium	20	40
Cobalt	20	40
Copper	20	40
Lead	20	40
Manganese	20	40
Molybdenum	20	40
Nickel	20	40
Selenium	20	40
Silver	20	40
Thallium	20	40
Vanadium	20	40
Zinc	20	40

* Levels shown indicate the spike concentration in the final digestate of the aqueous LCS or matrix spike, based on the addition of 0.1 mL of working spike standard to 50 mL of sample.

Table 3.

TCLP Reporting Limits, Regulatory Limits and Matrix Spike Levels

ELEMENT	RL (ug/L)	Regulatory Limit (ug/L)	Spike Level (ug/L)
Arsenic	500	5000	5000
Barium	10000	100000	50000
Cadmium	100	1000	1000
Chromium	500	5000	5000
Lead	500	5000	5000
Selenium	250	1000	1000
Silver	500	5000	1000

Table 4.

Summary of Quality Control Requirements

QC Parameter	Frequency	Acceptance Criteria	Corrective Action
Method Blank	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-digest and reanalyze samples associated with the method blank.
Laboratory Control Sample (LCS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-digest and reanalyze all samples associated with the LCS.
Matrix Spike (MS)	One per sample preparation batch of up to 20 samples.	Refer to determinative SOP: DV-MT-0002	Re-prep not required unless preparation error suspected.
Matrix Spike Duplicate (MSD)	See Matrix Spike	Refer to determinative SOP: DV-MT-0002	See Corrective Action for Matrix Spike.

Appendix A.

Contamination Control Guidelines

The following procedures are strongly recommended to prevent contamination:

All work areas used to prepare standards and spikes should be cleaned before and after each use.

All glassware should be washed with detergent and tap water and rinsed with 1:1 nitric acid followed by deionized water.

Proper laboratory housekeeping is essential in the reduction of contamination in the metals laboratory. All work areas must be kept scrupulously clean.

Powdered or latex gloves must not be used in the metals laboratory since the powder contains silica and zinc, as well as other metallic analytes. Only vinyl or nitrile gloves should be used in the metals laboratory.

Glassware should be periodically checked for cracks and etches and discarded if found. Etched glassware can cause cross contamination of any metallic analytes.

Autosampler trays should be covered to reduce the possibility of contamination. Trace levels of elements being analyzed in the samples can be easily contaminated by dust particles in the laboratory.

The following are helpful hints in the identification of the source of contaminants:

Reagents or standards can contain contaminants or be contaminated with the improper use of a pipette.

Improper cleaning of glassware can cause contamination.

Separate glassware if an unusually high sample is analyzed and soak with sulfuric acid prior to routine cleaning.

Appendix B.

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TAL DENVER WORK INSTRUCTION	WI-DV-017	A		Page 1 of 1

TITLE:	**Preparation of Water Samples for ICP-MS**	**COPY#**
AUTHOR:	Doug Gomer	
QA REVIEW:	Jay Willms	**DATE:** 9/28/2012
SOP REFERENCE:	DV-IP-0014	*Acid Digestion of Aqueous Samples by SW-846 Methods 3005A, 3020A, and EPA Method 200.8 for ICP-MS*

Total Metals by ICP-MS 6020 – SW-846 Method 3020A

1. Shake sample to homogenize.
2. Pour 50 mL into sample vessel.
3. Spike LCS, LCSD, MS, and MSD with 0.1 mL 2008CAL-1 and 2008CAL-2 each.
4. Add 1.5 mL conc HNO_3 to each sample and QC sample.
5. Place on hot block set at 95 °C until ~5 mL in volume.
6. Remove and let cool.
7. Add 1.5 mL conc HNO_3. Place back on the hot blocks for 15 minutes.
8. Remove and let cool.
9. Add ~10 mL reagent water and place back on the hot blocks for 15 minutes.
10. Remove and let cool completely.
11. Bring to final volume of 50 mL with reagent water. Cap and shake to mix.

Dissolved / Total Recoverable Metals by ICP-MS 6020 – SW-846 Method 3005A

1. Select the appropriate sample container for either dissolved or total recoverable digestion.
2. Shake sample to homogenize.
3. Pour 50 mL into sample vessel.
4. Spike LCS, LCSD, MS, and MSD with 0.1 mL 2008CAL-1 and 2008CAL-2 each.
5. For lab-filtered samples, filter blank and LCS/LCSD using same type of filter that was used to filter the samples.
6. Add 2.0 mL conc HNO_3.
7. Place on hot block set at 95 °C (covered container of water) until ~15-20 mL in volume.
8. Remove and let cool completely.
9. Bring to final volume of 50 mL with reagent water. Cap and shake to mix.

Dissolved / Total Recoverable Metals by ICP-MS 200.8 – Method 200.8

1. Select the appropriate sample container for either dissolved, potentially dissolved or total recoverable digestion.
2. Shake sample to homogenize.
3. Pour 50 mL into sample vessel.
4. Spike LCS, LCSD, MS, and MSD with 0.1 mL 2008CAL-1 and 2008CAL-2 each.
5. Add 0.5 mL conc HNO_3 and 0.25 mL conc HCl to sample vessel.
6. Place on hot block set at 95 °C until ~10 mL in volume.
7. Cover the sample with a ribbed watchglass and reflux for an additional 30 minutes.
8. Remove and let cool completely.
9. Bring to final volume of 25 mL with reagent water. Cap and shake to mix.

ATTACHMENT D

LABORATORY QUALITY ASSURANCE PLANS
(TestAmerica on CD-ROM)
GEL QA Manual – Confidential Business Information
These documents are available for review upon request accompanied by a confidentiality agreement

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REFERENCED CORPORATE SOPs AND POLICIES

SOP / Policy Reference	Title
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CW-Q-S-003	Internal Auditing
CA-Q-S-006	Detection Limits
CA-Q-S-004	Management Systems Review
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CW-L-S-002	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CW-L-P-004	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CA-C-S-001	Work Sharing Process
CA-T-P-001	Qualified Products List
CW-F-S-007	Controlled Purchases Policy
CA-Q-M-002	Corporate Quality Management Plan
CA-I-P-002	Electronic Reporting and Signature Policy
CW-E-M-001	Corporate Environmental Health & Safety Manual

REFERENCED LABORATORY SOPs

SOP Reference	Title
DV-HS-0004	Hazardous Waste Manifesting (Sec. 23.7)
DV-HS-0005	Excess Sample Material Management (Sec. 23.7)
DV-QA-0001	Thermometer Calibration Procedure (Sec. 20.3.3)
DV-QA-0003	Sample Management and Chain of Custody (Sec. 19.14.4, 23.2.1, 23.2.1.3, and 23.3.2)
DV-QA-0005	Document Archiving Procedure (Sec. 6.4 and 14.1.4)
DV-QA-0010	Document Control (Sec.3.4.1 and 6.1)
DV-QA-0014	Balance Calibration Check (Sec. 20.3.1)
DV-QA-0015	Verification and Storage of Calibration Standards (Sec. 21.4)
DV-QA-0019	Quarantine Soils Procedure (Sec. 23.5)
DV-QA-0020	Data Review (Sec. 19.14.4)
DV-QA-0022	Data Package Assembly (Sec. 19.14.4)
DV-QA-0023	Subsampling (Sec. 22.5)
DV-QA-0024	Training (Sec. 17.3, 19.4.2 and 19.4.3.1)
DV-QA-001P	Preparation and Management of Standard Operating Procedures and Other Controlled Documents (Sec. 6.3 and 19.2)
DV-QA-003P	Quality Assurance Program (Sec. 5.5, 5.6 and 24.6.1)
DV-QA-004P	Rounding and Significant Figures (Sec. 19.14.2.3)
DV-QA-005P	Determination of Method Detection Limits (Sec. 19.7 and 19.9)
DV-QA-011P	Acceptable Manual Integration Practices (Sec. 19.14.2, 19.14.4, and 19.14.5)
DV-QA-013P	Customer Complaints (Sec .10.1 and 10.2)
DV-QA-017P	Electronic Reporting (Sec. 19.14.1)
DV-QA-025P	Electronic Data Backup (Sec. 14.1.3)
DV-QA-028P	Management of Change (Sec. 13.2)

SECTION 3. INTRODUCTION, SCOPE AND APPLICABILITY

3.1 Introduction and Compliance References

TestAmerica Denver Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with The NELAC Institute (TNI) Standard, dated 2009, Volume 1 Modules 2 and 4, and ISO/IEC Guide 17025:2005(E) In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plan (CQMP) and the various accreditation and certification programs listed in Appendix 3. The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-88/039, *Methods for the Determination of Organic Compounds in Drinking Water,* EPA, Revised July 1991.
- EPA 600/R-95/131, *Methods for the Determination of Organic Compounds in Drinking Water,* Supplement III, EPA, August 1995.
- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories,* EPA, March 1979.
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *U.S. Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010.*
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005) (DW labs only)*
- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- APHA, *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 19th, 20th, 21st, and on-line Editions.
- *U.S. Department of Energy* Order 414.1B, *Quality Assurance*, Approved April 29, 2004.
- *U.S. Department of Energy* Order 414.1C, *Quality Assurance*, June 17, 2005.
- *U.S. Department of Energy*, *Quality Systems for Analytical Services*, Revision 2.9, May 2013.
- U.S. Department of Defense, *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP),* Version 4.0.02, May 2006.

- Nuclear Regulatory Commission (NRC) Quality Assurance Requirements.
- Marine Protection, Research, and Sanctuaries Act (MPRSA).
- Toxic Substances Control Act (TSCA).

3.2 Terms and Definitions

A Quality Assurance Program is a company-wide system designed to ensure that data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 2 for the Glossary/Acronyms.

3.3 Scope / Fields of Testing

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among air, drinking water, effluent water, groundwater, hazardous waste, sludge and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical parameters. The Program also contains guidelines on maintaining documentation of analytical processes, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all analytical requests are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in the LIMS. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet these requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory will abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director and the Quality Assurance (QA) Manager. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

3.4 Management of the Manual

3.4.1 Review Process

The template on which this manual is based is reviewed annually by Corporate Quality Management Personnel to assure that it remains in compliance with Section 3.1. This manual itself is reviewed annually by senior laboratory management to assure that it reflects current

practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager will review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates will be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control procedure (refer to SOP DV-QA-0010).

SECTION 4. MANAGEMENT REQUIREMENTS

4.1 Overview

TestAmerica Denver is a local operating unit of TestAmerica Laboratories, Inc.. The organizational structure, responsibilities and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Executive Officer, Corporate Quality, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate & TestAmerica Denver is presented in Figure 4-1.

4.2 Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program. At any time, individual positions described in this section may not be filled. These descriptions are maintained in the manual to allow for organizational flexibility.

4.2.1 Additional Requirements for Laboratories

The responsibility for quality resides with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica's Denver laboratory.

4.2.2 Laboratory Director

TestAmerica Denver's Laboratory Director is responsible for the overall quality, safety, financial, technical, human resource and service performance of the whole laboratory and reports to their respective GM. The Laboratory Director provides the resources necessary to implement and maintain an effective and comprehensive Quality Assurance and Data Integrity Program.

Specific responsibilities include, but are not limited to:

- Provides one or more technical directors for the appropriate fields of testing as required by NELAP. The name(s) of the Technical Director will be included in the national database. If

the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, the Laboratory Director must designate another full time staff member meeting the qualifications of the Technical Director to temporarily perform this function. If the absence exceeds 65 consecutive calendar days, the primary accrediting authority must be notified in writing. The role of the Technical Director at TestAmerica Denver is fulfilled by the Laboratory Director or appointed designee(s).

- Ensures that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented.
- Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work.
- Ensures TestAmerica's human resource policies are adhered to and maintained.
- Ensures that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory.
- Ensures that appropriate corrective actions are taken to address analyses identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Director.
- Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to.
- Pursues and maintains appropriate laboratory certification and contract approvals. Supports ISO 17025 requirements.
- Ensures client specific reporting and quality control requirements are met.
- Captains the management team, consisting of the QA Manager, the Technical Director(s), and the Operations Manager as direct reports.

4.2.3 Quality Assurance (QA) Manager or Designee

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system.

The QA Manager reports directly to the Laboratory Director and has access to Corporate QA for advice and resources. This position is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence. Corporate QA may be used as a resource in dealing with regulatory requirements, certifications and other quality assurance related items. The QA Manager directs the activities of the QA officers to accomplish specific responsibilities, which include, but are not limited to:

- Serves as the focal point for QA/QC in the laboratory.
- Having functions independent from laboratory operations for which he/she has quality assurance oversight.
- Maintaining and updating the QAM.

- Monitoring and evaluating laboratory certifications; scheduling proficiency testing samples.
- Monitoring and communicating regulatory changes that may affect the laboratory to management.
- Training and advising the laboratory staff on quality assurance/quality control procedures that are pertinent to their daily activities.
- Have documented training and/or experience in QA/QC procedures and the laboratory's Quality System.
- Having a general knowledge of the analytical test methods for which data audit/review is performed (and/or having the means of getting this information when needed).
- Arranging for or conducting internal audits on quality systems and the technical operation.
- The laboratory QA Manager will maintain records of all ethics-related training, including the type and proof of attendance.
- Maintain, improve, and evaluate the corrective action database and the corrective and preventive action systems.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs shall be investigated following procedures outlined in Section 12 and if deemed necessary may be temporarily suspended during the investigation.
- Objectively monitor standards of performance in quality control and quality assurance without outside (e.g., managerial) influence.
- Coordinating of document control of SOPs, MDLs, control limits, and miscellaneous forms and information.
- Review a percentage of all final data reports for internal consistency. Review of Chain of Custody (COC), correspondence with the analytical request, batch QC status, completeness of any corrective action statements, 5% of calculations, format, holding time, sensibility and completeness of the project file contents.
- Review of external audit reports and data validation requests.
- Follow-up with audits to ensure client QAPP requirements are met.
- Establishment of reporting schedule and preparation of various quality reports for the Laboratory Director, clients and/or Corporate QA.
- Development of suggestions and recommendations to improve quality systems.
- Research of current state and federal requirements and guidelines.
- Captains the QA team to enable communication and to distribute duties and responsibilities.
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.

- Evaluation of the thoroughness and effectiveness of training.
- Compliance with ISO 17025, The NELAC Institute (TNI) Standard, DOD ELAP and the various QC programs implemented at the Denver laboratory.

4.2.4

4.2.5 Quality Assurance Specialist

The Quality Assurance Specialist performs several roles. The QA Specialist reports to the facility QA Manager. The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitate external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assist the QA Manager in the preparation of new SOP's and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Manages the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Personnel training records review and maintenance.
- Document control maintenance.
- Assists the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Manages certifications and accreditations.
- Monitors for compliance the following QA Metrics: Temperature Monitoring of refrigeration units and incubators; thermometer calibrations; balance calibrations; eppendorf/pipette calibrations; and proper standard/reagent storage.
- Periodic checks on the proper use and review of instrument logs.
- Initiate the Mint-miner data file review process for organic instrumentation. Maintain tracking sheet of activity.
- Initiate the annual Instrument review.
- Assist in the technical review of data packages which require QA review.

4.2.6 Quality Assurance Assistant

The Quality Assurance Assistant performs several roles. The QA Assistant reports to the facility QA Manager. The QA Assistant is responsible for QA documentation and involvement in the

following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Serves as a project manager for proficiency testing samples and other QC samples. Processes and reports QC samples as routine samples to appropriate agencies.
- Assist the QA Manager in maintaining the laboratory's reference data to keep it current and accurate.
- Prepares certification applications for states as directed by QA Manager.
- Personnel training records review and maintenance.
- Document control maintenance.
- Assisting departments in generating MDL spreadsheets and calculations, reviewing MDL studies submitted to QA.
- Assisting in control limit generation.
- Ensuring maintenance of records archives.
- Maintaining historical indices for all technical records including SOPs, QC records, laboratory data, etc.

4.2.7 Operations Manager

The Operations Manager manages and directs the analytical production sections of the laboratory. He/She reports directly to the Laboratory Director. He/She acts as the Technical Director in compliance with TNI requirements and for compliance with the ISO 17025 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the ongoing training and development programs for existing analysts and new instrumentation. More specifically, he/she:

- Evaluates the level of internal/external non-conformances for all departments.
- Continuously evaluates production capacity and improves capacity utilization.
- Continuously evaluates turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments.
- Develops and improves the training of all analysts in cooperation with the Technical Director and QA Manager and in compliance with regulatory requirements.
- Is responsible for efficient utilization of supplies.
- Constantly monitors and modifies the processing of samples through the departments.
- Fully supports the quality system and, if called upon in the absence of the QA Manager, serves as his substitute in the interim.

4.2.8 Radiation Safety Officer

The Radiation Safety Officer (RSO) is responsible for implementing TestAmerica Denver's radiation safety program. The RSO reports directly to the Technical Director. The RSO's duties consist of:

- Manage the personnel radiation dosimetry program
- Maintains the Radioactive Materials License and radionuclide inventory
- Monitors laboratory operation for compliance with the Radiation Safety Manual
- Training, documenting, and evaluating the TestAmerica Denver personnel for handling radioactive material
- Creating, releasing, and decontaminating of Radiological Control Areas (RCAs)
- Monitoring and tracking of radioactive materials
- Conducting the radioactive material waste disposal program in accordance with State and Federal regulations
- Maintaining all records related to the radiation safety program

4.2.9 Employee Health and Safety Coordinator

The EH&S Coordinator is responsible for administering the EH&S program that provides a safe, healthy working environment for all employees and the environment. The Employee Health and Safety Coordinator (EH&S Coordinator) reports directly to the Laboratory Director and the corporate Environmental Health and Safety Director. He/She monitors all areas for unsafe conditions, acts, and potential hazards. Specific responsibilities include, but are not limited to:

- Staying current with the hazardous waste regulations
- Continuing training on hazardous waste issues
- Reviewing and updating annually the Hazardous Waste Contingency Plan in the Environmental Health & Safety Manual.
- Auditing the staff with regard to compliance with the Hazardous Waste Contingency Plan
- Contacting the hazardous waste subcontractors for review of procedures and opportunities for minimization of waste
- Conduct ongoing, necessary safety training and conduct new employee safety orientation.
- Assist in developing and maintaining the Chemical Hygiene/Safety Manual.
- Administer dispersal of all Material Safety Data Sheet (MSDS) information.
- Perform regular chemical hygiene and housekeeping instruction.
- Give instruction on proper labeling and practice.
- Serve as chairman of the laboratory safety committee.
- Provide and train personnel on protective equipment.

- Oversee the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed.
- Supervise and schedule fire drills and emergency evacuation drills.
- Determine what initial and subsequent exposure monitoring, if necessary to determine potential employee exposure to chemicals used in the laboratory.
- When determined necessary, conduct exposure monitoring assessments.
- Determine when a complaint of possible over-exposure is "reasonable" and should be referred for medical consultation.
- Assist in the internal and external coordination of the medical consultation/monitoring program conducted by TestAmerica's medical consultants.
- Conducts weekly inspections of satellite accumulation areas and all hazardous waste storage areas
- Coordinates the proper storage, packing and disposal of laboratory wastes according to Department of Transportation (DOT) and Resource Conservation and Recovery Act (RCRA) regulations
- Maintains waste disposal records
- Coordinates spill response activities including documentation for waste storage areas

4.2.10 Waste Disposal Technician

The Waste Disposal Technician is responsible for proper disposal of spent chemicals, process waste, and unused laboratory samples used in the laboratory according to corporate, federal, state, and local guidelines. The Waste Disposal Technician reports to the Hazardous Waste Specialist and EH&S Coordinator. The duties consist of:

- Packaging hazardous waste for transport per DOT, RCRA and TSCA guidelines
- Identifying waste streams and maintaining satellite accumulation areas
- Packages expired chemicals for shipment or disposal
- Tracks volume of waste generated for reporting to corporate and EPA
- Prepares and tracks implementation of the Waste Minimization Plan
- Empties satellite containers into bulk containers and returns to the laboratory for reuse

4.2.11 Department Manager/Supervisor

Department Managers/Supervisors report to the Operations Manager. At TestAmerica Denver these individuals may have the title of Department Manager I or II or Supervisor I or II. The title and level designation are based on the level of experience. He/she is accountable for all analyses and analysts under their experienced supervision and act as the Technical Managers in compliance with TNI requirements and for compliance with the ISO 17025 Standard. The scope of responsibility ranges from the new-hire process and existing technology through the

ongoing training and development programs for existing analysts and new instrumentation. Specific responsibilities include, but are not limited to:

- Exercises day-to-day supervision of laboratory operations for the appropriate field of accreditation and reporting of results.
- Ensure that analysts in their department adhere to applicable SOPs and the QA Manual. They perform frequent SOP and QA Manual review to determine if analysts are in compliance and if new, modified, and optimized measures are feasible and should be added to these documents.
- Coordinating, writing, and reviewing preparation of all test methods, i.e., SOPs, with regard to quality, integrity, regulatory and optimum and efficient production techniques, and subsequent analyst training and interpretation of the SOPs for implementation and unusual project samples.
- Reviewing and approving, with input from the QA Manager, Quality Assurance Project Plans (QAPPs). This procedure addresses the adequate definition of methods to be used for analysis and any limitations, the laboratory's capability and resources, the client's expectations. Differences are resolved before the contract is signed and work begins. A system documenting any significant changes is maintained, as well as pertinent discussions with the client regarding their requirements or the results of the analyses during the performance of the contract. Any deviations from the contract must be disclosed to the client. Once the work has begun, any amendments to the contract must be discussed with the client and so documented.
- Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with reviewing and supporting all new business contracts, insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process (training, development, and accountability at the bench), and providing technical and troubleshooting expertise on routine and unusual or complex problems.
- Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis. Training includes instruction on calculations, instrumentation management to include troubleshooting and preventive maintenance.
- Enhancing efficiency and improving quality through technical advances and improved LIMS utilization. Capital forecasting and instrument life cycle planning for second generation methods and instruments as well as asset inventory management.
- Coordinating sample management from "cradle to grave," insuring that no time is lost in locating samples.
- Scheduling all QA/QC-related requirements for compliance, e.g., MDLs, etc.
- Captains department personnel to communicate quality, technical, personnel, and instrumental issues for a consistent team approach.
- Coordinates audit responses with the QA Manager.
- Compliance with ISO 17025, The NELAC Institute (TNI) Standard, DOD ELAP and the various QC programs implemented at the Denver laboratory.

- With regard to analysts, participates in the selection, training, development of performance objectives and standards of performance, appraisal (measurement of objectives), scheduling, counseling, discipline, and motivation of analysts and documents these activities in accordance with systems developed by the QA and Personnel Departments. They evaluate staffing sufficiency and overtime needs. Training consists of familiarization with SOP, QC, Safety, and computer systems.
- Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and documentation, self-supervise, and function as a department team.
- Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Operations Manager, and/or QA Manager. Each is responsible for 100% of the data review and documentation, non-conformance and CPAR issues, the timely and accurate completion of performance evaluation samples and MDLs, for his/her department.
- Ensure all logbooks are maintained, current, and properly labeled or archived.
- Report all non-conformance conditions to the QA Manager, Operations Manager, and/or Laboratory Director.
- Ensure that preventive maintenance is performed on instrumentation as detailed in the QA Manual or SOPs. He/She is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments.
- Maintain adequate and valid inventory of reagents, standards, spare parts, and other relevant resources required to perform daily analysis.
- Achieve optimum turnaround time on analyses and compliance with holding times.
- Conduct efficiency and cost control evaluations on an ongoing basis to determine optimization of labor, supplies, overtime, first-run yield, capacity (designed vs. demonstrated), second- and third-generation production techniques/instruments, and long-term needs for budgetary planning.
- Develop, implement, and enhance calibration programs.
- Provide written responses to external and internal audit issues.

4.2.12 Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The Analyst position at TestAmerica Denver is divided into levels. These levels range from Analyst I to Analyst V. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the analysts are listed below:

- Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.

- Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database
- Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Director, and/or the QA Manager or member of QA staff.
- Perform 100% review of the data generated prior to entering and submitting for secondary level review.
- Suggest method improvements to their supervisor, the Technical Director, and the QA Manager. These improvements, if approved, will be incorporated. Ideas for the optimum performance of their assigned area, for example, through the proper cleaning and maintenance of the assigned instruments and equipment, are encouraged.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.13 Laboratory Technician

Laboratory Technicians are responsible for the preparation of samples and performing all tasks assigned to them by the group leader or supervisor. The Laboratory Technician position at TestAmerica Denver is divided into three levels. These levels are Laboratory Technician I, Laboratory Technician II, and Laboratory Technician III. The level designation is based on experience, expertise, and responsibilities. The responsibilities of the Laboratory Technician are listed below:

- Retrieving samples from Sample Control for analysis
- Performing sample preparation by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, and project-specific plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- Documenting standard and sample preparation, sample matrix effects, and any observed non-conformance on worklists, benchsheets, lab notebooks and/or the Non-Conformance Database
- Report all non-conformance situations, sample preparation problems, matrix problems and QC failures, which might affect the reliability of the data, to their supervisor, the Technical Director, and/or the QA Manager or member of QA staff.
- Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

4.2.14 Laboratory Assistant

The Laboratory Assistant position is an entry-level position to learn basic laboratory technician skills. The Laboratory Assistant reports to their group leader or supervisor. The Laboratory Assistants duties include the following:

- Assisting the Laboratory Technicians in preparation of samples for analysis
- Preparing routine forms and reports
- Collecting and preparing materials and supplies for the laboratory
- Assisting technicians in conducting routine analysis.

4.2.15 Sample Control Manager

The Sample Control Manager reports to the Laboratory Director. The responsibilities are outlined below:

- Manage department resources in cooperation with the Sample Control Supervisor.
- Serve as liaison between the Sample Receiving, the Customer Service Organization (CSO) and operations.

4.2.16 Sample Control Supervisor

The Sample Control Supervisor reports to the Sample Control Manager. The responsibilities are outlined below:

- Direct the logging of incoming samples into the LIMS
- Ensure the verification of data entry from login
- Provide daily assessments of sample receipts
- Monitor the preparation and shipment of bottle kits to clients
- Oversee the receipt, log in, and storage of samples
- Schedules couriers for sample pickup from customer sites

4.2.17 Sample Control Technician

The Sample Control Technician reports to the Sample Control Manager. The Sample Control Technician position at TestAmerica Denver is divided into levels. These levels range from Sample Control Technician I to Sample Control Technician IV. The level designation is based on experience and responsibilities of the Technician. The Sample Control Technician responsibilities include the following:

- Receive and unload samples or consignments in accordance with DOT regulations
- Verify samples against the Chain of Custody (COC)
- Log in sample into the LIMS to assign a lot number for tracking purposes and distribute the paperwork to the Project Managers and Department Managers/Supervisors

- Label samples with lot number assigned and deliver the samples to the appropriate labs for analysis daily
- Monitor freezer and cooler temperatures daily to confirm that the readings are within SOP guidelines
- Ship all subcontracted samples to designated lab in accordance with DOT regulations as needed

4.2.18 Shipping/Maintenance Technician

The Shipping/Maintenance Technician reports to the Sample Control Manager and the Project Management Manager. The Shipping/Maintenance Technician duties include the following:

- Maintaining the inventory control system
- Receiving and distributing incoming supplies
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Maintaining bottle and cooler inventory
- Packing in-house samples for shipment to other laboratories

4.2.19 Courier

The Courier reports to the Sample Control Manager and the Project Management Manager. The Courier's duties include the following:

- Picking up and delivering samples and reports to clients and the laboratory
- Receiving and signing the chain of custody for samples
- Preparing and shipping bottle sampling kits to clients or on-site crews
- Performing preventative maintenance on company vehicles

4.2.20 CSO Project Management Manager

The CSO Project Management Manager reports to the Regional CSO and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- Technical training and growth of the Project Management team
- Technical liaison for the Project Management team
- Human resource management of the Project Management team
- Responsible to ensure that clients receive the proper sampling supplies
- Accountable for response to client inquiries concerning sample status
- Responsible for assistance to clients regarding the resolution of problems concerning COC

- Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory
- Notifying the supervisors of incoming projects and sample delivery schedules
- Accountable to clients for communicating sample progress in daily status meeting with agreed-upon due dates
- Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff
- Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness
- Monitor the status of all data package projects in-house to ensure timely and accurate delivery of reports
- Inform clients of data package-related problems and resolve service issues
- Coordinate requests for sample containers and other services (data packages)

4.2.21 Project Manager

The Project Managers report to the Project Management Manager and serve as liaisons between the laboratory and its clients. At TestAmerica Denver there are two levels of Project Managers (I or II). The level designation is based on experience, expertise, and responsibilities. The Project Manager's responsibilities include:

- Ensuring client specifications are met by communicating project and quality assurance requirements to the laboratory
- Notifying laboratory personnel of incoming projects and sample delivery schedules
- Monitoring the status of all projects in-house to ensure timely delivery of reports
- Informing clients of project-related problems, resolving service issues and coordinating technical issues with the laboratory staff
- Coordinating client requests for sample containers and other services
- Scheduling sample pick-ups from client offices or project sites and notifying the laboratory staff of incoming samples.
- Coordinating subcontract work
- Assisting clients in procuring the proper sampling supplies
- Responding to client inquiries concerning sample status
- Assisting clients with resolution of problems concerning Chains-of-Custody

4.2.22 Project Support Manager

The Project Support Manager reports to the CSO Project Management Manager. He/she is responsible for managing the Project Management Assistants and also serves as a Project

Manager. See Section 4.2.21.

4.2.23 Project Management Assistant

The Project Management Assistant reports to the Project Support Manager and designated Project Manager. The Project Management Assistant assists the Project Manager in servicing the client's needs and communicating those needs to the laboratory. The Project Management Assistant's responsibilities include:

- Collating data reports, expanded deliverables, and electronic data deliverables (EDD's) for delivery to clients.
- Writing case narratives accompanying data packages to communicate anomalies to clients
- Entering data from subcontracted laboratories
- Proof reading and filing data reports received from the laboratory
- Assisting Project Managers in changing compound lists, TAT, and setting up tables in Word or Excel
- Monitoring report due dates for timely delivery
- Invoicing completed data packages
- Generating credit or debit invoices to ensure proper payment
- Copying and paginating reports

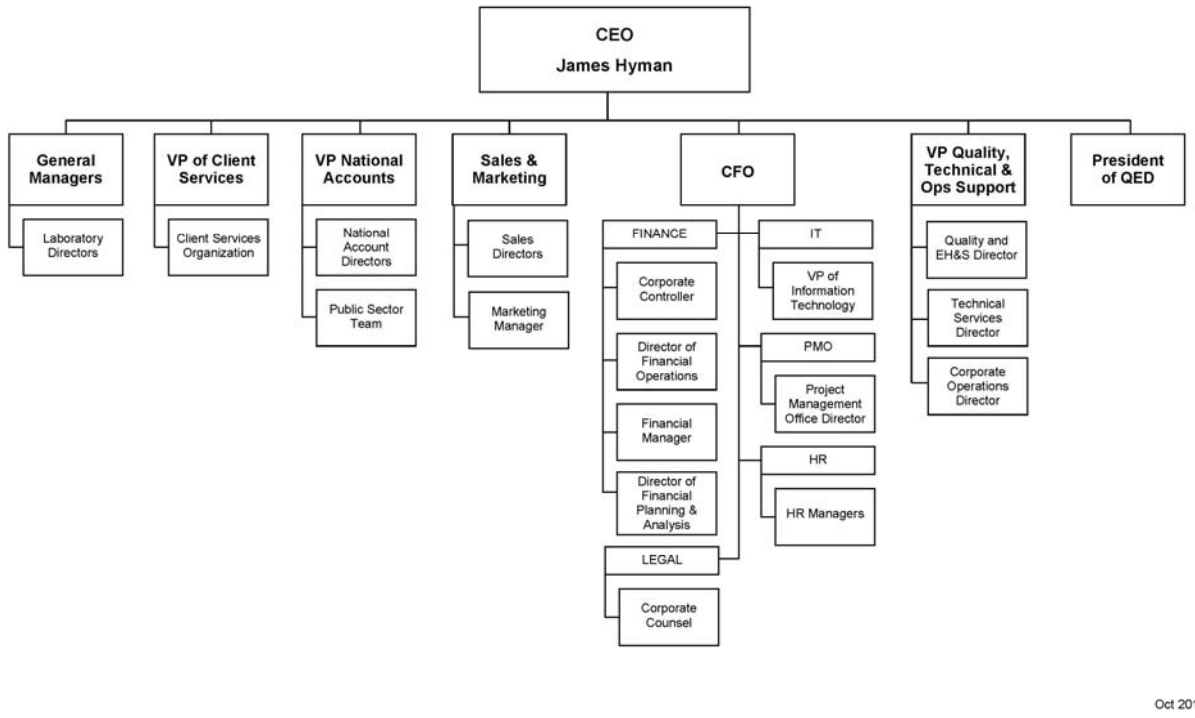
4.3 DEPUTIES

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Laboratory Director	Operations Manager
Quality Assurance Manager	Quality Assurance Specialist
Operations Manager	Department Manager/Supervisor
EHS Coordinator	Backup EHS Coordinator
CSO Project Management Manager	Project Support Manager

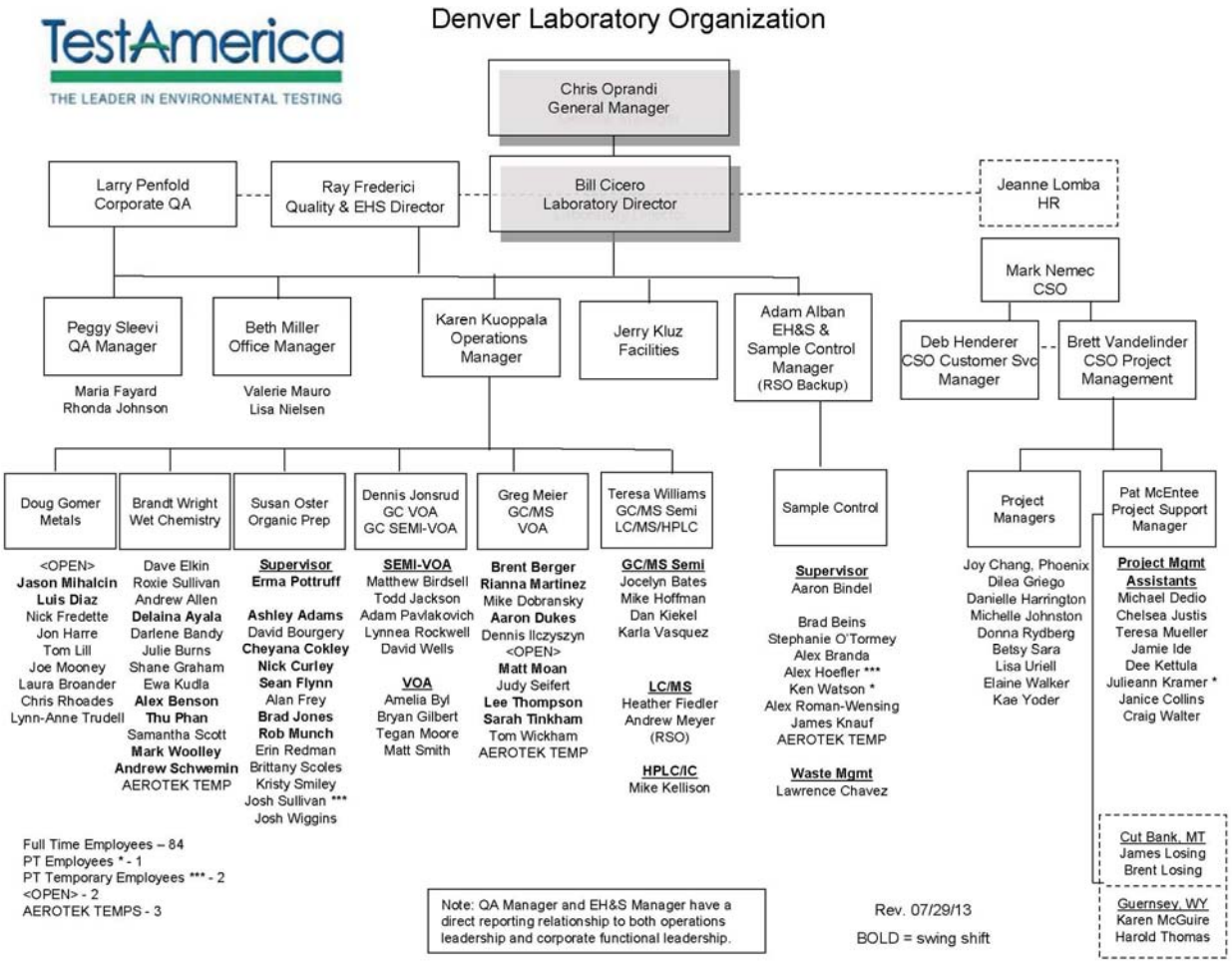
See WI-DV-0071 for the current list of personnel in these roles.

Figure 4-1. Corporate and Laboratory Organization Charts



The current version of this organization chart is available on Oasis in the QA Department.

Figure 4-1. Corporate and Laboratory Organization Charts – con't



The current version of this organization chart is available on the public drive: G:\HR\Read\Org Charts.

SECTION 5. QUALITY SYSTEM

5.1 Quality Policy Statement

It is TestAmerica's Policy to:

- Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements and the QA/QC protocols.
- Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- Continually improve systems and provide support to quality improvement efforts in laboratory, administrative and managerial activities. TestAmerica recognizes that the implementation of a quality assurance program requires management's commitment and support as well as the involvement of the entire staff.
- Provide clients with the highest level of professionalism and the best service practices in the industry.
- To comply with the ISO/IEC 17025:2005(E) International Standard, the 2009 TNI Standard and to continually improve the effectiveness of the management system.
- Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 Ethics and Data Integrity

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of TestAmerica's Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy CW-L-P-004) and Employee Ethics Statements.
- Ethics and Compliance Officers (ECOs).
- A Training Program.
- Self-governance through disciplinary action for violations.
- A Confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct. (Corporate SOP CW-L-S-002.)
- Procedures and guidance for recalling data if necessary (Corporate SOP CW-L-S-002).
- Effective external and internal monitoring system that includes procedures for internal audits (Section 15).
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).

- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 Quality System Documentation

The laboratory's Quality System is communicated through a variety of documents.

- Quality Assurance Manual – Each laboratory has a lab-specific quality assurance manual.
- Corporate SOPs and Policies – Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions – A subset of procedural steps, tasks or forms associated with an operation of a management system (e.g., checklists, preformatted bench sheets, forms).
- Laboratory SOPs – General and Technical
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies
- Other (Work Instructions (WI), memos, flow charts, etc.)

Note: The laboratory has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP

conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's QAM shall take precedence over the CQMP in those cases.

5.4 QA/QC Objectives for the Measurement of Data

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term *"analytical quality control"*. QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory will provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS).

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project), expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability will be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), interelement corrections (separation), use of matrix modifiers (separation), specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc..

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit). Other terms may be used to reflect the method detection limit or reporting limit for specific programs.

5.5 Criteria for Quality Indicators

The laboratory maintains a *Quality Control Limit Summary* in the LIMS referred *to as "Method Limit Groups"* that summarize the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated and are managed by the laboratory's QA department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where US EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in SOP DV-QA-003P, *Quality Assurance Program*.

5.6 Statistical Quality Control

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs [such as the Ohio Voluntary Action Plan (VAP)]. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The control charting process is defined in detail in SOP DV-QA-003P. The analysts are instructed to use the current limits in the laboratory active in the Laboratory Information Management System (LIMS). Limits are entered into the Method Limit Groups according to the effective date. All historical limits can be pulled using the "Historical" feature in the LIMS. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 24. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

As the QC limits are calculated, QC charts are generated showing warning and control limits for the purpose of evaluating trends. Refer to SOP DV-QA-003P for a description of the control charting process and evaluation of trending.

5.7 Quality System Metrics

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6. DOCUMENT CONTROL

6.1 Overview

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP CW-Q-S-001, Corporate Document Control and Archiving. The laboratory specific SOP DV-QA-0010, *Document Control* provides additional information for the Denver laboratory procedures.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. Instrument manuals (hard or electronic copies) are also maintained by the laboratory.

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and corrective action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 Document Approval and Issue

The pertinent elements of a document control system for each document include a unique document title and number, pagination, the total number of pages of the item or an 'end of document' page, the effective date, revision number and the laboratory's name. The QA personnel are responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department. In order to develop a new document, a department manager/supervisor submits an electronic or hardcopy draft to the QA Department for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document and retains that document as the official document on file. That document is then provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures will be reviewed at a minimum of every year and revised as appropriate. Changes to documents occur when a procedural change warrants.

6.3 Procedures for Document Control Policy

For changes to the QA Manual, refer to SOP DV-QA-001P, *Preparation and Management of Standard Operating Procedures (SOPs) and Other Controlled Documents*. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA department. Electronic copies are stored on the Public server in the QA folder G:\QA\READ\SOPS\ESOPS\ALL.

For changes to SOPs, refer to SOP DV-QA-001P, *Preparation and Management of Standard Operating Procedures (SOPs) and Other Controlled Documents.* The SOP identified above also defines the process of changes to SOPs.

Forms, worksheets, work instructions, white papers, protocols, and information are organized by department and document type in the QA office. Electronic versions are kept on the Public server in the QA folder under G:\QA\Edit\FORMS and G:\QA\READ\SOPS\Word Docs. The procedure for the care of these documents is in SOP DV-QA-001P.

6.4 Obsolete Documents

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP DV-QA-0005, *Document Archiving Procedure.*

SECTION 7. SERVICE TO THE CLIENT

7.1 Overview

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the

methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (% Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time will be checked for feasibility.

Electronic or hard copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this will be documented and discussed with the client prior to contract approval. (Refer to Section 8 for Subcontracting Procedures.)

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 Review Sequence and Key Personnel

Appropriate personnel will review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Customer Service Manager (CSM) is considered adequate. The CSM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the proposed contract is given to the National Account Director, who will decide which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, and available capacity to perform the work. The contract review process is outlined in SOP CA-L-P-002**,** Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- General Manager
- The Laboratory Project Manager
- Customer Service Manager
- The Laboratory Operations Manager
- Corporate Technical Directors
- Corporate Information Technology Managers/Directors
- Regional and/or National Account representatives
- Laboratory and/or Corporate Quality
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director reviews the formal laboratory quote and makes final acceptance for their facility.

The National Account Director, Legal Contracts Director, or local account representative then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her back-up will fulfill the review requirements.

The Legal & Contracts Director maintains copies of all signed contracts*.* TestAmerica Denver's Customer Service Department maintains copies of all signed contracts for reference locally.

7.3 Documentation

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Contracts filed by the CSM group are filed in locked fire proof cabinets.

The contract will be distributed to and maintained by the appropriate sales/marketing personnel and the Regional Account Manager. A copy of the contract and formal quote will be filed with the laboratory CSM and the Lab Director/Manager.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps a phone log of conversations with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. It is the PM's responsibility to ensure that project-specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing. Unique or large programs generally have a Quality Assurance Summary prepared by the PM. This summary is posted on the public Outlook folders for anyone in the lab to access. The Quality Assurance Summary documents all requirements that are non-standard.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes (e.g., use of a non-standard method or modification of a method) and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory during production meetings. Such changes are updated in the Quality Assurance Summery and are introduced to the managers at these

meetings. The laboratory staff is then introduced to the modified requirements via the PM or the individual laboratory Technical Manager. After the modification is implemented into the laboratory process, documentation of the modification is made in the case narrative of the data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 Special Services

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO/IEC 17025 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 Client Communication

Project managers are the primary communication link to the clients. They shall inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project management will maintain ongoing client communication throughout the entire client project.

The Operations Managers, Department Managers/Supervisors and/or Quality Assurance are available to discuss any technical questions or concerns that the client may have.

7.6 Reporting

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 Client Surveys

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service. TestAmerica's Sales and Marketing teams periodically develops lab and client specific surveys to assess client satisfaction.

SECTION 8. SUBCONTRACTING OF TESTS

8.1 Overview

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica laboratories. The phrase "work sharing" refers to internal transfers of samples between the TestAmerica laboratories. The term outsourcing refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and will meet the same commitments we have made to the client. Refer to TestAmerica's Corporate SOP's on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process (CA-C-S-001).

When outsourcing analytical services, the laboratory will assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in TNI/ISO 17025 and/or the client's Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation will be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work will be identified in the final report, as will non-TNI accredited work where required. Refer to SOP DV-QA-0027 for laboratory specific procedures.

Project Managers (PMs), Customer Service Managers (CSM), or Regional Account Executives (RAE) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory will advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client shall be retained in the project folder.

Note: In addition to the client, some regulating agencies (e.g, USDA) or contracts (e.g, certain USACE projects) may require notification prior to placing such work.

8.2 Qualifying and Monitoring Subcontractors

Whenever a PM or Customer Service Manager (CSM) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory;
- Firms specified by the client for the task (Documentation that a subcontractor was

designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder);

- Firms listed as pre-qualified and currently under a subcontract with TestAmerica: A listing of all approved subcontracting laboratories is available on the TestAmerica intranet site. Supporting documentation is maintained by corporate offices and by the TestAmerica laboratory originally requesting approval of the subcontract lab. Verify necessary accreditation, where applicable, (e.g., on the subcontractors TNI, A2LA accreditation or State Certification).
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses;
- TNI or A2LA accredited laboratories.
- In addition, the firm must hold the appropriate certification to perform the work required.

All TestAmerica laboratories are pre-qualified for work sharing provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. (Corporate SOP CA-C-S-001, Work Sharing Process).

When the potential sub-contract laboratory has not been previously approved, Account Executives, CSMs, or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director. The Laboratory Director requests that the QA Manager begin the process of approving the subcontract laboratory as outlined in Corporate SOP CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented).

8.2.1 Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They will add the lab to the approved list on the intranet site and notify the finance group for JD Edwards.

8.2.2 The client will assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are known to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list and can only be recommended to the extent that we would use them.

8.2.3 The status and performance of qualified subcontractors will be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified will be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.

- Complaints shall be investigated. Documentation of the complaint, investigation and corrective action will be maintained in the subcontractor's file on the intranet site. Complaints are posted using the Vendor Performance Report.
- Information shall be updated on the intranet when new information is received from the subcontracted laboratories.
- Subcontractors in good standing will be retained on the intranet listing. The QA Manager will notify all TestAmerica laboratories, Corporate Quality and Corporate Contracts if any laboratory requires removal from the intranet site. This notification will be posted on the intranet site and e-mailed to all Laboratory Directors, QA Managers and Sales Personnel.

8.3 Oversight and Reporting

The PM or CSM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM (or RAE or CSM, etc.) responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. The information is documented on a Subcontracted Sample Form (Figure 8-1) and the form is retained in the project folder. For TestAmerica laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a TestAmerica Chain of Custody (COC). A copy of the original COC sent by the client must also be included with all samples workshared within TestAmerica. Client CoCs are only forwarded to external subcontractors when samples are shipped directly from the project site to the subcontractor lab. Under routine circumstances, client CoCs are not provided to external subcontractors.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-TNI accredited work must be identified in the subcontractor's report as appropriate. If TNI accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratories EDD (i.e., imported), the report must explicitly indicate which lab produced the data for which methods and samples.

Note: The results submitted by a TestAmerica work sharing laboratory may be transferred electronically and the results reported by the TestAmerica work sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 Contingency Planning

The Laboratory Director may waive the full qualification of a subcontractor process temporarily to meet emergency needs; however, this decision & justification must be documented in the project files, and the 'Purchase Order Terms And Conditions For Subcontracted Laboratory Services' must be sent with the samples and Chain-of-Custody. In the event this provision is utilized, the laboratory (e.g., PM) will be required to verify and document the applicable accreditations of the subcontractor. All other quality and accreditation requirements will still be applicable, but the subcontractor need not have signed a subcontract with TestAmerica at this time. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1.

Example: Verification of Subcontract Lab Status Form

TestAmerica Denver is responsible to our clients for on-going assurance that subcontracted analytical services meet TestAmerica Denver's expectations for quality. As part of this program, we require on-going verification that the following statements are true. Please return the completed form with the final report to TestAmerica Denver.

Laboratory Name: _____

	True	False	N/A	Comments
Your laboratory continues to hold current certifications as applicable to the requested fields of testing?				
Your laboratory has successfully completed PT samples for at least 2 of the last 3 of the requested fields of testing?				
Your laboratory has successfully completed method detection limits for the requested fields of testing within the last 12 months?				
There are no changes in equipment that affect the laboratory's capability to perform the requested fields of testing?				
There are no changes in qualified personnel that affect the laboratory's capability to perform the requested fields of testing?				
All testing is performed at the location to which the samples were delivered?				
Your laboratory does not have any OSHA, DOT, DoE, DoD, or EPA citations or pending investigations?				

Completed by: _____ on _____.
Name

SECTION 9. PURCHASING SERVICES AND SUPPLIES

9.1 Overview

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with TestAmerica's Corporate Controlled Purchases Procedure, SOP CW-F-S-007.

Contracts will be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy CW-F-P-002. Request for Proposals (RFP's) will be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 Glassware

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass should be used where possible. For safety purposes, thick-wall glassware should be used where available.

9.3 Reagents, Standards & Supplies

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent & Acid Lot Testing & Approval, SOP CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any determination. This information is contained in the method SOP. The analyst completes the Material Request Sheet when requesting reagents, standards, or supplies. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use.

The analyst must provide the master item number (from the master item list that has been approved by the Technical Director), item description, package size, catalogue page number, and the quantity needed. If an item being ordered is not the exact item requested, approval must be obtained from the Technical Director prior to placing the order. The purchasing manager or designee places the order.

9.3.2 Receiving

It is the responsibility of the shipping/receiving technician to receive the shipment. It is the responsibility of the analyst who ordered the materials to document the date materials where received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

Methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, analytical reagent grade will be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five year expiration date on inorganic dry chemicals and solvents unless noted otherwise by the manufacturer or by the reference source method. Chemicals/solvents should not be used past the manufacturer's or SOPs expiration date unless 'verified' (refer to item 3 listed below).

- An expiration date cannot be extended if the dry chemical/solvent is discolored or appears otherwise physically degraded, the dry chemical/solvent must be discarded.
- Expiration dates can be extended if the dry chemical/solvent is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical/solvent is used for the preparation of standards, the expiration dates can be extended 6 months if the dry chemical/solvent is compared to an unexpired independent source in performing the method and the performance of the dry chemical/solvent is found to be satisfactory. The comparison must show that the dry chemical/solvent meets CCV limits. The comparison studies are maintained within each department.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 500 psig or the tank must be replaced. To prevent a tank from going to dryness, close observation of the tank gauge must take place as pressure decreases towards 500 psig, or the tank must be replaced. The quality of the gases must meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a specific conductivity of less than 1- µmho/cm (or specific resistivity of greater than 1.0 megohm-cm) at 25^{o}C. The specific conductivity is checked and recorded daily. If the water's specific conductivity is greater than the specified limit, the Facility Manager and appropriate Technical–Managers must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased bottleware used for sampling must be certified clean and the certificates must be maintained. If uncertified sampling bottleware is purchased, all lots must be verified clean prior to use. This verification must be maintained.

Records of manufacturer's certification and traceability statements are maintained in files or binders in the LIMS. These records include date of receipt, lot number (when applicable), and expiration date (when applicable). Incorporation of the item into the record indicates that the analyst has compared the new certificate with the previous one for the same purpose and that no difference is noted, unless approved and so documented by the Technical Director or QA Manager.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corp. Doc. CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 Purchase of Equipment / Instruments / Software

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or supervisor makes a supply request to the Operations Manager, and/or the Laboratory Director. If they agree with the request, the procedures

outlined in TestAmerica's Corporate Policy CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed and the corporate office places the actual order.

Upon receipt of a new or used piece of equipment, an identification name is assigned and added to the equipment list. IT must also be notified so that they can synchronize the instrument for back-ups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated, followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 19). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench.

9.5 Services

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Department Managers/Supervisors. The service providers that perform the services are approved by the Operations Manager and/or Laboratory Director.

9.6 Suppliers

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Procurement & Contracts Policy (Policy CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers/vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report.

The Corporate Purchasing Group will work through the appropriate channels to gather the information required to clearly identify the problem and will contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports will be summarized and reviewed to

determine corrective action necessary, or service improvements required by vendors.

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their financial stability. The QA Department and/or the Technology Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10. COMPLAINTS

10.1 Overview

The laboratory considers an effective client complaint handling processes to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following in SOP DV-QA-013P, *Customer Complaints.*

10.2 External Complaints

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to SOP DV-QA-013P.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints should be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery
- Process Improvement

The laboratory shall inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 Internal Complaints

Internal complaints include, but are not limited to: errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and shall follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing and IT may initiate a complaint by contacting the laboratory or through the corrective action system described in Section 12.

10.4 Management Review

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16).

SECTION 11. CONTROL OF NON-CONFORMING WORK

11.1 Overview

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a corrective action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a

systematic or improper practices issue, the corrective action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's corrective action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed. Refer to SOP DV-QA-0031, *Nonconformance and Corrective Action System* for the procedure to handle such situations.

Project Management may encounter situations where a client may request that a special procedure be applied to a sample that is not standard lab practice. Based on a technical evaluation, the lab may accept or opt to reject the request based on technical or ethical merit. An example might be the need to report a compound that the lab does not normally report. The lab would not have validated the method for this compound following the procedures in Section 19. The client may request that the compound be reported based only on the calibration. Such a request would need to be approved by the Technical Director and QA Manager, documented and included in the project folder. Deviations must also be noted on the final report with a statement that the compound is not reported in compliance with TNI (or the analytical method) requirements and the reason. Data being reported to a non-TNI state would need to note the change made to how the method is normally run.

11.2 Responsibilities and Authorities

TestAmerica's Corporate SOP entitled *Internal Investigation of Potential Data Discrepancies and Determination for Data Recall* (SOP CW-L-S-002) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances, the Laboratory Director, Operations Manager, or a member of the QA team may authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client will be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's corrective action procedures. This information may also be documented in logbooks and/or data review checklists as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to a member of the facility Senior Management within 24-hours. The Senior Management staff is comprised of the Laboratory Director, the QA Manager, and the Operations Manager. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality & Client Advocacy and the laboratory's Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine

the possible effect.

The Laboratory Director, QA Manager, ECOs, Corporate Quality, the General Managers and the Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 Evaluation of Significance and Actions Taken

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation & Recall Procedure (SOP CW-L-S-002) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECO's and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/corrective action reporting in lieu of the data recall determination form contained in TestAmerica's Corporate SOP CW-L-S-002.

11.4 Prevention of NonConforming Work

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's corrective action system. On a monthly basis the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's corrective action process may be followed.

11.5 Method Suspension / Restriction (Stop Work Procedures)

In some cases, it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality will be respected, and the problem with the required corrective and preventive action will be stated in writing and presented to the Laboratory Director.

The Laboratory Director shall arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting shall be held to confirm that there is a problem, that suspension/restriction of the method is required and will be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases, that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target or test fully back on line.

The QA Manager will also initiate a corrective action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the internet. It is the responsibility of the Laboratory Director to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction (e.g., Project Management, Log-in, etc.). Clients will NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager will determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Operations Manager, Department Manager/Supervisor, QA Manager) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed corrective action report.

SECTION 12. CORRECTIVE ACTION

12.1 Overview

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the corrective action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Non-Conformance Memos (NCM) and Corrective Action Reports (CAR) (refer to Figure 12-1).

12.2 General

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a corrective action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.

- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution.

12.2.1 Non-Conformance Report (NCM) - is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non-matrix related)
- Isolated reporting / calculation errors
- Client complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips.

12.2.2 Corrective Action Report (CAR) - is used to document the following types of corrective actions:

- Questionable trends that are found in the review of NCMs.
- Issues found while reviewing NCMs that warrant further investigation.
- Internal and external audit findings
- Failed or unacceptable PT results.
- Corrective actions that cross multiple departments in the laboratory.
- Systematic reporting / calculation errors
- Client complaints
- Data recall investigations
- Identified poor process or method performance trends
- Excessive revised reports
- Health and Safety violations

This will provide background documentation to enable root cause analysis and preventive action.

12.3 Closed Loop Corrective Action Process

Any employee in the company can initiate a corrective action. There are four main components to a closed-loop corrective action process once an issue has been identified: Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

- Upon discovery of a non-conformance event, the event must be defined and documented. An NCM or CAR must be initiated, someone is assigned to investigate the issue and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment.

- The cause analysis step is the key to the process as a long term corrective action cannot be determined until the cause is determined.
- If the cause is not readily obvious, the Department Manager/Supervisor, Operations Manager, Laboratory Director, or QA Manager (or QA designee) is consulted.

12.3.2 Selection and Implementation of Corrective Actions

- Where corrective action is needed, the laboratory shall identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.
- Corrective actions shall be to a degree appropriate to the magnitude of the problem identified through the cause analysis.
- Whatever corrective action is determined to be appropriate, the laboratory shall document and implement the changes. The NCM or CAR is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify Root Causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures; for example, by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Department Manager/Supervisor and QA Manager are responsible to ensure that the corrective action taken was effective.

- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers/Supervisors are accountable to the Operations Manager and Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each CAR is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring that the corrective actions have taken effect.
- The QA Manager (or designee) reviews monthly NCMs and CARs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and shall be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

(Also refer to Section 15.1.4, Special Audits.)

12.4 Technical Corrective Actions

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11). The documentation of these procedures is through the use of an NCM or CAR.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs. The laboratory may also maintain Work Instructions on these items that are available upon request.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, QAM Sections 19 and 20. All corrective actions are reviewed monthly, at a minimum, by the QA Manager and highlights are included in the QA monthly report.

To the extent possible, samples shall be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data will be reported with an appropriate data qualifier and/or the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by an NCM and appropriate corrective action (e.g., reanalysis) is taken and documented**.**

12.5 Basic Corrections

When mistakes occur in records, each mistake shall be crossed-out, [not obliterated (e.g. no white-out)], and the correct value entered alongside. All such corrections shall be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original "uncorrected" file must be maintained intact and a second "corrected" file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) shall also be documented.

Figure 12-1.
Example - Corrective Action Report

TestAmerica Corrective Action Plan

TAL Audit # *Program:* *Requirements Document:*

Purpose: Not entered *Company Auditing:*

Date Audited: *Lead Auditor:*

Date Report Received: *Response Due Date:*

TAL Issue Number *Status:* *Title:*

Reference Citation: *Lab Process:* *Lab Section:*

Client Issue #: *Type of Issue:* *Method #:*

Finding Description:

Cause Analysis:

Corrective Action Plan:

Lab Responsible Party:

Planned Completion Date:

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Table 12-1. Example – General Corrective Action Procedures

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Initial Instrument Blank *(Analyst)*	- Instrument response < ½ RL.	- Prepare another blank. - If same response, determine cause of contamination: reagents, environment, instrument equipment failure, etc..
Initial Calibration Standards *(Analyst, Department Manager(s)/Supervisor(s))*	- Correlation coefficient > 0.99. - Standard concentrations should bracket reporting limit. - % Recovery within acceptance range. - See details in Method SOP.	- Reanalyze standards. - If still unacceptable, remake standards and recalibrate instrument.
Independent Calibration Verification (Second Source) *(Analyst, Department Manager(s)/Supervisor(s))*	- % Recovery within control limits as defined in the method SOPs.	- Remake and reanalyze standard. - If still unacceptable, then remake calibration standards or use new primary standards and recalibrate instrument.
Continuing Calibration Standards *(Analyst, Data Reviewer)*	% Recovery within control limits.	- Reanalyze standard. - If still unacceptable, then recalibrate and rerun affected samples.
Matrix Spike / Matrix Spike Duplicate (MS/MSD) *(Analyst, Data Reviewer)*	- % Recovery within limits documented in LIMS.	- If the acceptance criteria for duplicates or matrix spikes are not met because of matrix interferences, the acceptance of the analytical batch is determined by the validity of the LCS. See SOP DV-QA-003P for detailed corrective actions.
Laboratory Control Sample (LCS) *(Analyst, Data Reviewer)*	- % Recovery within limits specified in LIMS.	See SOP DV-QA-003P for detailed corrective actions.
Surrogates *(Analyst, Data Reviewer)*	- % Recovery within limits of method or within three standard deviations of the historical mean.	See SOP DV-QA-003P for detailed corrective actions.
Method Blank (MB) *(Analyst, Data Reviewer)*	< Reporting Limit [1]	See SOP DV-QA-003P for detailed corrective actions.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Proficiency Testing (PT) Samples *(QA Manager, Department Manager(s)/Supervisor(s))*	- Criteria supplied by PT Supplier.	- Any failures or warnings must be investigated for cause. Failures may result in the need to repeat a PT sample to show the problem is corrected.
Internal / External Audits *(QA Manager, Department Manager(s)/Supervisor(s) Operations Manager, Laboratory Director)*	- Defined in Quality System documentation such as SOPs, QAM, etc.	- Non-conformances must be investigated through CAR system and necessary corrections must be made.
Reporting / Calculation Errors (Depends on issue – possible individuals include: Analysts, Data Reviewers, Project Managers, Department Manager(s)/Supervisor(s), QA Manager, Corporate QA, Corporate Management)	- SOP CW-L-S-002, Internal Investigation of Potential Data Discrepancies and Determination for Data Recall.	- Corrective action is determined by type of error. Follow the procedures in SOP CW-L-S-002 and DV-QA-019P.
Client Complaints *(Project Managers, Laboratory Director, Sales and Marketing)*	-	- Corrective action is determined by the type of complaint. For example, a complaint regarding an incorrect address on a report will result in the report being corrected and then follow-up must be performed on the reasons the address was incorrect (e.g., database needs to be updated). See SOP DV-QA-013P.
QA Monthly Report (Refer to Section 16 for an example) (QA Manager, *Laboratory Director*, *Department Manager(s)/Supervisor(s)*)	- QAM, SOPs.	- Corrective action is determined by the type of issue. For example, CARs for the month are reviewed and possible trends are investigated.

QC Activity *(Individual Responsible for Initiation/Assessment)*	Acceptance Criteria	Recommended Corrective Action
Health and Safety Violation (Safety Officer, *Laboratory Director*, *Department Manager(s)/Supervisor(s)*)	- Environmental Health and Safety (EHS) Manual.	- Non-conformance is investigated and corrected through CAR system.

Note:
1. Except as noted below for certain compounds, the method blank should be below ½ the reporting limit. Any exceptions shall be documented in laboratory SOPs. Concentrations up to five times the reporting limit will be allowed for the ubiquitous laboratory and reagent contaminants: methylene chloride, toluene, acetone, 2-butanone and phthalates **provided** they appear in similar levels in the reagent blank and samples. This allowance presumes that the detection limit is significantly below any regulatory limit to which the data are to be compared and that blank subtraction will not occur. For benzene and ethylene dibromide (EDB) and other analytes for which regulatory limits are extremely close to the detection limit, the method blank must be below the method detection limit.

SECTION 13. PREVENTIVE ACTION / IMPROVEMENT

13.1 Overview

The laboratory's preventive action programs improve or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive and continuous process of improvement activities that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and client satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the monthly QA Metrics Report, evaluation of internal or external audits, results & evaluation of proficiency testing (PT) performance, data analysis & review processing operations, client complaints, staff observation, etc.

The monthly Management Systems Metrics Report shows performance indicators in all areas of the laboratory and quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, ethics training, etc. These metrics are used in evaluating the management and quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-Out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process and management review.

13.1.2 Any Preventive Actions undertaken or attempted shall be taken into account during the annual Management Systems Review (Section 16). A highly detailed report is not required; however, a summary of successes and failures within the preventive action program is sufficient to provide management with a measurement for evaluation.

13.2 Management of Change

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: Facility Changes, Major Accreditation Changes, Addition or Deletion to Division's Capabilities or Instrumentation, Key Personnel Changes, Laboratory Information Management System (LIMS) changes. This process is discussed in further detail in SOP DV-QA-028P, *Management of Change.*

SECTION 14. CONTROL OF RECORDS

The laboratory maintains a records management system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 Overview

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA department in a database, which is backed up as part of the regular laboratory backup. Records are of two types; either electronic or hard copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Department Manager or their designee.

Table 14-1. Record Index[1]

	Record Types [1]:	Retention Time:
Technical Records	- Raw Data - Logbooks[2] - Standards - Certificates - Analytical Records - MDLs/IDLs/DOCs - Lab Reports	5 Years from analytical report issue*
Official Documents	- Quality Assurance Manual (QAM) - Work Instructions - Policies - SOPs - Policy Memorandums - Manuals	5 Years from document retirement date*
QA Records	- Internal & External Audits/Responses - Certifications - Corrective/Preventive Actions - Management Reviews - Method & Software Validation / Verification Data - Data Investigation	5 Years from archival* **Data Investigation:** 5 years or the life of the affected raw data storage whichever is greater (beyond 5 years if ongoing project or pending investigation)
Project Records	- Sample Receipt & COC Documentation - Contracts and Amendments - Correspondence - QAPP - SAP - Telephone Logbooks - Lab Reports	5 Years from analytical report issue*

	Record Types [1]:	Retention Time:
Administrative Records	Finance and Accounting	10 years
	EH&S Manual, Permits	7 years
	Disposal Records	Indefinitely
	Employee Handbook	Indefinitely
	Personnel files, Employee Signature & Initials, Administrative Training Records (e.g., Ethics)	Refer to HR Manual
	Administrative Policies Technical Training Records	7 years

[1] Record Types encompass hardcopy and electronic records.
[2] Examples of Logbook types: Maintenance, Instrument Run, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, Balance Calibration, Temperature (hardcopy or electronic records).
* Exceptions listed in Table 14-2.

14.1.1 All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility or the Iron Mountain data storage facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records shall be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records, electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees and shall be documented with an access log**.** Records archived off-site are stored in a secure location where a record is maintained of any entry into the storage facility. Whether on-site or off-site storage is used, logs are maintained in each storage box to note removal and return of records. Records are maintained on-site at the laboratory for at least 3 months after their generation and may be moved offsite for the remainder of the required storage time. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention shall be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have longer retention requirements and are subject to the requirements in Section 14.1.3.

14.1.2 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 14-2. Example: Special Record Retention Requirements

Program	[1]Retention Requirement
DOE	Indefinite
Drinking Water – All States	5 years (project records) 10 years - Radiochemistry (project records)
Drinking Water Lead and Copper Rule	12 years (project records)
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Housing and Urban Development (HUD) Environmental Lead Testing	10 years
Alaska	10 years
Louisiana – All	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
NY Potable Water NYCRR Part 55-2	10 years
Ohio VAP	10 years and State contacted prior to disposal
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

[1]Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.3 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hard copy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.14.1 for more information. In addition, refer to SOP DV-QA-025P, *Electronic Data Backup.*

14.1.4 The record keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data (Records stored off site should be accessible within 2 days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This shall include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory's copy of the COC is stored with the invoice and the work order sheet generated by the LIMS. The chain of custody would indicate the name of the sampler. If any sampling notes are provided with a work order, they are kept with this

package.

- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.

- The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes (e.g., set format for naming electronic files, set format for what is included with a given analytical data set per SOP DV-QA-0005, *Document Archiving Procedure*. Instrument data are stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run log or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into the LIMS for each method as required.

- Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

- The reason for a signature or initials on a document is clearly indicated in the records such as "sampled by," "prepared by," "reviewed by", or "analyzed by".

- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.

- Hard copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure that no data are lost and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard copy that was scanned. The procedure for this verification can be found in SOP DV-QA-0005, *Document Archiving Procedure*.

- Also refer to Section 19.14.1 'Computer and Electronic Data Related Requirements'**.**

14.2 Technical and Analytical Records

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement. The records for each analysis shall contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records shall include the identity of laboratory personnel responsible for the sampling, performance of each analysis and reviewing results.

14.2.2 Observations, data and calculations are recorded real-time and are identifiable to the specific task.

14.2.3 Changes to hardcopy records shall follow the procedures outlined in Section 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- laboratory sample ID code;
- Date of analysis; Time of Analysis is also required if the holding time is seventy-two (72) hours or less, or when time critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a benchsheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available.
- analysis type;
- all manual calculations and manual integrations;
- analyst's or operator's initials/signature;
- sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;
- test results;
- standard and reagent origin, receipt, preparation, and use;
- calibration criteria, frequency and acceptance criteria;
- data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;
- quality control protocols and assessment;
- electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and
- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.3 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)**;**

- a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;
- copies of final reports;
- archived SOPs;
- correspondence relating to laboratory activities for a specific project;
- all corrective action reports, audits and audit responses;
- proficiency test results and raw data; and
- results of data review, verification, and crosschecking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include but are not limited to records pertaining to:

- sample preservation including appropriateness of sample container and compliance with holding time requirement;
- sample identification, receipt, acceptance or rejection and login;
- sample storage and tracking including shipping receipts, sample transmittal / COC forms; and
- procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 Administrative Records

The laboratory also maintains the administrative records in either electronic or hard copy form. Refer to Table 14-1.

14.5 Records Management, Storage and Disposal

All records (including those pertaining to test equipment), certificates and reports are safely stored, held secure and in confidence to the client. Certification related records are available upon request.

All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

Records that are stored or generated by computers or personal computers have hard copy, write-protected backup copies, or an electronic audit trail controlling access.

The laboratory has a record management system (a.k.a., document control) for control of

laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially. All data are recorded sequentially within a series of sequential notebooks. Bench sheets are filed sequentially. Standards are maintained in the LIMS – no logbooks are used to record that data**.** Records are considered archived when noted as such in the records management system (a.k.a., document control.)

14.5.1 Transfer of Ownership

In the event that the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

14.5.2 Records Disposal

Records are removed from the archive and destroyed after 5 years unless otherwise specified by a client or regulatory requirement. On a project specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration. (Refer to Tables 14-1 and 14-2).

Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15. AUDITS

15.1 Internal Audits

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and**,** when requested**,** to corporate management.

Audits are conducted and documented as described in the TestAmerica Corporate SOP on performing internal auditing, SOP CW-Q-S-003. The types and frequency of routine internal

audits are described in Table 15-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems Audits	QA Department, QA approved designee, or Corporate QA	All areas of the laboratory annually
Method Audits	Joint responsibility: a) QA Manager or designee b) Department Manager or Designee (Refer to CW-Q-S-003)	Methods Audits Frequency: 50% of methods annually 100% of methods annually (DoD Labs)
Special	QA Department or Designee	Surveillance or spot checks performed as needed, e.g., to confirm corrective actions from other audits.
Performance Testing	Analysts with QA oversight	Two successful per year for each TNI field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, TestAmerica's Data Integrity and Ethics Policies, TNI quality systems, client and state requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to data review, quality controls, preventive action and corrective action. The completeness of earlier corrective actions is assessed for effectiveness & sustainability. The audit is divided into sections for each operating or support area of the lab, and each section is comprehensive for a given area. The area audits may be performed on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, electronic audit miner programs (e.g., MintMiner and Chrom AuditMiner) used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits will include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs will be assessed by the Technical Manager or qualified designee at least every two years. It is also recommended that the work of each newly hired analyst is assessed within 3 months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products will be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies: Drinking Water (WS), Nonpotable Water (WP), Soil, Underground Storage Tank (UST).

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 External Audits

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory supervisors are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2009 TNI standards.

15.3 Audit Findings

Audit findings are documented using the corrective action process and database. The laboratory's corrective action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must be set and agreed to by operations management and the QA Manager.

Developing and implementing corrective actions to findings is the responsibility of the Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. When requested, a copy of the audit report and the labs corrective action plan will be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory shall take timely corrective action, and shall notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24-hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16. MANAGEMENT REVIEWS

16.1 Quality Assurance Report

A comprehensive QA Report shall be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director, their Quality Director as well as the General Manager.

All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director, General Manager or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2 Annual Management Review

The senior lab management team (Laboratory Director, Technical Managers, QA Manager) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining goals, objectives and action items that feed into the laboratory planning system. Corporate Operations and Corporate QA personnel are to be included in this meeting at the discretion of the Laboratory Director. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory will summarize any critical findings that cannot be solved by the lab and report them to Corporate IT.

This management systems review (Corporate SOP CA-Q-S-004 & Work Instruction CA-Q-WI-003) uses information generated during the preceding year to assess the “big picture” by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective, therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review.
- Issues from prior Monthly QA Reports.
- Laboratory QA Metrics.
- Review of report reissue requests.
- Review of client feedback and complaints.
- Issues arising from any prior management or staff meetings.
- Minutes from prior senior lab management meetings. Issues that may be raised from these meetings include:
    - Adequacy of staff, equipment and facility resources.
    - Adequacy of policies and procedures.
    - Future plans for resources and testing capability and capacity.
- The annual internal double blind PT program sample performance (if performed).
- Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity.

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and the Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants.
- A reference to the existing data quality related documents and topics that were reviewed.
- Quality system or operational changes or improvements that will be made as a result of the review [e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)].

Changes to the quality systems requiring update to the laboratory QA Manual shall be included in the next revision of the QA Manual.

16.3 Potential Integrity Related Managerial Reviews

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/Recall SOP shall be followed (SOP CW-L-S-002). All investigations that result in a finding of inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's VP of Quality, Technical and Operations Support, General Managers and Quality Directors receive a monthly report from the Director of Quality & EH&S summarizing any current data integrity or data recall investigations. The General Manager's are also made aware of progress on these issues for their specific labs.

SECTION 17. PERSONNEL

17.1 Overview

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training shall have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff shall be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of

experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training shall be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 Education and Experience Requirements for Technical Personnel

The laboratory makes every effort to hire analytical staffs that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet site's Human Resources web-page (Also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc., are also considered).

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
GFAA, CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least 1 year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	or 5 years of prior analytical experience

Specialty	Education	Experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience Or 5 years of prior analytical experience
Technical Managers– **General**	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Managers – **Wet Chem** only (no advanced instrumentation)	Associates degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Technical Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 Training

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame	Employee Type
Environmental Health & Safety	Prior to lab work	All
Ethics – New Hires	1 week of hire	All
Ethics – Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All

Required Training	Time Frame	Employee Type
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in the training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics is maintained in their training file.
- Documentation of proficiency (refer to Section 19).
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training.
- A Confidentiality Agreement signed by each staff member signed at the time of employment.
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct (e.g., ethics violations). This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts knowledge to refer to QA Manual for quality issues.
- Analysts following SOPs, i.e., practice matches SOPs.
- Analysts regularly communicate to supervisors and QA if SOPs need revision, rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP DV-QA-0024.

17.4 Data Integrity and Ethics Training Program

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within 1 week of hire followed by technical data integrity training within 30 days, comprehensive

training within 90 days, and an annual refresher for all employees. Senior management at each facility performs the ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times; TestAmerica has established a Corporate Ethics Policy (Policy CW-L-P-004 and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts, and for that reason, TestAmerica has a Zero Tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting.
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping.
- Discussion regarding data integrity procedures.
- Specific examples of breaches of ethical behavior (e.g. peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion)
- Internal monitoring. Investigations and data recalls.
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution.
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient.

Additionally, a data integrity hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

18.1 Overview

The laboratory is a 54,000 ft^2 secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc., OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, microbiological sample analysis, and administrative functions.

18.2 Environment

Laboratory accommodation, test areas, energy sources, and lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing will be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 Work Areas

There is effective separation between neighboring areas when the activities therein are incompatible with each other such as:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to and use of all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory. Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory.
- Sample receipt areas.
- Sample storage areas.
- Chemical and waste storage areas.
- Data handling and storage areas.
- Sample processing areas.
- Sample analysis areas.

18.4 Floor Plan

A floor plan can be found in Appendix 1.

18.5 Building Security

Building keys and alarm codes are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor's logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed. Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

SECTION 19. TEST METHODS AND METHOD VALIDATION

19.1 Overview

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 Standard Operating Procedures (SOPS)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP entitled 'Writing a Standard Operating Procedure', CW-Q-S-002 or the laboratory's SOP DV-QA-001P.
- SOPs are reviewed at a minimum of every 2 years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 Laboratory Methods Manual

For each test method, the laboratory shall have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory shall demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 Selection of Methods

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists), the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods shall be used.

When clients do not specify the method to be used or methods are not required, the methods used will be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)*
- *Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.*
- *Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.*
- *Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.*
- *Methods for the Determination of Organic Compounds in Drinking Water, EPA-600/4-88-039, December 1988, Revised, July 1991, Supplement I, EPA-600-4-90-020, July 1990, Supplement II, EPA-600/R-92-129, August 1992. Supplement III EPA/600/R-95/131 - August 1995 (EPA 500 Series) (EPA 500 Series methods)*
- *Technical Notes on Drinking Water Methods, EPA-600/R94-173, October 1994*

- *Statement of Work for Inorganics & Organics Analysis, SOM and ISM, current versions, USEPA Contract Laboratory Program Multi-media, Multi-concentration.*
- *Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th/ on-line edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.*
- *Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.*
- *Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.*
- *National Status and Trends Program, National Oceanographic and Atmospheric Administration, Volume I-IV, 1985-1994.*
- *Manual for the Certification of Laboratories Analyzing Drinking Water (EPA 815-R-05-004, January 2005)*
- *Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261*

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory shall inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it will be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

A demonstration of capability (DOC, SOP DV-QA-0024) is performed whenever there is a change in instrument type (e.g., new instrumentation), method or personnel (e.g., analyst hasn't performed the test within the last 12 months).

The initial demonstration of capability must be thoroughly documented and approved by the Technical Director and QA Manager prior to independently analyzing client samples. All

associated documentation must be retained in accordance with the laboratories archiving procedures.

The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).
- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted: *Reporting Limit based on the low standard of the calibration curve.*

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 Refer to SOP DV-QA-0024, Training.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

A certification statement (refer to Figure 19-1 as an example shall be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst's training folder.

Methods on line prior to the effective date of this Section shall be updated to the procedures outlined above as new analysts perform their demonstration of capability. A copy of the new record will replace that which was used for documentation in the past. At a minimum, the precision and accuracy of four mid-level laboratory control samples must have been compared to the laboratory's quality control acceptance limits.

19.5 Laboratory Developed Methods and Non-Standard Methods

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and

the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 Validation of Methods

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities are required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method. For example for GC methods a confirmation analysis must be performed using a different column. This would not be necessary for mass spectrometry methods.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the

analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data are to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria. An example of this would be to run various spike levels across the calibration range to verify acceptable accuracy and precision.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS, method blanks or PT samples.

19.7 Method Detection Limits (MDL) / Limits of Detection (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements. Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the

calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL.

Refer to the Corporate SOP CA-Q-S-006 or the laboratory's SOP DV-QA-005P *Determination of Method Detection Limits*, for details on the laboratory's MDL process.

19.8 Instrument Detection Limits (IDL)

The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either using 7 replicate spike analyses, like MDL but without sample preparation, or by the analysis of 10 instrument blanks and calculating 3x the absolute value of the standard deviation.

If the IDL is > than the MDL, it may be used as the reported MDL.

19.9 Verification of Detection and Reporting Limits

Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL or perform and pass two consecutive MDLVs at a higher concentration and set the LOD at the higher concentration. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. Refer to the laboratory SOP DV-QA-005P, *Determination of Method Detection Limits* for further details.

The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 Retention Time Windows

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis or as specific in the reference method, each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept with the files associated with an instrument for later quantitation of the analytes. Complete details are available in the laboratory SOPs.

19.11 Evaluation of Selectivity

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, spectrochemical, atomic absorption or fluorescence profiles, co-precipitation evaluations and specific electrode response factors.

19.12 Estimation of Uncertainty of Measurement

19.12.1 Uncertainty is "a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand" (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result's validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an "expanded uncertainty": the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor k=2.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent uncertainties at approximately the 99% confidence level with a coverage factor of k = 3. As an example, for a reported result of 1.0 mg/l with an LCS recovery range of 50 to 150%, the estimated uncertainty in the result would be 1.0 +/- 0.5 mg/l.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement (e.g., 524.2, 525, etc.) and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 Sample Reanalysis Guidelines

Because there is a certain level of uncertainty with any analytical measurement, a sample re-preparation (where appropriate) and subsequent analysis (hereafter referred to as 'reanalysis') may result in either a higher or lower value from an initial sample analysis. There are also variables that may be present (e.g., sample homogeneity, analyte precipitation over time, etc.) that may affect the results of a reanalysis. Based on the above comments, the laboratory will reanalyze samples at a client's request with the following caveats.

Note: Client specific Contractual Terms & Conditions for reanalysis protocols may supersede the following items.

- Homogenous samples: If a reanalysis agrees with the original result to within the RPD limits for MS/MSD or Duplicate analyses, or within $\pm$ 1 reporting limit for samples $\leq$ 5x the reporting limit, the original analysis will be reported. At the client's request, both results may be reported on the same report but not on two separate reports.

- If the reanalysis does not agree (as defined above) with the original result, then the laboratory will investigate the discrepancy and reanalyze the sample a third time for confirmation if sufficient sample is available.

- Any potential charges related to reanalysis are discussed in the contract terms and conditions or discussed at the time of the request. The client will typically be charged for reanalysis unless it is determined that the lab was in error.

- Due to the potential for increased variability, reanalysis may not be applicable to Non-homogenous, Encore, and Sodium Bisulfate preserved samples. See the Area Supervisor or Laboratory Director if unsure.

19.14 Control of Data

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.14.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. More detail is outlined in SOP DV-QA-017P, *Electronic Reporting*. The laboratory is currently running the TestAmerica Laboratory Information Management System which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes Sequel Server which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.14.1.1 **Maintain the Database Integrity:** Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use. Cells containing calculations must be lock-protected and controlled.
- Instrument hardware and software adjustments are safeguarded through maintenance logs, audit trails and controlled access.

19.14.1.2 **Ensure Information Availability:** Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.14.1.3 **Maintain Confidentiality:** Ensure data confidentiality through physical access controls such as password protection or website access approval when electronically transmitting data.

19.14.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the Department Manager or alternate analyst prior to updating the data in LIMS. The data review checklists, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, *Acceptable Manual Integration Practices*. and TestAmerica Denver SOP DV-QA-011P, *Acceptable Manual Integration Practices*.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it should not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.14.2.1 All raw data must be retained in the batch folder and batch file in LIMS. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.14.2.2 In general, concentration results are reported in milligrams per liter (mg/L) or micrograms per liter (µg/L) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg) for solids. For values greater than 10,000 mg/L, results can be reported in percent, i.e., 10,000 mg/L = 1%**.** Units are defined in each lab SOP.

19.14.2.3 In reporting, the analyst or the instrument output records the raw data result using values of known certainty plus one uncertain digit. If final calculations are performed external to LIMS, the results should be entered in LIMS with at least three significant figures. In general, results are reported to 2 significant figures on the final report. Refer to DV-QA-004P, *Rounding and Significant Figures* for details regarding the number of significant figures to report for each step in the process.

19.14.2.4 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. When this is not possible the data is entered into a logbook which becomes part of the raw data. LIMS has a defined significant figure criterion for each analyte.

19.14.2.5 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst reviews the values in LIMS against the raw results to check for errors. The instrument's calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the batch file in LIMS. In addition, the data file is stored in a monthly folder on the instrument computer; periodically, this file is transferred to the server and, eventually, to a tape file.

19.14.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out 'real time' and have enough information on them to trace the events of the applicable analysis/task. (e.g. calibrations, standards, analyst, sample

ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.)

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA department. A record is maintained of all logbooks in the lab.
- Unused portions of pages must be "Z"'d out, signed and dated.
- Worksheets are created with the approval of the Technical Director/QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.14.4 Review / Verification Procedures

Review procedures are outlined in several SOPs (e.g. DV-QA-0003, *Sample Management and Chain of Custody*, DV-QA-0020, *Data Review*, and DV-QA-0022, *Data Package Assembly),* to ensure that reported data are free from calculation and transcription errors, that QC parameters have been reviewed and evaluated before data is reported. The laboratory also has an SOP discussing Manual Integrations to ensure the authenticity of the data DV-QA-011P, *Acceptable Manual Integration Practices*. The general review concepts are discussed below, more specific information can be found in the SOPs.

19.14.4.1 The data review process at the laboratory starts at the Sample Control level. Sample Control personnel review chain-of-custody forms and input the sample information and required analyses into a computer LIMS. The Sample Control Supervisor reviews the transaction of the chain-of-custody forms and the inputted information. The Project Managers perform final review of the chain-of-custody forms and inputted information.

19.14.4.2 The next level of data review occurs with the Analysts. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The Analysts transfer the data into the LIMS and add data qualifiers if applicable. To ensure data compliance, a different analyst performs a second level of review. Second level review is accomplished by checking reported results against raw data and evaluating the results for accuracy. During the second level review, blank runs, QA/QC check results, initial and continuing calibration results, laboratory control samples, sample data, qualifiers and spike information are evaluated. Where calibration is not required on a daily basis, secondary review of the initial calibration results may be conducted at the time of calibration. Approximately 15% of all sample data from manual methods and from automated methods, all GC/MS spectra and all manual integrations are reviewed. Manual integrations are also electronically reviewed utilizing auditing software to help ensure compliance to ethics and manual integration policies. Issues that deem further review include the following:

- QC data are outside the specified control limits for accuracy and precision
- Reviewed sample data does not match with reported results
- Unusual detection limit changes are observed

- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration
- Transcription errors
- Results outside of calibration range

19.14.4.3 Unacceptable analytical results may require reanalysis of the samples. Any problems are brought to the attention of the Laboratory Director, Project Manager, Quality Assurance Manager, Operations Manager, or Department Manager for further investigation. Corrective action is initiated whenever necessary.

19.14.4.4 The results are then entered or directly transferred into the computer database and a hard copy (or .pdf) is printed for the client.

19.14.4.5 As a final review prior to the release of the report, the Project Manager reviews the results for appropriateness and completeness. This review and approval ensures that client requirements have been met and that the final report has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, COC is followed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

19.14.4.6 Any project that requires a data package is subject to a tertiary data review for transcription errors and acceptable quality control requirements. The Project Manager then signs the final report. The accounting personnel also check the report for any clerical or invoicing errors. When complete, the report is sent out to the client.

19.14.4.7 A visual summary of the flow of samples and information through the laboratory, as well as data review and validation, is presented in Figure 19-2.

19.14.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002) as the guideline for our internal SOP DV-QA-011P, entitled *Acceptable Manual Integration Practices.*

19.14.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.14.5.2 Analysts shall not increase or decrease peak areas for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.14.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.14.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale “after” chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale “before” chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Analysts Name
Date

SOP Number
Method Name
Method Number
Analysis / Extraction – Waters

We the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the TestAmerica Quality Assurance Manual, has met the Initial or Ongoing Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification following the TestAmerica SOP and source method.
3. A copy of the laboratory-specific SOP and source method is available for all personnel on-site. These documents have been reviewed by the analyst as part of this Demonstration of Capability.
4. The data associated with the initial/ongoing demonstration of capability are true, accurate, complete and self-explanatory (*). These data are attached to this certification statement.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

Comments/Observations:

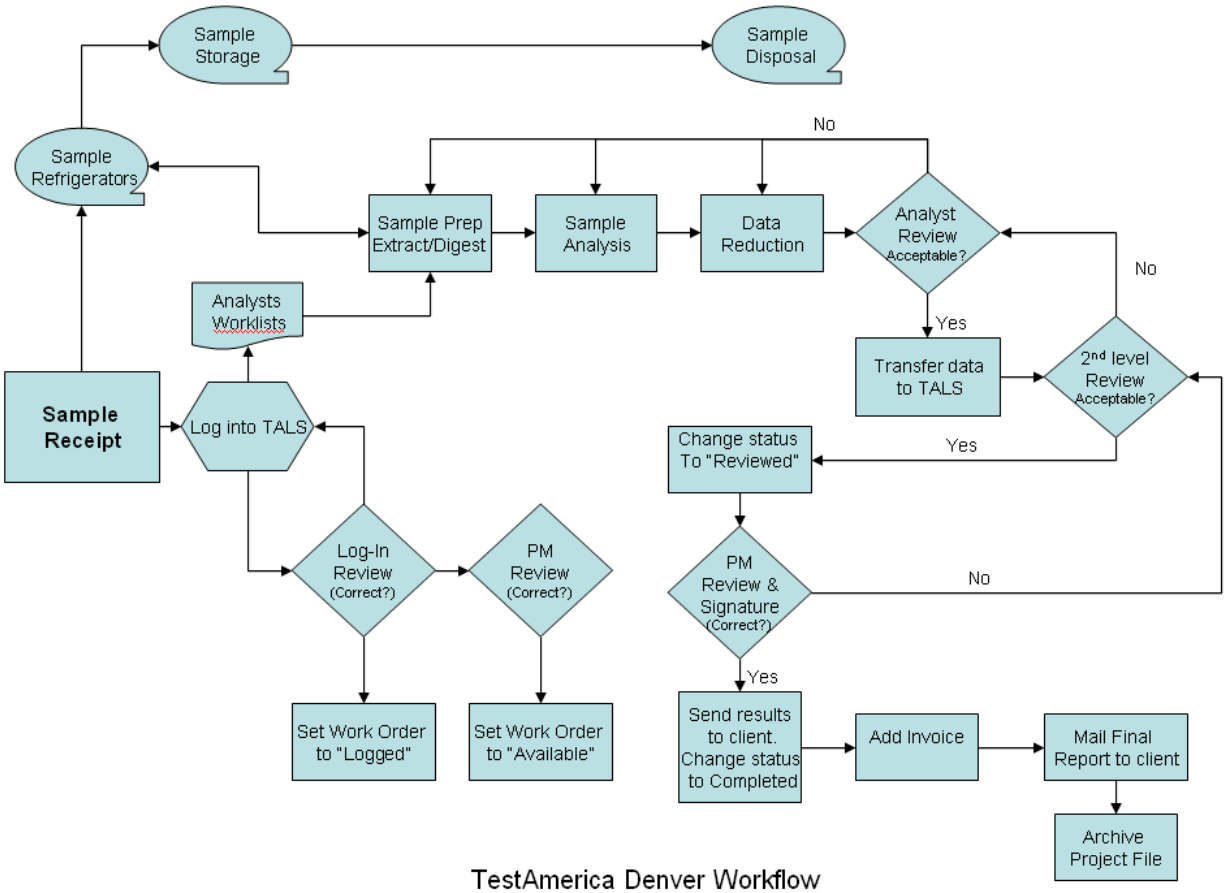
Analyst's Name Signature & Date

Operations Manager's Name Signature & Date

QA Manager's Name Signature & Date

** True: Consistent with supporting data.*
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are traceable and require no additional explanation.
Revision 2 5/9/2013

Figure 19-2. Example: Work Flow



SECTION 20. EQUIPMENT AND CALIBRATIONS

20.1 Overview

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers' instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 Preventive Maintenance

The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

Routine preventive maintenance procedures and frequency, such as cleaning and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Department Manager to ensure that instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures may be/are also outlined in analytical SOPs or instrument manuals. (Note: for some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs shall be kept for all major pieces of equipment. Instrument maintenance logs may also be used to specify instrument parameters.

- Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.
- Each entry in the instrument log includes the Analyst's initials, the date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or

maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control. e.g. CCV run on *'date'* was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

- When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled in page must be signed across the page entered and the logbook so that it is clear that a page is missing if only half a signature is found in the logbook.

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it shall be taken out of operation and tagged as out-of-service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory shall examine the effect of this defect on previous analyses.

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Back up instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the back up is not available and the analysis cannot be carried out within the needed timeframe, the samples shall be subcontracted.

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 Support Equipment

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, thermal/pressure sample preparation devices and volumetric dispensing devices if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM type 1 weights spanning its range of use (weights that have been calibrated to ASTM type 1 weights may also be used for daily verification). ASTM type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually

and if no damage is observed, they are calibrated at least every 5 years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Refer to SOP DV-QA-0014, *Balance Calibration Check*.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer at temperatures bracketing the range of use. IR thermometers, digital probes and thermocouples are calibrated quarterly. IR Thermometers should be calibrated over the full range of use, including ambient, iced (4 degrees) and frozen (0 to -5 degrees), per the Drinking Water Manual.

The mercury NIST thermometer is recalibrated every five (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logbooks. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logbooks. More information on this subject can be found in SOP DV-QA-0001, *Thermometer Calibration Procedure*.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored 7 days a week.

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between > 0ºC and ≤ 6 ºC.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logbooks and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware and Glass microliter syringes) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

For those dispensers that are not used for analytical measurements, a label is / can be applied to the device stating that it is not calibrated. Any device not regularly verified cannot be used for any quantitative measurements. Refer to an SOP DV-QA-0008, *Calibration and Verification of Mechanical Pipettes.*

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. Syringes are verified for syringe sizes of ≥ 100 µL are verified. Details are in DV-QA-0008.

20.4 Instrument Calibrations

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, corrective action is performed and any affected samples are reanalyzed if possible. If the reanalysis is not possible, any data associated with an unacceptable initial calibration will be reported with appropriate data qualifiers (refer to Section 12).

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 Calibration Standards

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP. If a reference method does not specify the number of calibration standards, a minimum of 3 calibration points (exception being ICP and ICP/MS methods) will be used.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to at least the same number of significant figures used to report the data) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst at a different time or a different preparation would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.1.1 Calibration Verification

The calibration relationship established during the initial calibration must be verified initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and in the 2009 TNI Standard. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models. Initial calibration verification is with a standard source secondary

(second source standard) to the calibration standards, but continuing calibration verifications may use the same source standards as the calibration curve.

Note: The process of calibration verification referred to here is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met, i.e., RPD, per 2009 TNI Std. EL-V1M4 Sec. 1.7.2.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample, QC, or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after ever 10 samples or injections, including matrix or batch QC samples.

Note: If an internal standard calibration is being used (e.g., GC/MS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

If the results of a CCV are outside the established acceptance criteria and analysis of a second consecutive (and immediate) CCV fails to produce results within acceptance criteria, corrective action shall be performed. Once corrective actions have been completed & documented, the laboratory shall demonstrate acceptable instrument/method performance by analyzing two consecutive CCVs, or a new initial instrument calibration shall be performed.

Sample analyses and reporting of data may not occur or continue until the analytical system is calibrated or calibration verified. However, data associated with an unacceptable calibration verification may be fully useable under the following special conditions:

a) When the acceptance criteria for the CCV are exceeded high (i.e., high bias) and the associated samples within the batch are non-detects, then those non-detects may be reported with a footnote or case narrative explaining the high bias. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted; or

b) When the acceptance criteria for the CCV are exceeded low (i.e., low bias), those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable CCV shall be re-analyzed after a new calibration curve has been established, evaluated and accepted.

Samples reported by the two conditions identified above will be appropriately flagged.

20.4.1.2 Verification of Linear and Non-Linear Calibrations

Calibration verification for calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs. Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

- When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

- When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. Alternatively, a reporting limit standard may be analyzed to demonstrate that the laboratory can still support non-detects at their reporting limit.

20.5 Tentatively Identified Compounds (TICs) – GC/MS Analysis

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this type of identification will be determined by the purpose of the analyses being conducted. Data

system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS Tuning

Prior to any GC/MS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Example: Instrumentation List

TestAmerica Denver Instrument List

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
ICP	Thermo Fischer (025)	ICP 6500	S/N 20090307	2006	6010, 200.7
ICP	Thermo Fischer (026)	ICP 6500	S/N 20063207	2006	6010, 200.7
ICP/MS	Agilent ICP-MS (024)	7500 Series	S/N JP51201530	2006	6020, 200.8
ICP/MS	Agilent ICP-MS (077)	7700 Series	S/N JP09320047	2009	6020, 200.8
Mercury Analyzer	Cetac CVAA (033)	M-7500	S/N 08092QTA	2010	7470, 7471, 245.1
Mercury Analyzer	Cetac CVAA (034)	M-7500	S/N 0021105QTA	2011	7470, 7471, 245.1
Graphite Furnace	Perkin Elmer GFAA (MT_035)	AAnalyst 600	S/N 601S2030105	2013	939M
Ion Chromatograph	Dionex (IC3)	DX-120	S/N 98040510	2003	300.0, 9056, 9056A
Ion Chromatograph	Dionex (IC4)	AS 50	S/N 056537	2000	Hydrazine, MMH, UDMH
Ion Chromatograph	Dionex (IC5)	LC 20	S/N 0106180	2002	314.0
Ion Chromatograph	Dionex (IC6)	ICS 2000	S/N 03100162/03100118	2003	300.0, 9056, 9056A
Ion Chromatograph	Dionex (IC7)	ICS 2000	S/N 03100161/03100122	2003	300.0, 9056, 9056A
Ion Chromatograph	Dionex (IC8)	ICS 2000 RFIC	S/N 08020954/08020762	2008	300.0, 9056, 9056A
Ion Chromatograph	Dionex (IC9)	ICS 3000	S/N 08020888	2008	Hydrazine, MMH, UDMH
Ion Chromatograph	Metrohm (IC10)	881 Compact IC	S/N 1881000124128	2012	300.0, 9056, 9056A
TOC	LECO (LEC)	C632 (Solid)	S/N 3097	2007	9060, 5310B
TOC	Shimadzu (SHI3)	TOC-VCPN	S/N H51404335027	2005	415.1, 9060, 5310B
TOC	Shimadzu (SHI2)	TOC-VCSH	S/N 414445340	2008	415.1, 9060, 5310B
TOX	Thermo Euroglass (Thermo 2)	ECS 1200	S/N 2004.119/ 2008.28	2008	9020, 9021, 9023

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
TOX	Thermo Scientific (Thermo 3)	ECS 1200	S/N 993728/ 2008.28	2004	9020, 9021, 9023
UV/VIS	Alpkem (Alp2)	A002393	S/N 908893427/ 906850834	1997	325.2, CN, Phenol
UV/VIS	Alpkem (Alp1)	A002393	S/N 917893398/ 912850458	1997	350.1, 353.2
UV/VIS	Alpkem (ALP3)	Flow Solution 3000	S/N 632-1010-49/60092	2010	350.1
UV/VIS	Konelab	Model 20	S/N P0518697	2003	365.1, 420.1
UV/VIS	Astoria Pacific Analyzer	Astoria 2	S/N 200052	2005	351.2, 353.2, 365.1, 365.1_LL
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT2)	PC – Titrate / PC-1000	S/N MS-0D0-240	2000	9040, 9045, 2320B, 2510B, 9050A
Autotitrator (pH, Alkalinity, Conductance)	Man-Tech (AT3)	PC – Titrate / PC-1000	S/N MS-0A9-546	2011	9040, 9045, 2320B, 2510B, 9050A
pH Meter	ThermoScientific	Orion 5 Star	S/N B27854	2012	9040, 9045, 4500-H B
pH Meter	ThermoScientific	Orion 3 Star	S/N B15566	2009	2320B, 2310B
Conductivity Meter	YSI	YSI 3200-115V	S/N 02G0765 AF	2009	Not in Use
Conductivity Meter	Orion	Orion 160	S/N 42536014	1985	2510B, 9050A
Dissolved Oxygen Meter	YSI	5100	S/N 08D100984	2008	Not in Use
Dissolved Oxygen Meter	YSI	5100	S/N 02G0238	2008	405.1, 5210B
Turbidimeter	HF Scientific (TB2)	Micro 100	S/N 104008	2001	180.1
Flashpoint	Herzog Pensky Martens	Model MP-329	S/N 43291648	2003	1010, 1010A
Spectrophotometer	HACH	DR/2010	S/N 990200012321	2007	410.4, 7196A, 3500 Fe D, 3500 Cr B, 4500S-2 D, 420.1
Spectrophotometer	Genysys	Genysys 20	SN: 3SGP171002	2011	410.4, 7196A, 3500 Fe D, 3500 Cr B, 4500S-2 D, 420.1
TCLP - pH Meter	Thermo Orion	SA720	S/N TVT71A	2005	1311, 1312
GC/MS Semivolatiles	Hewlett-Packard (B)	6890 – GC 5973 - MSD	S/N US00007283 S/N US70820578	1999	8270, 625

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
GC/MS Semivolatiles	Hewlett-Packard (D)	6890 – GC 5973 – MSD	S/N US00007319 S/N US70820578	1996	8270, 625
GC/MS Semivolatiles	Agilent Technologies (F)	6890 – GC 5973N – MSD	S/N US00036181 S/N US02480180	1996	8270 SIM
GC/MS Semivolatiles	Agilent Technologies (K)	6890N – GC 5973 – MSD	S/N CN10332028 S/N US33266011	2003	8270, 8270 SIM, 625
GC/MS Semivolatiles	Agilent Technologies (GCMS6)	7890A – GC 5975C inert XL w/ triple Axis Detector	S/N CN10933128 S/N US92033627	2010	8270
GC/MS Semivolatiles	Agilent Technologies (G4)	6890N – GC 5973 Inert – MSD	S/N CN10438087 S/N US43120937	2004	8270 Best Practice
GC/MS Semivolatiles	Agilent Technologies (X4)	6890N – GC 5973 inert – MSD	S/N CN10438076 S/N US43120927	2004	8270, 625
GC/MS Semivolatiles	Hewlett-Packard (Y)	6890 – GC 5973 – MSD	S/N US00007291 S/N US70820572	1996	8270, 625
GC/MS Semivolatiles	Hewlett-Packard (B2)	6890 – GC 5973 – MSD	S/N US00010475 S/N US7820578	2013	8270, 8270 SIM, 625
GC/MS Semivolatiles	Agilent Technologies (GCMS5)	6890N – GC 5975 – MSD	S/N CN10605078 S/N US60532282	2006	8270, 625
GC/MS Semivolatiles	Agilent Technologies (MSS_01)	7890A – GC 5975 – MSD	S/N CN11351161 S/N US11353905	2011	8270, 625
GC/MS Volatiles	Agilent Technologies (C) O·I Analytical	6890N – GC 5973 – MSD 4552 - Purge & Trap 4660 Concentrator	S/N US00007315 S/N US70820571 S/N 14049 S/N A344466379E	2002	8260
GC/MS Volatiles	Agilent Technologies (E) O·I Analytical	6890 – GC 5973 – MSD 4552 - Purge & Trap 4660 – Concentrator	S/N-US00029543 S/N –US93122910 S/N - 13442 S/N – G116466985P	2011	8260
GC/MS Volatiles	Hewlett-Packard (H) O·I Analytical	5890II – GC 5972 – MSD 4552 – Purge & Trap 4660 – Concentrator	S/N 3336A60700 S/N 3524A03013 S/N 14383 S/N A3444663771	1994	8260-Water
GC/MS Volatiles	Hewlett Packard (P) O·I Analytical	6890 - GC 5973 – MSD 4552 – Purge & Trap 4660 - Concentrator	S/N US00007321 S/N US70820566 S/N 14377 S/N C509466078P	1997	8620, 624
GC/MS Volatiles	Hewlett-Packard (G) Varian OI Analytical	5890 Series II - GC 5972 – MSD Archon Purge & Trap O•I 4560 - Concentrator	S/N 3336A56276 S/N 3435A01850 S/N 12751 S/N 1913460964	1996	8260
GC/MS Volatiles	Hewlett-Packard (J) Hewlett Packard Varian O•I Analytical	5890 II Series - GC 5972 - MSD Archon Purge & Trap 4560 - Concentrator	3336A60701 3524A03016 3524A03016 D308367	1994	8260
GC/MS Volatiles	Agilent Technologies (R1) O•I Analytical	6890N - GC 5973 Inert – MSD 4552 – Purge & Trap 4660 – Concentrator	CN10524033 US52420237 14043 A344466372B	1994	8260, 624
GC/MS Volatiles	Hewlett-Packard (R2) O·I Analytical	5890II - GC 5972 – MSD 4552 – Purge & Trap 4660 – Concentrator	S/N 336A53965 S/N 3501A02273 S/N 14052 S/N C509466077E	1995	8260, 624

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
GC/MS Volatiles	Hewlett-Packard (Z) O·I Analytical	5890II – GC 5972 – MSD Archon Purge & Trap O•I 4660 – Concentrator	S/N 3336A60013 S/N 352AA02693 S/N C429411174 S/N G109466777	1996	8260
GC/MS Volatiles	Agilent Technologies (GCMS1) O·I Analytical	6890N – GC 5973 – MSD 4552 – Purge & Trap 4660 – Concentrator	S/N CN10420009 S/N US35120257 S/N 14593 S/N C509466077P	2004	8260, 624
GC/MS Volatiles	Agilent Technologies (G2) Varian	6890N – GC 5973 – MSD Archon Purge & Trap O•I 4660 – Concentrator	S/N CN10421078 S/N GS36120303 S/N MS0902W012 S/N 19374669269	2004	8260
GC/MS Volatiles	Hewlett-Packard (Q) Varian OI Analytical	6890 – GC 5973 – MSD Archon Purge & Trap O•I 4560 – Concentrator	S/N US0000021949 S/N US72810801 S/N 12750 S/N H216466454P	2001	8260
GC/MS Volatiles	Agilent Technologies (GCMS7) OI Analytical	6890N – GC 5975B – MSD Archon 4552 Eclipse 4660	S/N US10229109 S/N US60522608 S/N 14212 B428466805P	2012	8260, 624
GC/MS Volatiles	Hewlett-Packard (I) Tekmar Dohrmann	5890 – GC 7000 – Headspace Autosampler 7000 - Autosampler Tray	S/N 2643A11361 S/N US03038002 S/N US03045009	2003	Volatile Screening
GC/MS Volatiles	Hewlett-Packard (T) Tekmar Dohrmann	5890 Series II – GC 7000HT Headspace 7000HT Autosampler	S/N 2750A14928 S/N US01198005 S/N US01281004	2001	Volatile Screening
GC/MS Volatiles	Hewlett-Packard (GCMS8) O·I Analytical	HP6890 HP5973 4552 –Autosampler 4560 –Purge & Trap	S/N US0006567 S/N US63810338 S/N 11958-696A S/N M934460860	2013	8260
GC Semivolatiles	Hewlett-Packard (A)	5890 Dual FID	S/N 2750A16891	1987	8015 Alcohols
GC Semivolatiles	Hewlett-Packard (C)	6890 Dual ECD	S/N US00029514	1999	608, 8081
GC Semivolatiles	Hewlett-Packard (D)	6890 Dual NPD	S/N DE00020818	1997	614, 8141
GC Semivolatiles	Agilent Technologies (D2)	6890N Dual NPD	S/N US10521035	2004	614, 8141
GC Semivolatiles	Hewlett-Packard (E)	5890II Dual ECD	S/N 3121A35858	1992	504.1, 8011
GC Semivolatiles	Hewlett-Packard (M)	6890 Dual ECD	S/N US00024143	1999	615, 8151
GC Semivolatiles	Agilent Technologies (P1)	6890N Dual ECD	S/N US10418019	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P2)	6890N Dual ECD	S/N US10418024	2004	608, 8081
GC Semivolatiles	Agilent Technologies (P3)	6890N Dual ECD	S/N US10418023	2004	608, 8082
GC Semivolatiles	Hewlett-Packard (R)	5890II Dual ECD	S/N 3336A55030	1994	Not in Use
GC Semivolatiles	Hewlett-Packard (U)	5890II Single FID	S/N US00063217	1999	8015 DRO
GC Semivolatiles	Agilent (U2)	7890A Dual FID	S/N CN10942072	2009	8015 DRO

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
GC Semivolatiles	Hewlett-Packard (V)	5890 Dual ECD	S/N 2631A08686	1990	615, 8151
GC Semivolatiles	Hewlett-Packard (W)	5890II Dual ECD	S/N 3126A36250	1990	608, 8082
GC Semivolatiles	Hewlett-Packard (Z2)	5890II Dual FID	S/N 3336A51924	1990	Glycols
GC Volatiles	Hewlett-Packard (B) Tekmar Dohrmann	5890 Series II Dual PID/FID LSC 2000 Concentrator ALS 2016 Purge & Trap	S/N 3019A28634 S/N 90142014 S/N 89108007	1990	8021 GRO
GC Volatiles	Hewlett-Packard (J) Tekmar Dohrmann	6890 Dual FID HS Autosampler 7000 HS Autosampler 7000 HT	S/N US00026194 S/N US02296006 S/N US02296004	1997	RSK-175
GC Volatiles	Hewlett-Packard (K) Tekmar Dohrmann	5890A Dual PID Single FID LSC 2000 Concentrator ALS 2016 Purge & Trap	S/N 2843A19497 S/N 92098003 S/N 92101007	1988	8015, 8021 Aromatics, 8021 GRO
GC Volatiles	Hewlett-Packard (L) Tekmar Dohrmann	5890A FID LSC 2000 Concentrator ALS 2016 Purge & Trap ALS 2032 Purge & Trap	S/N 2336A00164 S/N 89283001 S/N 90121028 S/N 94300004	1988	8015 GRO
GC Volatiles	Hewlett-Packard (P) Tekmar Dohrmann	5890A Dual PID Single FID LSC 2000 Concentrator ALS 2016 Purge & Trap	S/N 2518A05337 S/N 89310005 S/N 90100036	1990	8021
GC Volatiles	Agilent Technologies (S-1) O I Analytical	6890 Dual PID/ Dual ELCD 4552 – Purge & Trap 4660 – Concentrator	S/N US10341120 S/N 14046 S/N 343466333P	2003	8021
GC Volatiles	Hewlett-Packard (Y) Tekmar Dohrmann	5890A PID/FIDLSC 3000 Concentrator ALS 2016 Purge & Trap ALS 2032 Purge & Trap	S/N 2843A19484 S/N 93132006 S/N 88145006 S/N 91112002	1988	Screening
GC Volatiles	Agilent (Q) OI Corporation	7890A Dual PID Dual FID 4660 Concentrator 4552 Autosampler	S/N CN12161119 S/N H216466450P S/N US12090001	2012	8015 GRO, AK101
HPLC	Hewlett-Packard (G)	Multiple wavelength UV Detector G1365A Fluorescence detector G1321A Quarternary Pump G1311A	S/N DE91600240 S/N DE92001251 S/N DE91606289	1999	8310

Equipment/ Instrument	Manufacturer	Model Number	Serial Number	Year Put into Service	Method Performed
HPLC	Agilent Technologies (G2)	UV Diode Array Detector G1315B Fluorescence detector G1321A Binary Pump G1321A	S/N DE11112694 S/N DE40506039 S/N US83105106	2011	8310, 8330
HPLC	Agilent Technologies (Q)	UV Multiple wavelength detector 1365B Quarternary Pump G1311A	S/N DE11101025 S/N DE11114412	2001	8310
HPLC	Agilent Technologies (X3)	UV Diode Array Detector G1315B Fluorescence detector G1321A Quarternary Pump G1311A	S/N DE23917239 S/N DE33205520 S/N DE33224364	2004	8330
HPLC	Agilent Technologies (X4)	UV Multiple wavelength detector 1365B Quarternary Pump G1311A	S/N DE22601691 S/N DE14918799	2010	8330
HPLC/MS/MS	Waters (LCMS1) Shimadzu Dionex	Quattro Ultima MS/MS HPLC Pumps LCIDAD UP (2) Injector (IC) AXP-MS Conductivity Detector CD25A	S/N VB118 S/N C20963952100 US S/N C20963952101 US S/N 02080163 S/N 02010062	2000	8321, 6860
HPLC/MS/MS	Waters (LCMS2) Waters Dionex	Quattro Ultima MS/MS HPLC 2790 Ion Chromatography (IC) System ICS-2000	S/N VB304 S/N D00SM9378M S/N 07070021	2001	8321, 6860, 6850
HPLC/MS/MS	Waters (LCMS3)	Quattro Premier XE MS/MS Sample Manager Acquity Binary Solvent Manager Acquity	S/N VAB661 S/N M04UPS473M S/N M04UPB504M	2005	8321
HPLC/MS/MS	Waters (LCMS4)	Quattro Micromass MS/MS HPLC Inlet Acquity Waters Ion Sabre Control Unit	S/N QAA632 S/N K035M4028M S/N 29005	2006	8321
HPLC/MS/MS	Agilent Technologies (LCMS5) Agilent	G6460A MS/MS Binary Pump G1312B Binary Pump G1379B	S/N US95270371 S/N DE63061753 S/N JP94112712	2010	8321
CI/MS/MS	Varian (CIMS1)	1200L MS/MS DS 102 CP-3800 GC CP-8400	S/N 1200L-680 S/N 240651 S/N 10828 S/N 2648	2004	Low Level NDMA (1625)

TestAmerica Denver Support Equipment

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Balance	Mettler	AE 160	C33519	Metals - ICPMS
Balance	Mettler	AE 163	D91301	Wet Chemistry /South Prep
Balance	Mettler	AE 240	I23294	Stnds & Aliquotting Hood #58
Balance	Mettler	AE 260	H52017	MS VOA Standards Prep Room
Balance	Sartorius	CP124S	19350788	Wet Chemistry Soil TOC
Balance	Mettler	PE600	D14862	GC
Balance	Mettler	PM 4600	H31422	Wet Chemistry
Balance	Mettler	PM4000	M28318	Metals Prep
Balance	Denver Instruments	TP 1502	24650239	Wet Chemistry
Balance	Denver Instruments	TP 1502	24750525	GC SVOA Hood #32
Balance	Denver Instruments	TP 1502	24750526	Explosives Prep
Balance	Denver Instruments	TP 214	24450835	North Prep
Balance	Denver Instruments	TP 214	P214088008	South Prep
Balance	Denver Instruments	TP 214	24850570	Wet Chemistry
Balance	Denver Instruments	TP 3102	24750836	(Explosives Prep)
Balance	Denver Instruments	TP 3102	24750837	Hg Prep Room
Balance	Denver Instruments	TP 3102	24950431	TCLP
Balance	Denver Instruments	TP 3102	24950432	Wet Chemistry
Balance	Denver Instruments	TP 323	24850252	MS VOA Hood #36
Balance	Denver Instruments	TP 323	24650437	MS VOA Hood #37
Balance	Denver Instruments	TP 6101	24750402	North Prep
Balance	Denver Instruments	TP 6101	24350888	North Prep
Balance	Denver Instruments	TP 6101	24750399	Wet Chemistry
Balance	Denver Instruments	TP 6101	24950441	Wet Chemistry
Centrifuge	Beckman-Coulter	Allegra X-22	ALB102L007	Explosives Prep
Centrifuge	Beckman	Beckman GS-G	GA1J23	Wet Chemistry
Centrifuge	IEC Clinical	IEC Clinical	428-25419	Mass Spectrometry
Centrifuge	International Equipment Company	K	71652079	North Prep
Centrifuge	International Equipment Company	Model K	71654070	TCLP
Centrifuge	Sorvall Legend T	Sorvall Legend T	40507140	Metals

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Centrifuge	International Equipment Company	UV	88340M-4	North Prep
Chiller	Remcor	CA550A	62A1031LC003	Explosives Prep
Chiller	Neslab	CFT-75	197031137	North Prep
Chiller	Neslab	CFT-75	92EML23290-S	North Prep
Chiller	Brinkman	WK 4600 Lauda	LWG-736-04-0004	North Prep
Chiller	Brinkman	WL 4600 Lauda	B05002	North Prep
Chiller	Brinkman	WL 4600 Lauda	A13015	South Prep
Chiller	Brinkman	WL 4600 Lauda	LWG736-04-0001	South Prep
COD Digestor	HACH	DRB 200	10030C0116	Wet Chemistry
Cool Flow 25 NES Lab Kontes w/Midi Vap 2000	Scientific Glassware Instruments	120	2199	Wet Chemistry
Cyanide Digestor	Westco Scientific Instruments, Inc.	Westco Scientific Instruments, Inc.	1022A	Wet Chemistry
Digestion System w/ Controller	A I Scientific	AIM 500	3550A4475	Wet Chemistry
Digestion System w/ Controller	A I Scientific	AIM 600	4809A13098	Wet Chemistry
Drying Oven	Blue M	Temp-O-Loy Annealing Oven	TLG-102	North Prep
Drying Oven	Despatch	VRE2-2S-1E	149691	Wet Chemistry
Freezer	Kenmore	5	881200048	MS South Aliquoting
Freezer	GE	FUF 14DTCRWH	DR169039	MS South Aliquoting
Freezer	GE	FUF 20DTFRWH	FR171928	MS South Aliquoting
Freezer	Fisher Scientific	Isotemp (13-986-149)	0168153201110318	MS-VOA
Freezer	Fisher Scientific	Isotemp (13-986-149)	0168246901110414	MS-VOA
Freezer	White-Westinghouse	MFU17M3BW2	WB50400991	GC-VOA/Log-in
Grinder	US Stoneware	Ball mill	CS04003	Grinding Room
Grinder	Humboldt	H-4199	12014199	Explosives Prep
Grinder	Humboldt	H-4199	10014199	Explosives Prep
Grinder	Cutler-Hammer	Ring in puck	--	Grinding Room
Hot Block	Environmental Express	SC100	145CEC0266	Metals Prep
Hot Block	Environmental Express	SC100	No tag	Metals Prep
Hot Block	Environmental Express	SC100	5873CEC2707	Metals Prep
Hot Block	Environmental Express	SC100	No tag	Metals Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Hot Block	Environmental Express	SC100	145CEC0267	Metals Prep
Hot Block	Environmental Express	SC100	145CEC0275	Metals Prep
Hot Block	Environmental Express	SC100	No tag	Metals Prep
Hot Block	Environmental Express	SC100	3366CEC1595	Metals Prep
Hot Block	Environmental Express	SC100	3366CEC1596	Metals Prep
Hot Block	Environmental Express	SC100	3703CEC1727	Metals-Hg
Hot Block	Environmental Express	SC100	3366CEC1603	Metals-Hg
Hot Block	Environmental Express	SC151	6435CECW3032	Metals Prep
Hot Block	Environmental Express	SC151	6435CECW3033	Metals Prep
Hot Block	Environmental Express	SC154	8297CECW3531	Metals Prep
Hot Block	Environmental Express	SC154	6435CECW3006	Metals-Hg
Hot Block	Environmental Express	SC154	6435CECW3007	Metals-Hg
Hotblock	CPI	Modblock	None	South Prep
Incubated Shaker Table	Lab Line Industries, Inc	3527	1196 0534	South Prep
Incubator	Thermo Electron Corporation	BOD50A15	P20R-610933-PR	Wet Chemistry
Incubator	Fisher Scientific	Incubator 35.0	--	Wet Chemistry
Incubator	Fisher Scientific	Low Temperature Incubator	--	Wet Chemistry
Incubator	Precision Scientific	Spore Strip Incubator	22-AD-3	Wet Chemistry
Large Main Walk-in	Dixon ware	None	--	Log-in
Magnifier	Darkfield Quebec	Colony Counter 3325	--	Wet Chemistry
Microwave Digester	CEM	MARSX	XM3023	Metals Prep
Microwave Extraction	CEM Corporation	MARSXpress Xtraction	MD1875	North Prep
Muffle Furnance	Lindberg	51828	919081	South Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	50320	North Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator	10262	North Prep
N-Evap	Organomation Associates, Inc.	N-Evap II Nitrogen Evaporator Model 111	7243	South Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Oil & grease Machine	Horizon Technology	Controller	09-1126	Wet Chemistry
Oil & grease Machine	Horizon Technology	SPE-DEX 3000 XL	50-0412-02	Wet Chemistry
Oil & grease Machine	Horizon Technology	Speed VAP II 9000	00-245	Wet Chemistry
Oil & grease Machine	Horizon Technology	Vac Generator	03-0424	Wet Chemistry
Oven	VWR/SHEL-Lab	1310	1310886	TCLP
Oven	VWR	1320	1320587	South Prep
Oven	Fisher Scientific	Isotemp Muffle Furnace	01511060452701	North Prep
Oven	Fisher Scientific	Isotemp Oven	212N0439	TCLP
Oven	Labline	L-C Oven	OL85-0192	TCLP
Oven	Precision	Oven	602051362	GC-VOA
Oven	Blue M	Temp O Lay – TLG-36-1G-2	TLG 102	North Prep
Oven (A)	Yamato	Mechanical Convection Oven DKN 810	--	Wet Chemistry
Oven (C)	VWR	1370 G	5860370	Wet Chemistry
Oven (D)	VWR	1370 GD	600390	Wet Chemistry
Oven (E)	Fisher Scientific	750F	407N0067	Wet Chemistry
Oven (F)	Fisher Scientific	6925	275807-283	Wet Chemistry
Refrigerator	Beverage Air	--	4007882	GC-VOA
Refrigerator	VWR Scientific	--	902331	GC-VOA
Refrigerator	Fisher Scientific	3556FS	0119097301100515	North OP
Refrigerator	Vulcan	CRA2	3202290	GC-VOA/Log-in
Refrigerator	Beverage Air	E Series	1405890	GC North Aliquoting
Refrigerator	Beverage Air	ER48-IAS	6126470	MS-VOA
Refrigerator	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator	Trautsen	G20010	T39912A03	MS-VOA
Refrigerator	Fisher Scientific	Isotemp - 3556FS	0119097401100515	North OP
Refrigerator	Fisher Scientific	Isotemp (13-986-245G)	407N0077	North OP
Refrigerator	Fisher Scientific	Isotemp Plus (13-986-126)	512N0035	MS-VOA
Refrigerator	Beverage Air	Refrigerator	4007879	GC-VOA
Refrigerator	Beverage Air	Refrigerator	8548726	MS-VOA
Refrigerator	Beverage Air	Refrigerator	8524I09	Wet Chemistry
Refrigerator	Hoshizaki	RH2AAC	M60350G	MS-VOA
Refrigerator	Hoshizaki	RH2AAC	M60349G	MS-VOA
Refrigerator	Sanyo	SR1287X	880508138	Log-in
Refrigerator	Lab Line Industries, Inc	VWR Frigid Cab	--	North OP
Refrigerator	Glenco	XL Series E (ALA-48-TE)	EE-319830-C	North OP
Refrigerator/Freezer	Precision	813	14AW-5	GC-VOA

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Refrigerator/Freezer	Sears	25367800792	BA81102895	GC-VOA
Refrigerator/Freezer	Fisher Scientific	--	--	Explosives Prep
Refrigerator/Freezer	VWR	--	--	Explosives Prep
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	--	--	MS South Aliquoting
Refrigerator/Freezer	Fisher Scientific	13-986-111A	016875390110908	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119104401100518	MS-VOA
Refrigerator/Freezer	Fisher Scientific	97-925-1	0119196001100611	MS-VOA
Refrigerator/Freezer	Frigidaire	Crown Series (FR4C18571)	BA01927318	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	Frigid Cab	--	GC North Aliquoting
Refrigerator/Freezer	GE	GTH17DBDDRWW	AA813320	GC North Aliquoting
Refrigerator/Freezer	Hotpoint	HTS18GBSARWW	HR731980	GC-VOA
Refrigerator/Freezer	Hotpoint	HTS18GBSBRWW	HS748902	GC North Aliquoting
Refrigerator/Freezer	Curtin Matheson Scientific	P73953-33WW	CK3737-5084-8	North OP
Refrigerator/Freezer	GE	TBF22306	RN507856	Wet Chemistry
Refrigerator/Freezer	Fisher Scientific	TDX15SNBRWH	GH812576	MS-VOA
Refrigerator/Freezer	Fisher Scientific	TDX15SNSBRWH	MH732121	North OP
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S63228358	GC North Aliquoting
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	--	GC-VOA
Refrigerator/Freezer	Lab Line Industries, Inc	VWR Frigid Cab	S82927189	MS-VOA
Rotary Agitation Apparatus	Associated Mfg	--	1192	TCLP Prep
Rotary Agitation Apparatus	Associated Mfg	--	1184	TCLP Prep
Rotary Agitation Apparatus	Associated Mfg	--	1198	TCLP Prep
Separatory Funnel Rotators	Ap & R Machine Tool	Ap & R Machine Tool	--	North Prep
Separatory Funnel Rotators	Ap & R Machine Tool	Ap & R Machine Tool	--	North Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Separatory Funnel Rotators	Ap & R Machine Tool	Ap & R Machine Tool	--	North Prep
Separatory Funnel Rotators	AP & R Machine Tool	AP & R Machine Tool	--	South Prep
Separatory Funnel Rotators	AP & R Machine Tool	AP & R Machine Tool	--	South Prep
Shaker	New Brunswick Scientific	Innova 2100	300443795	Explosives Prep
Sieve Shaker	Humboldt	--	--	Grinding Room
Small Main Walk-in	Bally Engineered Structures	3478-3L	DX110981-01	Log-in
Solvent Evaporator w/Digital Temperature Control System	UA-SYS	UA-SYS Heating System S-EVAP KD	68984	Wet Chemistry
Sonic Bath	Fischer Scientific	FS60D	RUC100966684A	Metals
Sonicator	Fisher Scientific	550 Sonic Dismembrator	F2448	North Prep
Sonicator	Fisher Scientific	550 Sonic Dismembrator	F1858	North Prep
Sonicator	Fisher Scientific	F550	F1860	North Prep
Sonicator	Misonix	Sonicator 3000	R1373	North Prep
Sonicator	Misonix	Sonicator 3000	R1374	North Prep
Sonicator	Heat Systems	Sonicator Ultrasonic Processor XΔ	G1970	North Prep
Sonicator	Heat Systems	XL-2020	G1971	North Prep
Sonicator	Heat Systems	XL-2020	G1464	North Prep
Sonicator	Heat Systems	XL-2020	G1969	North Prep
Sonicator Bath	Branson	5510	RNA010513460E	Explosives Prep
Sonicator Bath	Branson	5510	RNA030516341E	Explosives Prep
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
TOX Sample Preparation	Microcoulometric Titration System	Microcoulometric Titration System	Not visible	Wet Chemistry
Turbo Vap	Caliper Life Science	Turbo Vap II	TV0532N12460	North Prep
Turbo Vap	Caliper Life Science	Turbo Vap II	TV0532N12459	North Prep
Turbo Vap	Zymark	Turbo Vap II	TV9452N5926	North Prep
Vacuum Manifold	Waters/VWR	Vacuum Manifold/Pump	None	South Prep
Vacuum Manifold	Waters/KNF	Vacuum Manifold/Pump	4458745	South Prep

Support Equipment				
Instrument Type	**Manufacturer**	**Model Number**	**Serial Number**	**Location**
Walk-in Refrigerator	BallyEngineered Structures	3478-3-P-M	DX205276-02	Archive
Water Bath	Fisher Scientific	Isotemp 2150	2090013007	Wet Chemistry
Water Bath	Waterlow	Waterlow	--	North Prep
Water Bath	Waterlow	Waterlow	--	North Prep
Water Purifier	ELGA	Pure lab Classic	CLUVG273290	North Prep
Water Purifier	ELGA	Pure Lab Classic	CLUVH273307	South Prep
Water Purifier	ELGA	Ultra Scientific	USM203644	Wet Chemistry
Water Purifier	ELGA	Ultra Scientific	USM203643	Wet Chemistry

Note: The current list of equipment is maintained in the Master List of Documents, Software and Hardware stored at G:\QA\Read\Master List of Documents, Software and Hardware.

Table 20-2. Example: Schedule of Routine Maintenance

Instrument	Procedure	Frequency
Cetac Mercury Analyzers	• Change Lamp • Clean cell and GLS as needed • Check pump tubing and pump flow • Check Waste Container • Fill reductant bottle with 10% Stannous Chloride and check acid reagent	As needed As needed Daily Daily Daily
GFAA	• Check fluid level in rinse and waste containers • Check condition of autosampler tubing • Check the condition of graphite tube and replace as needed • Check coolant level in chiller and replace as needed • Check condition of Contact Rings and replace as needed • Clean or replace air filters	Daily Daily Daily Daily Daily As needed
ICP	• Check pump tubing • Check fluid level in waste container • Clean or replace air filters • Check torch for residue • Check nebulizer flow • Clean nebulizer and drain chamber • Fill rinse solution/ IS solution • Replace capillary tubing/sipper probe • Change internal cooling fluid	Daily Daily As needed Daily Daily Daily Daily As needed Quarterly
ICP MS	• Change pump tubing • Check level of tuning solution • Check waste container • Load printer with paper • Check air filters • Replace coolant on chiller • Clean or change nebulizer • Clean or replace torch • Replace sample tubing • Change oil in vacuum pumps • Remove and clean cones	Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed
UV-Vis Spectrophotometer	• Clean ambient flow cell • Precision check/alignment of flow cell • Wavelength verification check	As required As required Semi-annually
Colorimetric Analyzer	• Clean detector • Clean filters • Check tubing • Clean sample probe shaft • Clean pump, diluter, and XYZ sampler. • Lubricate pump roller	Daily Daily Daily Daily Monthly Semi-annually

Instrument	Procedure	Frequency
Ion Chromatograph	• Check plumbing for leaks • Check gases • Check pump pressure • Check eluent level • Check conductivity meter • De-gas pump head when flow is erratic • Change analytical columns and bed supports guard • Check and replace any damaged/discolored tubing	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Total Organic Halide Analyzer	• Check electrodes/polish if needed • Replace dehydrating fluid /electrolyte fluid • Clean quartz boat • Perform cell performance check • At the end of each day of use, wash out the absorption module, empty the electrolyte and fill chamber with DI water, empty dehydrator tube • Clean or replace pyrolysis tube • Clean titration cell • Replace reference electrode fluid • Change quartz wool • Replace o-rings and seals	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed
Hewlett Packard GC/MS	• Check Septa and clean injection port • Check carrier gas supply • Check tune parameters • Check oil levels in mechanical pumps and the diffusion pump if the vacuum is insufficient • Replace electron multiplier • Clean Source • Replace filaments • Change rough pump oil and exhaust filters • Relubricate the turbomolecular pump-bearing wick	Daily Daily Daily As needed As needed As needed As needed Annually Annually
Gas Chromatograph	• Check carrier gas supply • Check temperatures of inlet, detectors, verify temperature program • Check septa clean injection port or replace injection port liner and cut column if needed • Reactivate carrier gas drying agents • Replace or repair flow controllers if constant flow cannot be maintained	Daily Daily As needed As needed As needed

Instrument	Procedure	Frequency
Electron Capture Detector (ECD)	• Detector wipe test (Ni-63) • Detector cleaning	Semi-annually As needed
Flame Ionization Detector (FID)	• Detector cleaning	As needed
Nitrogen Phosphorus Detector (NPD)	• Replace bead • Replace ceramic rings	As needed As needed
Photoionization Detector (PID)	• Change O-rings • Clean lamp window	As needed As needed
HPLC	• Check level of eluent vessels • Change pump seals • Change the column frit • Change fuses in power supply • Filter all samples • Change autosampler rotor or oil autosampler slides • Change or backflush columns • Replace needle • Replace needle seat assembly • Replace Active Inlet Valve (AIV) cartridge • Replace lamps	Daily As needed As needed As needed Daily As needed As needed As needed As needed As needed As needed
APCI/ESI LC/MS/MS	• Check solvent reservoirs • Verify that pump is primed and operating pulse free • Verify temperatures for capillary heater/vaporizer heater • Verify pressure of manifold/fore-pump • Verify that corona and multiplier are functional • Clean Lenses • Clean skimmer • Replace column • Oil autosampler • Change autosampler filters • Replace sample inlet tube • Replace fused silica tubing at ESI interface • Replace rough pump oil • Replace turbo pump oil • Vacuum system components including fans and fan covers	Daily Daily Daily Daily Daily As needed As needed As needed As needed As needed As needed As needed Annually Annually Annually
Balances	• Class “S” traceable weight check • Clean pan and check if level • Field service	Daily, when used Daily At least Annually
Sonicator	• Inspect probe for etching/pitting • Tune sonicator assembly • Disassemble and clean probe tips	Daily Weekly As needed

Instrument	Procedure	Frequency
Conductivity Meter	• Standardize with KCL • Conductivity cell cleaning • Check probes and cables	Daily As needed As needed
Flash Point Tester	• Check stirrer • Check tubing • Check gas supply • Check thermometer against NIST thermometer	Daily Daily Daily Quarterly by QA
Digestion Block	• Check with NIST thermometer	Annually
Turbidimeter	• Check light bulb • Inspect cells • Clean housing	Daily, when used Monthly Monthly
Deionized/Distilled Water	• Conductivity check • System cleaning • Replace cartridge & large mixed bed resins	Daily As needed As needed
Drying Ovens	• Temperature monitoring • Temperature adjustments	Daily As required
Refrigerators/ Freezers	• Temperature monitoring • Temperature adjustment • Defrosting/cleaning	Daily As required As required
pH/Specific Ion Meter	• Calibration/check slope • Clean electrode	Daily As required
BOD Incubator	• Temperature monitoring	Daily
Water baths	• Temperature monitoring • Water replaced	Daily Monthly or as needed

SECTION 21. MEASUREMENT TRACEABILITY

21.1 Overview

Traceability of measurements shall be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard shall be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices. (Refer to Section 20.3). With the exception of Class A Glassware and Glass microliter syringes, quarterly accuracy checks are performed for all mechanical volumetric devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A Glassware and Glass microliter syringes should be routinely inspected for chips, acid etching or deformity (e.g., bent needle). If the Class A glassware or syringe is suspect, the accuracy of the glassware will be assessed prior to use.

21.2 NIST-Traceable Weights and Thermometers

Reference standards of measurement shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), or another accreditation organization that is a signatory to a MRA (Mutual Recognition Arrangement) of one or more of the following cooperations – ILAC (International Laboratory Accreditation Cooperation) or APLAC (Asia –Pacific Laboratory Accreditation Cooperation). A calibration certificate and scope of accreditation is kept on file at the laboratory. Refer to Section 21 for calibration of weights and thermometers.

Calibration laboratory's policy for achieving measurement traceability is defined and includes the subsequent elements of uncertainty.

The uncertainty calculations of the calibration laboratory are supported by uncertainty budgets and are represented by expanded uncertainties typically using a coverage factor of k=2 to approximate the 95% confidence level. This explanation accompanies the measurement result and the associated uncertainty.

The tolerance uncertainty ratio (TUR) is calculated using the expanded uncertainty of the measurement, not the collective uncertainty of the measurement standards. A statement to this effect accompanies the TUR along with the coverage factor and confidence level.

The calibration report or certificate submitted to TestAmerica Denver contains, in a well designed format, a traceability statement, the conditions under which the calibrations were made in the context of any potential influence, a compliance statement with an identified metrological specification and the pertinent clauses, a clearly identified record of the quantities

and functional test results before and after re-calibration, and no recommendation on the calibration interval. Opinions and interpretations of results are presented along with the basis upon which they were made and identified as such. The report may be submitted by facsimile or other electronic means as long as the requirements of the International Standard are achieved. If significant amendments are made to a calibration certificate, a supplemental certificate for the serial-number-specified piece of equipment is so identified. When a new certificate is offered, it uniquely identifies and references the one it replaces. All calibration reports are filed in the QA Office.

The calibration laboratory supports in-house calibration systems: documented procedures for in-house calibrations, evidence by a report, certificate, or sticker, for an appropriate amount of time; training records of calibration personnel; certificates from accreditation services demonstrating traceability to national or international standards of measurement; procedures for evaluating measurement uncertainty; timely and documented recalibration of reference standards. When subcontracting to a calibration laboratory, TestAmerica Denver does not use a firm who subcontracts the work.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 Reference Standards / Materials

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation) with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the ‘true’ value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor certified different lot is acceptable for use as a second source. For unique situations, such as Disodium Iminodiacetate (IDA) analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source

confirmation. These checks are generally performed as an integral part of the analysis method (e.g., calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to the Corporate Environmental Health & Safety Manual or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

Standards and reference materials shall not be used after their expiration dates unless their reliability is verified by the laboratory and their use is approved by the Quality Assurance Manager. The laboratory must have documented contingency procedures for re-verifying expired standards.

21.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. [Refer to TestAmerica's Corporate SOP (CA-Q-S-001), *Solvent and Acid Lot Testing and Approval*.]

All manufacturer or vendor supplied Certificates of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in the analytical groups and by QA on the public drive. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection. For detailed information on documentation and labeling, please refer to Denver SOP DV-QA-0015, *Verification and Storage of Calibration Standards.*

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96% a correction will be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into the laboratory's LIMS system, and are assigned a unique identification number. The following information is typically recorded in the electronic database within the LIMS.

- Standard ID
- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number

- Preparation Date
- Expiration Date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent Standard Analyte Concentration (if applicable)
- Parent Standard Amount used (if applicable)
- Component Analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained electronically for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration Date (include prep date for reagents)
- Standard ID
- Special Health/Safety warnings if applicable

Note: Reagents that are not prepared and used directly from the vendor bottle only need to have a lot number, open date and expiration date.

Records must be maintained of the date of receipt for commercially purchased items or date of preparation for laboratory prepared items. Special Health/Safety warnings must also be available to the analyst. This information is maintained in the LIMS and TestAmerica Intranet Oasis.

21.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Recommended Storage Conditions
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include an expiration date and an ID number to trace back to preparation.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority: 1) with the manufacturer's recommendations; 2) with requirements in the specific analytical methods as specified in the laboratory SOP.

SECTION 22. SAMPLING

22.1 Overview

The laboratory does not provide sampling services. The laboratory's responsibility in the sample collection process lies in supplying the sampler with the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack, and ship samples to the laboratory

22.2 Sampling Containers

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are maintained at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 Definition of Holding Time

The date and time of sampling documented on the COC form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in "days" (e.g., 14

days, 28 days), the holding time is based on calendar day measured. Holding times expressed in "hours" (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends twenty-four hours after sampling. Holding times for analysis include any necessary reanalysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of how long the holding time is.

22.4 Sampling Containers, Preservation Requirements, Holding Times

The preservation and holding time criteria specified in the laboratory SOPs are derived from the source documents for the methods. If method required holding times or preservation requirements are not met, the reports will be qualified using a flag, footnote or case narrative. As soon as possible or "ASAP" is an EPA designation for tests for which rapid analysis is advised, but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 Sample Aliquots / Subsampling

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative subsample or aliquot of the sample provided for analysis.

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots & subsampling are located in SOP DV-QA-0023, *Subsampling.*

SECTION 23. HANDLING OF SAMPLES

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 Chain of Custody (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

When the sampling personnel deliver the samples directly to TestAmerica personnel, the samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory personnel. The sample collector must assure that each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the sample control personnel at the laboratory or to a TestAmerica courier. When sampling personnel deliver the samples through a common carrier (Fed-Ex, UPS), the COC relinquished date/time is completed by the field personnel and samples are released to the carrier. Samples are only considered to be received by lab when personnel at the fixed laboratory facility have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The receipt from the courier is stored in log-in by date; it lists all receipts each date.

23.1.2 Legal / Evidentiary Chain-of-Custody

All samples are tracked through the LIMS software program to ensure internal chain of custody and cradle to grave tracking of each sample container. If samples are identified for legal/evidentiary purposes on the COC an internal COC can be generated from the LIMS and included in the data package.

23.2 Sample Receipt

Samples are received at the laboratory by designated sample receiving personnel and a unique laboratory project identification number is assigned. Each sample container shall be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking and storage procedures are summarized in the following sections.

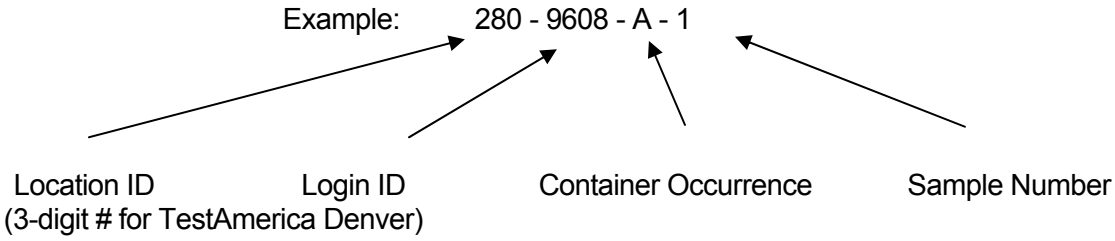
23.2.1 Laboratory Receipt

When samples arrive at the laboratory, sample receiving personnel inspect the coolers and samples. The integrity of each sample must be determined by comparing sample labels or tags with the COC and by visual checks of the container for possible damage. Any non-conformance, irregularity, or compromised sample receipt must be documented on a Condition Upon Receipt Anomaly Form (CUR) and brought to the immediate attention of the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the project record. Refer to SOP DV-QA-0003, *Sample Management and Chain of Custody* for detailed information on receipt of samples.

23.2.1.1 Unique Sample Identification

All samples that are processed through the laboratory receive a unique sample identification to ensure that there can be no confusion regarding the identity of such samples at anytime. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates.

The laboratory assigns a unique identification (e.g., Sample ID) code to each sample container received at the laboratory. This Primary ID is made up of the following information (consisting of 4 components):



The above example states that TestAmerica Denver Laboratory (Location 280). Login ID is 9608 (unique to a particular client/job occurrence). The container code indicates it is the first container ("A") of Sample #1.

If the primary container goes through a prep step that creates a "new" container, then the new container is considered secondary and gets another ID. An example of this being a client sample in a 1-Liter amber bottle is sent through a Liquid/Liquid Extraction and an extraction vial is created from this step. The vial would be a SECONDARY container. The secondary ID has 5 components.

Example: 280 - 9608 - A - 1 - **A** ←——**Secondary Container Occurrence**

Example: 280-9608-A-1-A, would indicate the PRIMARY container listed above that went through a step that created the 1st occurrence of a Secondary container.

With this system, a client sample can literally be tracked throughout the laboratory in every step from receipt to disposal.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy (Figure 23-2) that clearly outlines the circumstances under which samples shall be accepted or rejected. These include:

- a COC filled out completely;
- samples must be properly labeled;
- proper sample containers with adequate volume for the analysis (Sampling Guide) and necessary QC;
- samples must be preserved according to the requirements of the requested analytical method (Sampling Guide);
- sample holding times must be adhered to (Sampling Guide);
- all samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time;
- the project manager will be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined.

23.3.1 After inspecting the samples, the sample receiving personnel sign and date the COC form, make any necessary notes of the samples' conditions and store them in appropriate refrigerators or storage locations.

23.3.2 Any deviations from these checks that question the suitability of the sample for analysis, or incomplete documentation as to the tests required will be resolved by consultation with the client. If the sample acceptance policy criteria are not met, the laboratory shall either:

- Retain all correspondence and/or records of communications with the client regarding the disposition of rejected samples, or

- Fully document any decision to proceed with sample analysis that does not meet sample acceptance criteria.

Note: North Carolina requires that they be notified when samples are processed that do not meet sample acceptance criteria.

Once sample acceptance is verified, the samples are logged into the LIMS according SOP DV-QA-0003, *Sample Management and Chain of Custody.*

23.4 Sample Storage

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix, except metals sample containers which may be stored unrefrigerated**.** In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every two weeks.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator, document the transfer of containers in LIMS and place them on carts, analyze the sample, and return the remaining sample to the refrigerator from which it originally came, documenting the return in LIMS. Empty containers are stored in the sample archive area until disposal, this transfer is documented in LIMS. All samples are kept in the refrigerators until the project is invoiced. At this time, the samples will be retained for an additional thirty days, either in the refrigerators, or in the sample archive area. Special arrangements may be made to store samples for longer periods of time. This extended holding period allows additional metal analyses to be performed on the archived sample and assists clients in dealing with legal matters or regulatory issues. Upon disposal, the drum number used for disposal is logged into LIMS.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 Hazardous Samples and Foreign Soils

To minimize exposure to personnel and to avoid potential accidents, hazardous and foreign soil samples are stored in a designated area. For any sample that is known to be hazardous at the time of receipt or, if after completion of analysis the result exceeds the acceptable regulatory levels, the analyst will notify login staff so the hazardous sample is properly labeled as such. The sample itself is clearly marked with a label reading “HAZARDOUS”, “PCBs” or “FOREIGN SOIL”. All hazardous samples are either returned to the client or disposed of appropriately through a hazardous waste disposal firm. All foreign soil samples are sent out for incineration

by a USDA-approved waste disposal facility; refer to SOP DV-QA-0019, *Quarantine Soils Procedure* for more detail.

23.6 Sample Shipping

In the event that the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses (see Note). The chain-of-custody form is signed by the sample control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper chain-of-custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

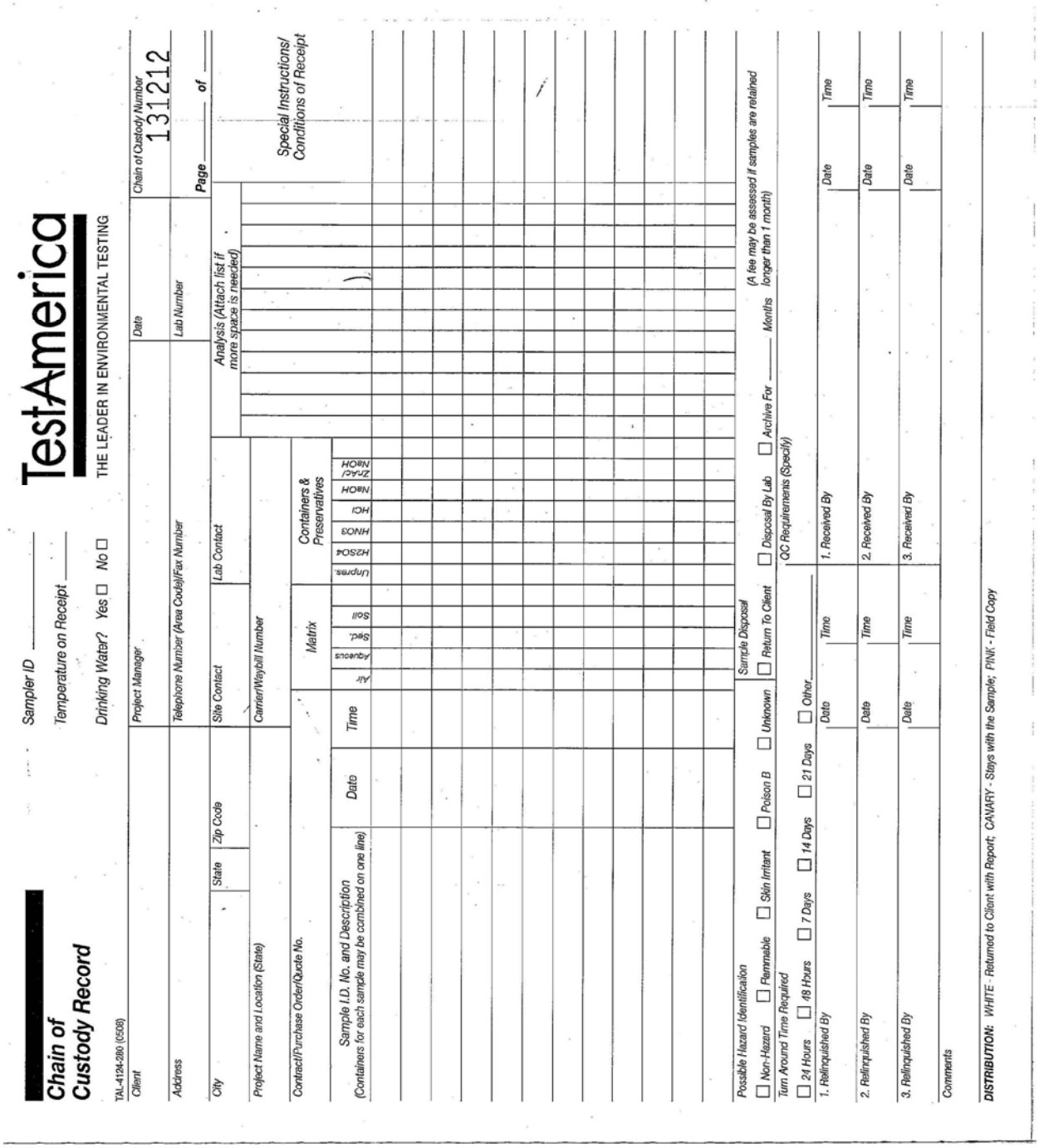
Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 Sample Disposal

Samples should be retained for a minimum of 30 days after the project report is sent, however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist: the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP: DV-HS-0005, *Excess Sample Material Management)*. All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work.

All documentation and correspondence concerning the disposal of samples is kept on file. The LIMS Internal Chain of Custody software allows tracking for each sample container from the time of sample receipt through the disposal process, including such detail as the identifying number of the waste drum used for disposal. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), names of individuals who conducted the arrangements and physically completed the task. The laboratory will remove or deface sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). A Hazardous Waste Manifest will be prepared to document the disposal of each drum. Additional detail is in SOP DV-HS-0004, *Hazardous Waste Manifesting*.

Figure 23-1. Example: Chain of Custody (COC)



Chain of Custody Record

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Sampler ID _____ Temperature on Receipt _____ Drinking Water? Yes ☐ No ☐

TAL-4124-280 (0508)

Chain of Custody Number 131212

Client | Project Manager | Date

Address | Telephone Number (Area Code)/Fax Number | Lab Number | Page _____ of _____

City | State | Zip Code | Site Contact | Lab Contact | Analysis (Attach list if more space is needed) | Special Instructions/ Conditions of Receipt

Project Name and Location (State) | Carrier/Waybill Number

Contract/Purchase Order/Quote No. | Matrix | Containers & Preservatives

Sample I.D. No. and Description (Containers for each sample may be combined on one line) | Date | Time | Air | Aqueous | Sed. | Soil | Unpres. | H2SO4 | HNO3 | HCl | NaOH | ZnAc/ NaOH

Possible Hazard Identification

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

1. Relinquished By | Date | Time | 1. Received By | Date | Time

2. Relinquished By | Date | Time | 2. Received By | Date | Time

3. Relinquished By | Date | Time | 3. Received By | Date | Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Figure 23-2. Example: Sample Acceptance Policy

All incoming work will be evaluated against the criteria listed below. Where applicable, data from any samples that do not meet the criteria listed below will be noted on the laboratory report defining the nature and substance of the variation. In addition the client will be notified either by telephone, fax or e-mail ASAP after the receipt of the samples.

1) Samples must arrive with labels intact with a Chain of Custody filled out completely. The following information must be recorded.
   - Client name, address, phone number and fax number (if available)
   - Project name and/or number
   - The sample identification
   - Date, time and location of sampling
   - The collectors name
   - The matrix description
   - The container description
   - The total number of each type of container
   - Preservatives used
   - Analysis requested
   - Requested turnaround time (TAT)
   - Any special instructions
   - Purchase Order number or billing information (e.g. quote number) if available
   - The date and time that each person received or relinquished the sample(s), including their signed name.
   - The date and time of receipt must be recorded between the last person to relinquish the samples and the person who receives the samples in the lab, and they must be exactly the same.
   - Information must be legible

2) Samples must be properly labeled.
   - Use durable labels (labels provided by TestAmerica are preferred)
   - Include a unique identification number
   - Include sampling date and time & sampler ID
   - Include preservative used.
   - Use indelible ink
   - Information must be legible

3) Proper sample containers with adequate volume for the analysis and necessary QC are required for each analysis requested. See Lab Sampling Guide.

4) Samples must be preserved according to the requirements of the requested analytical method (See Sampling Guide**.**

5) Most analytical methods require chilling samples to 4^{o} C (other than water samples for metals analysis). For these methods, the criteria are met if the samples are chilled to below 6^{o} C and above freezing (0^{o}C). For methods with other temperature criteria (e.g. some bacteriological methods

require ≤ 10 °C), the samples must arrive within ± 2° C of the required temperature or within the method specified range.

Note: Samples that are hand delivered to the laboratory immediately after collection may not have had time to cool sufficiently. In this case the samples will be considered acceptable as long as there is evidence that the chilling process has begun (arrival on ice).

- Chemical preservation (pH) will be verified prior to analysis and the project manager will be notified immediately if there is a discrepancy. If analyses will still be performed, all affected results will be flagged to indicate improper preservation.

- For Volatile Organic analyses in drinking water (Methods 502.2 or 524.2). Residual chlorine must be neutralized prior to preservation. If there is prior knowledge that the samples are not chlorinated, state it on the COC and use the VOA vials pre-preserved with HCl. The following are other options for a sampler and laboratory where the presence of chlorine is not known:
  - 1. Test for residual chlorine in the field prior to sampling.
    - If no chlorine is present, the samples are to be preserved using HCl as usual.
    - If chlorine is present, add either ascorbic acid or sodium thiosulfate prior to adding HCl.
  - 2. Use VOA vials pre-preserved with sodium thiosulfate or ascorbic acid and add HCl after filling the VOA vial with the sample.

- **FOR WATER SAMPLES TESTED FOR CYANIDE (by Standard Methods or EPA 335)**

  - In the Field: Samples are to be tested for Sulfide using lead acetate paper prior to the addition of Sodium Hydroxide (NaOH). If sulfide is present, the sample must be treated with Cadmium Chloride and filtered prior to the addition of NaOH.

    - If the sulfide test and treatment is not performed in the field, the lab will test the samples for sulfide using lead acetate paper at the time of receipt and if sulfide is present in the sample, the client will be notified and given the option of retaking the sample and treating in the field per the method requirements or the laboratory can analyze the samples as delivered and qualify the results in the final report.

  - It is the responsibility of the client to notify the laboratory if thiosulfate, sulfite, or thiocyanate are known or suspected to be present in the sample. This notification may be on the chain of custody. The samples may need to be subcontracted to a laboratory that performs a UV digestion. If the lab does not perform the UV digestion on samples that contain these compounds, the results must be qualified in the final report.

  - The laboratory must test the sample for oxidizing agents (e.g. Chlorine) prior to analysis and treat according to the methods prior to distillation. (ascorbic acid or sodium arsenite are the preferred choice).

6) Sample Holding Times
   - TestAmerica will make every effort to analyze samples within the regulatory holding time. Samples must be received in the laboratory with enough time to perform the sample analysis. Except for short holding time samples (< 48hr HT) sample must be received with at least 48 hrs (working days) remaining on the holding time for us to ensure analysis.

   - Analyses that are designated as “field” analyses (Odor, pH, Dissolved Oxygen, Disinfectant Residual; a.k.a. Residual Chlorine, and Redox Potential) should be analyzed ASAP by the field

sampler prior to delivering to the lab (within 15 minutes). However, if the analyses are to be performed in the laboratory, TestAmerica will make every effort to analyze the samples within 24 hours from receipt of the samples in the testing laboratory. Samples for "field" analyses received after 4:00 pm on Friday or on the weekend will be analyzed no later than the next business day after receipt (Monday unless a holiday). Samples will remain refrigerated and sealed until the time of analysis. The actual times of all "field" sample analyses are noted on the "Short Hold Time Detail Report" in the final report. Samples analyzed in the laboratory will be qualified on the final report with an 'H' to indicate holding time exceedance.

7) All samples submitted for Volatile Organic analyses must have a Trip Blank submitted at the same time. TestAmerica will supply a blank with the bottle order.

8) The project manager will be notified if any sample is received in damaged condition. TestAmerica will request that a sample be resubmitted for analysis.

9) Recommendations for packing samples for shipment.

   - Pack samples in Ice rather than "Blue" ice packs.
   - Soil samples should be placed in plastic zip-lock bags. The containers often have dirt around the top and do not seal very well and are prone to intrusion from the water from melted ice.
   - Water samples would be best if wrapped with bubble-wrap or paper (newspaper, or paper towels work) and then placed in plastic zip-lock bags.
   - Fill extra cooler space with bubble wrap.

Figure 23-3. Example: Cooler Receipt Form

TestAmerica Denver
Sample Receiving Checklist

Login #:_____ Date/Time Received:_____

Company Name & Sampling Site: _____

PM/PMA to Complete This Section at Cooler Greet: Residual chlorine check required: *Yes* ☐ *No* ☐ Quarantined: *Yes* ☐ *No* ☐

TALS Project #:
Special Instructions:

Time Zone: • EDT/EST • CDT/CST • MDT/MST • PDT/PST • OTHER State:

PM/PMA to Complete This Section Upon Review:
Matrix/Count: Field QC samples: Client Requested MS/MSD:

Document any problems or discrepancies and the actions taken to resolve them on a Condition Upon Receipt Anomaly Report (CUR)

Unpacking Checks: ***Initials*** _____

Temperatures (°C): _____ _____ _____ _____ _____ _____ _____ _____

N/A	*Yes*	*No*	
☐	☐	☐	1. Is radioactivity at or below background? BKG CPM:_____ CPM Reading: _____
☐	☐	☐	2. Is the cooler's custody seal intact? Do cooler or samples appear to not have been compromised or tampered with?
☐	☐	☐	3. Were samples received on ice? Is cooler temperature acceptable? Has temperature been recorded?
☐	☐	☐	4. Is COC present; filled out in ink and legible; and filled out with all pertinent information?
☐	☐	☐	5. Is the Field Sampler's name present on the COC?
☐	☐	☐	6. Are there no discrepancies between the sample IDs on the containers and the COC?
☐	☐	☐	7. Are samples received within Holding Time?
☐	☐	☐	8. Do sample containers have legible labels?
☐	☐	☐	9. Are all sample containers intact (not broken or leaking)?
☐	☐	☐	10. Are appropriate sample containers used? Are sample bottles completely filled? Is sufficient vol. for all requested analyses, incl. any requested MS/MSDs provided?
☐	☐	☐	11. No splitting or compositing of samples required?
☐	☐	☐	12. Was Sample Preservation verified and found to be correct?
☐	☐	☐	13. Do all VOA sample vials have no headspace or bubbles >6 mm (1/4") in diameter?
☐	☐	☐	14. Were VOA vials labeled as preserved? Preservative ☐ HCl ☐ 0-6°C ☐ Sodium Thiosulfate ☐ Ascorbic Acid
☐	☐	☐	15. Are all samples single phase? (i.e., no multiphasic samples are present.)
☐	☐	☐	16. Was Residual Chlorine checked and noted on the CUR if present?

Login Checks: ***Initials*** _____

☐	☐	☐	17. Was a Priority Form completed for any short holds or quick TATs?
☐	☐	☐	18. Were any tests logged for subcontract?
☐	☐	☐	19. Were special archiving instructions and login instructions indicated in the Project Notes?

Note Archive Requirements: _____

☐	☐	☐	20. Were multiple Series logged for this job?

Labeling and Storage Checks: ***Initials*** _____

☐	☐	☐	21. If subcontract work was requested, was volume placed on sub shelf?
☐	☐	☐	22. Did the sample ID on TA label match the client's sample ID on container? ***Verified by:*** _____
☐	☐	☐	23. Were stickers for special archiving instructions affixed to each box?

SDG labels applied ***(initials):*** _____ ***Verified by:*** _____

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SECTION 24. ASSURING THE QUALITY OF TEST RESULTS

24.1 Overview

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g. Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. Quality control samples are to be treated in the exact same manner as the associated field samples being tested. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 Controls

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, evaporation, and drying. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 Negative Controls

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blank (MB)	Used to assess preparation and analysis for possible contamination during the preparation and processing steps.
	The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.
	The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).
	Reanalyze or qualify associated sample results when the concentration of a targeted analyte in the blank is at or above ½ the reporting limit as established by the method or by regulation, AND is greater than 1/10 of the amount measured in the sample.
Calibration Blanks	Prepared and analyzed along with calibration standards where applicable. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve.
Instrument Blanks	Blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.

Table 24-1. Example – Negative Controls

Control Type	Details
Trip Blank [1]	Required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses (or as specified in the client's project plan). Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks [1]	Sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks [1]	Also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (**TNI**)
Holding Blanks	Also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

[1] When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 Positive Controls

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon (1) Method Performance (Laboratory Control Sample (LCS) or Blank Spike (BS)), which entails both the preparation and measurement steps; and (2) Matrix Effects (Matrix Spike (MS) (Matrix spikes are not applicable to air) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch

Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects in a laboratory batch.

The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is

spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g. solid matrix LCS for metals, TDS, etc.).

The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally 1 for each batch of samples; not to exceed 20 environmental samples.

If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable (e.g. no spike of pH). However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

- For methods that have 1-10 target analytes, spike all components.
- For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.
- For methods with more than 20 target analytes, spike at least 16 components.
- Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.
- Exception: Due to analyte incompatibility between the various PCB aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the aroclors. Specific aroclors may be used by request on a project specific basis.

24.5 Sample Matrix Controls

Table 24-3. Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	Used to assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency [1]	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates[2]	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency [1]	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] See the specific analytical SOP for type and frequency of sample matrix control samples.

[2] LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 Acceptance Criteria (Control Limits)

As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project specific control limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Once control limits have been established, they are verified, reviewed, and updated if necessary on a semi-annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

Laboratory generated % Recovery acceptance (control) limits are generally established by taking $\pm$ 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

- Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV). (Unless the analytical method specifies a tighter limit).

- In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

- The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5% and the analyte must be detectable and identifiable.

- If either the high or low end of the control limit changes by $\leq$ 5% from previous, the control chart is visually inspected and, using professional judgment, the limit(s) may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.1 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical control limits. Refer to Denver SOP DV-QA-003P, *Quality Assurance Program* for a detailed description of the control charting procedure.

24.6.2 A LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with a LCS with recoveries outside of the acceptance limits may be determined as out of control and should be reanalyzed if possible. If reanalysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal corrective action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without reanalysis if:

- The analyte results are below the reporting limit and the LCS is above the upper control limit.

- If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Or, for TNI and Department of Defense (DoD) work, there are an allowable number of Marginal Exceedances (ME):

<11 analytes	0 marginal exceedances are allowed.
11 – 30 Analytes	1 marginal exceedance is allowed
31-50 Analytes	2 marginal exceedances are allowed
51-70 Analytes	3 marginal exceedances are allowed
71-90 Analytes	4 marginal exceedances are allowed
> 90 Analytes	5 marginal exceedances are allowed

- Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (TNI).

- Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.3 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and reanalyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.4 If a surrogate standard falls outside the acceptance limits, if there is not obvious chromatographic matrix interference, reanalyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the reanalysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client). Under certain circumstances, where all of the samples are from the same location and share similar chromatography, the reanalysis may be performed on a single sample rather than all of the samples and if the surrogate meets the recovery criteria in the reanalysis, all of the affected samples would require reanalysis.

24.7 Additional Procedures to Assure Quality Control

The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21) and use of PT samples (see Section 15).

A discussion regarding MDLs, Limit of Detection (LOD) and Limit of Quantitation (LOQ) can be found in Section 19.

- Use of formulae to reduce data is discussed in the method SOPs and in Section 20.
- Selection of appropriate reagents and standards is included in Section 9 and 21.
- A discussion on selectivity of the test is included in Section 5.
- Constant and consistent test conditions are discussed in Section 18.
- The laboratories sample acceptance policy is included in Section 23.

SECTION 25. REPORTING RESULTS

25.1 Overview

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory will work with the client during project set up to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client. Review of reported data is included in Section 19.

25.2 Test Reports

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed on laboratory letterhead, reviewed, and signed by the appropriate project manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title (e.g., Analytical Report For Samples) with a "sample results" column header.

25.2.2 Each report cover page printed on company letterhead, which includes the laboratory name, address and telephone number.

25.2.3 A unique identification of the report (e.g. job number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented as page # of ##. Where the first number is the page number and the second is the total number of pages.

25.2.4 A copy of the chain of custody (COC).

- Any COCs involved with Subcontracting are included.

25.2.5 The name and address of client and a project name/number, if applicable.

25.2.6 Client project manager or other contact

25.2.7 Description and unambiguous identification of the tested sample(s) including the client identification code.

25.2.8 Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis if the required holding time for either activity is less than or equal to 72 hours.

25.2.9 Date reported or date of revision, if applicable.

25.2.10 Method of analysis including method code (EPA, Standard Methods, etc).

25.2.11 Reporting Limits

25.2.12 Method detection limits (if requested)

25.2.13 Definition of Data qualifiers and reporting acronyms (e.g. ND).

25.2.14 Sample results.

25.2.15 QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits.

25.2.16 Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (Refer to Sec. 25.2.4 – Item 3 regarding additional addenda).

25.2.17 A statement expressing the validity of the results, that the source methodology was followed and all results were reviewed for error.

25.2.18 A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.

25.2.19 A statement that the report shall not be reproduced except in full, without prior express written approval by the laboratory coordinator

25.2.20 A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.

25.2.21 When TNI accreditation is required, the lab shall certify that the test results meet all requirements of TNI or provide reasons and/or justification if they do not.

25.2.22 The laboratory includes a cover letter.

25.2.23 Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.

25.2.24 When soil samples are analyzed, a specific identification as to whether soils are reported on a "wet weight" or "dry weight" basis.

25.2.25 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.26 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report (e.g., partial report). A complete report must be sent once all of the work has been completed.

25.2.27 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

25.2.28 Non-accredited tests shall be clearly identified in the case narrative when claims of accreditation to the TNI standard are made.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy (CA-I-P-002) for details on internally applying electronic signatures of approval.

25.3 Reporting Level or Report Type

The laboratory offers four levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Level I is a report with the features described in Section 25.2 above. TestAmerica Denver rarely utilizes this report.
- Level II is a Level I report plus summary information, including results for the method blank reported to the laboratory MDL, percent recovery for laboratory control samples and matrix spike samples, and the RPD values for all MSD and sample duplicate analyses.
- Level III contains all the information supplied in Level II, but presented on the CLP-like summary forms, and relevant calibration information. A Level II report is not included, unless specifically requested. No raw data are provided.
- Level IV is the same as Level III with the addition of all raw supporting data.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Initial reports may be provided to clients by facsimile. All faxed reports are followed by hardcopy. Procedures used to ensure client confidentiality are outlined in Section 25.6.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica's services. The Denver laboratory offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), Excel, Dbase, GISKEY, SEDD 2A, and Text Files.

EDD specifications are submitted to the IT department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs shall be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 Supplemental Information for Test

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet TNI sample acceptance requirements such as improper container, holding time, or temperature.

Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response will be fully documented, and reviewed by the Laboratory

Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

Note: Review of data deliverable packages for submittal to regulatory authorities requires responses to non-conforming data concerning potential impact on data quality. This necessitates a limited scope of interpretation, and this work is performed by the QA Department. This is the only form of "interpretation" of data that is routinely performed by the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 Environmental Testing Obtained From Subcontractors

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP on Subcontracting (SOP CA-L-S-002).

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of TestAmerica are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 Client Confidentiality

In situations involving the transmission of environmental test results by telephone, facsimile or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the Client or any other person designated by the Client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the Client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

This material is intended only for the use of the individual(s) or entity to whom it is addressed, and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering this material to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify us immediately by telephone at 1-800-765-0980 (or for e-mails: please notify us immediately by e-mail or by phone (1-800-765-0980) and delete this material from any computer).

25.7 Format of Reports

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 Amendments to Test Reports

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

The revised report is retained on the Archive data server, as is the original report. The revised report is stored in the Archive data server under the job number followed by "Rev#".

When the report is re-issued, a notation of "revised report "is placed on the cover/signature page of the report *or at the top of the narrative page* with a brief explanation of reason for the re-issue and a reference back to the last final report generated. *For Example*: *Report was revised on 11/3/08 to include toluene in sample NQA1504 per client's request.*

25.9 Policies on Client Requests for Amendments

25.9.1 Policy on Data Omissions or Reporting Limit Increases

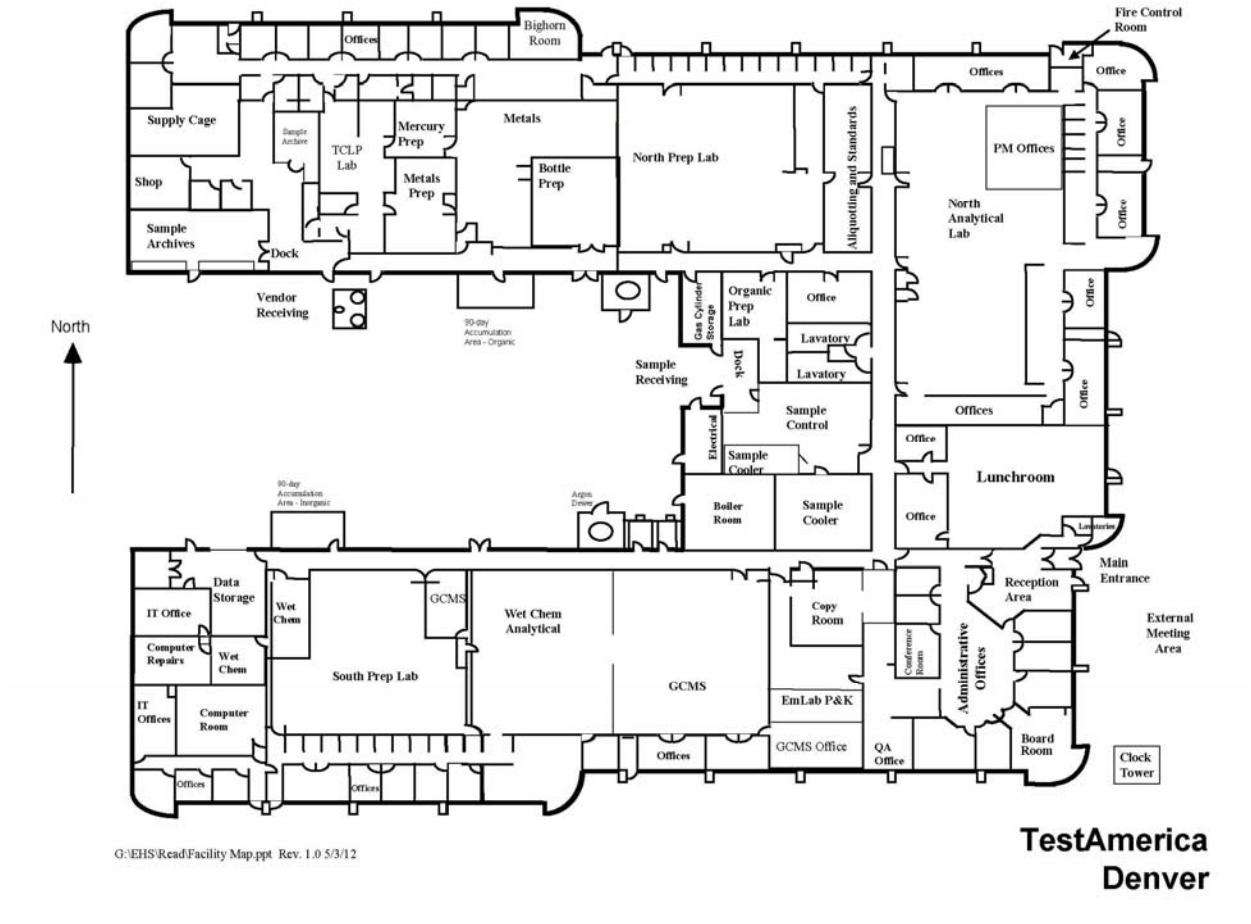
Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

- Laboratory error.
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements.
- The requested change has absolutely *no possible* impact on the interpretation of the analytical results and there is *no possibility* of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1. Laboratory Floor Plan



Appendix 2. Glossary/Acronyms (EL-V1M2 Sec. 3.1)

Glossary:

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Aliquot, aliquant: A measured portion of a sample taken for analysis.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis. (TNI)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation). (TNI)

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives. (TNI)

Batch: Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one (1) to twenty (20) environmental samples of the same quality systems matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be twenty-four (24) hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various quality system matrices and can exceed twenty (20) samples. (TNI)

Bias: The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). (TNI)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (TNI)

1) In calibration of support equipment the values realized by standards are established through the use of reference standards that are traceable to the International System of Units (SI).

2) In calibration according to methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.

Calibration Curve: The mathematical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (TNI)

Calibration Standard: A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM): A reference material accompanied by certificate, having a value, measurement uncertainty, and stated metrological traceability chain to a national metrology institute. (TNI)

Chain of Custody (COC) Form: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses. (TNI)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. TNI and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to Second Column Confirmation; Alternate wavelength; Derivatization; Mass spectral interpretation; Alternative detectors or Additional Cleanup procedures. (TNI)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction: Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis**.** No significant action is taken to change behavior, process or procedure.

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data re of acceptable quality (i.e., that they meet specified acceptance criteria).

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collation into a more useable form. (TNI)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision. (TNI)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity if performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank: Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures.

External Standard Calibration: Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Field Blank: Blank prepared in the field by filing a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Holding Times: The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (TNI)

Internal Standard Calibration: Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ± 100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS shall be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to determine batch acceptance.

Least Squares Regression (1st Order Curve): The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit(s) of Detection (LOD) [a.k.a., Method Detection Limit (MDL)]: A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect in their facility. (TNI)

LOD Verification [a.k.a., MDL Verification]: A processed QC sample in the matrix of interest, spiked with the analyte at no more than 3X the LOD for single analyte tests and 4X the LOD for multiple analyte tests and processed through the entire analytical procedure.

Limit(s) of Quantitation (LOQ) [a.k.a., Reporting Limit]: The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. (TNI)

(QS) Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: Any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-Aqueous Liquid: Any organic liquid with <15% settleable solids.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Solids: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.

Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.

Air & Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (TNI)

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared and analyzed to obtain a measure of the precision of the recovery for each analyte.

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (TNI)

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis. (TNI)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (TNI)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (TNI)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within specified acceptance criteria. (TNI)

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type of quality needed and expected by the client. (TNI)

Quality Assurance [Project] Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control: The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against “out of control” conditions and ensuring that the results are of acceptable quality. (TNI)

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control. (TNI)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (TNI)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC activities. (TNI)

Raw Data: The documentation generated during sampling and analysis. This documentation includes, but is not limited to, field notes, electronic data, magnetic tapes, untabulated sample results, QC sample results, print outs of chromatograms, instrument outputs, and handwritten records. (TNI)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Material: Material or substance one or more properties of which are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (TNI)

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or a given location. (TNI)

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system. (TNI)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (TNI)

Spike: A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies. (TNI)

Standard Operating Procedures (SOPs): A written document which details the method for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks. (TNI)

Storage Blank: A blank matrix stored with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and shall be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Manager: A member of the staff of an environmental laboratory who exercises actual day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (TNI)

Trip Blank: A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Uncertainty: A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

Acronyms:

CAR – Corrective Action Report
CCV – Continuing Calibration Verification
CF – Calibration Factor
CFR – Code of Federal Regulations
COC – Chain of Custody
DOC – Demonstration of Capability
DQO – Data Quality Objectives
DUP - Duplicate
EHS – Environment, Health and Safety
EPA – Environmental Protection Agency
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
HPLC - High Performance Liquid Chromatography
ICP - Inductively Coupled Plasma Atomic Emission Spectroscopy
ICP/MS – ICP/Mass Spectrometry
ICV – Initial Calibration Verification
IDL – Instrument Detection Limit
IH – Industrial Hygiene
IS – Internal Standard
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LIMS – Laboratory Information Management System
LOD – Limit of Detection
LOQ – Limit of Quantitation
MDL – Method Detection Limit
MDLCK – MDL Check Standard
MDLV – MDL Verification check standard
MRL – Method Reporting Limit Check Standard
MS – Matrix Spike
MSD – Matrix Spike Duplicate
MSDS - Material Safety Data Sheet
NELAP - National Environmental Laboratory Accreditation Program
PT – Performance Testing
QAM – Quality Assurance Manual
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan

RF – Response Factor
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
SD – Standard Deviation
SOP – Standard Operating Procedure
TAT – Turn-Around-Time
TNI – The NELAC Institute
VOA – Volatiles
VOC – Volatile Organic Compound

Appendix 3. Laboratory Certifications, Accreditations, Validations

TestAmerica Denver maintains accreditations, certifications, and approvals with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Certifications

Laboratory	Program	Authority	Identification	Expiration Date
TestAmerica Denver	A2LA	Wyoming (UST)		10/31/2013
TestAmerica Denver	DoD ELAP	A2LA	2907.01	10/31/2013
TestAmerica Denver	Federal	USDA	P330-13-00202	07/02/2016
TestAmerica Denver	ISO/IEC 17025	A2LA	2907.01	10/31/2013
TestAmerica Denver	NELAP	Florida	E87667	06/30/2014
TestAmerica Denver	NELAP	Illinois	200017	04/30/2014
TestAmerica Denver	NELAP	Kansas	E-10166	04/30/2014
TestAmerica Denver	NELAP	Louisiana	02096	08/01/2013
TestAmerica Denver	NELAP	Minnesota	8-999-405	12/31/2013
TestAmerica Denver	NELAP	New Hampshire	205310	04/28/2014
TestAmerica Denver	NELAP	New Jersey	CO004	06/30/2014
TestAmerica Denver	NELAP	New York	11964	04/01/2014
TestAmerica Denver	NELAP	Oregon	CO200001	01/16/2014
TestAmerica Denver	NELAP	Pennsylvania	68-00664	08/01/2013
TestAmerica Denver	NELAP	Texas	T104704183-08-TX	09/30/2013
TestAmerica Denver	NELAP	Utah	CO000262012-4	08/01/2013
TestAmerica Denver	NELAP	Virginia	460232	06/14/2014
TestAmerica Denver	State Program	Alabama	40730	09/30/2013
TestAmerica Denver	State Program	Alaska (UST)	UST-30	04/05/2014
TestAmerica Denver	State Program	Arizona	AZ0713	12/19/2013
TestAmerica Denver	State Program	Arkansas DEQ	88-0687	08/01/2013
TestAmerica Denver	State Program	Colorado	N/A	09/30/2013
TestAmerica Denver	State Program	Connecticut	PH-0686	09/30/2014
TestAmerica Denver	State Program	Idaho	CO00026	09/30/2013
TestAmerica Denver	State Program	Iowa	370	12/01/2014
TestAmerica Denver	State Program	Maine	CO0002	03/03/2015
TestAmerica Denver	State Program	Maryland	268	03/31/2014
TestAmerica Denver	State Program	Nevada	CO0026	08/01/2013
TestAmerica Denver	State Program	New Mexico	CO00026	06/30/2014
TestAmerica Denver	State Program	North Carolina DENR	358	12/31/2013
TestAmerica Denver	State Program	North Dakota	R-034	06/30/2014
TestAmerica Denver	State Program	Oklahoma	8614	08/31/2013
TestAmerica Denver	State Program	South Carolina	72002	08/01/2013
TestAmerica Denver	State Program	Washington	C583	08/03/2013
TestAmerica Denver	State Program	West Virginia DEP	354	11/30/2013
TestAmerica Denver	State Program	Wisconsin	999615430	08/31/2013

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* Certification Valid - Laboratory is Pending Renewal with the Program Authority

For more information, or to contact a local TestAmerica representative nearest you, please visit our website at www.testamericainc.com

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The certificates and parameter lists (which may differ) are available, upon request, from a laboratory representative. for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, marketing, and project management.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

TESTAMERICA DENVER
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Arvada, CO 80002
Margaret S. Sleevi Phone: 303-736-0100
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ENVIRONMENTAL

Valid To: October 31, 2015 Certificate Number: 2907.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality Systems Manual for Environmental Laboratories), and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Atomic Absorption/ICP-AES Spectrometry, ICP/MS, Gas Chromatography, Gas Chromatography/Mass Spectrometry, Gravimetry, High Performance Liquid Chromatography, Ion Chromatography, Misc.- Electronic Probes (pH, O_2), Oxygen Demand, Hazardous Waste Characteristics Tests, Spectrophotometry (Visible), Spectrophotometry (Automated), Titrimetry, Total Organic Carbon, Total Organic Halide

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Metals				
Aluminum	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Antimony	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Arsenic	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Barium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Beryllium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Boron	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Cadmium	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A

5301 Buckeystown Pike, Suite 350 | Frederick, Maryland 21704-8373 | Phone: 301 644 3248 | Fax: 301 662 2974 | www.A2LA.org

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Calcium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Chromium	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Cobalt	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Copper	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Iron	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Lead	EPA 6010C	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Lithium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Magnesium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Manganese	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Mercury	----------	----------	EPA 7470A	EPA 7471A / 7471B
Molybdenum	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nickel	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Potassium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Selenium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Silica	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Silicon	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Silver	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Sodium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Strontium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Thallium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Tin	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Titanium	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Vanadium	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Zinc	----------	----------	EPA 6010B / 6010C / 6020 / 6020A	EPA 6010B / 6010C / 6020 / 6020A
Nutrients				
Nitrate (as N)	----------	By calculation	By calculation / EPA 9056 / 9056A	By calculation / EPA 9056 / 9056A
Nitrate-nitrite (as N)	----------	EPA 353.2	EPA 353.2 / 9056 / 9056A	EPA 9056 / 9056A
Nitrite (as N)	----------	SM 4500-NO2 B	SM 4500-NO2 B; EPA 9056 / 9056A	EPA 9056 / 9056A
Orthophosphate (as P)	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Total phosphorus	----------	----------	EPA 6010B / 6010C	EPA 6010B / 6010C
Demands				
Total Organic Carbon	----------	----------	EPA 9060 / 9060A	EPA 9060 / 9060A
Total Organic Halides	----------	----------	EPA 9020B	----------
Wet Chemistry				----------
Alkalinity (Total Bicarbonate, Carbonate, and Hydroxide Alkalinty)	----------	SM 2320 B_1997	SM 2320 B	SM 2320 B
Ammonia	----------	EPA 350.1	EPA 350.1	----------
Biological Oxygen Demand	----------	SM 5210B	SM 5210B	----------
Bromide	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Chloride	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Chemical Oxygen Demand	----------	EPA 410.4	EPA 410.4	
Conductivity	----------	----------	EPA 9050 / 9050A	EPA 9050 / 9050A
Cyanide	----------	----------	9012A / 9012B	9012A / 9012B
Ferrous Iron	----------	SM 3500 Fe B, D	SM 3500 Fe B, D	----------
Fluoride	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Hexavalent Chromium	EPA 7196A	----------	EPA 7196A	----------
pH	----------	----------	EPA 9040B / 9045C	EPA 9040B / 9045C
Oil and Grease (HEM and SGT-HEM)	----------	----------	EPA 1664A/ 1664B	9071B
Percent Moisture	----------	----------	----------	ASTM D2216
Perchlorate	----------	----------	EPA 6860	EPA 6860
Phenols	----------	----------	EPA 9066	EPA 9066
Solids, Total	----------	SM 2540 B	SM 2540 B	SM 2540 B
Solids, Total Suspended	----------	SM 2540 D	SM 2540 D	SM 2540 D
Solids, Total Dissolved	----------	SM 2540 C	SM 2540 C	SM 2540 C
Sulfate	----------	----------	EPA 9056 / 9056A	EPA 9056 / 9056A
Sulfide, Total	----------	----------	EPA 9034	EPA 9034
Sulfide	----------	----------	EPA 9030B	EPA 9030B
Total Kjeldahl Nitrogen	----------	----------	EPA 351.2	----------

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Purgeable Organics (volatiles)				----------
Acetone	----------	----------	EPA 8260B	EPA 8260B
Acetonitrile	----------	----------	EPA 8260B	EPA 8260B
Acrolein	----------	----------	EPA 8260B	EPA 8260B
Acrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Allyl Chloride	----------	----------	EPA 8260B	EPA 8260B
tert-Amyl Methyl Ether	EPA 8260B			
Benzene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B / AK101/ OK DEQ GRO
Bromobenzene	----------	----------	EPA 8260B	EPA 8260B
Bromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromodichloromethane	----------	----------	EPA 8260B	EPA 8260B
Bromoform	----------	----------	EPA 8260B	EPA 8260B
Bromomethane	----------	----------	EPA 8260B	EPA 8260B
2-Butanone	----------	----------	EPA 8260B	EPA 8260B
n-Butyl alcohol	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
tert-Butyl alcohol	EPA 8260B			
n-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
sec-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
tert-Butylbenzene	----------	----------	EPA 8260B	EPA 8260B
Carbon disulfide	----------	----------	EPA 8260B	EPA 8260B
Carbon tetrachloride	----------	----------	EPA 8260B	EPA 8260B
Chlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
2-Chloro-1,3-butadiene	----------	----------	EPA 8260B	EPA 8260B
Chloroethane	----------	----------	EPA 8260B	EPA 8260B
2-Chloroethyl vinyl ether	----------	----------	EPA 8260B	EPA 8260B
Chloroform	----------	----------	EPA 8260B	EPA 8260B
1-Chlorohexane	----------	----------	EPA 8260B	EPA 8260B
Chloromethane	----------	----------	EPA 8260B	EPA 8260B
Chloroprene	----------	----------	EPA 8260B	EPA 8260B
4-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
2-Chlorotoluene	----------	----------	EPA 8260B	EPA 8260B
Cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Cyclohexanone	----------	----------	EPA 8260B	EPA 8260B
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dibromo-3-chloropropane (DBCP)	----------	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
Dibromochloromethane	----------	----------	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	----------	----------	EPA 8260B	EPA 8260B
Dibromomethane	----------	----------	EPA 8260B	EPA 8260B
1,2 Dibromoethane (EDB)	EPA 8011	EPA 504	EPA 504 / 8260B / 8011	EPA 8260B / 8011
1,2-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
1,3-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
1,4-Dichlorobenzene	----------	----------	EPA 8260B / 8021B	EPA 8260B / 8021B
cis-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
trans-1,4-Dichloro-2-butene	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	----------	EPA 8260B	EPA 8260B
1,1-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
cis-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	----------	----------	EPA 8260B	EPA 8260B
Dichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
2,2-Dichloropropane	----------	----------	EPA 8260B	EPA 8260B
1,1-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	----------	----------	EPA 8260B	EPA 8260B
Diethyl ether	----------	----------	EPA 8260B	EPA 8260B
Di-isopropylether	EPA 8260B	----------	EPA 8260B	EPA 8260B
1,4-Dioxane	----------	----------	EPA 8260B / 8260B SIM	EPA 8260B / 8260B SIM
Ethanol	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Ethyl Acetate	----------	----------	EPA 8260B	EPA 8260B
Ethyl Benzene	EPA 8260B/8021B	----------	EPA 8260B / 8021B / AK101/ OK DEQ GRO	EPA 8260B / 8021B/ AK101/ OK DEQ GRO
Ethyl Methacrylate	----------	----------	EPA 8260B	EPA 8260B
Ethyl tert-Butyl Ether	EPA 8260B			
Ethylene Glycol	----------	----------	EPA 8015C	EPA 8015C
Gas Range Organics (GRO)	EPA 8015C	----------	EPA 8015B / 8015C / AK101 / 8015D	EPA 8015B / 8015C / AK101 / 8015D
Hexane	----------	----------	EPA 8260B	EPA 8260B
2-Hexanone	----------	----------	EPA 8260B	EPA 8260B
Hexachlorobutadiene	----------	----------	EPA 8260B	EPA 8260B
Isobutyl Alcohol (2-Methyl-1-propanol)	----------	----------	EPA 8260B / 8015B / 8015C	EPA 8260B / 8015B / 8015C
Isopropyl Alcohol	----------	----------	EPA 8260B	EPA 8260B
Isopropylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,4-Isopropyltoluene	----------	----------	EPA 8260B	EPA 8260B
Iodomethane	----------	----------	EPA 8260B	EPA 8260B
Methacrylonitrile	----------	----------	EPA 8260B	EPA 8260B
Methanol	----------	----------	EPA 8015B / 8015C	EPA 8015B / 8015C
Methyl Acetate	----------	----------	EPA 8260B	EPA 8260B
Methyl Cyclohexane	----------	----------	EPA 8260B	EPA 8260B
Methylene Chloride	----------	----------	EPA 8260B	EPA 8260B
Methyl Ethyl Ketone (MEK)	----------	----------	EPA 8260B	EPA 8260B
Methyl Isobutyl Ketone	----------	----------	EPA 8260B	EPA 8260B
Methyl Methacrylate	----------	----------	EPA 8260B	EPA 8260B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Methyl tert-Butyl Ether (MtBE)	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / OK DEQ GRO	EPA 8260B / 8021B/ OK DEQ GRO
4-Methyl-2-Pentanone	----------	----------	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B / 8021B	----------	EPA 8260B/ OK DEQ GRO	EPA 8260B / OK DEQ GRO
2-Nitropropane	----------	----------	EPA 8260B	EPA 8260B
2,2' Oxybisethanol	----------	----------	EPA 8015C	EPA 8015C
2-Pentanone	----------	----------	EPA 8260B	EPA 8260B
Propionitrile	----------	----------	EPA 8260B	EPA 8260B
n-Propylbenzene	----------	----------	EPA 8260B	EPA 8260B
Propylene Glycol	----------	----------	EPA 8015C	EPA 8015C
Styrene	----------	----------	EPA 8260B	EPA 8260B
1,1,1,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	----------	----------	EPA 8260B	EPA 8260B
Tetrachloroethene	----------	----------	EPA 8260B	EPA 8260B
Tetrahydrofuran	----------	----------	EPA 8260B	EPA 8260B
Toluene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Total Petroleum Hydrocarbons (TPH)	----------	EPA 1664A EPA 1664B	EPA 1664A EPA 1664B	----------
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
1,1,2-Trichloroethane	----------	----------	EPA 8260B	EPA 8260B
Trichloroethene	----------	----------	EPA 8260B	EPA 8260B
Trichlorofluoromethane	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	----------	EPA 504.1	EPA 504.1 / 8260B / 8011	EPA 8260B / 8011
1,1,2-Trichloro-1,2,2-trifluoroethane	----------	----------	EPA 8260B	EPA 8260B
Triethylene Glycol	----------	----------	EPA 8015C	EPA 8015C
1,2,3-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	----------	----------	EPA 8260B	EPA 8260B
Vinyl Acetate	----------	----------	EPA 8260B	EPA 8260B
Vinyl Chloride	----------	----------	EPA 8260B	EPA 8260B
Xylenes, total	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
1,2-Xylene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
M+P-Xylene	EPA 8260B / 8021B	----------	EPA 8260B / 8021B / AK101 / OK DEQ GRO	EPA 8260B / 8021B / AK101 / OK DEQ GRO
Methane	----------	----------	RSK-175	----------
Ethane	----------	----------	RSK-175	----------
Ethylene (Ethene)	----------	----------	RSK-175	----------
Acetylene	----------	----------	RSK-175	----------

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Acetylene Ethane	----------	----------	RSK-175	----------
Extractable Organics (semivolatiles)				
Acenaphthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acenaphthylene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Acetophenone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Acetylaminofluorene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Alachlor	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Aminobiphenyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Aniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Aramite	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Atrazine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Azobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzaldehyde	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzoic acid	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Benzo (a) Anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (b) Fluoranthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (k) Fluoranthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (ghi) Perylene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzo (a) Pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Benzyl Alcohol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethoxy) methane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroethyl) Ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Bis (2-chloroisopropyl) Ether (2,2'Oxybis(1-chloropropane)	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Bis (2-ethylhexyl) Phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Bromophenyl Phenyl Ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Butyl Benzyl Phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-sec-Butyl-4,6-Dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Carbazole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloroanilene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Chlorobenzilate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chloro-3-Methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Chloronaphthalene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chloronaphthalene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Chlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Chlorophenyl Phenyl Ether	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Chrysene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Cresols	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diallate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dibenzo (a,h) Anthracene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Dibenzofuran	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3'-Dichlorobenzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diethyl phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethoate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3,3-Dimethylbenzidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
p-Dimethylaminoazobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
7,12-Dimethylbenz(a)anthracene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Alpha-,alpha-Dimethylphenethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dimethylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Dimethyl Phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-Butyl Phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Di-n-Octyl Phthalate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3-Dinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4-Dinitrotoluene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,6-Dinitrotoluene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,4-Dioxane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diphenylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2-Diphenylhydrazine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Disulfoton	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Diesel Range Organics (DRO)	EPA 8015C	----------	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO	EPA 8015B / 8015C, AK102, TX 1005 / 8015D / OK DEQ DRO
Ethyl Methanesulfonate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Famphur	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Fluoroanthene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Fluorene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Gasoline Range Organics	----------	----------	TX 1005 / OK DEQ GRO	TX 1005 / OK DEQ GRO
Hexachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorobutadiene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachlorocyclopentadiene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Hexachloroethane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Hexachloropropene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Indeno (1,2,3-cd) Pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Isodrin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Isophorone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Isosafrole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Methapyrilene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Methylcholanthrene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methyl-4,6-Dinitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Methyl Methane Sulfonate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Methylcholanthrene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Methylnaphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylnaphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
2-Methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3+4-Methylphenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Naphthalene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
1,4-Naphthoquinone	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1-Naphthylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Naphthylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
3-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitroaniline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Nitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
4-Nitrophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Nitroquinoline-1-Oxide	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
N-Nitrosodiethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodimethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-Butylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodi-n-Propylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosodiphenylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomethylethylamine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosomorpholine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopiperidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
N-Nitrosopyrrolidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
5-Nitro-o-Toluidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,2-oxybis(1-chloropropane)	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, Methyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Parathion, Ethyl	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloroethane	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachloronitobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pentachlorophenol	----------	----------	EPA 8270C / 8270D / 8321A / 8321B	EPA 8270C / 8270D / 8321A / 8321B
Phenacetin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Phenanthrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Phenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Phorate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2-Picoline	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pronamide	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Pyrene	----------	----------	EPA 8270C / 8270D / 8270SIM	EPA 8270C / 8270D / 8270SIM
Pyridine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Safrole	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Sulfotepp	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4,5-Tetrachlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,3,4,6-Tetrachlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Thionazin	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
o-Toluidine	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,2,4-Trichlorobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,5-Trichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
2,4,6-Trichlorophenol	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
o,o,o-Triethyl Phosphorothioate	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
1,3,5-Trinitrobenzene	----------	----------	EPA 8270C / 8270D	EPA 8270C / 8270D
Motor Oil (Residual Range Organics)	----------	----------	EPA 8015B / 8015C, AK103 / OK DEQ RRO	EPA 8015B / 8015C, AK103 / OK DEQ RRO
Pesticides/Herbicides/PCBs				
Aldrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Atrazine	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos ethyl	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Azinophos methyl	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
beta-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
delta-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
gamma-BHC	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Bolstar	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
alpha-Chlordane	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
gamma-Chlordane	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Chlordane (technical)	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Chloropyrifos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Coumaphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4-D	----------	----------	EPA 8151A / 8321A	EPA 8151A /8321A
Dalapon	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
2,4-DB	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
4,4'-DDD	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDE	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
4,4'-DDT	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Demeton-O	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton-S	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Demeton, total	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Diazinon	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dicamba	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Dichlorovos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dichloroprop	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Dieldrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Dimethoate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Dinoseb	----------	----------	EPA 8151A / 8321A	EPA 8321A
Disulfoton	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Endosulfan I	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endosulfan II	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endonsulfan sulfate	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin aldehyde	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Endrin ketone	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
EPN	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Ethoprop	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Ethyl Parathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Famphur	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Fensulfothion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Fenthion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Heptachlor	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Heptachlor Epoxide	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Hexachlorobenzene	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Malathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
MCPA	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
MCPP	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Merphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Methoxychlor	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Methyl parathion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Mevinphos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Naled	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
PCB-1016 (Arochlor)	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1221	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1232	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1242	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1248	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1254	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1260	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1262	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
PCB-1268	----------	----------	EPA 8082 / 8082A	EPA 8082 / 8082A
Phorate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Phosmet	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Propazine	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Ronnel	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Simazine	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Stirophos	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Sulfotepp	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-T	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Thionazin	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Tokuthion	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
2,4,5-TP	----------	----------	EPA 8151A / 8321A	EPA 8151A / 8321A
Toxaphene	----------	----------	EPA 8081A / 8081B	EPA 8081A / 8081B
Trichloronate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
o,o,o-Triethylphos Phorothioate	----------	----------	EPA 8141A / 8141B	EPA 8141A / 8141B
Explosives				
1,3,5-Trinitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
1,3-Dinitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,4,6-Trinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3,5-Dinitroaniline	----------	----------	EPA 8330B	EPA 8330B
2,4-Dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2,6-Dinitroltoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Amino-4,6-Dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
2-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
3-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Amino-2,6-Dinitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
4-Nitrotoluene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Nitrobenzene	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Nitroglycerin	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Octahydro-1,3,5,7-Tetrabitro-1,3,5,7-Tetrazocine (HMX)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Pentaerythritoltetranitrate (PETN)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Picric acid	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
RDX (Hexahydro-1,3,5-Trinitro-1,3,5-Triazine)	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Tetryl (Methyl 2,4,6-Trinitrophenylnitramine	----------	----------	EPA 8330A / 8330B / 8321A / 8321B	EPA 8330A / 8330B / 8321A / 8321B
Perfluorinated Hydrocarbons (PFCs) and Perfluorinated Sulfonates (PFSs)				
Perfluorobutanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoropentanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroheptanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorononanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluoroundecanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorododecanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotridecanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorotetradecanoic Acid	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorobutane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorohexane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorodecane Sulfonate	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Perfluorooctane Sulfonamide	----------	SOP DV-LC-0012	SOP DV-LC-0012	SOP DV-LC-0012
Hazardous Waste Characteristics				
Conductivity	----------	----------	EPA 9050A	EPA 9050A
Corrosivity	----------	----------	EPA 9040B	9045C
Ignitibility	----------	EPA 1010/EPA 1010A	EPA 1010 / 1010A	EPA 1010 / 1010A
Paint Filter Liquids Test	----------	----------	EPA 9095A	EPA 9095A
Synthetic Precipitation Leaching Procedure (SPLP)	----------	----------	EPA 1312	EPA 1312

Parameter/Analyte	WY Storage Tank Program	Non-Potable Water	Solid Hazardous Waste (Water)	Solid Hazardous Waste (Solid)
Toxicity Characteristic Leaching Procedure	----------	----------	EPA 1311	EPA 1311
Organic Prep Methods				
Separatory Funnel Liquid-Liquid Extraction	----------	----------	EPA 3510C	----------
Continuous Liquid-Liquid Extraction	----------	----------	EPA 3520C	----------
Soxhlet Extraction	----------	----------	----------	EPA 3540C
Microwave Extraction	----------	----------	----------	EPA 3546
Ultrasonic Extraction	----------	----------	----------	EPA 3550B
Ultrasonic Extraction	----------	----------	----------	EPA 3550C
Waste Dilution	----------	----------	EPA 3580A	EPA 3580A
Solid Phase Extraction Volatiles Purge and trap Volatiles Purge and Trap for Soils	----------	----------	EPA 3535A EPA 5030B	EPA 5030B EPA 5035
Organic Cleanup Procedures				
Florisil Cleanup	----------	----------	EPA 3620B	EPA 3620B
Florisil Cleanup	----------	----------	EPA 3620C	EPA 3620C
Sulfur Cleanup	----------	----------	EPA 3660B	EPA 3660B
Sulfuric Acid/Permanganate Cleanup	----------	----------	EPA 3665A	EPA 3665A
Metals Digestion				
Acid Digestion Total Recoverable or Dissolved Metals	----------	----------	EPA 3005A	----------
Acid Digestion for Total Metals	----------	----------	EPA 3010A	----------
Acid Digestion for Total Metals	----------	----------	EPA 3020A	----------
Acid Digestion of Sediments, Sludges and Soils	----------	----------	----------	EPA 3050B

American Association for Laboratory Accreditation

Accredited DoD ELAP Laboratory

A2LA has accredited

TESTAMERICA DENVER

Arvada, CO

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2003 NELAC Chapter 5 Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 4.2 of the DoD Quality System Manual for Environmental Laboratories (QSM); accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 5th day of November 2013.

President & CEO
For the Accreditation Council
Certificate Number 2907.01
Valid to October 31, 2015

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

Environmental Laboratory Certification Program

In accordance with the provisions of Regulation 61-81, entitled "State Environmental Laboratory Certification Regulations"

TESTAMERICA DENVER
4955 YARROW ST
ARVADA, COLORADO 80002

is hereby certified to perform analyses as documented on the attached parameter list(s). This certification does not guarantee validity of data generated, but indicates the laboratory's adherence to prescribed methodology, quality control, records keeping, and reporting procedures. This certificate is the property of S.C. DHEC and must be surrendered upon demand. This certificate is non-transferable and is valid only for the parameters and methodology listed on the attached parameter list(s).

Laboratory Director: WILLIAM S CICERO
Certifying Authority: FL
Date of Issue: January 22, 2014
Date of Expiration: June 30, 2014
Certificate Number: 72002001

Director
Office of Environmental Laboratory Certification

CR-010021 2/11

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

TESTAMERICA DENVER (Laboratory ID 72002)
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CLEAN WATER ACT

INORGANIC - DEMAND

BIOCHEMICAL OXYGEN DEMAND(BOD)	SM 5210 B-2011	5 DAY DO DEPLETION
CHEMICAL OXYGEN DEMAND (COD)	EPA 410.4 (1993)	SPECTROPHOTOMETRIC, MANUAL OR AUTOMATED
DISSOLVED OXYGEN	SM 4500-O G-2011	ELECTRODE
TOTAL ORGANIC CARBON (TOC)	SM 5310 B-2011	HIGH TEMPERATURE COMBUSTION (TOC)

INORGANIC - MINERAL

ALKALINITY	SM 2320 B-2011	TITRIMETRIC
CHLORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
HYDROGEN-ION CONC. (PH)	SM 4500-H B-2011	ELECTROMETRIC MEASUREMENT
SPECIFIC CONDUCTANCE	SM 2510 B-2011	CONDUCTANCE AT 25 DEGREES C
SULFATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

SULFIDE	SM 4500-S2 C-2011	SAMPLE PRETREATMENT OR CONCENTRATION
SULFIDE	SM 4500-S2 D-2011	COLORIMETRIC (METHYLENE BLUE)

INORGANIC - NUTRIENT

AMMONIA-NITROGEN	EPA 350.1 (1993)	MANUAL DISTILLATION WITH AUTOMATED PHENATE
KJELDAHL-NITROGEN	EPA 351.2 (1993)	SEMI-AUTOMATED BLOCK DIGESTER COLORIMETRIC
NITRATE-NITRITE (N02&N03)	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540 C-2011	GRAVIMETRIC (180)

INORGANIC - TRACE METAL

ALUMINUM	EPA 200.7 (1994)	ICP/AES
ANTIMONY	EPA 200.7 (1994)	ICP/AES
ARSENIC	EPA 200.7 (1994)	ICP/AES
BARIUM	EPA 200.7 (1994)	ICP/AES
BERYLLIUM	EPA 200.7 (1994)	ICP/AES
BORON	EPA 200.7 (1994)	ICP/AES
CADMIUM	EPA 200.7 (1994)	ICP/AES
CALCIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.7 (1994)	ICP/AES

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CLEAN WATER ACT

INORGANIC - TRACE METAL

COBALT	EPA 200.7 (1994)	ICP/AES
COPPER	EPA 200.7 (1994)	ICP/AES
IRON	EPA 200.7 (1994)	ICP/AES
LEAD	EPA 200.7 (1994)	ICP/AES
MAGNESIUM	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.7 (1994)	ICP/AES
MERCURY	EPA 245.1 (1994)	COLD VAPOR (MANUAL)
MOLYBDENUM	EPA 200.7 (1994)	ICP/AES
NICKEL	EPA 200.7 (1994)	ICP/AES
POTASSIUM	EPA 200.7 (1994)	ICP/AES
SELENIUM	EPA 200.7 (1994)	ICP/AES
SILICA, TOTAL	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.7 (1994)	ICP/AES
THALLIUM	EPA 200.7 (1994)	ICP/AES
VANADIUM	EPA 200.7 (1994)	ICP/AES
ZINC	EPA 200.7 (1994)	ICP/AES

SAFE DRINKING WATER ACT

INORGANIC - NUTRIENT

NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540C (18TH)	GRAVIMETRIC (180)

SYNTHETIC ORGANIC COMPOUNDS (SOCS)

EDB, DBCP AND 1,2,3 TCP BY MICROEXT.-GC	EPA 504.1 (1995)	

SOLID & HAZARDOUS WASTES

INORGANIC - HAZARDOUS WASTE CHARACTERISTICS

TCLP - BOTTLE EXTRACTION	EPA 1311	TOXICITY CHARACTERISTIC LEACHING PROCEDURE
TCLP - ZERO HEADSPACE	EPA 1311	TOXICITY CHARACTERISTIC LEACHING PROCEDURE

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SOLID & HAZARDOUS WASTES

INORGANIC - MINERAL

HYDROGEN-ION CONC. (PH)	EPA 9045D	SOIL AND WASTE

INORGANIC - MISCELLANEOUS

CYANIDE	EPA 9012B	TOTAL AND AMENABLE (COLORIMETRIC, AUTOMATED UV)
TOTAL ORGANIC HALIDES (TOX)	EPA 9020B	MICOULOMETRIC-TITRATION DETECTOR

INORGANIC - TRACE METAL

ALUMINUM	EPA 6010C	ICP/AES
ANTIMONY	EPA 6010C	ICP/AES
ANTIMONY	EPA 6020A	ICP/MS
ARSENIC	EPA 6010C	ICP/AES
ARSENIC	EPA 6020A	ICP/MS
BARIUM	EPA 6010C	ICP/AES
BARIUM	EPA 6020A	ICP/MS
BERYLLIUM	EPA 6010C	ICP/AES
BERYLLIUM	EPA 6020A	ICP/MS
CADMIUM	EPA 6010C	ICP/AES
CADMIUM	EPA 6020A	ICP/MS
CALCIUM	EPA 6010C	ICP/AES
CHROMIUM	EPA 6010C	ICP/AES
CHROMIUM	EPA 6020A	ICP/MS
COBALT	EPA 6010C	ICP/AES
COBALT	EPA 6020A	ICP/MS
COPPER	EPA 6010C	ICP/AES
COPPER	EPA 6020A	ICP/MS
IRON	EPA 6010C	ICP/AES
LEAD	EPA 6010C	ICP/AES
MAGNESIUM	EPA 6010C	ICP/AES
MANGANESE	EPA 6010C	ICP/AES
MERCURY	EPA 7470A	COLD VAPOR TECHNIQUE LIQUID
MERCURY	EPA 7471B	COLD VAPOR TECHNIQUE SOLID
METALS DIGESTION	EPA 3005A	AQUEOUS ACID DIGESTION TOTAL OR DISSOLVED METALS FLAA OR ICP
METALS DIGESTION	EPA 3010A	AQUEOUS ACID DIGESTION TOTAL METALS FLAA OR ICP
METALS DIGESTION	EPA 3050B	SOLID ACID DIGESTION
MOLYBDENUM	EPA 6010C	ICP/AES
NICKEL	EPA 6010C	ICP/AES
NICKEL	EPA 6020A	ICP/MS
POTASSIUM	EPA 6010C	ICP/AES

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SOLID & HAZARDOUS WASTES

INORGANIC - TRACE METAL

SELENIUM	EPA 6010C	ICP/AES
SILVER	EPA 6010C	ICP/AES
SILVER	EPA 6020A	ICP/MS
SODIUM	EPA 6010C	ICP/AES
THALLIUM	EPA 6020A	ICP/MS
TIN	EPA 6010C	ICP/AES
VANADIUM	EPA 6010C	ICP/AES
ZINC	EPA 6010C	ICP/AES
ZINC	EPA 6020A	ICP/MS

PCBS AND PESTICIDES

ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B	EPA 3550C
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B	EPA 3510C

SEMI-VOLATILES

EDB & DBCP BY MICROEXTRACTION AND GC	EPA 8011	
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D	EPA 3520C
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D	EPA 3550C

VOLATILES (VOCS)

VOLATILE ORGANICS BY GC/MS	EPA 8260B	EPA 5035
VOLATILE ORGANICS BY GC/MS	EPA 8260B	EPA 5030B

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SAFE DRINKING WATER ACT

---SYNTHETIC ORGANIC COMPOUNDS (SOCS)---

EPA 504.1 (1995)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

----------PCBS AND PESTICIDES----------

EPA 8081B
EPA 3510C

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIALLATE
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B
EPA 3550C

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
DELTA-BHC
DIALLATE
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE

EPA 8081B
EPA 3550C

GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR

----------SEMI-VOLATILES----------

EPA 8011

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

EPA 8270D
EPA 3520C

1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-NAPHTHOQUINONE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE

EPA 8270D
EPA 3520C

3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANILINE
ANTHRACENE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CHLOROBENZILATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZ0(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE

EPA 8270D
EPA 3520C

DISULFOTON
ETHYL METHANESULFONATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
THIONAZIN

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

TESTAMERICA DENVER (Laboratory ID 72002)
Certifying Authority: FL
Certificate Number: 72002001

Date of Issue: January 22, 2014
Expiration Date: June 30, 2014

SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D
EPA 3550C

1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
ACENAPHTHENE
ACENAPHTHYLENE

EPA 8270D
EPA 3550C

ACETOPHENONE
ANILINE
ANTHRACENE
ARAMITE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CHLOROBENZILATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZ0(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DISULFOTON
ETHYL METHANESULFONATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE

EPA 8270D
EPA 3550C

N-NITROSOMORPHOLINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
THIONAZIN

----------VOLATILES (VOCS)----------

EPA 8260B
EPA 5030B

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER

EPA 8260B
EPA 5030B

2-HEXANONE
2-NITROPROPANE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
ETHANOL
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
ETHYLENE OXIDE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTANOL
NAPHTHALENE
PROPIONITRILE
STYRENE

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

TESTAMERICA DENVER (Laboratory ID 72002)
Certifying Authority: FL
Certificate Number: 72002001

Date of Issue: January 22, 2014
Expiration Date: June 30, 2014

SOLID & HAZARDOUS WASTES

----------VOLATILES (VOCS)----------

EPA 8260B
EPA 5030B

T-BUTYL ALCOHOL
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B
EPA 5035

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-HEXANONE
2-NITROPROPANE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE

EPA 8260B
EPA 5035

BENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
ETHANOL
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
ETHYLENE OXIDE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
N-BUTANOL
NAPHTHALENE
PROPIONITRILE
STYRENE
T-BUTYL ALCOHOL
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE

EPA 8260B
EPA 5035

VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

D H E C
PROMOTE PROTECT PROSPER
Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

January 27, 2014

WILLIAM S CICERO
TESTAMERICA DENVER
4955 YARROW ST
ARVADA, COLORADO 80002

Laboratory ID # 72002
Certificate # 72002001

Dear William S Cicero:

Your certificate and associated parameter/method list(s) are enclosed. These documents now represent the certificate of record for your laboratory. Any certificate(s) and associated parameter list(s) received prior to your receipt of these documents are now null and void and should be destroyed. Please be reminded that all environmental data submitted to the Department is reviewed to ensure that the reporting laboratory possesses the necessary certification. Data reported by laboratories without the proper certification will be addressed by the affected enforcement programs.

If you have any questions or problems are detected concerning your certificate, please contact our office within ten (10) working days at (803)896-0970 or by e-mail at labcerthelp@dhec.sc.gov.

Sincerely,

Carol F. Smith, Director
Office of Environmental Laboratory Certification
Bureau of Environmental Health Services

Enclosures

Register on our website at www.scdhec.gov/labcert to receive e-mail updates for the Laboratory Certification Program. Subscribing is easy and you'll automatically receive new posts to our website.

APPENDIX F

FORMS

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Daily Quality Control Report

Report No.:		**Date:**

Site/Installation Name:	**City:**	**State:**	**Date:**

Weather:

Clear ☐ Fog ☐ Cloudy ☐ Rain ☐ Snow ☐ Windy ☐ _____ mph

Temperature:

Minimum: _____ °F Maximum: _____ °F

Employer:	**Position:**	**Name:**	**Activity:**
	Project Manager		
	Site Manager		
	Senior UXO Supervisor		
	Senior Geophysicist		
	Site Safety and Health Officer		
	UXO Quality Control Specialist		
	UXO Safety Officer		
Team ONE			
Team TWO			
Team THREE			
Team FOUR			

1. Work performed today:

2. Worked performed today by subcontractors:

3. Inspections performed (include name of team present, specifications, plans and submittals required for definable feature of work [DFOW]). Indicate 3-Phase inspection level with: Preparatory = P; Initial = I; Follow-up = F.

Phase	Team Name:	DFOW	Comments

		Grid #	Grid #	Grid #	Grid #	Grid #	Grid #

GRID INSPECTIONS

QC inspections completed today:				QA inspections completed to date:			
Pass	**Fail**	**Total**		**Pass**	**Fail**	**Total**	**Remaining**

DFOW:	**Team (indicate by: UXO = U; or Geo = G; and No:**					**Pass**	**Fail**	**NA**
Proper work attire (PPE)								
Equipment calibration check								
Vehicle condition								
Equipment condition								
Emergency equipment								
Proper grid layout								
Proper search techniques								
Team leader daily log								
SUXOS daily log								
GIS and map data								
Exclusion zone								
Field office interior								
Field office exterior								
Proper demolition operations								
Safety violations								

4. a Soil samples taken:

Pre-Detonation: ☐ No ☐ Yes ☐ None required

Post-Detonation: ☐ No ☐ Yes ☐ None required

5. a Verbal instructions received by the Government representative or client and actions taken:

6. Non-conformances/deficiencies reported:

CERTIFICATION: *I certify the above information is complete and correct and that I, or my representative, have inspected all work identified on this report performed by HGL and our subcontractor(s) and have determined to the best of my knowledge and belief that noted work activities are in compliance with the plans and specifications, except as may be noted above.*	
Contractor Quality Control Systems Manager	Signature

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Quality Control Preparatory Phase Checklist

Contract No.: _____ Date: _____

Definable Feature of Work: _____ Spec. Section: _____

I. Personnel Present:

Government Rep Notified: (circle) Y / N Hours in advance: _____

	Name	Position	Company/Government
1.			
2.			
3.			
4.			
5.			
6.			
7.			

(List additional personnel on reverse side)

II. Submittals

1. Review submittals and/or submittal log. Have all submittals been approved?

   Yes _____ No _____

   If No, what items have not been submitted?

   a. _____

   b. _____

   c. _____

2. Are all materials on hand? Yes _____ No _____

   If No, what items are missing?

   a. _____

   b. _____

   c. _____

3. Check approved submittals against delivered material. (This should be done as material arrives.)

   Comments: _____

III. Material Storage

Are materials stored properly? Yes _____ No _____

If No, what action is taken? _____

_____

IV. Specifications

1. Review each paragraph of specifications.

_____

_____

_____

2. Discuss procedures for accomplishing the work.

_____

_____

_____

3. Clarify any differences.

V. Preliminary Work and Permits

Ensure preliminary work is correct and permits are on file.

If not, what action is taken: _____

_____

_____

VI. Testing

1. Identify test to be performed, frequency, and whom.

_____

_____

2. When is it required? _____

_____

3. Where is it required? _____
4. Review Testing Plan: _____

_____

5. Has the test facility been approved: Yes _____ No _____

If not, what action has been taken?: _____

_____

VII. Safety

1. Review applicable portion of EM 385-1-1. _____

_____

2. Activity Hazard Analysis approved? Yes _____ No _____

VIII. USACE Representative comments during meeting.

_____

_____

_____

_____

_____
QC Manager / Date

This page was intentionally left blank.

Quality Control Initial Phase Checklist

Contract No.: _____ **Date:** _____

Defineable Feature of Work: _____

Reference Contract Drawings: _____

A: Planned attendants:

	NAME	POSITION	COMPANY
1.			
2			
3.			
4.			

B. Materials being used are in strict compliance with the contract plans and specifications:
Yes ☐ No ☐ If not explain:

C. Procedures and/or work methods witness are in strict compliance with the contract specifications:
Yes ☐ No ☐ If not explain:

D. Workmanship is acceptable: Yes ☐ No ☐
State areas where improvement is needed:

E. Safety violation noted: Yes ☐ No ☐
If yes, corrective action taken:

_____ _____
Quality Control Representative **Date**

HGL MR Form 15.11 (Jul 2008)

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Equipment/Instrument Calibration/Maintenance Log

Project Location (Name, City and State):				Contract No:
Team Number:		Instrument Description/Type:		Equipment/Instrument Serial Number:
Date	**Calibration Standard (example, Test Pit)**	**Test results (check box)** Pass	Fail	**Name of Individual**	**Comments or Observations**
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		
		☐	☐		

HGL MR Form 15.16 (Oct 2007)

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Site Daily Production Report

Contract No:	Click here to enter	**Date:**	Click here to enter
Delivery Order No:	Click here to enter	**Report No:**	Click here to enter

1. Location of Work: Enter installation/ name, City and State

2. Personnel Summary:

Position/Company	Position/Team Assigned	Name

3. Manpower Summary

Position	Total Positions Assigned	Hours Per Position	Total Hours
Site Manager			
SUXOS			
UXOSO			
UXOQCS			
UXO Technician III			
UXO Technician II			
UXO Technician I			
UXO Sweep Personnel			
Geophysical Personnel			
Subcontractors			

4. Work Summary

Work Activity	Daily Total	Weekly Total	Project Total
Anomalies Dug			
Grids Completed			
Grids QC'd			
Grids QA'd			
Summary of today's work activities:			

5. Inspections:

Inspection	Total Daily		Total Weekly		Total Project	
	Pass	Fail	Pass	Fail	Pass	Fail
Grids QC's						
Grids QA'd						
Safety						

6. Explosive Usage:

Item	Quantity	Comments

7. MEC Summary:

Item	Grid	Classification			Disposition
		UXO	MPPEH	DMM	

8. Non-MEC Scrap (pounds).

Type	Daily Total (lbs)	Weekly Cumulative Total	Project Total
Munitions Debris (MD)			
Cultural Debris (CD)			
Range Related Debris (RRD)			

9. Equipment Usage:

Item Description	Quantity	Hours (each)	Total Hours	Comments (Rent/Own)
Truck, pickup, 4x4				
Suburban, 4x4				
Mini Track Hoe				
Radio, handheld				
Radio, truck mount				
Radio, base station				
Radio, Repeater				
White XLT				
Schonstedt				
Camera, digital				
Range finder				
Lightning detector				
PDA/GPS				
GPS RTK Rover				
First aid kit				

Team gear				
Demo kit				
Site Safety Officer Kit				
Computer, laptop				
Computer, desktop				
Printer/copier/scanner/fax				
Telephone				
Cellular Telephones				

10. Discrepancies.

11. Guidance or Instructions Received From Client.

12. Attachment Summary.

13. Continuation/other.

14. Signature.

CERTIFICATION: I certify the above information is complete and correct and that I, and have determined to the best of my knowledge and belief that noted work activities are in compliance with the plans and specifications, except as may be noted above.	
Site Manager or SUXOS	Signature

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Munitions and Explosives of Concern/Unexploded Ordnance Accountability Record

Site Location:			
Contract Number:		**Delivery/Task Order Number:**	

Grid Coordinates	Anomaly No.	Identification	Date Located	Date Disposed	Method of Disposal	Comments

Reviewed and Accepted (print name)	**Senior UXO Supervisor Signature**	**Date**

HGL MR Form 15.04 (Nov 2010)

Page _____ of _____

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Magazine Data Card

HydroGeoLogic, Inc
MUNITIONS RESPONSE TEAM

Magazine Data Card—
Daily Summary of Magazine Transactions

Nomenclature/Brand Name of Manufacturer:	Lot No./Manufacturer Mark:	Hazard Class/Division:
Site Name:	Grid No./Lat/Long Coord:	Contract No.:

Date	Quantity Received	Quantity Issued	Current Balance	Signatures	
				Conducted or Issued by:	Conducted or Received by:

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Manufacturer of Explosives Record of Acquisition

Manufacturer of Explosives Record of Acquisition

Site Name/Location:				Supervisor Name and Position
Date of Manufacture or other Acquisition	**Lot Number or Manufacturer's Marks of Identification**	**Nomenclature/ Description**	**Quantity Acquired**	**Name, Address and License or Permit Number of Distributor**

HGL MR Form 15.03 (Revised May 2011)

Page _____ of _____.

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Explosive Usage Record/Bill of Lading

Explosive Usage Record/Bill of Lading

Demolition Team Number:	**Date:**	**Project Name**
Team Leader:	**Work Area/Grid Number:**	**Location Name:**

Explosives Issue:

Nomenclature/Brand Name	Quantity	Lot Number / Manufacturer's Marks	Checked by (Initials)

Demolition Team Leader Signature:	**Explosive Driver Signature** (required when transporting explosives by vehicle)**:**

Explosives Expended:

Nomenclature/Brand Name	Quantity	Lot Number	Checked by (Initials)

Explosives Returned:

Nomenclature/Brand Name	Quantity	Lot Number	Checked by (Initials)

Explosive Driver Signature (required when transporting explosives by vehicle)**:**	
Demolition Team Leader Signature:	**SUXOS/UXOQCS Signature:**

1. The signatures in each section of this record indicate the items listed in that section were in fact issued, expended, or returned to storage and that the explosive quantities listed were verified by a true and accurate physical count.
2. This form will serve as a bill of lading when explosives listed herein are picked up, delivered and transported by vehicle on public transportation routes.

HGL MR 15.05 (Nov 2011)

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Key Control Register and Inventory Form

Project Name: Location:

Lock Number	Where Located	Number of Keys	Key Numbers

Date	Key Number	Time Out	Time In	Print Name and Signature

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Noncompliance and Corrective Action Report

Report No.:	Site Name and Location:	Gird No. (when required):

Prepared by:	Position:	Date:

Nonconformance

Representative Notified:	Date Notified:	Date Corrective Action Plan Due:

Description of the Nonconformance:

Potential Harm:

Cause:

Corrective Action Plan

Corrective Actions:

Actions to Prevent Recurrence:

Estimated Completion Date:	

Signature:	Date:

Corrective Action Approval Signature:	Date:

Agency Representative Signature :	Date :

Corrective Action Closure

Comments:

Approval Signature:	Date:

Quality Control Audit/Inspection Report

1. Definable Feature of Work:

☐ Location Surveying & Mapping	☐ MEC Surface Removal	☐ MEC Subsurface Removal
☐ Geophysical Data Collection	☐ Geophysical Data Processing	☐ MEC Disposal
☐ Anomaly Reacquisition	☐ Intrusive Investigation	☐ MPPEH Inspection and Processing
☐ Metal Detector/Magnetometer Test	☐ Explosive Material Storage	☐ Vegetation Removal

2. Phase

☐ Preparatory ☐ Initial ☐ Follow up

3. References (associated to task):

4. Observed Condition/Activities:

5. Comments:

6. Results of Surveillance

☐ Acceptable	☐ Unacceptable	**Deficiency No:**	**NCR No:**
Conducted By:	**Signature:**		**Date:**

7. Site QA/QC Representative Comments/Review

☐ Concur ☐ Non-Concur	**Signature:**	**Date:**

8. Distribution:

☐Client ☐Project Manager ☐Site Manager ☐SUXOS ☐UXOSO ☐Other:

Munitions Response Project
Quality and Safety Audit/Self Assessment Checklist

PROJECT SITE: _____ **AUDIT DATE:** _____

CONTRACT NO./DO/TO: _____ **CONDUCTED BY:** _____

1. REVIEW SCOPE OF WORK (DO/TO), ESS/ESP AND WORK PLAN	**REFERENCES**	**YES**	**NO**	**N/A**	**COMMENTS**
a. Clearance areas & objectives clearly identified	PWS; WP; DoD 6055.9-M; ESS/ESP	☐	☐	☐	
b. Check for changes to WP are up to date and change pages posted?	WP	☐	☐	☐	
c. Proper depth of clearance identified?	WP, ESS/ESP	☐	☐	☐	
d. Proper target MEC identified	WP, ESS/ESP	☐	☐	☐	
e. DDESB-approved ESS/ESP:	ESS/ESP, EM 385-1-97	☐	☐	☐	
1) Do current site conditions comply/met the ESS/ESP requirements?		☐	☐	☐	
2) Is an amendment required base on current or foreseen changes to MEC/explosive demolition operations?		☐	☐	☐	
f. Is the munition with the greatest fragmentation distance (MGFD) identified?	WP, ESS/ESP	☐	☐	☐	
g. Detection depth and target depth specified	WP, ESS/ESP	☐	☐	☐	
h. EZ/MSDs identified in the WP?	WP, ESS/ESP	☐	☐	☐	
i. Corrective action standards established?	WP, HGL MR Form 15.13	☐	☐	☐	
2. DOCUMENTATION/PUBLICATION REQUIREMENTS		**YES**	**NO**	**N/A**	**COMMENTS**
a. Approval letter for WP?		☐	☐	☐	
b. Approval letter for notice to proceed?		☐	☐	☐	
c. Maps in the WP identifying the proper EZ	WP; ESS/ESP	☐	☐	☐	
d. Approval letter, FAA (NOTAM)/Notice to Mariners?	AR 95-10/AFR 11-208/OPNAVINST 3721.20B	☐	☐	☐	

e. Certificate of grounding, lightning protection for explosive storage facilities	DoD 6055.9-M; HGL SOP 15.02	☐	☐	☐	
f. WP on-site?		☐	☐	☐	
g. DDESB-approved ESS/ESP on-site?	PWS; DoD 6055.9-M	☐	☐	☐	
h. All associated work task SOPs on-site?		☐	☐	☐	
i. Medical clearance (personal physical exam)?	29 CFR 1910.120 (f)	☐	☐	☐	
j. Current copy of USACE UXO resume database on-site?		☐	☐	☐	
k. UXO technician letter submitted to USACE contracting officer (when required)?		☐	☐	☐	
l. EM 385-1-1on-site?		☐	☐	☐	
m. EM 385-1-97 on-site?		☐	☐	☐	
n. APP/SSHP on-site?		☐	☐	☐	
o. Recording, reporting and implementing lessons learned procedures established?		☐	☐	☐	
p. Security clearances/site access passes obtained?		☐	☐	☐	
q. Dig permits approved and on-site?		☐	☐	☐	
3. QUALITY CONTROL PLAN/FILES ESTABLISHED	WP; HGL SOP 15.22	**YES**	**NO**	**N/A**	**COMMENTS**
a. Three-Phase QC training established?		☐	☐	☐	
1) QC Preparatory checklist completed?	HGL MR Form 15.10	☐	☐	☐	
2) QC Initial checklist completed?	HGL MR Form 15.11	☐	☐	☐	
3) QC Final checklist completed?	HGL MR Form 15.11	☐	☐	☐	
b. Daily QC Reports?	HGL MR Form 15.14	☐	☐	☐	
c. QC Surveillance Reports completed weekly for each field team?	HGL MR Form 15.15	☐	☐	☐	

d. Daily site production report?	HGL MR Form 15.27	☐	☐	☐	
e. Government acceptance of work record on file?		☐	☐	☐	
4. APP OR SSHP	EM 385-1-1; PWS	**YES**	**NO**	**N/A**	**COMMENTS**
a. Emergency notification list posted & available?	WP, APP/SSHP	☐	☐	☐	
b. Emergency routes maps available & issued to each team?	WP, APP/SSHP	☐	☐	☐	
c. Hazard analysis & risk assessment for all tasks/equipment operations identified?	APP/SSHP and AHAs	☐	☐	☐	
d. All training requirements met**:**	29 CFR 1910.120(e), HGL SOP 15.23	☐	☐	☐	
1) General site workers HAZWOPER qualified and possess current 8-hour annual refresher?	29 CFR 1910.120(e), HGL SOP 15.23	☐	☐	☐	
1) All site workers received site specific hazards awareness training and indoctrination IAW with the provisions of the APP/SSHP?	HGL SOP 15.23	☐	☐	☐	
2) All safety and hazards awareness training and meetings properly documented?	HGL MR Form 15.18	☐	☐	☐	
e. All personnel on-site in proper PPE for tasked performed?	EM 385-1-1, 29 CFR 1910.120/134 & 132, APP/SSHP	☐	☐	☐	
f. Minimum of 2 personnel on-site First Aid/CPR certified?	EM 385-1-1, Section 03.A.03	☐	☐	☐	
g. First aid equipment immediately available to field teams?	EM 385-1-1; SSHP	☐	☐	☐	
h. Emergency eye-washes/showers comply with ANSI Standards?	ANSI Z-385.1	☐	☐	☐	
i. Fire extinguishers (specific type, size and location)?	APP/SSHP and EM 385-1-1	☐	☐	☐	
j. Ongoing safety & health training program?	HGL SOP 15.23	☐	☐	☐	
k. Work tasks identified in hazard analysis?	APP/SSHP	☐	☐	☐	
l. Do field team supervisors conduct and document daily task hazard safety briefing?	APP/SSHP and HGL Form 15.19	☐	☐	☐	
m. All approved MSDS(s) on-site?	APP/SSHP and HGL SOP 15.23	☐	☐	☐	
n. List of all MSDS inventory items and location on-site?	APP/SSHP and HGL SOP 15.23	☐	☐	☐	

o. Adequate site control during MEC operations?	WP and ESS/ESP	☐	☐	☐	
p. Visitors/safety brief log current and updated?	WP, HGL SOP 15.23	☐	☐	☐	
5. TECHNICAL MANAGEMENT PLAN	WP	**YES**	**NO**	**N/A**	**COMMENTS**
a. Procedure for discovery of MEC?	WP and ESS/ESP	☐	☐	☐	
b. Project grid size, layout and lane width established?	WP/PWS	☐	☐	☐	
c. Procedures established for changed site conditions	WP	☐	☐	☐	
d. Proper test sources/test plot established	WP	☐	☐	☐	
e. Organization chart current and indicates personnel assignments, duties and responsibilities	WP	☐	☐	☐	
f. MPPEH reporting procedures established	PWS; DoD 60559-M; DoD 4160.21-M; DoD 4140.62; EM 385-1-97	☐	☐	☐	
g. MPPEH inspection/certification procedures established	DoD 60559-M; DoD 4160.21-M; DoD 4140.62; EM 385-1-97; ESS/ESP, HGL SOP 15.03	☐	☐	☐	
h. Managing, reporting, venting and disposing of munitions debris and range-related debris established	DoD 60559-M; DoD 4160.21-M; DoD 4140.62; EM 385-1-97; ESS/ESP, HGL SOP 15.03	☐	☐	☐	
i. Limitations posed and ability of detection systems chosen?		☐	☐	☐	
6. LOCATION, MAPPING CULTURAL SURVEY PLAN	EM 385-1-97; HGL SOP 15.12	**YES**	**NO**	**N/A**	**COMMENTS**
a. Professional land surveyor/cultural survey required?		☐	☐	☐	
b. Survey teams received MEC avoidance and site safety brief?		☐	☐	☐	
c. Survey teams have UXO Technician II or above escort provided for MEC anomaly avoidance?		☐	☐	☐	
d. Grid stake, locations swept with geophysical equipment before driving stakes in ground?		☐	☐	☐	
e. Coordinates/survey notes recorded?		☐	☐	☐	

7. VEGETATION REMOVAL	WP; SSHP; HGL SOP 15.10	**YES**	**NO**	**N/A**	**COMMENTS**
a. Vegetation removal localized as required?		☐	☐	☐	
b. UXO team pre-sweeps and marks MEC hazards?		☐	☐	☐	
c. Equipment operated to prevent impact with possible surface MEC/UXO?		☐	☐	☐	
d. Cutting does not present impalement hazard?		☐	☐	☐	
e. UXO Technician II or abovel monitoring cutting operation?		☐	☐	☐	
f. Discovered MEC hazards clearly identified and area marked appropriately?		☐	☐	☐	
8. QUALITY CONTROL PLAN	WP; APPLICABLE DID; HGL SOP 15.23	**YES**	**NO**	**N/A**	**COMMENTS**
a. QC operational/audits conducted WP?		☐	☐	☐	
b. QC grid/transects established and inspection pattern adequate?		☐	☐	☐	
c. QC training conducted and documented (preparatory, initial and follow-on surveillance)?		☐	☐	☐	
d. Pass/fail criteria clearly established?		☐	☐	☐	
e. QC check results recorded?		☐	☐	☐	
9. FACILITIES	**EM 385-1-1**	**YES**	**NO**	**N/A**	**COMMENTS**
a. Adequate work space, equipment and sanitary facilities?		☐	☐	☐	
b. Good housekeeping practices, no fire hazards or tripping hazards present?		☐	☐	☐	
c. Approved and suitable containers for flammable, toxic and explosive materials?	Section 9	☐	☐	☐	
d. Approved/adequate Explosive Storage Facilities?	DoD 6555.9-M; 27 CFR Part 555, Subpart K; ESS/ESP	☐	☐	☐	
e. Fire/emergency exits clear/unbarred?	Sections 1, 9, & 26	☐	☐	☐	
f. Personnel occupancy limits maintained and posted (on-site office trailers)		☐	☐	☐	

g. Adequate site security and facilities properly secured after hours		☐	☐	☐	
h. Toilets and washing facilities?	EM 385-1-1 Section 02.B - 02.C	☐	☐	☐	
i. Trailers and temporary structures properly anchored?	EM 385-1-1, Section 04	☐	☐	☐	
10. EQUIPMENT		**YES**	**NO**	**N/A**	**COMMENTS**
a. Automatic External Defibrillator (AED) readily available to field crews at remote locations?	EM 385-1-1, Section 03	☐	☐	☐	
b. At least one dry chemical or CO_2 fire extinguisher, minimum rating 5-BC on-site	EM 385-1-1 Section 16	☐	☐	☐	
c. Tools appropriate and serviceable		☐	☐	☐	
d. Appropriate weather monitoring devices on-hand (handheld weather station; lightning detector)?		☐	☐	☐	
e. PPE present, serviceable/utilized?	EM 385-1-1, Section 05	☐	☐	☐	
f. Equipment calibrated with last and next cal date annotated?	Operators Manual	☐	☐	☐	
g. Survey equipment inspected/serviceable?	Operators Manual	☐	☐	☐	
h. Heavy equipment inspected/serviceable?	Operators Manual, EM 385-1-1 Section 16	☐	☐	☐	
i. Two separate means of communications, radio(s)/cell phone, land line(s)?		☐	☐	☐	
j. Geophysical equipment on-hand, serviceable & identified in WP?	EM 1110-14009; Operators Manual	☐	☐	☐	
k. Copy of manufacturer's instructions & recommendations maintained with all hand and power Tools?	EM 385-1-1, Section 13	☐	☐	☐	
11. EXPLOSIVE STORAGE	27 CFR PART 555, Subpart K; AFMAN 91-201, AR 190-11; NAVSEA OP 5; HGL SOP 15.00	**YES**	**NO**	**N/A**	**COMMENTS**
a. Proper explosive storage magazines, Type 2 conforming to ATF standard?	27 CFR §555.206 (ATF P 5700.04)	☐	☐	☐	
b. Placards. Each magazine properly placarded with DOT Haz Class/Division symbol?		☐	☐	☐	
c. Explosive compatibility groups. Separated into the appropriate Haz Class/Division?		☐	☐	☐	

d. Physical Security survey conducted and documented?	HGL SOP 15.00 and 15.02	☐	☐	☐	
e. Security locks met ATF standards?	27 CFR §555.208.(a)(4) (ATF P 5700.04)	☐	☐	☐	
f. Key control system established and functional?	HGL SOP 15.00 and 15.02	☐	☐	☐	
g. Lightening Protection"		☐	☐	☐	
4) Magazine constructed of minimum 3/16 inch metal?	2 7 CFR Part 555, Subpart K, NFPA 780	☐	☐	☐	
5) Magazine grounded?	NFPA 780	☐	☐	☐	
6) Magazine located 6.5 feet from nearest fence?		☐	☐	☐	
7) BRAC, IRP, FUDS and active installation standards met?		☐	☐	☐	
h. Fire Protection. Minimum size/type fire extinguisher located within 30 feet of storage magazine:		☐	☐	☐	
1) Proper fire division symbol at entrance to storage site?		☐	☐	☐	
8) Fire fighting control plan established & posted?		☐	☐	☐	
9) Area surrounding magazine free of rubbish, brush, dry grass, trees for a minimum of 25 foot?		☐	☐	☐	
i. Magazine site location meets IBD/PTR distances?		☐	☐	☐	
j. Commercial explosives being stored in DoD facilities require DoD HC/SCG approval?	DA PAM 385-64; AR 385-64; AF 91-210; NAVSEA OP 5	☐	☐	☐	
k. Adequate earth cover used to meet IBD & PTR distances?		☐	☐	☐	
12. EXPLOSIVE MANAGEMENT PLAN	27 CFR Part 555; 49 CFR; DoD 6055.9-M; AFMAN 91-201; AR 190-11; NAVSEA OP 5; DIDs; HGL SOP 15.00, WP	**YES**	**NO**	**N/A**	**COMMENTS**
a. Explosive accountability and management responsibilities and organization?		☐	☐	☐	
b. Explosive material purchase/receipt signature authority on-hand?		☐	☐	☐	
c. Inventory conducted once every 7 days?		☐	☐	☐	
d. Special inventories conducted annually or as prescribed?		☐	☐	☐	

e. Accountability records maintained?		☐	☐	☐	
f. MEC final disposition/accountability records maintained?	HG L MR Form 15.04	☐	☐	☐	
g. Key control/security log maintained?	HGL MR Form 15.26	☐	☐	☐	
h. Lost, missing and stolen procedures in place?		☐	☐	☐	
i. Disaster preparedness plan in place?		☐	☐	☐	
j. Each explosive item identified in equipment plan (not required on FFP task orders)?		☐	☐	☐	
k. Initial receipt procedures & documentation on-site?		☐	☐	☐	
l. Explosives specified within WP being used at project site?		☐	☐	☐	
m. Receipt procedures accounting for each item of explosives properly documented on-site?		☐	☐	☐	
n. Individuals authorized to receive, issue and transport identified and granted explosive access by the ATF FELC?	EPQ ATF Form 5400.28	☐	☐	☐	
o. Reconciliation, receipt documents on-site?		☐	☐	☐	
p. Duplicate DSMT-magazine data cards (magazine/facility)?	HGL SOP 15.00, HGL MR Form 15.02	☐	☐	☐	
13. TRANSPORTATION OF EXPLOSIVE MATERIALS	DOT 49 CFR PARTS 100 TO 199; AR 385-64; EM 385-1-1 SEC 29; HGL SOP 15.00, WP, ESS/ESP	**YES**	**NO**	**N/A**	**COMMENTS**
a. Hazardous waste manifest on-hand and maintained?	HGL MR Form 15.06	☐	☐	☐	
b. MEC hazard properly classified?	DoD TB 700-2	☐	☐	☐	
c. Approved transportation plan?	ESS/ESP	☐	☐	☐	
d. MEC transportation training IAW DOT and State requirements?	49 CFR, Part 172	☐	☐	☐	
e. Explosive Transport Vehicle:	HGL SOP 15.22	☐	☐	☐	
1) Pre-operational inspection properly conducted?	HGL SOP 15.22	☐	☐	☐	

2) Proper DOT placards, lettering, and/numbering?	HGL MR Form 15.06	☐	☐	☐	
3) Operators licensed (CDL/HazMat endorsement)?	HGL MR Form 15.06	☐	☐	☐	
4) Explosive transport compatibility requirements maintained?	HGL MR Form 15.06	☐	☐	☐	
5) Cargo properly loaded, blocked and braced?	HGL MR Form 15.06	☐	☐	☐	
6) First aid kit on board vehicle?	HGL MR Form 15.06	☐	☐	☐	
7) Has communication capability?	HGL MR Form 15.06	☐	☐	☐	
8) Blasting caps stored separate and in appropriate container (cap box)?	HGL MR Form 15.06	☐	☐	☐	
9) NEW limits maintained for each transport container?	HGL MR Form 15.06	☐	☐	☐	
f. No Flame-producing devices in vehicle or on persons?	HGL MR Form 15.06	☐	☐	☐	
14. MEC OPERATIONAL PLAN	WP; EP 1110-1-18	**YES**	**NO**	**N/A**	**COMMENTS**
a. Is there a centrally located catalog of MEC ID guides associated to the MRA/MRS available to all UXO Technicians on-site?		☐	☐	☐	
b. Defined methodology followed:		☐	☐	☐	
a. SUXOS conducted physical check prior to MEC clearance/sweep operations?		☐	☐	☐	
b. Daily health and safety meeting conducted and documented by the UXOSO/SSHO?	APP/SSH, HGL SOP 15.23	☐	☐	☐	
c. Geophysical/magnetometer equipment used:	Applicable SOPs	☐	☐	☐	
1) Pre-operational checks conducted?		☐	☐	☐	
2) Calibration/test strip used?		☐	☐	☐	
3) Calibration/test results annotated in team and equipment test log by serial number?	WP, HGL MR Form 15.16	☐	☐	☐	
d. SUXOS on-site supervising removal operation?	WP, ESS/ESP	☐	☐	☐	
e. Operational teams operating IAW:	WP; ESS/ESP	☐	☐	☐	

1)	UXO Supervisor conducted physical check MEC clearance/sweep prior to operation?		☐	☐	☐	
2)	Supervisor conducted pre-operational tail-gate safety briefing?		☐	☐	☐	
3)	Supervisor ensures public barricades established prior to MEC operation?		☐	☐	☐	
4)	Supervisor ensures all personnel are wearing the required PPE?		☐	☐	☐	
5)	Supervisor ensures proper grid selected?		☐	☐	☐	
6)	Supervisor ensures individual MEC lanes established?		☐	☐	☐	
7)	Team using correct detector/magnetometer instruments & model specified in WP?		☐	☐	☐	
8)	Detector instruments checked against test source daily prior to MEC operations?		☐	☐	☐	
9)	Results of detector check, by individual instrument serial # annotated in field log book and on equipment maintenance/ calibration log?		☐	☐	☐	
10)	Supervisor ensures proper sensitivity setting based on check sources?		☐	☐	☐	
11)	Anomalies/contacts are clearly marked and logged?		☐	☐	☐	
12)	Supervisor ensures clearance/sweep operation results recorded?		☐	☐	☐	
13)	All MPPEH, RRD, MD & CD examined by at least a one UXO Technician III and one UXO Technician II?		☐	☐	☐	
14)	Supervisor ensures all MEC-MDEH clearly marked IAW WP/ESS/ESP?		☐	☐	☐	
a)	MPPEH processing IAW	PWS/SOW, EM 1110-104009/EM 385-1-97, ESS/ESP and HGL SOP 15.03	☐	☐	☐	
b)	Supervisor ensures MD, RRD, CD is collected and inspected?	HGL SOP 15.03	☐	☐	☐	
c)	QC operation IAW?	WP	☐	☐	☐	
15)	Results of MEC operation recorded?	WP, HGL SOP 15.01	☐	☐	☐	
f.	All MEC/UXO is clearly marked and logged?	WP	☐	☐	☐	
g.	Non-MD being collected?	WP; HGL SOP 15.03	☐	☐	☐	

h. MD inspected, vented and segregated?	WP; ESS or ESP; HGL SOP 15.03;	☐	☐	☐	
4. MPPEH MANAGEMENT	DOT 49 CFR, DoD 6055.9-M, DoD 4140.62, EM 385-1-97, HGL SOP 15.03	**YES**	**NO**	**N/A**	**COMMENTS**
a. Are UXO Technicians involved in the MPPEH inspection/certification process properly training and understand their responsibilities?		☐	☐	☐	
b. Have all UXO Technicians performing MPPEH inspection/certification sign the SOP? acknowledgement?		☐	☐	☐	
c. Project startup procedures being followed?		☐	☐	☐	
d. Is the MPPEH inspection and certification process being properly followed?		☐	☐	☐	
e. Are inspected material and uninspected material properly segregated and procedures in place to prevent comingling?		☐	☐	☐	
f. Are storage container properly sealed, locked and secured from general access?		☐	☐	☐	
g. Are storage container properly labeled to distinguish between inspected material and uninspected material?		☐	☐	☐	
h. Weekly and spot check inspection performed?		☐	☐	☐	
i. Is chain of custody, certification, transfer/release records accurate and complete?	HGL MR Forms 15.07/15.08 and DD FORM 1348–1A	☐	☐	☐	
5. DISPOSAL OPERATIONS PLANNED ON-SITE	WP; ESS/ESP; HGL SOP 15.01	**YES**	**NO**	**N/A**	**COMMENTS**
a. MEC/UXO/MDEH disposal method IAW approved procedures?		☐	☐	☐	
b. Adequate security for explosive operation?		☐	☐	☐	
c. Disposal notification list available?		☐	☐	☐	
d. All necessary notifications made?		☐	☐	☐	
e. Movement of MEC items, or is MEC consolidation feasible IAW ESS/ESP		☐	☐	☐	
f. Protective measures/tamping being used/appropriate for MEC being destroyed?		☐	☐	☐	
g. Disposal procedures IAW:	60A-1-1-31	☐	☐	☐	

1) Misfire procedures properly performed (electric)?		☐	☐	☐	
2) Misfire procedures properly performed (non-electric)?		☐	☐	☐	
3) Misfire procedures properly performed (remote firing device)?		☐	☐	☐	
6. MUNITIONS CONSTITUENTS (MC) SAMPLING AND ANALYSIS PLAN	DOT 49 CFR, DoD 6055.9-M, HGL SOP 15.14/15	**YES**	**NO**	**N/A**	**COMMENTS**
a. Key personnel identified?		☐	☐	☐	
b. Quality assurance/control responsibilities identified?		☐	☐	☐	
c. Collection sample procedures established and followed?		☐	☐	☐	
d. Local courier identified?		☐	☐	☐	
e. Are local field logs maintained?		☐	☐	☐	
7. TRANSPORTATION PLAN	DOT 49 CFR, DoD 6055.9-M, HGL SOPs 15.14 and 15.15	**YES**	**NO**	**N/A**	**COMMENTS**
a. Pre-operational vehicle inspection logged/recorded?		☐	☐	☐	
a. Are vehicles operators licensed for specific vehicle types?		☐	☐	☐	
b. All vehicles licensed for specific vehicle type?		☐	☐	☐	
c. Fire fighting & first aid equipment on board?		☐	☐	☐	
d. Cargo properly segregated/blocked & braced?		☐	☐	☐	
e. Proper DOT placarding used?		☐	☐	☐	

8. FIELD AUDIT/SELF ASSESSMENT FEEDBACK		
	Describe the condition or issue	**Feedback Response**
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		

https://sharepoint.hgl.com/docs/Munitions%20Response/UXO%20Personnel/01%20-%20UXOQCS/Form%2015.40%20Quality-Safety%20Assurance%20Field%20Audit%20Checklist.docx

By signing below, I acknowledge being notified of the results of this audit:

POSITION	**PRINTED NAME**	**SIGNATURE**	**DATE**
UXOSO/SSHO:			
UXOQCS:			
Site Manager/SUXOS:			
Project Manager:			
UXO Quality/Safety Manager:			
Senior UXO Operations Manager:			

APPENDIX G

PERSONNEL QUALIFICATIONS LETTER

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The Personnel Qualifications letters will be furnished as a slip page amendment to the Work Plan when the personnel have been finalized for staffing the field work.

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APPENDIX H

TECHNICAL PROJECT PLANNING MEMORANDUM

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FINAL TECHNICAL PROJECT PLANNING MEMORANDUM AND ASSOCIATED DOCUMENTATION

In Support of

Remedial Investigation/Feasibility Study

Project Site:

Former Conway Bombing and Gunnery Range Horry County, South Carolina

U.S. Army Corps of Engineers

Prepared for:

U.S. Army Engineering and Support Center, Huntsville

Prepared by: HydroGeoLogic, Inc.
5030 Bradford Drive, Building 1, Suite 230
Huntsville, Alabama 35805

Contract No. W912DY-10-D-0023
Task Order No. 0018

October 2014

FINAL TECHNICAL PROJECT PLANNING MEMORANDUM AND ASSOCIATED DOCUMENTATION

In Support of Remedial Investigation/Feasibility Study

Project Site:
Former Conway Bombing and Gunnery Range Horry County, South Carolina

Prepared for

U.S. Army Engineering and Support Center, Huntsville

Prepared by HydroGeoLogic, Inc.
5030 Bradford Drive, Building 1, Suite 230
Huntsville, Alabama 35805

Contract No. W912DY-10-D-0023
Task Order No. 0018

October 2014

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LIST OF ACRONYMS AND ABBREVIATIONS

AAB	Army Air Base
AAF	Army Air Field
ASR	Archive Search Report
BIP	blow-in-place
CA	Cost Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLIN	Contract Line Item Number
COR	Contract Officer Representative
CRP	Community Relations Plan
CSM	Conceptual Site Model
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Programs
DD	Decision Document
DGM	digital geophysical mapping
DID	Data Item Descriptions
DMM	discarded military munitions
DoD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EPA	Environmental Protection Agency
ESP	Explosives Site Plan
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GIS	Geographical Information System
GSV	Geophysical System Verification
HE	High Explosives
HGL	HydroGeoLogic, Inc.
IAW	In Accordance With
IGD	Interim Guidance Documents
ISM	incremental sampling method
ISO	industry standard objects
IVS	instrument verification strip

MC	munitions constituents
MD	munitions debris
MDAS	Material documented as safe
MEC	munitions and explosives of concern
MG	Machine Gun
MMRP	Military Munitions Response Program
MRS	Munitions Response Site
NDAI	No Department of Defense Action Indicated
PM	Project Manager
PMP	Project Management Plan
POC	Point of Contact
PP	Proposed Plan
PWS	Performance Work Statement
QA	Quality Assurance
QASP	Quality Assurance Surveillance Plan
QAPP	Quality Assurance Project Plan
RAB	Restoration Advisory Board
RI	Remedial Investigation
RPM	Remedial Project Manager
RR	Rifle Range
RTS	Robotic Total Station
SAA	Small arms ammunition
SCDHEC	South Carolina Department of Health and Environmental Control
TCRA	time critical removal action
TO	Task Order
TP	Technical Paper
TPP	Technical Project Planning
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USAESCH	U.S Army Engineering and Support Center, Huntsville
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VSP	Visual Sampling Plan
WERS	Worldwide Environmental Remediation Services
WP	Work Plan

FINAL TECHNICAL PROJECT PLANNING MEMORANDUM AND ASSOCIATED DOCUMENTATION

1.1 INTRODUCTION

This document provides a record of Technical Project Planning (TPP) for four munitions response sites (MRS) within the Former Conway Bombing and Gunnery Range (BGR), Horry County, South Carolina. The meeting occurred November 21, 2013 at the Courtyard Myrtle Beach, in Myrtle Beach, South Carolina. This TPP meeting was held to familiarize the TPP team with the site background and the proposed Technical Approach, and ultimately, facilitate planning of the Remedial Investigation/Feasibility Study (RI/FS) at the Former Conway BGR. The meeting was attended by the Project Team members listed in Table 1.1. Attendees were presented with an Advance Summary that included HGL's initial RI/FS Technical Approach for purposes of discussion with stakeholders. The TPP Team discussed the initial Technical Approach for implementation of the RI/FS at the four MRSs. The Technical Approach will be further detailed in the forthcoming Draft RI/FS Work Plan. The Draft Work Plan will be submitted to the TPP Team members for review to ensure that the key aspects of the TPP Meeting resolutions are fully captured. The list of key contacts is provided in Section 2. The sign-in sheet for the meeting is provided in Section 3. The details of the TPP meeting incorporated into this TPP Memorandum are also provided in the Conceptual Site Model (CSM), Data Quality Objectives (DQO), TPP Worksheets, and figures provided in Section 4. The TPP Meeting presentation slides are provided in Section 5. The SCDHEC review of the Advance Summary is provided in Section 6.

Table 1.1 Technical Project Planning Participants

Shawn Boone U.S. Army Corps of Engineers (USACE) Charleston District Project Manager	Julie Hiscox USACE Savannah District FUDS Program Manager
Chris Cochrane U.S Army Engineering and Support Center, Huntsville (USAESCH) Contracting Officer's Representative	Kelly Longberg USACE Technical Manager
Debra Edwards USAESCH Geophysicist	Susan Byrd South Carolina Department of Health and Environmental Control SCDHEC Project Manager
Kimberly Vaughn HGL Project Manager	Neil Feist HGL MMRP Operations Manager

1.1 SITE HISTORY

The area that became the former Conway BGR was used for timber harvest and farming prior to 1940. From June 1940 to December 1941, the Army Air Corps conducted aerial photographing and charting and in 1941 support operations for a bombing and gunnery range were set up. In March 1942, the Savannah Army Air Base (AAB) and the Myrtle Beach municipal airport became the Myrtle Beach General BGR (renamed Myrtle Beach Army Air Field [AAF] in November 1943). Myrtle Beach AAF consisted of a cantonment area in Myrtle Beach, air-to-ground gunnery ranges in the Myrtle Beach area, the bombing and gunnery range in the Conway area (Conway BGR), a bombing and gunnery range in the Georgetown area, and crash target boats at Murrells Inlets. Other airfields/bases may also have utilized Conway BGR, including Columbia AAB, Greenville AAB, Florence AAF, Morris Field and Charleston AAB. By 1948, the leases for the majority of the property had been terminated and land had been returned to private ownership.

The former Conway BGR historically consisted of 55,854 acres in Horry County, South Carolina, immediately southeast of Conway, South Carolina. There are nine MRSs included within Conway BGR; however, only four are being addressed by this TO. The four MRSs which are included in this TO scope of work are: MRS-R01, MRS-R02, MRS-R03, and MRS-R09. Figure 1 shows the regional location of the former Conway BGR and the location of the four subject MRSs.

1.2 TPP DISCUSSION TOPICS

In addition to the summary of TPP Team determinations included in Sections 2 through 6, the following issues and resolutions were identified and discussed:

- The TPP group reviewed the webmap "live" during the meeting to facilitate discussion of each MRS. The GIS-based webmap shows site boundaries, historical features and current site conditions. The webmap can be accessed by all stakeholders, similar to browsing an online map such as Google Maps. The webmap login instructions are:

  http://gis.hgl.com/conway
  username "HGL\giswebmap"
  password "Gwm2011" -- if using Internet Explorer.
  If using Firefox or Chrome, "HGL\" before username should be omitted.

  - An additional webmap has been created: http://gis.hgl.com/conway/roe/ for coordination of ROE status with CESAC. This webmap allows CESAC personnel to change the status (Yes, Refused, Pending) on individual parcels.

- Ms. Byrd asked a question about landowner involvement and whether landowners were included for purposes of the current meeting. Ms. Cochrane and Mr. Boone noted that the specific parcels are still being identified that will be included in the current project field activities. Separate meetings, such as public meetings, will be held to include landowners and county officials. The future TPP meetings, ROE negotiations, and

public meetings will be held both for public educational purposes and to facilitate negotiation of rights-of-entry.

- Ms. Byrd and Ms. Cochrane discussed the status of some third party removals that have been performed previously. Ms. Byrd had information for the group on other third-party removals that may have been performed and are not included in the site history (see Tables 4.2 through 4.5). For instance, the Presbyterian Church across from the Goodson property (a site visit stop) will probably have third-party removal actions performed. There was also privately funded work performed on a LandBank, LLC, owned parcel to the west and south of the church property, near the Goodson property. Marie Stephens (previously with Kestrel) and currently with Meridian Energy and Environment, Inc.is representing LandBank and the New Harmony Presbytery for the private party removal actions at MRS-02/Range III. Ms. Byrd noted there were also Tetra Tech reports for various phases from Phase 1 through possibly Phase 20 that Ms. Byrd may have as hard copy reports.
    - *Following the TPP Meeting, HGL contacted SCDHEC to request copies of the Tetra Tech reports, to ensure all existing data is captured in the project GIS. HGL will continue to coordinate obtaining these documents during the work plan development.*
- Ms. Byrd and Ms. Cochrane also discussed the DR Horton owned properties agreement with the HTC. DR Horton is anticipated to participate by granting ROE for this project. DR Horton is not pursuing a cost recovery. Ms. Byrd noted that the DR Horton lawyer has attended public meetings in the past, for example they attended the previous RI public meeting. Ms. Byrd noted for the group that DR Horton does provide public educational awareness materials to its residents.
- Ms. Vaughn asked to confirm that HGL currently has the most recent version of the project GIS. Ms. Cochrane stated that the final 2012 RI report GIS submittal may be available, and she will follow up. She believes that the GIS provided at the proposal stage is the most current.
- Ms. Byrd requested that the laboratory sampling approach ensure that the data is from a South Carolina certified laboratory. Ms. Vaughn stated that test America is the laboratory HGL intends to use. Ms. Byrd and Mr. Boone discussed that biased, discrete samples be used to characterize for metals instead of the incremental sampling method for metals evaluation. Any potential source areas will need sampling conducted by biased, discrete sampling of the soil. This approach has been used on other sites, Mr. Boone summarized, and will be appropriate for these MRSs.
- Mr. Boone noted that with the prevalence of golf courses on these four MRSs, it may be beneficial to conduct fieldwork during the winter. The coldest time of the year would be more reasonable for gaining access to the golf courses.
- Ms. Vaughn summarized that during the proposal site visit, Horry County landfill employees reported that there had been a prior MEC clearance. HGL will follow up with Horry County landfill personnel to try to evaluate the date conducted and who performed the removals.
    - *Following the TPP meeting, HGL contacted Horry County Solid Waste Authority, Deputy Director, Mr. Wayne Martin, to request additional*

information. Mr. Martin stated that during dredging/expansion of the pond performed by landfill personnel projectile casings and cartridges were recovered. He believes these were of military origin. He believes this was in the mid-1990s. He is unaware that any "live" munitions have been found in the past on landfill property. He is not aware of any removal actions performed by the government or a private contractor. He stated that there was also an archeologist survey performed by either a private firm or the federal government during the 1990s. HGL will continue to follow up with Mr. Martin during the work plan phase, to obtain copies of any relevant documents that may exist.

- Ms. Cochrane and Mr. Boone noted that rainfall will drastically affect performance of the field activities. Rainfall and the resulting water, is a seasonal occurrence, but is also affected by hurricanes, and can be hard to predict. Ms. Vaughn noted that HGL proposes to use shallow water (amphibious) methods to conduct geophysical survey operations. An ongoing evaluation of rainfall, and levels of standing water, will need to occur as field activities approach. HGL will need to remain flexible in the approach, to adapt to changing site conditions.

- Ms. Cochrane, Ms. Hiscox, and Ms. Byrd discussed the LandBank settlement. Ms. Byrd asked if the International Paper, LandBank, and Goodson properties were excluded or included in this project. Ms. Hiscox stated this depends on the terms of the settlement, and she or Ms. Cochrane will need to follow up to confirm. At the current time the Goodson property is excluded. The DR Horton settlement is different from the Goodson settlement in that the DR Horton settlement did not mean they could not participate in future clearances. The local homeowners associations have intrusive and nonintrusive deed restrictions for the common land areas. DR Horton obtained additional private party investigations and removals for a portion of land, referred to as the Farm, which was purchased from International paper. A settlement for cost recovery with the Federal Government was never reached for this portion of land. DHEC issued an agreement with DR Horton concerning the Farm which included regulatory oversight and land use controls. The LandBank settlement with the Federal Government is also complete. LandBank is currently negotiating with DHEC for regulatory oversight for their private party removal action. The wetlands portion of the LandBank property was excluded from the settlement and should be investigated as part of the RI at the Former Conway Bombing and Gunnery Range site or under another settlement agreement. The LandBank should be participating in investigations (by granting ROE) going forward.

- Mr. Boone and Ms. Vaughn discussed the right of entry support that HGL will provide. HGL has evaluated the current Horry County parcel data, and developed a list of transects to be completed. HGL will evaluate where transects cross a parcel by a small amount, so that extra parcels will not be included in ROE requests, when they do not provide a significant amount of data to meet project goals.

    - *HGL continued transect placement evaluation against current Horry County parcel data following the TPP meeting, adjustments continue to be made.*

- The format for public meetings was discussed. There are currently three public meetings anticipated, one in support of the proposed plan and the others to support right of entry negotiations. Mr. Boone asked if it were possible to hold public meetings at each MRSs, individually. In the past landowners have objected to attending public meetings where more sites are being discussed in a group, rather than the one site that is closest to their parcel. Ms. Cochrane and Ms. Vaughn stated that additional public

meetings can be discussed if the currently funded amount is not sufficient. Ms. Cochrane and Ms. Vaughn also discussed the recommended format for public meetings, as an open house. An open house forum at public meetings would allow unique topic stations to be set up to meet landowners concerns. If a dedicated discussion area is set up for each individual MRS, the landowner can go to the booth that interests them alone. An overview of the entire project can be presented at one booth. Other areas can be set up to summarize each individual MRS. HGL can provide staff at each booth to discuss landowners concerns specifically.

- The hunting seasons that are in effect near these MRSs were also discussed. HGL will include more information on the hunting seasons and any threatened or endangered species that may be present onsite, in the draft work plan.
- The site closeout statement was presented to the group for consideration: "To reduce the potential MEC and MC risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC. After completion of the Decision Document requirements the potential risk to human health and the environment from MEC or MC will be reduced to the extent practical."

Following the RI fieldwork, all results will be fully documented in an RI/FS Report for the TPP Team and other stakeholder review. The finalized RI/FS Technical Approach will not be modified without consultation and agreement by the TPP Team listed in Table 1.1.

2.0 LIST OF KEY CONTACTS

Key Contacts
Remedial Investigation/Feasibility Study
at the Former Conway Bombing and Gunnery Range

Name/Organization	Address	Telephone/Email
USAESCH Contracting Officer's Representative Chris Cochrane	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1696 (c) 256-990-0888 chris.cochrane@usace.army.mil
USAESCH Technical Manager Kelly Longberg	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1408 (c) 256-541-0907 kelly.d.longberg@usace.army.mil
USAESCH Geophysicist Debra Edwards	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1626 debra.l.edwards@usace.army.mil
USACE Savannah District FUDS Program Manager Julie Hiscox	USACE Savannah District 100 W. Oglethorpe Avenue Savannah, GA 31401-0889	(o) 912-652-5363 (c) 912-429-1474 julie.a.hiscox@usace.army.mil
~~USACE Charleston District Project Manager Shawn Boone~~	~~USACE Charleston District 69 A Hagood Avenue Charleston, SC 29403~~	~~(o) 843-329-8158 shawn.a.boone@usace.army.mil~~
Please note that following this TPP-1 Meeting, Mr. Ray Livermore has replaced Mr. Boone:		
U.S. Army of Corps of Engineers, Wilmington District Project Manager Ray Livermore	Attn: CESAW-TS-EG (Ray Livermore) 69 Darlington Avenue Wilmington, NC 28402-1890	910-251-4702 Raymond.R.Livermore@usace.army.mil
SCDHEC Land and Waste Management Division Project Manager Ms. Susan Byrd	SCDHEC Land and Waste Management Division 2600 Bull Street Columbia, SC 29201	(o) 803-898-0308 byrdks@dhec.sc.gov
Horry County Administrator's Office	Horry County Administrator's Office 1301 Second Avenue Conway, SC 29526	(o) 843-915-5020
HydroGeoLogic, Inc. Program Manager Timothy P. Hiles	HydroGeoLogic, Inc. 5030 Bradford Drive Building 1, Suite 230 Huntsville, AL 35805	(o) 256-970-2102 (c) 256-541-0944 thiles@hgl.com
HydroGeoLogic, Inc. Project Manager Kimberly Vaughn	HydroGeoLogic, Inc. 1403 Balmorhea Lane Round Rock, TX 78664	(o) 512-828-6684 (c) 512-658-6828 kvaughn@hgl.com
HydroGeoLogic, Inc. MMRP Operations Manager Neil Feist	HydroGeoLogic, Inc. 5030 Bradford Drive Building 1, Suite 230 Huntsville, AL 35805	(o) 256-970-2103 (c) 256-714-5808 nfeist@hgl.com

3.0 TPP MEETING ATTENDANCE SIGN IN SHEET

TPP-1 Meeting Sign-in Sheet

Thursday, November 21, 2013

Initial	Name	Role	Phone Numbers	E-Mail Address
	Shawn Boone	USACE Charleston District PM	843-329-8158	shawn.a.boone@usace.army.mil
JH	Julie Hiscox	USACE SAD FUDS Program Manager	912-652-5363 (o) 912-656-1183 (m)	julie.a.hiscox@usace.army.mil
	Chris Cochrane	USAESCH Contracting Officers Representative	256-895-1696 (o) 256-990-0888 (m)	chris.cochrane@usace.army.mil
	Kelly Longberg	USACE Technical Manager	256-895-1408	Kelly.d.longberg@usace.army.mil
	Debra Edwards	USAESCH Geophysicist	256-895-1626	Debra.L.Edwards@usace.army.mil
via teleco	Susan Byrd	SCDHEC Project Manager	803 898-0308	
	Kimberly Vaughn	HGL Project Manager	512-828-6684	kvaughn@hgl.com
	Neil Feist	HGL MMRP Operations Manager	256-970-2103	Nfeist@hgl.com

4.0 TECHNICAL APPROACH

4.1 INTRODUCTION

HydroGeoLogic, Inc. (HGL) is providing support for environmental remediation services to the U.S. Army Engineering and Support Center, Huntsville (USAESCH) under a firm fixed price performance-based TO under the Worldwide Environmental Remediation Services (WERS) Contract No. W912DY-10-D-0023, Task Order (TO) No. 0018. The remedial investigation (RI) / feasibility study (FS) at the Former Conway Bombing and Gunnery Range (BGR) munitions response sites (MRSs) is being implemented under the Military Munitions Response Program (MMRP), which was created by the FY02 National Defense Authorization Act by modifying the Defense Environmental Restoration Programs (DERP) to address munitions and explosives of concern (MEC) and munitions constituents (MC) contamination on inactive, non-operational military ranges.

The Conway BGR RI/FS will be conducted for four MRSs: MRS-R01 (former Range II), MRS-R02 (Range III), MRS-R03 (Range IV), and MRS-R09 (Machine Gun/Rifle Range). The objective of this RI/FS is to characterize the nature and extent of MEC and MC at these four MRS in compliance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended and Department of Defense (DoD), Army, and USACE regulations and guidance to include Interim Guidance Documents (IGDs) and Data Item Descriptions (DIDs). Under this TO, HGL will design and complete the RI, evaluate alternatives for each MRS and document the results in an FS, prepare a Proposed Plan (PP) that provides rationale for selection of the recommended alternative to the public, and submit a DD describing the decisions made by stakeholders and document acceptance of the selected remedy.

The primary goals of a CERCLA-based MMRP RI are:

i. To collect and analyze the data necessary to determine the nature and extent of MEC and MC contamination, and
ii. To conduct a baseline risk assessment to quantify risk and explosives safety concerns to human health and the environment.

The primary objective of an MMRP FS is to ensure that appropriate remedial alternatives are developed and evaluated and that an appropriate remedy is selected. For the MMRP, the FS is the mechanism in the remedial process for the development, screening, and detailed evaluation of alternative munitions response options that will result in timely and appropriate decisions for protecting human health, safety, and the environment. The accuracy and completeness of the RI characterization of the site conditions with respect to MEC and MC is critical to the evaluation of available technologies performed during the FS. The scope of work for the Conway BGR project also includes preparation of a PP and a DD for each MRS.

HGL has developed this technical approach based on the historical site-specific information provided by USAESCH, including prior Engineering Evaluation/Cost Analysis (EE/CA), MEC removal actions activities, and the prior RI/FS. HGL's proposed approach to the investigation is to perform a combination of instrument-assisted intrusive investigations

(referred to as mag-and-dig), instrument-assisted surface reconnaissance, and digital geophysical mapping (DGM) across select grids to characterize the nature, density, and extent of MEC at each MRS. Locations and spacing of transects and sampling grids is based upon statistical analysis performed with the Visual Sampling Plan (VSP) and UXO Estimator tools. MC sampling will be performed at applicable MRSs to augment existing environmental sampling data to fully characterize the nature and extent of MC in the RI in order to support the FS and follow-on DD. HGL understands that this technical approach for MEC investigations and MC sampling are subject to change during discussion and review as part of the TPP process. The following provides a summary of the proposed technical approach for the sites.

4.2 SITE DESCRIPTION AND HISTORY

The area that became the former Conway BGR was used for timber harvest and farming prior to 1940. From June 1940 to December 1941, the Army Air Corps conducted aerial photographing and charting and in 1941 support operations for a bombing and gunnery range were set up. In March 1942, the Savannah Army Air Base (AAB) and the Myrtle Beach municipal airport became the Myrtle Beach General BGR (renamed Myrtle Beach Army Air Field [AAF] in November 1943). Myrtle Beach AAF consisted of a cantonment area in Myrtle Beach, air to ground gunnery ranges in the Myrtle Beach area, the bombing and gunnery range in the Conway area (Conway BGR), a bombing and gunnery range in the Georgetown area, and crash target boats at Murrells Inlets. Other airfields/bases may also have utilized Conway BGR, including Columbia AAB, Greenville AAB, Florence AAF, Morris Field and Charleston AAB. By 1948, the leases for the majority of the property had been terminated and land had been returned to private ownership.

The former Conway BGR historically consisted of 55,854 acres in Horry County, South Carolina, immediately southeast of Conway, South Carolina. There are nine MRSs included within Conway BGR; however, only four are being addressed by this TO. The four MRSs which are included in this TO scope of work are: MRS-R01, MRS-R02, MRS-R03, and MRSR09. Figure 1 shows the regional location of the former Conway BGR and the location of the four subject MRSs.

4.3 DESCRIPTION OF EACH MRS AND PREVIOUS INVESTIGATIONS

4.3.1 MRS-R01, Range II

This site was identified in the EE/CA conducted previously (Parsons, 2003). Various historical investigations on some portions of the MRS have been conducted and are summarized in Table 4.1. Based on the information provided in the Archives Search Report (ASR) Supplement (USACE, 2004), the historical usage of MRS-R01, Range II, was practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing.

4.3.2 MRS-R02, Range III

A time critical removal action (TCRA) was performed on 45 acres within this site and summarized in a TCRA Report (Parsons, 2002). Various MEC were identified during the TCRA. Additional historical investigations were conducted as summarized in Table 4.2. Based on information in the ASR Supplement (USACE, 2004), the historical usage of MRSR02, Range III, was high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing. Historical evidence at this MRS indicates that 100-pound practice bombs and 2.25-inch rockets were used.

4.3.3 MRS-R03, Range IV

This site was identified in the previously conducted EE/CA (Parsons, 2003). However, no further investigations have been performed at this MRS since that time (see Table 4.3). Based on the information in the ASR Supplement, the historical usage of MRS-R03, Range IV was for practice bombing, including medium-altitude bombing.

4.3.4 MRS-R09, Machine Gun / Rifle Range

This site was identified during the EE/CA (Parsons, 2003) and was included in the RI conducted by EODT (EODT, 2012). The presence of MEC has been confirmed at this site; however, not MC characterization has been conducted (Table 4.4). Historical documentation indicates that activities at the Machine Gun (MG) Range were limited to firing bomber turrets and MGs in a ground-mounted mode, and that those at the Rifle Range (RR) were limited to basic rifle marksmanship training.

4.4 TECHNICAL APPROACH

4.4.1 Technical Project Planning

The TPP-1 meeting was part of the TPP process and was conducted to facilitate discussion of questions and comments among the stakeholders. The objective of the TPP memorandum is to document stakeholder agreements and/or comments made during the meeting regarding data quality objectives (DQOs) established for the site. Following review and approval of the memorandum by the stakeholders, the Work Plan (and other associated plans) will be developed and submitted for review.

4.4.2 Right-of-Entry Negotiation

USACE will be responsible for obtaining ROE; with HGL support for development of maps and lists of relevant parcels and landowner contact information. HGL will maintain the ROE status tracking in the project geographical information system (GIS) and on the team webmap, for coordination with USACE.

Table 4.1
MRS-R01 (Range II) Previous Investigations

Investigation/Report	MRS-R01 (Range II)
2003 EE/CA, Parsons	Identified the potential presence of MEC in Area A, a 425-acre area established at the center of Range II. No risk identified in Area A-1 (a buffer around Area A). Recommended clearance to depth only at planned construction sites for the 425 acre Area A; recommended surface clearance elsewhere and institutional controls throughout. Munitions debris (MD) identified included: • 100-lb practice bomb • Small arms ammunition (SAA)
2005 Final Sampling Report (Removal Action), Area A and A-1, EODT	EODT performed a geophysical sampling subsurface investigation for Sun Star, LLC. The investigation covered 439 acres at the Wild Wing Plantation (including the Avocet, Wood Stork, and Hummingbird golf courses, as well as the clubhouse). No MEC were identified, however MD found included: • 100-lb practice bomb pieces (Wood Stork Hole #2) • 100-lb practice bomb (tail fin only) (Avocet Hole #4) • Bomb rack 20 lbs (Wood Stork Hole #5) • Expended .50-cal cartridge (Wood Stork Hole #15) • Bomb lugs (Wood Stork Hole #16) • Expended .50-cal cartridge (Avocet Hole #3) Recommended 70 acres for subsurface clearance.
July 2012 RI, EODT, Revision 1	Potential for MEC hazard determined “Unlikely”. Concluded no MC contamination present. Stated MEC not delineated. Recommends further investigation. No rights-of-entry granted.

Table 4.2
MRS-R02 (Range III) Previous Investigations

Investigation/Report	MRS-R02 (Range III)
2002 TCRA, Parsons	TCRA performed on 45-acres of Range III. MEC found included MK II 1.1-inch projectile, M38A2 100-lb sand-filled practice bombs, M48 practice 20-lb fragmentation bomb, practice 5" HVAR warhead, M69 6-lb incendiary bomb, fuzes, M16 fuze burster, M16 igniter, AN-M16 white phosphorus igniter, M57 250-lb general purpose bomb. MC sampling for cadmium.
2003 EE/CA, Parsons	Confirmed the presence of MEC only at Area B. Recommended clearance to depth and ICs for Area B. Recommended clearance to depth only at planned construction sites within buffer surrounding Area B (Area B-1); recommended surface clearance elsewhere along with ICs. MEC identified included: • 4-lb incendiary bombs MD identified included: • 2.25-inch rockets • 4-lb incendiary bombs • 20-lb fragmentation bombs • 100-lb practice bomb • SAA
2005, August, ERM Removal Report at Parcel 22b (within Area B-1)	ERM performed for International Paper Realty Company (property owner) Removal Action Report covering 231 acres in Range III. Geophysical survey – 100%.
2005 Removal Actions (Phase I, II, and III), Kestrel	Kestrel (with others) performed clearance covering 456 acres (Parcels A and B) in Range III. MEC contamination confirmed. No MC contamination identified. Soil sampling conducted for explosives.
2006 MC Sampling, Parsons	Soil and surface water sampling. No explosives detected. Metals detected (lead, zinc, cadmium, and mercury) only were related to MC potentially present.
2006 Phase I Ordnance Removal, TetraTech	Removal conducted for D.R. Horton on 114 acres immediately east of and outside the Area B-1 safety zone established during the EE/CA. MD found included: • 100-lb practice bomb • 5-inch ZUNI rocket warhead • 2.75-in rocket
2007, Site Specific Final Report, Kestrel	Removal conducted for Landbank, LLC, on 336 acres (Tracts 15, 16A, and 16B) within the buffer safety zone. DGM was conducted, wetlands (83 acres) excluded from removals. MEC contamination confirmed, and 221 unexploded ordnance (UXO) items reported destroyed. No MC contamination reported. Soil sampling conducted and analyzed for explosives, metals, and semi-volatiles.
July 2012 RI, EODT, Revision 1	MEC presence confirmed. Concluded no MC contamination present. Stated MEC was delineated. Recommends further investigation.

Table 4.3
MRS-R03 (Range IV) Previous Investigations

Investigation/Report	MRS-R03 (Range IV)
2003 EE/CA, Parsons	Identified the potential presence of MEC in both Area C and Area C-1. Recommended clearance to depth only at planned construction sites; surface clearance elsewhere for both. MD identified included: • 4-lb incendiary bombs • 20-lb fragmentation bombs • 100-lb practice bomb
July 2012 RI, EODT, Revision 1	Concluded that the possibility of MEC hazards is unknown, but unlikely. Concluded no MC contamination is present. Recommends further investigation.

Table 4.4
MRS-R09 (Machine Gun/Rifle Range) Previous Investigations

Investigation/Report	MRS-R09 (Machine Gun/Rifle Range)
2003 EE/CA, Parsons	No Department of Defense Action Indicated (NDAI) recommended for this MRS.
July 2012 RI, EODT, Revision 1	MEC presence confirmed. No MC characterization. Stated MEC was delineated. Recommends further investigation.

4.5 DATA QUALITY OBJECTIVES

4.5.1 Introduction for DQOs

To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design the requisite data collection program in an effort to characterize the residual hazards/risk remaining at the project site. DQOs are statements defining the quality, quantity, and type of data required (e.g., geophysical), the manner in which data may be collected, and the acceptance criteria for those data, to provide an adequate database to support project decisions. DQO worksheets addressed during the TPP meeting and DQOs established during the TPP process are listed in Section4. As a summary of the DQO development conducted during the TPP process and to present the site-specific DQO statements developed for the site, Table 4.5 provides an overview of the DQOs. Table 4.5 also provides a cross walk for each DQO to the development steps from both the USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE Technical Project Planning Process, EM 200-1-2, 31 August 98. The data collected under the DQOs summarized in Table 4.5 will be continuously evaluated against the appropriate decision rule. The anticipated decision rules are included in Table 4.6. HGL will solicit project team

concurrence and input during evaluation of the RI data collected against the project DQOs and decision rules.

4.5.2 MPPEH Characterization DQOs

The purpose of the MPPEH DQOs is to evaluate the nature and extent of MPPEH contamination and determine if further response actions are required to support current and future residential, commercial, agricultural, and recreational land use. The MPPEH DQOs in this section cover explosively hazardous items: (1) MEC (including UXO; (2) DMM; and (3) explosively hazardous concentrations of MC. The MPPEH DQOs in this section also cover non-explosively hazardous items: MD.

A. State the Problem

- Previous investigations have determined the site is potentially contaminated with MPPEH. The lateral extent of MPPEH is unknown. The nature and lateral/vertical extent within the four MRSs requires definition.

B. Identify the Decision

- The MPPEH potentially present at the MRSs requires the investigations planned in this project. Will the nature and extent of MPPEH require future response actions? If so, where? What future response actions may be appropriate for the land use?

C. Identify Inputs to the Decision: The inputs to the decision are designed to answer the following questions: What is the distribution density of MPPEH? What type of MPPEH is present? What is the depth of the MPPEH? The inputs include:

- All historical data from prior investigations
- All data generated from the project field activities, including the current and future conceptual site model inputs, intrusive results, excavation results, geophysical surveys, and environmental sampling.
- Data collected may be limited by right-of-entry refusals, available detection technologies, etc.

D. Define Boundaries of Study

- The MRS-R01, MRS-R02, MRS-R03, and MRS-R09.

E. Develop a Decision Rule for MPPEH (see Table 4.6). The RI/FS field activities decision rules are listed in Table 4.6.

- Is the MPPEH material documented as explosive hazard (MDEH)/MEC or material documented as safe (MDAS)/MD? Depending upon the documented status (MDEH or MDAS), the below decision rules will apply:
  i. If MDEH, then does the MDEH or MEC (which may be either UXO, DMM, or MC) need to be blown-in-place (BIP)?

ii. If MDAS or MD, then does material need to be moved for stockpiling and/or recycling?

F. Specify Tolerable Limits of Decision Error

- Tolerable limits of decision error are the applicable accuracy requirements for the location and lateral extent of anticipated contamination areas to be located (reacquired) and intrusively investigated. All accuracy requirements for data to be obtained will be defined in the draft work plan.

G. Optimize the Design for confirming MPPEH presence

- RI/FS field activities will be conducted in accordance with the performance and data quality metrics that will be outline in the Quality Control Plan of the draft work plan, and in compliance with the performance work statement.

4.5.3 MC Contaminants DQOs

The purpose of the MC DQOs is to determine the nature and extent of potential contamination; verify any future response action for confirmed contamination will be adequate; and determine if further response actions are required to support current and future land use.

A. State the Problem

- Previous investigations have determined the site is potentially contaminated with MC contaminants. The nature and lateral/vertical extent of MC contaminants requires definition. If MC contaminants are present, it is not known whether concentrations could potentially pose an unacceptable risk to human or ecological receptors.

B. Identify the Decision

- Is there evidence of MC contamination within the MRSs (incremental sampling method sampling)?
- Based on results of sampling, determine whether concentrations in soil exceed screening levels and whether receptors could potentially be affected.
- What is the nature and extent of any MC contamination determined to be present?

C. Identify Inputs to the Decision. The inputs to the decision are designed to answer the following questions: Where is MC contamination, if present? What is the extent? What are the MC contaminant concentrations, if present? The inputs include:

- All historical data from prior investigations
- All data generated from the RI/FS field activities, including the current and future conceptual site model inputs, intrusive results, excavation results, geophysical surveys, and environmental sampling. These inputs will identify presence of MEC within the MRSs that potentially released MC contamination to the environment.
- Establish analytical methods for MC contaminants.

- Laboratory analytical data to determine MC contaminant concentrations through chemical analysis.
- Site-specific screening levels for MC contaminants. Identify background metal concentrations.
- Data collected may be limited by right-of-entry refusals, available detection technologies, etc.

D. Define Boundaries of Study

- The MRS-R01, MRS-R02, MRS-R03, and MRS-R09.
- Areas where MEC is discovered within the MRSs.
- Areas where evidence of MC contamination are observed.

E. Develop a Decision Rule for Soil (see Table 4.6). The RI/FS findings and appropriate Decision Rules for MC are listed in Table 4.6.

- If maximum concentrations of MC contaminants within a source area exceed screening levels and a complete contaminant pathway and receptor exist, the source area where MEC and/or MD item(s) were found will be delineated for MC contamination during these field activities.

F. Specify Tolerable Limits of Decision Error for Soil

- Tolerable limits of decision error will be specified in the draft work plan UFP-QAPP, based on method detection limits and quantitation limits for analytical methods.
- Constituent screening levels are based on USEPA regional screening levels (RSLs) where no established South Carolina levels exist. A discussion of screening levels and associated tables will be presented in the project-specific UFP-QAPP.

G. Optimize the Design for Collecting Soil Data

- Sample numbers and positions will be calculated to most efficiently investigate potential MC contamination at the MRSs.

Table 4.5, Site-Specific Data Quality Objectives Summary

DQO Criteria from USEPA [1]	Problem Statement / Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
DQO Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MPPEH response	Evaluate the nature and extent of MPPEH and determine if further response actions are required to support current and future residential, commercial, agricultural, and recreational land use.[2]	Risk, Remedy	MPPEH – whether MEC (UXO, DMM, or explosively hazardous MC) and MD	Surface and Subsurface soil	Within MRS-R01, MRS-R02, MRS-R03, and MRS-R09. Focus on areas not previously characterized, to include delineate of lateral extent.	Surface clearance, DGM transects and grids, mag and dig transects and intrusive investigations are detailed in Section 4.5.4. Section 4.5.4 lists all inputs to be generated from the RI/FS field activities.	All investigations shall be conducted IAW the performance and data quality metrics outlined in the QCP (Chapter 4 of the draft work plan) and IAW the performance standards of the PWS: Demonstrate that all areas with elevated anomaly density or with potential to contain MEC have been traversed at the completion of fieldwork and that there is at least 90% chance of detecting these areas. Demonstrate in areas outside of the MEC contaminated areas that there is a 90% confidence there is less than or equal to 0.1 UXO per acre in residential areas, 0.5 UXO per acre in low use areas, and 1.0 UXO per acre in areas without intrusive activities. Demonstrate that the boundaries of all identified MEC-contaminated areas have been delineated to an accuracy of a maximum 250 feet, and demonstrate that at least 90% confidence has been achieved for bounding the potential depth of MEC. Demonstrate that data inputs from the RI into the FS will enable remediation cost estimates with an accuracy of +50%/-30%.	Evaluations of the presence of MPPEH, (MEC/UXO), MD, frag, and anomaly density will be used to indicate the likelihood of UXO contamination.	Not applicable.
MC Contamination	Evaluate and determine nature and extent of MC contamination [3]	Risk, Remedy	Sampling (as set out in Section 4.5.4.2.1) to include: Metals and explosives	Soil, sediment, and groundwater	Within MRS-R01, MRS-R02, MRS-R03, and MRS-R09. Focus on areas not previously characterized, to include delineate of lateral extent.	See sampling rationale in Section 4.5.4.2.1	If MC analytes are detected, results will be compared against site-specific background levels and screening levels to determine if contamination is present. Site-specific background samples will be used to assess metals concentrations. Based on evaluation of the IS sample results, shallow subsurface soil samples or groundwater samples may be collected.	Includes collection of incremental soil samples or biased, discrete surface soil samples	IS will be analyzed for explosives (8330B). Biased, discrete soil samples will be analyzed for select metals (6020A/7471B).

(1) This table provides a summary of the DQO development for this project. This table provides a cross walk for each DQO element to the development steps from both the USEPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* USEPA, USEPA QA/G-4, USEPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized will be continuously evaluated during field activities against the appropriate decision rules.

(2) The project objectives include development of future response actions to limit the interaction between potential MEC present and the anticipated receptors accessing the site.

(3) The preliminary remediation objective for MC contaminants are based on the appropriate screening levels.

Table 4.6, Decision Rules for Conway RI/FS

	Preliminary Status	Investigation	Decision Rule	Intermediate Status	Decision Rule	Intermediate Status	Decision Rule	Final Status and Recommendation
1	MPPEH known or potentially present; Areas where MPPEH (including MEC) is anticipated	Conduct surface clearance, DGM transects and grids, mag and dig transects, anomaly reacquisition, intrusive investigation of DGM survey grids.	If MPPEH categorized as MDEH is located: Modify MRS boundary to improve boundary accuracy. Expand investigation (if needed).	**MEC contamination** is confirmed.	Evaluate nature and extent of MDEH/MEC, as appropriate. Expand investigation area (if needed).	MDEH/MEC contamination confirmed, extent delineated to performance criteria.	**MDEH/MEC contamination confirmed and delineated.**	**Recommended for evaluation in FS**
			If MPPEH categorized as MDAS/MD is located: Expand investigation (if needed).	**No MEC contamination**. **MDAS/MD contamination confirmed** (The presence of more than 2 pieces of confirmed MD will be considered "MD contamination.")	Complete evaluation for other exposure hazards (MC), and for presence of MDAS/MD or CD, as required.	MDAS/MD contamination confirmed.	**No MEC present; MDAS/MD confirmed to be present.**	**MDAS/MD extent delineated** **No MEC contamination.** No FS evaluation required, potential NDAI.
			If no MPPEH is located:	**No MEC or MD contamination.**				No FS evaluation required, potential NDAI.
2	MC contaminants	Sampling as outlined in Section 4.5.4.2.1	MC contaminants are not detected or concentrations are less than screening levels	**No MC Contamination** Recommended for NDAI	**NDAI for MC contamination.**			
			MC contaminants are detected at concentrations exceeding the screening levels.	**MC contamination is confirmed.**	If MC contamination is present, additional evaluation of the area (additional soil sampling and/or a risk assessment) will be conducted and the contamination delineated.	No MC contamination present in additional sampling results and all contaminated soils are removed.	**MC contamination.** Recommended for FS.	

4.5.4 RI/FS Field Activities

HGL's technical approach for each MRS is based on the anticipated MEC or MC contaminated area size, suspected past DoD activities, potential MEC/MD, previous investigation/removal activities, current and future land use, and the planned field investigation activities. Highlights of HGL's field investigation approach are provided in Figure 2 through Figure 5 and can be viewed on the project webmap. The preliminary conceptual site models for MEC and MC are included in Figures 6 and 7.

4.5.4.1 Site-Specific Technical Approaches

After review of available historical data and additional historical aerial research conducted for this proposal, HGL has defined areas of expected MEC contamination within each MRS. The MRSs are composed of various types and sizes of ranges. The investigation strategy proposed for portions of each MRS where MEC contamination is expected to be present consists of the following:

- Conduct DGM along transects of appropriate spacing at various widths (person portable single sensor and array transects) based on the suspected target area characteristics to define areas containing elevated concentrations of anomalies.
- Following evaluation of DGM person portable and towed array transect data, propose locations for DGM grids, within the elevated anomaly density areas. A minimum of 20% of the golf course, residential, wetland and overland transect acreage will be investigated using grids (with intrusive investigation).
- Following evaluation of person portable DGM transect data, propose locations for DGM grids for intrusive investigation in areas containing relatively low concentrations of anomalies to confirm interpreted transect data.
- If land owners are agreeable (i.e. golf course), specific transect anomalies may be evaluated instead of installing and intrusively investigating full coverage grids, assuming an even acreage / anomaly trade-off.
- Delineate the boundaries of resulting munitions use areas defined by person portable and array transects with intrusive mag and dig transect segments, as necessary. A buffer area of the MRS outside of the expected MEC areas will be characterized using a grid sampling approach to confirm that MEC is not present. HGL proposes 100 grids (100-ft x 100-ft size), to be placed in these outlying areas based on TPP discussions and confirmed during WP preparation. The site-specific technical approach for each MRS is presented below. The general methods for accomplishing the field activities are described in Section 4.4.3.2.

4.5.4.1.1 MRS-R01, Range II, Site-Specific Technical Approach

Given the lack of historical investigation data for this MRS, HGL proposes to investigate the area within the footprint shown in Figure 2. The investigation proposed will combine golf course coverage (to be negotiated with the golf course using HGL's proposed alternative methods to minimize impacts to course usage) and residential and open lands investigations.

HGL proposes 1.29 miles of residential area transects, 9.31 miles of golf course transects, 9.31 miles of overland transects, and 4.87 miles of wetland/ponds transect investigations. Spacings for these transects will be 500 feet, unless smaller spacings are used as adapted to golf course investigation. Additionally, based on the 2.25-inch SCAR observed by the HGL site visit team, HGL proposes to investigate the Horry County landfill present north of the MRS. These proposed transects will provide additional delineation north, northwest and east.

4.5.4.1.2 MRS-R02, Range III, Site-Specific Technical Approach

HGL proposes to investigate the area within the footprint shown in Figure 3. Review of historical data shows that 20-lb bomb fragments were located at the previously identified northeast boundary and that 100-lb sand-filled bomb fragments were present at the previous northwest boundary. HGL's historical aerial photographic analysis identified features outside the south and southwest boundaries. Based on these evaluations, HGL proposes to investigate 16.29 miles of overland transects and 4.31 miles of wetland/ponds transects, outside historically investigated areas, as shown. HGL also proposes to investigate 2.47 miles of mag and dig transects within the known target areas.

4.5.4.1.3 MRS-R03, Range IV, Site-Specific Technical Approach

The RI includes extensive historical data for Range IV generated from privately funded RAs conducted by private developers in the central and southern portions of the MRS. Based on this data, HGL proposes to investigate the 2.54 miles golf course transects, 4.45 mi overland transects, and 8.66 miles wetland/ponds of transects as shown on Figure 4. Review of historical data shows that the extent of the MRS is delineated to the northwest, but not to the northeast, southeast, or southwest. The proposed transects will accomplish the delineation to PWS requirements. HGL also proposes to investigate 7.89 miles of mag and dig transects within the known target areas.

4.5.4.1.4 MRS-R09, MG/RR, Site-Specific Technical Approach

HGL proposes to use transects spaced at a 500 feet and concentrated in the undeveloped areas of the MG/RR. At this time, HGL does not propose any investigation of the residential areas, or of the golf course, as data from the previous investigations and historical photographic analysis indicate a low potential for MEC to be present. Proposed investigations are targeted in the outer edges of the MRS on the open, undeveloped land, to determine the presence of MPPEH within the range and include 7.49 miles of overland transects and 2.20 miles of wetlands transects.

4.5.4.2 Field Investigation Activities

Safety: Safety is the greatest concern for all HGL activities. Before any field operations begin, a site-safety briefing will be provided to all field personnel. This will include a discussion of Activity Hazard Analyses for assigned tasks, a description of potential biological, physical, and meteorological hazards, and a presentation of the hazards presented by MEC potentially present within the work areas.

Project Site Setup: HGL will establish a field office at a centrally located area. HGL will site an explosives magazine IAW the approved ESP at the approved location. Existing or newly established temporary Class I, 3rd Order survey control monuments will be used to provide location survey control for the investigative teams. Additional GPS survey control will be established by HGL across the site as needed for data collection, evaluation of the requirements and applicability of professional land survey data will be performed during WP development.

Brush Clearing: HGL recognizes that limited brush clearing may be required and will attempt to conduct site activities in a manner such that brush clearing is minimal. As necessary, and where practical and feasible, the HGL team will clear undergrowth along transects and within grids that will be investigated during the RI, and will leave flagging and survey stakes to mark transect paths and grids. Vegetation removal will be coordinated with the individual landowners and the PDT. Additional coordination may be required to ensure that operations do not disturb endangered species. HGL is aware that some property owners may have concerns that transect paths cut through wooded areas may promote trespassing. When transect pathway clearance is required, pathways will be limited to the width of the anticipated tow vehicle (such as the amphibious vehicle proposed). Brush clearing will be accomplished by a two-person brush clearing team consisting of a UXO Technician II and a heavy equipment operator using a tracked loader with mulching head or brush-hog attachment. Brush clearing personnel will don appropriate personal protective equipment during brush clearing activities. Any discovered surface MEC items will be documented for inclusion in the RI report and disposed of.

Basis for MEC Investigation: HGL will utilize three different approach techniques/methods to define the nature and extent of MEC present at Conway BGR. These approaches include variations of both transect and grid-based investigation strategies and are summarized below:

i. **Historical Use Transect Bias:** Site-specific data and information identifying munitions formerly used at the MRSs will be used to define the proposed geophysical transect investigation strategy across the area. Historical information will be used to outline the general distribution of potential MEC items. Specifically, this method will allow HGL to identify target areas and other areas of high anomaly density. The transect spacing (sampling density) for each area will be based on the activities that reportedly took place within them and/or munition items recovered during previous investigations and RAs. Factors such as historical range use, ordnance type, and range size and shape were incorporated into the strategy to determine probable target size and representative transect spacing. The VSP module “Transect Spacing Needed to Locate a UXO Target Area” was used to quantitatively validate the transect spacing and orientation that is necessary to detect target areas with 90% confidence. These data will be detailed in the CSM. During the completion of field activities, HGL will also incorporate collected empirical data into the VSP software to generate estimates of anomaly density for identifying areas of elevated anomaly concentrations.

ii. **Historical Use, Transect Data, and Grid Bias:** Grid locations will be distributed throughout the area based on person portable overland and array golf course, residential, and wetland transect data to refine the extent of the MEC and determine its nature. The grids will be of various sizes depending on the anomaly density of the "target" areas, but will average 2,500SF. These grids will be mapped using DGM to identify potential MEC items. Targets identified within the grids will be evaluated and MEC-like anomalies intrusively investigated by UXO-qualified technicians. All that could potentially represent MEC/MD and 10% of the residual anomalies not thought to be related to MEC/MD will be investigated within each grid to adequately determine the nature of MEC within the grid. Once a munitions contaminated area has been identified, the boundaries of the area (initially determined during transect data analysis) will be validated with intrusive transect segments, as necessary. The intrusive transect segment will assist in accurately defining the extent of the munitions contaminated area.

iii. **Non-Biased Grids:** Grid locations will be distributed throughout areas less likely to contain munitions to confirm the absence of MEC. These grids will be mapped using DGM to identify potential MEC items as discussed above. Grid coverage will be selected based on the UXO Estimator software and ensure a 90% confidence that the residual UXO density will be less than 0.1, 0.5, or 1 UXO item per acre depending on site-specific land use. If munitions are found during the grid investigation in presumed "no MEC present" areas, additional characterization (DGM transects, DGM grids, intrusive transect segments) may be required to verify the extent of residual MEC.

VSP Methodology for Transect Design: HGL's approach involves selecting the optimum transect spacing to determine the necessary area for investigation at each MRS. The VSP tool provides a transparent and real-time means of testing the effect of assumptions on the transect planning. Assumptions about target size, density, and usage can be varied in order to produce a sampling design that achieves the project objectives and can be implemented with the available resources. Successful application of VSP requires a reasonable hypothesis describing the target area size, density, and the background density. During project planning, HGL will apply the appropriate module within VSP to detect target areas of interest for this project with a 90% confidence. As part of this process, HGL will include a range of anomaly densities to ensure an adequate transect spacing based on the anticipated anomaly density.

VSP Methodology Post Transect Survey Analysis: Geophysical sensors are capable of detecting significant target types listed in the ASR to common depths of interest for this project. Ground transects using geophysical sensors are effective for detecting concentrations of munitions and fragments or metal scrap of relatively small size. Transect data will be used to estimate the extent and anomaly density patterns of the presumed target area requiring further evaluation. VSP is a useful tool for analyzing transect coverage and anomalies detected along transects in a quantitative manner. The results can provide quantifiable determination and confidence that a postulated target area may or may not be present. Analysis of the data can provide estimates of the number of anomalies that will ultimately require investigation and the size of area to be remediated.

After survey data have been collected, HGL will utilize VSP's target-identification algorithms ("Geostatistical Mapping of Anomaly Density" and/or "Locate and Mark Areas Based on Elevated Anomaly Density"), which uses a user-defined window that systematically moves along each transect surveyed, to identify locations that have an anomaly density greater than expected from background. An estimate of the background anomaly density is obtained by examining the histogram distribution of densities found during the survey. Based on both quantitative and visual tools within VSP, HGL will determine the significant density above the background (the critical density) that is potentially related to historical target area use. Geostatistical estimation (Kriging) will be used to produce a color-coded image of anomaly density across the MRS, and areas of significant anomaly density above background will be defined and shared with the client for acceptance.

Digital Geophysical Mapping: DGM will be conducted using both linear transects and full coverage grids to identify potential subsurface MEC/MD items. The DGM program will be consistent with USACE DID WERS- 004.01, including the deliverables defined in Attachment C to the DID and general performance requirements provided in Attachment D to the DID. Positioning instrumentation used for the DGM investigation will consist of a combination of wheel/fiducial mode for grids in dense canopy, RTK GPS or Robotic Total Station (RTS) in "open" areas, and WAAS-capable GPS for use along density transects in wooded and "open" areas. Prior to production DGM activities, an instrument verification strip (IVS) test will be performed and the results provided to the client for acceptance.

Geophysical sensors anticipated for use on the project include the EM61-MKII (single-sensor, two-sensor and three-sensor array), or equivalent. The use of the EM61 time-domain electromagnetic technology is warranted because of its ability to detect the munitions of interest at the required depths and the actual results of the past DGM investigations at or near some of the project sites. The tow vehicle anticipated for use for the multiple sensor array is a specially configured Hydratek XA66. The Hydratek is designed to work in the marine and terrestrial environments and will be fitted with special tires to mitigate environmental damage in the wetlands and golf courses.

The EM61-MKII single-coil unit will primarily be used along transects in wooded areas and over full coverage DGM grids in wooded and open rural areas to detect and accurately locate subsurface anomalies for subsequent intrusive investigation. The EM61-MKII three sensor array will be utilized over golf course and residential transects areas. The array collects a swath of data 10 feet wide that essentially represents a "grid" along the transect path, which will permit accurate reacquisition of anomalies and subsequent intrusive investigation.

Geophysical System Verification: Geophysical System Verification (GSV) is a process that combines appropriate instrument testing on a daily basis and a blind seeding program to ensure that the data collected are of sufficient quantity and quality to meet project objectives. EM61-MKII physics-based models are used to verify that the instrument's responses are within specifications. The blind seed program verifies that data collection, processing, and reacquisition methodologies meet requirements set forth by USACE. Blind seed items will consist of a small industry standard objects (ISO) placed within 6 inches of the surface within

the full coverage DGM grids and along portions of transects covered with the three-coil array. The blind seed items will be placed to ensure that the data acquisition team encounters a minimum of one blind seed item per full coverage grid and one blind seed item per day for the transects surveyed with the array. The HGL QC Geophysicist will review the interpretation and subsequent dig results to ensure the dynamic position and signal response metrics prescribed by the USACE for the blind seed items are achieved.

Data Acquisition Methodology over Transects (Overland Wooded and Open Rural Areas): HGL will use DGM data acquired along transects to identify areas with elevated anomaly concentrations that may correlate with the extent of potential MEC contaminated areas. The detection footprint for the transects is 3 feet wide using a single-sensor EM61-MKII metal detection system on a wheeled cart equipped with WAAS-capable GPS for positioning. The WAAS-capable GPS will be used to record the track of the transect surveys to within ± 3 to 10 meters, which will be adequate to define the initial distribution of densities. Along DGM transects, crews will also record the position of any MEC and MD encountered, and any other features that might be related to the munitions features of interest (e.g., fragmentation, berms, high explosive [HE] craters).

Data Acquisition Methodology over Grid Areas (Golf Course, Residential, Wetland, Overland Wooded and Open Rural Areas): HGL will place grids in high-, medium- and low-density areas to effectively characterize the nature of the MEC distribution. The grid sizes may be different depending on their intended location and purpose. The grids may also be used in "transect-like" configurations (e.g., 25 by 200 feet), centered on the boundary of the presumed target as determined from the anomaly density distribution as defined by VSP. Grid sizes will average 50 by 50 feet in most areas, and the final locations and distribution of grid types will be determined in consultation with the PDT. A single-sensor EM61-MKII on a wheeled cart will be used to collect full coverage DGM data within the grids at a line spacing determined from the results of the IVS. The anticipated line spacing is 2.5 to 3 feet. Positioning in wooded areas will be accomplished using wheel/fiducial mode; if numerous grids are located in "open" areas, RTK GPS or RTS may be used to provide accurate positions for the geophysical measurements.

Data Acquisition Methodology over Golf Course and Residential Transects: HGL will utilize a three-sensor EM61-MKII array (10-foot coverage swath) with RTK GPS along transects in Golf Course and Residential areas to accurately locate and detect anomalies. These data will be assessed along with the transect DGM data collected in wooded and wetland areas using VSP to determine the anomaly density distribution across the areas of interest. Along DGM transects, crews will also record the position of any MEC and MD encountered, and any other features that might be related to the munitions features of interest (e.g., fragmentation, berms, high explosive [HE] craters).

Data Acquisition Methodology over Wetland Transects ("Wetlands"): HGL will utilize a two- or three-sensor EM61-MKII array with an appropriate platform and positioning system along transects in wetlands areas to detect anomalies. These data will be assessed along with the transect DGM data collected in other project areas using VSP to determine the anomaly

density distribution across the areas. Along DGM transects, crews will also record the position of any MEC and MD encountered, and any other features that might be related to the munitions features of interest (e.g., fragmentation, berms, HE craters).

Data Acquisition Methodology over Existing Ponds (as necessary): HGL will utilize a Geometrics 882 TVG (6- foot swath) over existing ponds that may have been used as bombing targets based on a review of historical information. The data in the ponds will supplement the terrestrial DGM data and permit a more comprehensive evaluation of the historical uses related to MEC. HGL anticipates collecting data across ponds using parallel lines spaced at intervals of approximately 10 to 12 feet. RTK GPS or RTS will be used to provide accurate positions for the geophysical measurements. A marine "drop camera" may be used to identify the origin of some anomalies that are determined to be proud of the bottom.

Intrusive Investigation and Removal of Anomalies: The data obtained from mag-and-dig activities will augment the digital geophysical data and aid in the characterization of MEC/MD extent. These data will also be used to determine grid placement for intrusive investigation. Grids will be placed in areas of high, medium, and low concentrations of MEC and/or MD to characterize the nature of munitions.

HGL will intrusively investigate all subsurface anomalies identified along mag-and-dig transects. In addition, HGL will intrusively investigate all MEC-like anomalies within grids and along array transects, and the source of large area anomalies will be identified and characterized. Multiple teams, each consisting of UXO technicians meeting the standards of DDESB Technical Paper (TP)-18 for their respective assigned positions, will intrusively investigate the reacquired anomalies. HGL's SUXOS, UXOQCS, and UXOSO will be on site at all times. Electronic dig sheets will be properly annotated and all columns completed. Anomalies will be excavated IAW the approved WP to positively identify each item. HGL will maintain a detailed record of the items including amounts of MEC, proper nomenclature and condition, location, depth, and disposition. The record will include classification of the item (i.e., discarded military munitions [DMM], UXO, or MC with enough explosives to present an explosive hazard) and the mark/model number of the item. Digital photographs will be taken for reporting purposes. Dig sheets and photographs will be linked to the project GIS. QC checks of the cleared designated anomaly locations will be accomplished by the UXOQCS. UXO-qualified technicians will backfill excavations and restore the ground surface to its original condition.

MEC Disposal: The on-site SUXOS and UXOSO will directly supervise MEC disposal operations. Traffic and engineering controls should not be required; however, if needed, they will be employed to mitigate the effects of an explosive detonation (fragmentation, blastoverpressure, noise) to protect human health, and property. Items that are acceptable to move will be consolidated for destruction with items that are unacceptable to move. Explosives will be stored IAW the approved ESP. If necessary, HGL will post a guard on-site when explosives are delivered and/or stored onsite to maintain public safety. HGL will closely coordinate all explosive disposal operations with local law enforcement and other emergency

management agencies as necessary. The UXO Technician III Team Leader will document each MEC item and note its final disposition.

Disposal/Disposition of MPPEH: HGL will furnish the necessary personnel and equipment to make final disposition of all recovered MPPEH. HGL will remove and consolidate all inert ordnance and metallic debris encountered and will follow the provisions of Chapter 14 of EM 1110-1-4009 and Errata Sheet No. 2 when making final disposition of MEC, MPPEH, and MD. The inspected materials will be packaged, weighed and sealed, and a completed DoD Form 1348-1A will be prepared for each container. These containers will be transferred to a scrap dealer with a written statement that all MD will be immediately processed through a smelter prior to release. All MPPEH will be inspected, weighed, and placed in lockable roll-off containers at the end of each workday. Material documented as safe (MDAS) and metallic debris will have already been inspected and segregated by the UXO teams. This debris (shaped MDAS, MDAS fragments and metallic debris) will be stored in three separate containers. The first container will be used for scrap metal. Items such as banding wire, hinges, nails, etc. will be placed in the scrap metal container. The second container will be used for MDAS fragments. MDAS that has been inspected and reinspected/ certified to not require further treatment prior to final disposition, such as indiscernible fragments will be placed in this container type. The third container will be used for shaped MDAS, which requires further treatment by demilitarization IAW DoD's Demilitarization Manual 4160.21M prior to final disposition. These lockable containers will be stored inside of a locked CONEX box on site until they are shipped off site for proper disposal.

4.5.4.2.1 MC Characterization (Environmental Sampling and Analysis)

A primary goal of the RI/FS is to identify the presence and delineate the nature and extent of MC concentrations present in various MRS environmental media (soil, sediment, and groundwater). Review of the existing data provided for this proposal indicates that there has been site-specific data previously collected at Conway BGR. However, additional sampling is required to augment existing analytical data, to generate a defensible RI/FS. Costs associated with supplemental MC sampling are relatively low compared to the potential risks associated with not developing an acceptable RI/FS; therefore, HGL proposes additional MC sampling at each MRS that will provide adequate support for the RI/FS and subsequent DDs. The following sections define HGL's technical approach (shown in Table 4.7) for environmental sampling and analysis.

Table 4.7
Sample Collection and Analysis Decision Rules

Identification of MC contamination	Compare analytical results to background concentrations and state/federal criteria to evaluate whether an exceedence exists in surface soils (Phase 1).
Delineation of MC contamination	(If required) when MC concentrations exceed established regulatory criteria or background, additional media will be sampled and additional samples will be collected to identify the extent of contamination (Phase 2 and Phase 3).

MC Sampling and Analytical Approach

HGL's proposed RI/FS approach incorporates site history, previous investigation analytical results, and HGL's extensive experience conducting phased RI/FS projects. During HGL's completion of the RI/FS, activities will be conducted to identify the presence or absence of soil, sediment and/or groundwater contamination, to delineate the nature and extent of existing MC contamination, and to evaluate migration pathways and/or pathways for the potential discharge of chemical constituents into the surface water or groundwater. Field sampling activities will be conducted in coordination with MEC field activities in three phases with six separate stages:

Phase 1

- Stage 1 – geophysical surveys to evaluate site conditions and identify the presence and extent of surface and subsurface MEC/MD;
- Stage 2 – MEC characterization, identification, and disposal; and
- Stage 3 – ISM surface soil sampling (explosives) and discrete soil sampling (metals) activities to define the nature and extent of soil contamination compared to site-specific background metal concentrations.

Phase 2

- Stage 4 – dependent upon Phase 1 soil sampling results, additional discrete or ISM surface and/or subsurface soil sampling at locations (estimated 10 per MRS) where a release of MC is verified; and
- Stage 5 – additional sediment sampling (estimated 20 per MRS) from surface water bodies adjacent to potential source areas to characterize the impact on the local drainage, if necessary.

Phase 3

- Stage 6 – dependent upon Phase 1 and Phase 2 results, groundwater sample collection from existing wells to characterize the nature and extent of groundwater contamination, if necessary.

HGL has designed this phased approach for sampling that will adequately characterize the nature and extent of contaminants, provide the necessary data for a risk-based evaluation, and serve as a basis for future response decisions. The following section specifies HGL's approach for the completion of the Conway BGR RI environmental sampling and analysis.

Phase 1 Soil Sampling (Incremental and Discrete)

HGL proposes to collect a total of 40 surface soil samples using a combination of ISM sampling (explosives) and discrete samples (metals). Ten ISM samples will be collected from each MRS. The VSP Multi-Increment Sample Module was used to calculate the number of

surface soil samples required to achieve 95% confidence that the site is impacted above action levels. Sampling will be conducted throughout each MRS based on confirmation of historical information, DGM analysis, and intrusive investigative results IAW the approved RI WP.

HGL proposes the collection of 10 samples from identified background locations for the generation, use, and reporting of a site-specific background dataset. Background samples will be collected from areas similar to, but outside of the MRS boundaries, per EPA guidance. Background soil samples will be collected as discrete samples and will be analyzed for select metals using Method 6020A/7471B. Background samples will not be analyzed for explosives.

MRS-specific areas will be designated as sampling units (SU) based on their status as suspected source areas (the confirmed presence of MEC or MD). ISM sampling for explosives will be conducted in the SUs using the methodology outlined in Appendix A of EPA Method 8330B and IGD 09-02 (USACE, 2009b). Judgmentally located (biased) discrete sampling will be conducted at each MRS for selected metals, dependent upon the confirmed presence of MEC or MD. Analytical parameters will be based on munitions used on site and are anticipated to be explosives and the metals previously detected (lead, zinc, cadmium, and mercury).

Each primary sample collected for Method 8330B (explosives analysis) will consist of at least 30 subsamples collected from a gridded area including equal surface areas covering each respective SU. The VSP Multi-Increment Sample Module was used to determine that each SU will be 100 feet x 100 feet. Each subsample increment will be advanced from 0 to 6 inches using a specialized 8330B coring device. A total of approximately 1.5 kilograms of soil sample will be collected in each bag, homogenized, and sampled. Based on HGL's experience with SCDHEC and past project experience, HGL is not proposing the collection of pre- or post blow- in-place (BIP) samples.

Phase 2 Soil Sampling

Based on the decisions made by the PDT during the TPP process and the Phase 1 analytical results, additional soil samples may be required; therefore HGL is proposing the collection of up to 20 discrete or ISM soil samples associated with delineation of the results obtained during Phase 1. These sample locations will be selected based on Phase 1 results and existing site conditions (MEC, MPPEH, MD or anomalies), and each sample analysis may include explosives (8330B) and select metals (6020A/7471B).

An HGL environmental scientist and a UXO-qualified technician (to provide escort) will collect soil samples for chemical analysis. In addition, HGL will collect QC (e.g., field duplicates, equipment rinsate, and trip blanks), and QA samples.

Both discrete and background soil samples will be collected for chemical analysis using decontaminated stainless-steel spoons. Soil will be transferred to a stainless-steel bowl for homogenization before being transferred to the sample jars. Samples will be assigned a unique sampling identification number based on the location, media, and sample depth. Samples will

be packed in coolers immediately upon collection and tracked using a chain of custody. The samples will be forwarded directly to the analytical laboratory in waterproof coolers on wet ice; both sample jars and ice will be packed in separate bags in a manner to minimize cross-contamination and cooler leakage during shipment. Coolers will be sealed and marked with custody seals to prevent tampering.

All hand augers, spoons, trowels, sample coring devices, and other reusable sampling equipment used to collect surface and subsurface soil samples will be decontaminated between each sampling location by using a multi-step decontamination process.

HGL's approach defined above focuses on soil sampling for the following reasons: (1) historical data associated with Conway BGR suggests that source areas of MC contamination are limited to areas with MEC contamination present; (2) the likelihood of MRS specific MC sediment and groundwater impact is minimal given the low solubility of most of the suspected constituents; and 3) in HGL's experience, it is an extreme rarity to find munitions related reportable explosives or metal concentrations above threshold criteria in groundwater samples at formerly used defense sites (FUDS) locations.

Phase 2 Sediment Sampling

With TPP team concurrence, during Phase 2 of the field investigation activities 20 sediment sample locations will be selected within each MRS, if applicable. HGL will coordinated with the TPP team to evaluate the Phase 1 results to determine that potential source areas exist within surface soil that may impact adjacent surface water bodies. If necessary, sediment samples will be collected to evaluate the potential impact of MC and selected metals on local surface water bodies.

Sediment samples will be collected from surface water locations (ponds, creeks, rivers) identified during the completion of the RI field activities to characterize potential migration of MC. Sediment samples will be collected using either a stainless steel hand auger or a stainless steel trowel, based on site conditions. Sediment samples for explosives and metals analysis will be placed in a stainless steel bowl and homogenized before placing them into the laboratory-specified sample containers.

Laboratory Qualifications

The Denver facility of TestAmerica will provide primary analytical services for this project. Accutest will provide independent QA laboratory analysis of split samples. TestAmerica and Accutest are certified under DoD ELAP and the South Carolina Environmental Laboratory Certification Program. Analysis includes the development of a project-specific automated data review format and Superfund electronic data deliverables 2a or higher. The laboratories will supply sample containers with added preservatives as appropriate. Field QA/QC samples will be used to assess the representativeness of the sampling activities to ensure sample integrity and that samples sent to the laboratory are representative of site conditions. Field QC samples collected will include field duplicates, matrix spike/matrix spike duplicate samples and

equipment rinsate blanks. The field QA sample will consists of a field split sample; field QA/QC samples will be collected as follows:

- Field QC Duplicates – 1:10 (10%, minimum 1 per MRS);
- Field QA Splits – 1:10 (10%, minimum 1 per MRS);
- matrix spike/matrix spike duplicate – 1:20 (5%, minimum 1 pair per MRS);
- Equipment Rinsate Blanks – 1 per day per matrix (for reusable sampling devices); and
- Temperature Blanks – 1 per cooler

Field duplicate (QC) samples will be collected simultaneously from the same media source under Identical conditions, homogenized, and split into separate containers. All samples will be homogenized prior to division of split samples to ensure that all subsamples have the same properties. Field duplicates sent to the laboratories will be labeled so that analysts performing laboratory analyses cannot distinguish duplicate samples.

To provide a measure of the representativeness of the sampling procedure and precision between primary and secondary laboratories, QA field duplicate splits will be collected from the same respective locations as the parent samples under identical conditions and sent to a separate laboratory (Accutest) by HGL for independent analysis. The QA split sample containers will be filled immediately after the field duplicate samples and labeled identically to the parent sample with the addition of "QA" to the name. HGL will ensure that analytical results are forwarded directly to the USACE. The costs associated with QA sampling have been incorporated into HGL's cost proposal.

MS/MSDs will be collected to assess interferences in analytical results caused by the sampled matrix. The samples for MS/MSD will be shared with the parent sample containers. The sample volume for aqueous samples will be sufficient to ensure that enough sample is collected for all MS/MSD analyses. Samples of deionized water used to rinse sampling equipment will be collected on a daily basis to assess potential cross-contamination from the non-disposable sampling equipment, the sample container, and/or preservatives.

HGL will perform definitive data validation services on all analytical data collected at the project site. HGL will produce Quality Control Summary Reports documenting the data validation.

All sample locations will be surveyed for horizontal control by using a PPK GPS unit IAW EM 1110-1-4009 and WERS-DID-007.01. All data submitted will be in the Universal Transverse Mercator coordinate system.

Data from the RI sampling event will be used to perform the human health and ecological risk analysis. The full datasets and risk results will be presented during the third TPP meeting. This information, combined with previous data, geophysical results, and intrusive findings will be used to determine that all data gaps have been addressed.

Chemical analytical results will be compared to established background criteria to determine if site concentrations significantly exceed those background criteria. Numerous statistical methods may be appropriate for processing the data collected at the site. The method selected depends on such things as number of samples, distribution of the data, and percent of samples with values reported as less than method detection limit or reporting limit. If chemical analytical results are detected above background criteria, then those results will be compared to appropriate risk-based screening criteria.

4.6 FINAL REPORTS

Following field activities HGL will prepare an RI report in draft, draft final, and final versions. Major components of the RI report will include site characterization, MRS characterization for MEC and MC contamination (if any), including data evaluation, human health and ecological risk assessments, based on current and future land use, and recommendations including no further action and assessment of required interim measures. HGL will incorporate all relevant previously collected data into the RI report. If warranted, HGL will recommend MRS boundary revisions within the RI report. Other reports will follow the preparation and review of the RI report, and subsequent documents include the Feasibility Study, Proposed Plan, and Decision Document.

4.7 COMMUNITY RELATIONS PLAN SUPPORT

4.7.1 Community Relations Activities

Throughout the performance of RI field activities, various community relations support efforts will be ongoing. HGL will provide community relations support throughout the project life to accomplish project requirements and objectives. HGL will draft a Community Relations Plan to keep community leaders, local government officials, and affected citizens informed about the project. HGL will support USAESCH and USACE in the maintenance of the project repository/Administrative Record. The project repository will be updated by HGL on a monthly basis, and made available to the public.

Public Meetings

Three public meetings will be held near the site in Conway, South Carolina. One of the public meetings will be held to discuss the PP with interested stakeholders. Community relations support tasks include development and delivery of presentations, graphics, handouts, and posters. HGL will provide printing services associated with the meeting materials and will submit all presentation materials to USACE for approval no later than 14 days prior to the meetings with final meeting materials available no later than the day of the meeting. HGL will also coordinate the logistical support for these meetings.

Evacuations

As negotiated with landowners during planning stages, HGL will provide for evacuations and temporary relocation of personnel when residences are located within a defined safety

exclusion zone. HGL will work closely with affected individuals and businesses whose property may be impacted by intrusive investigations to ensure that everyone is kept informed of the field work schedule. HGL will make telephone calls or attempt face-to-face meetings with affected residents and establish a look-ahead schedule to identify plans and locations for on-going and future work, when evacuations may be needed. HGL will coordinate logistics for individuals requiring temporary lodging (a hospitality area or individual hotel rooms), when necessary.

FIGURES

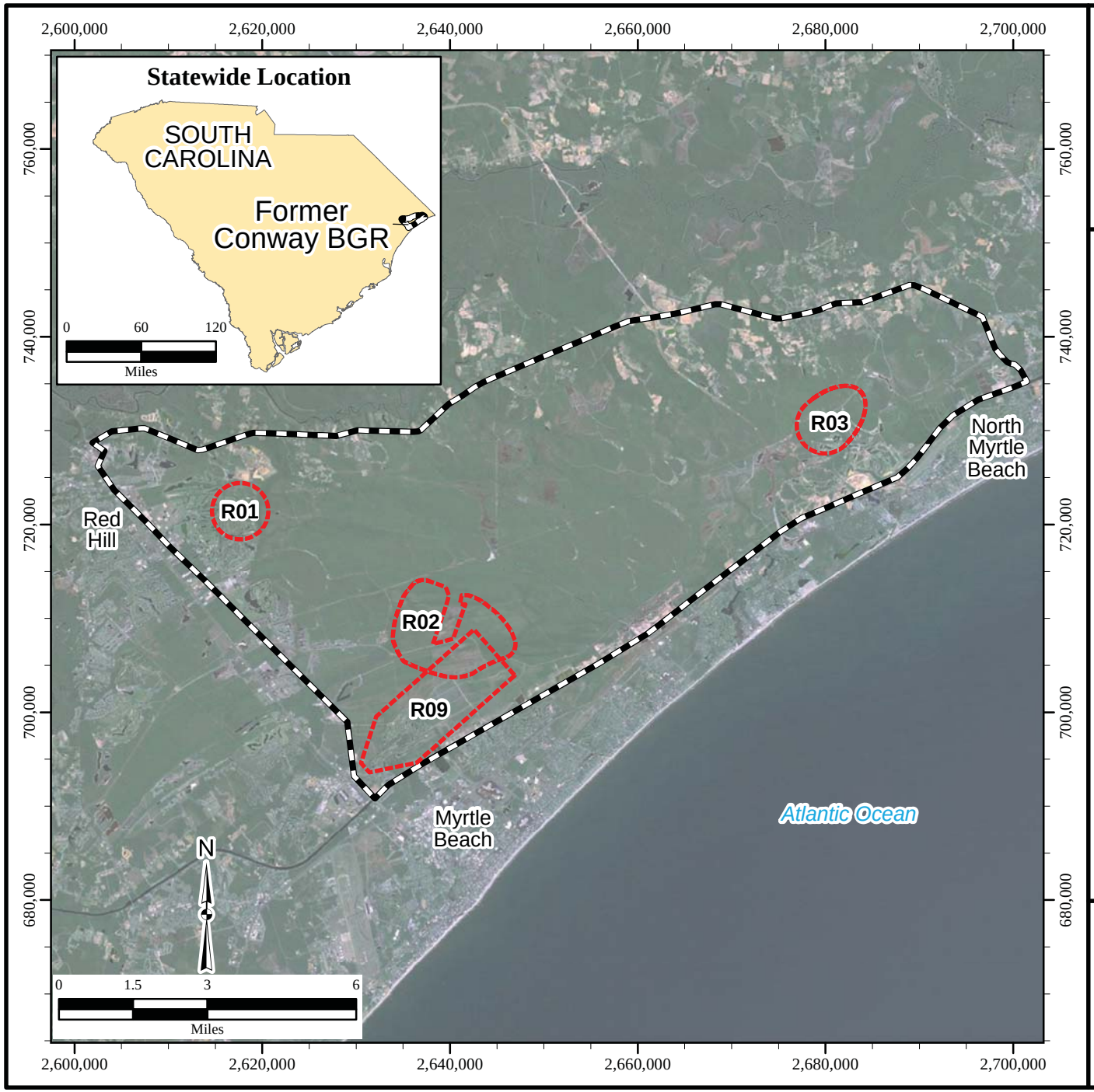

Figure 1

Site Locations

Legend

Munitions Response Site

Former Conway Bombing and Gunnery Range

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range

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Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HGL HydroGeoLogic, Inc

HGL—Former Conway Bombing and Gunnery Range, SC

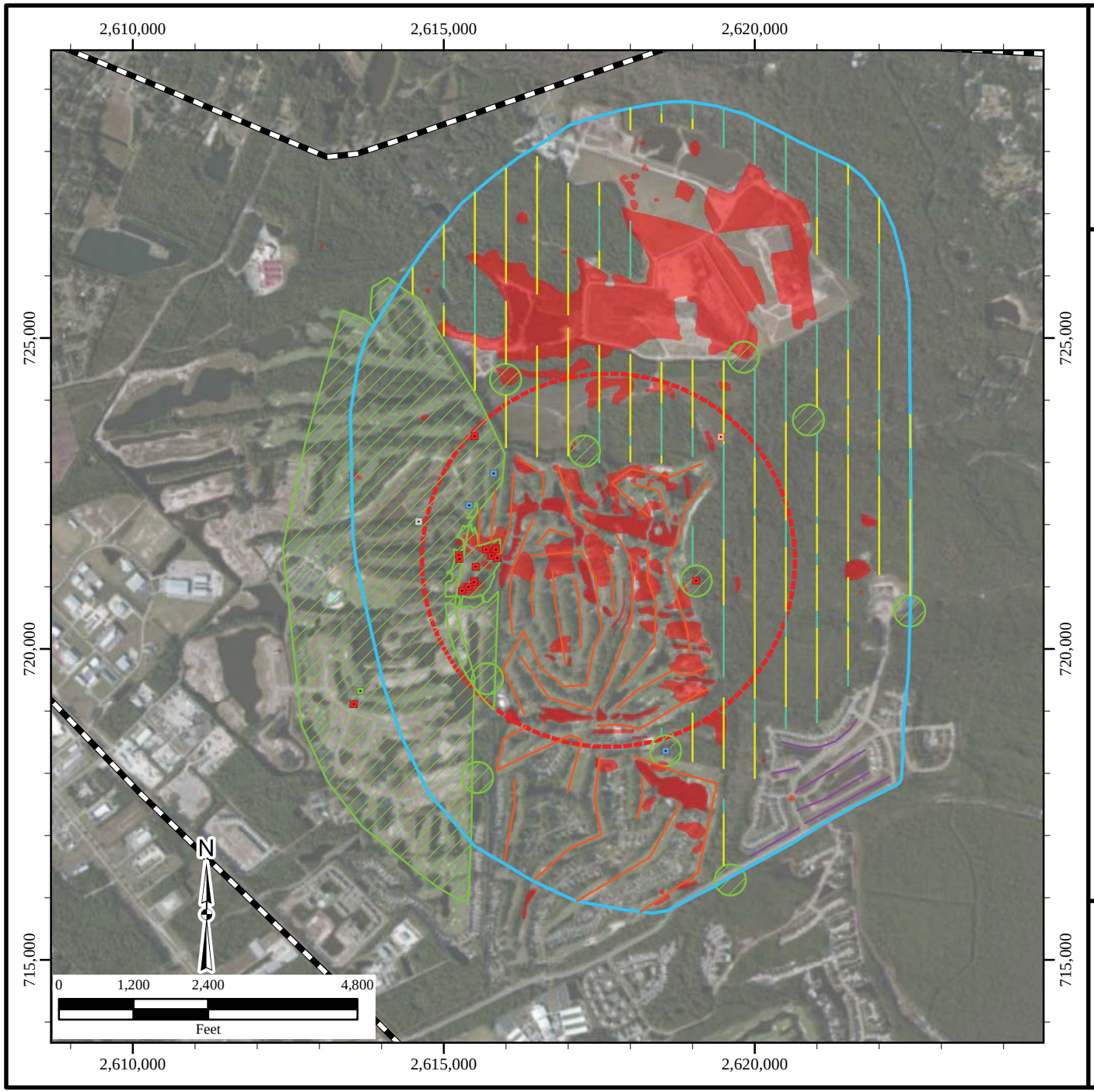

Figure 2

MRS-R01, Range II RI Site-Specific Technical Approach

Legend

MEC/MD:

- 100lb Bomb
- 2.25" Rocket
- 20lb Bomb
- Small Arms
- Other

- Proposed Overland Transect
- Proposed Wetland Transect
- Proposed Golf Course Transect
- Proposed Residential Transect
- Previously Characterized Area
- Investigation Area
- Historical Use Area
- Munitions Response Site R01
- Former Conway Bombing and Gunnery Range

Note:
Coordinates in South Carolina Stateplane, NAD83, feet.

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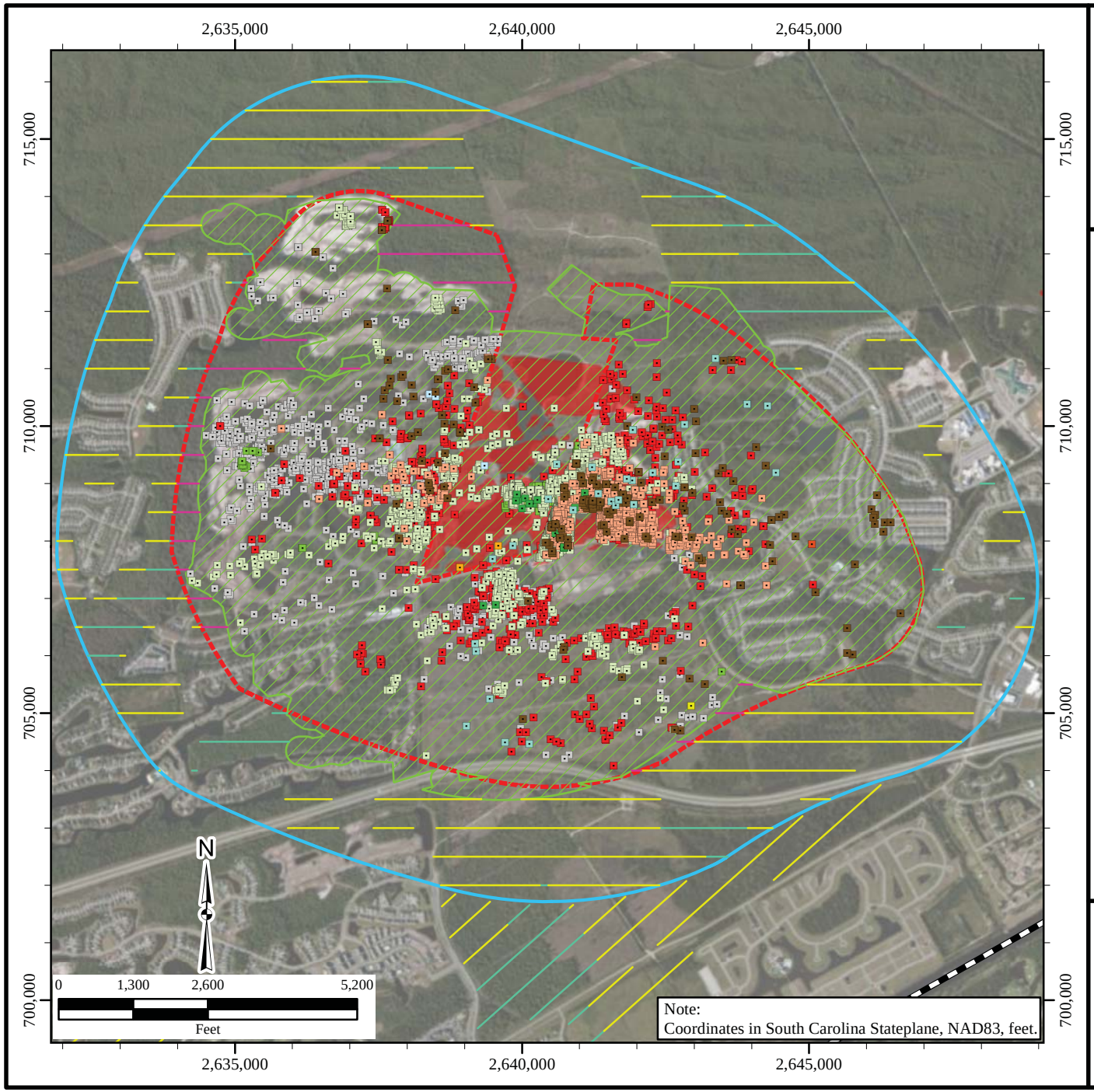
4/29/2013 CNL
Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HGL HydroGeoLogic, Inc

HGL—Former Conway Bombing and Gunnery Range, SC

Figure 3

MRS-R02, Range III
RI Site-Specific
Technical Approach



Legend

MEC/MD:

- 1.1" Projectile
- 100lb Bomb
- 2.25" Rocket
- 2.36" Rocket
- 2.75" Rocket
- 3" Rocket
- 20lb Bomb
- 250lb Bomb
- 37mm Projectile
- 4lb Bomb
- 5" Rocket
- 6lb Bomb
- Other
- Proposed Overland Transect
- Proposed Wetland Transect
- Proposed Mag and Dig Transect
- Previously Characterized Area
- Investigation Area
- Historical Use Area
- Munitions Response Site R02
- Former Conway Bombing and Gunnery Range

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Source: HGL, USGS, USACE
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HydroGeoLogic, Inc

HGL—Former Conway Bombing and Gunnery Range, SC

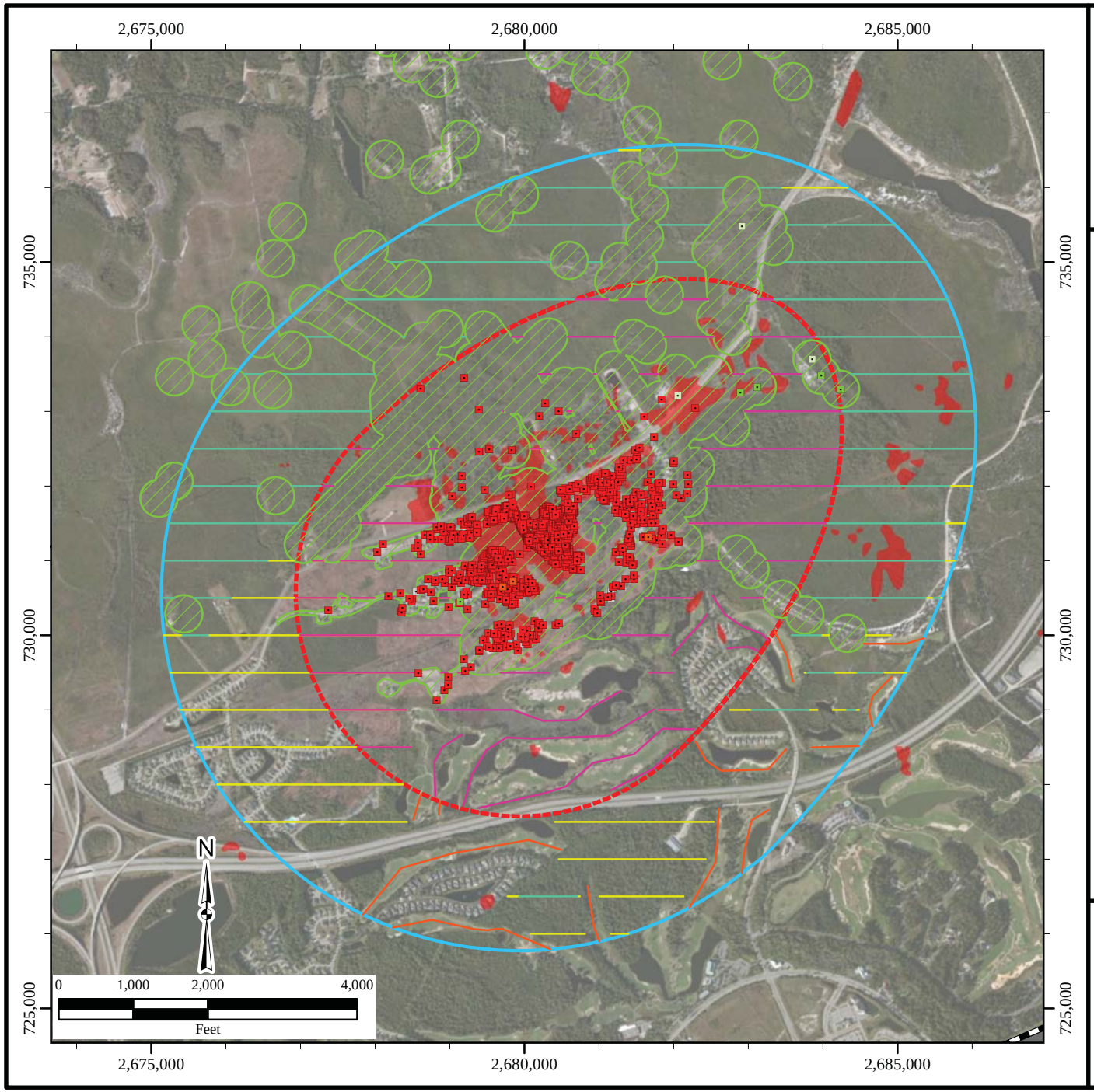

Figure 4

MRS-R03, Range IV
RI Site-Specific
Technical Approach

Legend

MEC/MD:

- 100lb Bomb
- 2.75" Rocket
- 20lb Bomb
- 4lb Bomb
- Other
- Proposed Overland Transect
- Proposed Wetland Transect
- Proposed Golf Course Transect
- Proposed Mag and Dig Transect
- Previously Characterized Area
- Investigation Area
- Historical Use Area
- Munitions Response Site R03
- Former Conway Bombing and Gunnery Range

Note:
Coordinates in South Carolina Stateplane, NAD83, feet.

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Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

HGL—Former Conway Bombing and Gunnery Range, SC

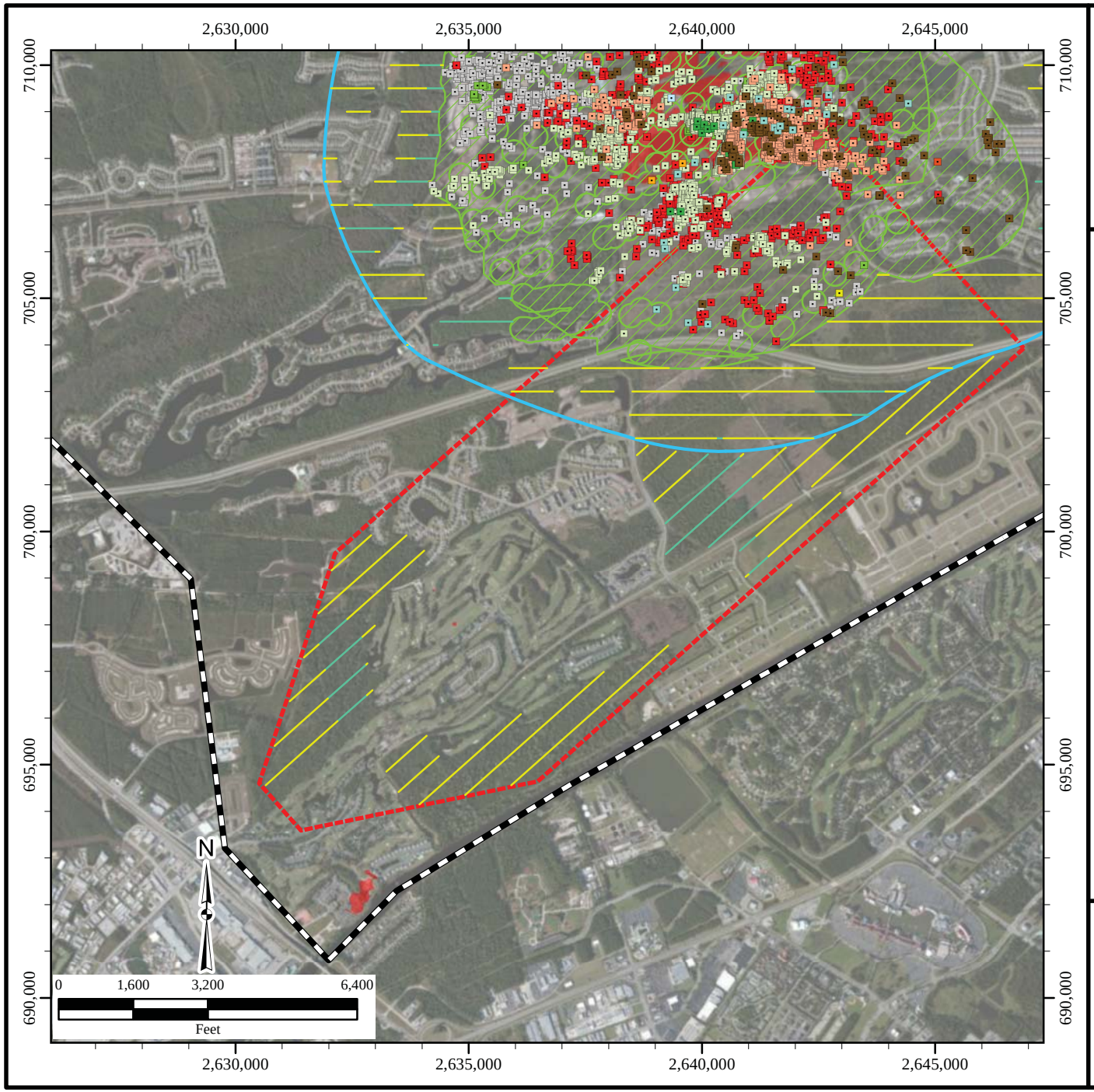

Figure 5
MRS-R09
Machine Gun/Rifle Range
RI Site-Specific
Technical Approach

Legend

MEC/MD:

- 1.1" Projectile
- 100lb Bomb
- 2.25" Rocket
- 2.36" Rocket
- 2.75" Rocket
- 3" Rocket
- 20lb Bomb
- 250lb Bomb
- 37mm Projectile
- 4lb Bomb
- 5" Rocket
- 6lb Bomb
- Other

Proposed Overland Transect

Proposed Wetland Transect

Previously Characterized Area

Investigation Area

Historical Use Area

Munitions Response Site R09

Former Conway Bombing and Gunnery Range

Note:
Coordinates in South Carolina Stateplane, NAD83, feet.

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Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

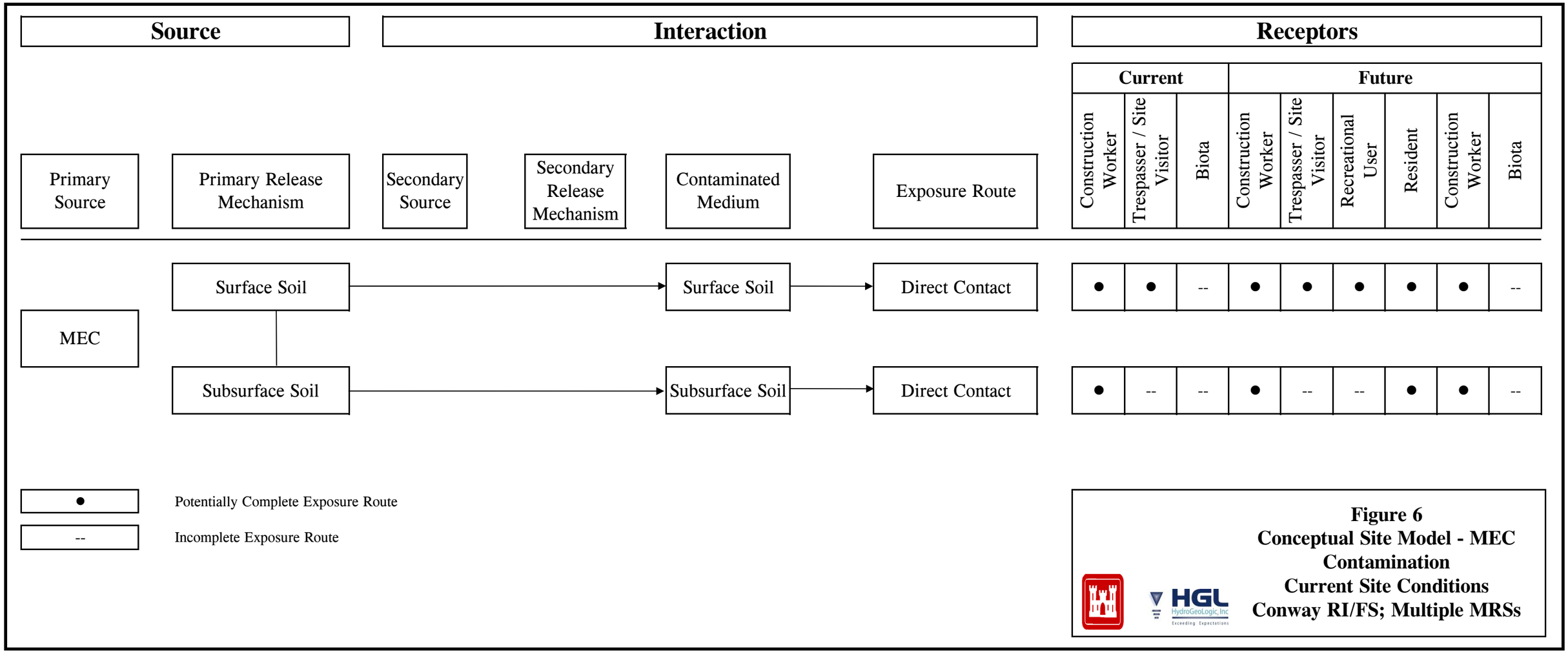

Figure 6
Conceptual Site Model - MEC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

Source	Interaction				Receptors								
					Current			Future					
Primary Source	Primary Release Mechanism	Secondary Source	Secondary Release Mechanism	Contaminated Medium	Exposure Route	Construction Worker	Trespasser / Site Visitor	Biota	Construction Worker	Trespasser / Site Visitor	Recreational User	Resident	Construction Worker	Biota
MC (from MEC presence)	Erosion and Stormwater Runoff			Surface Soil	Incidental Ingestion	●	●	●	●	●	●	●	●	●
					Dermal Contact	●	●	--	●	●	●	●	●	--
		Surface Soil	Bioaccumulation	Vegetation/Prey	Ingestion	--	--	●	--	--	--	--	--	●
		Surface Soil	Dust Emissions	Ambient Air	Inhalation	●	●	--	●	●	●	●	●	--
		Subsurface Soil		Subsurface Soil	Incidental Ingestion	--	--	--	--	--	--	--	●	--
					Dermal Contact	--	--	--	--	--	--	--	●	--
	Leaching			Groundwater	Ingestion	--	--	--	--	--	--	●	--	--
					Dermal Contact	--	--	--	--	--	--	●	--	--
					Inhalation while Showering	--	--	--	--	--	--	●	--	--

● Potentially Complete Exposure Route

-- Incomplete Exposure Route

Note: The composition of future surface soil (surface soil data or pooled surface/subsurface soil data) will be determined after evaluation of the soil data.

Figure 7
Conceptual Site Model - MC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

TPP WORKSHEETS

TPP Team	EM 200-1-2, Paragraph 1.1.1	
Decision Makers		
Customer	US Army Corps of Engineers, Support Center Huntsville (USAESCH) USACE Charleston District	
Project Manager	USAESCH PM Chris Cochrane and CESAC PM Shawn Boone	
Contract Manager	Chris Cochrane, USAESCH COR	
TPP Technical Manager	Kelly Longberg, USAESCH Technical Manager	
Regulators	South Carolina Department of Health and Environmental Control (SCDHEC) - Susan Byrd, Project Manager and U.S. Environmental Proction Agency Region 4	
Primary Stakeholders	USACE, USAESCH, SCDHEC, representatives of local county and municipal governments, and major landowners	
Data Types	**Data Users**	**Data Gatherer**
Compliance/Regulatory (CR)	Regulatory Perspective	HGL RI/FS Team
Demographics/Land Use	Risk, Responsibility, and Compliance Perspectives	HGL RI/FS Team
Site Conditions	Remedy Perspective	HGL RI/FS Team
Munitions and Explosives of Concern (MEC)	Risk and Remedy Perspectives	HGL RI/FS Team
Munitions Constituents (MC)	Risk and Remedy Perspectives	HGL RI/FS Team
Chemical Warefare Materiel (CWM and ABPs)	Risk and Remedy Perspectives	HGL RI/FS Team
Archaeology	Compliance and Remedy Perspectives	HGL RI/FS Team
Endangered Species	Risk and Compliance Perspectives	HGL RI/FS Team

CUSTOMER'S GOALS		EM 200-1-2, Paragraph 1.1.2	
Munitions Response Site (MRS)	**Contaminant Issues**	**Future Land Use**	**Site-specific Closeout Goal (if applicable)**
Four (4) Munitions Response Sites: Range II (R01), Range III (R02), Range IV (R03), and Machine Gun (MG)/Rifle Range (RR) (R09)	MEC and MC	Residential, Commercial, Recreational, Agricultural	Remedy protective of human health, safety, and the environment.

Site Closeout Statement
To manage the munitions and explosives of concern (MEC) and munitions constituents (MC) risk through a combination of characterization, administrative controls, remediation, and public education; thereby rendering the site as safe as reasonably possible to humans and the environment and conducive to the anticipated future land use.

Customer's Schedule Requirements
RI/FS process through Decision Document by April 2016.

Customer's Site Budget		
RI/FS: Fully Funded Through Decision Document.		
IDENTIFY SITE APPROACH		
EXISTING SITE INFORMATION & DATA EM 200-1-2, Paragraph 1.1.3 and 1.2.1		
TPP Information and Data	**Located at Repository**	**Preliminary Conceptual Site Model**
Archive Search Report (ASR)	Horry County Memorial Library in Conway, SC	No
ASR Supplement (2004)	Horry County Memorial Library in Conway, SC	No
EE/CA 2004	Horry County Memorial Library in Conway, SC	No
TC Removal Action - Blalock and Riley Properties	Horry County Memorial Library in Conway, SC	No
Time Critical Removal Action - Lakeview Subdivision	Horry County Memorial Library in Conway, SC	No
Interim Removal Actions (2008, 2009, 2010)	Horry County Memorial Library in Conway, SC	No
POTENTIAL POINTS OF COMPLIANCE EM 200-1-2, Paragraph 1.2.1.3		
Determination of nature and extent of explosive safety hazards, MC, and CWM, as applicable.		
If MC is detected, comparison against background concentrations and Soil Screening Levels (SSLs) will be conducted to evaluate whether an exceedance exists in surface soils (Phase 1). If required, when MC contaminations exceed established regulatory criteria or background data, additional media will be sampled and additional samples will be collected to identify the extent of contamination (Phase 2 and Phase 3).		
MEDIA OF POTENTIAL CONCERN EM 200-1-2, Paragraph 1.2.1.4		
Qualitative review of MEC presence in surface and subsurface soils.		
Quantitative screening of MC constituents for soil, and if necessary, sediment contamination. Background sampling of surface soils for metals.		
SITE OBJECTIVES EM 200-1-2, Paragraph 1.2.2		
Phased approach for geophysical evaluation and media sampling focused on areas of greatest concern (historical use and existing site conditions).		
MEC and MC sampling to adequately characterize site conditions		
Evaluation of MEC and MC data to determine if acceptable for completion of RI/FS		
Eliminate from further consideration those releases that pose no significant threat to public health or the environment.		
Completion of RI/FS		
Develop MRSPP scores for each MRS		
REGULATOR AND STAKEHOLDER PERSPECTIVES EM 200-1-2, Paragraph 1.2.3		
Regulators	**Community Interests**	**Others**
Regulators principal concern is the protection of human health and the environment. Also ensuring that sampling results are defensible by requiring the use of approved analytical laboratories and methods.	Landowners (including homeowners) primary concern is the presence of potential hazards (MEC and MC). Land is safe for intended/current land use.	Nearby towns concerned with potential for future land development.
PROBABLE REMEDIES EM 200-1-2, Paragraph 1.2.4		
Remedial Action following RI/FS characterization.		
Institutional controls following RI/FS characterization.		
EXECUTABLE STAGES TO SITE CLOSEOUT EM 200-1-2, Paragraph 1.2.5		
Remedial Investigation/Feasibility Study (RI/FS)		
Community Relations Plan (CRP)		
Proposed Plan		
Decision Document		
Follow work as stipulated in Decision Document		

IDENTIFY CURRENT PROJECT		
SITE CONSTRAINTS AND DEPENDENCIES EM 200-1-2, Paragraph 1.3.1		
Administrative Constraints and Dependencies		
Rights of Entry (ROE) will be executed by USACE, supported by HGL .		
Utility review and coordination.		
Coordination with landowners		
Cultural Resources		
Funding beyond the RI/FS		
Site Security		
Scheduling		
Technical Constraints and Dependencies		
Establishment of exclusion zone for munition of greatest fragmentation distance during excavation of MEC/UXO.		
Working depth of geophysical instruments.		
MEC avoidance		
Topography/Vegetation		
Heat stress consideration during summer activities		
Hunting seasons		
Legal and Regulatory Milestones and Requirements		
Consistent with CERCLA and NCP		
Public, stakeholder & regulatory involvement & review of key documents		
Screening levels as agreed upon by the Project Team. Background samples will be used to assess metals.		
CURRENT EXECUTABLE STAGE EM 200-1-2, Paragraph 1.3.3		
Technical Project Planning (TPP)		
Remedial Investigation/ Feasibility Study (RI/FS) Work Plan Development		
RI fieldwork		
RI/FS Reports		
Proposed Plans		
Decision Documents		
Basic (For Current Projects)	**Optimum** (For Future Projects)	**Excessive** (Objectives that do not lead to site closeout)
MEC investigation and MC sampling within MRSs	MEC and MC Removal Actions, if warranted.	

Acronyms

ASR - Archives Search Report
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
CESAC - U.S. Army Corps of Engineers, Charleston District
EPA - U.S. Environmental Protection Agency
EE/CA - Engineering Evaluation/Cost Analysis
ESV - Ecological Screening Value
FUDS - Formerly Used Defense Sites
HGL - HydroGeoLogic
HRS - Hazard Ranking System
MC - munitions constituents
MEC - munitions and explosives of concern
MRS - Munitions Response Site
MRSPP - Munitions Response Site Prioritization Protocol
NCP - National Contingency Plan

Acronyms (cont'd)
NDAI - No Department of Defense Action Indicated
PIP - Public Involvement Plan
PRG - Preliminary Remediation Goal
RAB - Restoration Advisory Board
RI/FS - Remedial Investigation and Feasibility Study
ROE - Rights of Entry
SCDHEC - South Carolina Department of Health and Environmental Control
SSL - Soil Screening Level
TBD - To be determined
TPP - Technical Project Planning
UXO - Unexploded Ordnance

PROJECT OBJECTIVES WORKSHEET

SITE: **MRSs - R01, R02, R03, and R09**
PROJECT: **Former Conway Bombing and Gunnery Range, SC**

Site Objective					Data Needs	Data Collection Methods	Data Users	Project Objective Classification [d]
Number	Executable Stage [b]		Description	Source [c]				
	Current	Future						
1	Yes		Assess MEC data, determine risk reduction alternatives.	ASR, EE/CA, RAs	Additional MEC investigation	Digital Geophysical Mapping, Mag-and-dig, intrusive investigation	Risk and Remedy Perspectives	Basic
2	Yes		Assess MC data to evaluate risk to human health or the environment	ASR, EE/CA, RAs	Additional MC sampling	Soil, sediment, and, if necessary, groundwater/surface water sample collection	Risk and Remedy Perspectives	Basic

a Refer to EM 200-1-2, Paragraph 1.2.2
b Refer to EM 200-1-2, Paragraph 1.2.5
c For example, Meeting with Customer/stakeholder/Regulator, State Regulation____,
d Classification of project objectives can only occur after the current project has been identified.
Refer to EM 200-1-2, Paragraph 1.3.3.

ASR - Archive Search Report
IAW - In accordance with
MEC - Munitions and Explosives of Concern
LU - Land Use
MC - Munitions Constituents
SAP - Sampling and Analysis Plan

MEC Data Quality Objective Worksheet

Site: MRSs - R01, R02, R03, and R09

Project: Former Conway Bombing and Gunnery Range RI/FS

DQO Statement Number: 1 of 2

DQO Element Number [(1)]	DQO Element Description [(1)]	Site-Specific DQO Statement
Intended Data Use(s):		
1	Project Objective(s) Satisfied	Evaluate presence/absence of MEC and determine if further response actions are required to support current and future residential, commercial, agricultural, and recreational land use.
Intended Need Requirements:		
2	Data User Perspective(s)	Risk, Remedy
3	Contaminant or Characteristic of Interest	MEC, Munitions Debris distribution/density
4	Media of Interest (Surface and Subsurface Soil)	N/A
5	Required Locations or Areas	MRSs - R01, R02, R03, R09 - Investigation of each MRS as described in paragraphs 5.3.1.1.1 to 5.3.1.1.4 of the Advance Summary.
6	Number of Samples Required	N/A
7	Reference Concentration of Interest or Other Performance Criteria	DGM and intrusive investigations will be conducted to meet the performance critieria required by the PWS (90% confidence that MEC contaminated areas are bounded to an accuracy of 250 feet, etc.) DQOs will be expanded in the TPP Memorandum and Work Plan to include Decision Rules, etc.
Appropriate Sampling and Analysis Methods:		
8	Sampling Method	Digital Geophysical Mapping (DGM), Mag-and-Dig Intrusive Investigation.
9	Analytical Method	N/A

[(1)] Refer to EM 200-1-2, Para. 4.2.1

MC Data Quality Objective Worksheet

Site: R01, R02, R03, and R09

Project: Former Conway Bombing and Gunnery Range RI/FS

DQO Statement Number: 2 of 2

DQO Element Number [(1)]	DQO Element Description [(1)]	Site-Specific DQO Statement
Intended Data Use(s):		
1	Project Objective(s) Satisfied	Evaluate presence/absence of MC
Intended Need Requirements:		
2	Data User Perspective(s)	Risk, Remedy
3	Contaminant or Characteristic of Interest	See Table 1 (Human Health and Ecological Screening Values for Soil)
4	Media of Interest	Soil, and other media (if applicable)
5	Required Locations or Areas	Incremental sampling (IS) will be conducted throughout the R01, R02, R03, and R09 MRSs, based on confirmation of historical information, DGM analysis, and intrusive investigative results IAW the approved WP. These areas will be designated as sampling units (SUs). IS will also be conducted at identified background locations for the site-specific background dataset. Background IS samples will be collected from areas similar to, but outside of the MRS boundaries, per EPA guidance. Based on decisions made by the PDT during the TPP process and IS analytical results, discrete soil sampling may be required at locations identified during the completion of field activities. Discrete sample locations will be selected based on incremental sampling results and existing site conditions. Based on the soil sampling results, other media may also be sampled.
6	Number of Samples Required	During Phase 1: Ten IS surface soil samples will be collected from the following MRSs: R01, R02, R03, and R09. Ten IS surface soil samples will also be collected from areas similar to, but outside of the MRS boundaries.
7	Reference Concentration of Interest or Other Performance Criteria	If MC is detected, comparison against background levels and screening levels will be conducted to determine if further MC evaluation is warranted. Screening levels, listed in Table 1, will be agreed upon by the Project Team. Characterization of MC presence will be performed in compliance with the performance objectives set out in the PWS for the project.
Appropriate Sampling and Analysis Methods:		
8	Sampling Method	Samples in accordance with SAP.
9	Analytical Method	IS will be analyzed for explosives (8330B) and select metals (6010C). Background IS will be analyzed for select metals (6020A). Analysis of discrete samples will include explosives (8330A), select metals (6010C).

[(1)] Refer to EM 200-1-2, Para. 4.2.1

TABLE 1 - Human Health and Ecological Screening Values for Soil

Analyte	Abbreviation	CAS #	Human Health Screening Values[1]				Ecological Screening Values			
			EPA Regional Screening Levels for Residential Soil (mg/kg) (THQ=1)	EPA Regional Screening Levels for Residential Soil (mg/kg) (THQ=0.1)	EPA Regional Screening Levels for Industrial Soil (mg/kg) (THQ=1)	EPA Regional Screening Levels for Industrial Soil (mg/kg) (THQ=0.1)	Ecological Soil Screening Values (mg/kg)	Eco Soil SV Source	Ecological Sediment Screening Values (mg/kg)	Eco Sediment SV Source
Trinitrobenzene, 1,3,5-	1,3,5-TNB	99-35-4	2200	220	27000	2700	0.376	B	1300	C
Dinitrobenzene, 1,3-	1,3-DNB	99-65-0	6.1	0.61	62	6.2	0.655	B	0.00861	B
Trinitrotoluene, 2,4,6-	2,4,6-TNT	118-96-7	36	3.6	420	42	6.4	C	420	C
Dinitrotoluene, 2,4-	2,4-DNT	121-14-2	1.6	1.6	5.5	5.5	1.28	B	0.0144	B
Dinitrotoluene, 2,6-	2,6-DNT	606-20-2	0.33	0.33	1.2	1.2	0.0328	B	0.0398	B
Dinitrotoluene, 2-Amino-4,6-	2-Am-DNT	35572-78-2	150	15	2000	200	10	C	34	C
Nitrotoluene, 2-	2-NT (o)	88-72-2	2.9	2.9	13	13	9.9	C	28	C
Nitrotoluene, 3-	3-NT (m)	99-08-1	6.1	0.61	62	6.2	12	C	24	C
Dinitrotoluene, 4-Amino-2,6-	4-Am-DNT	19406-51-0	150	15	1900	190	3.6	C	9.5	C
Nitrotoluene, 4-	4-NT (p)	99-99-0	30	24	110	110	22	C	52	C
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0	3800	380	49000	4900	27	C	27000	C
Nitrobenzene	NB	98-95-3	4.8	4.8	24	24	1.31	B	0.145	B
Nitroglycerin	NG	55-63-0	6.1	0.61	62	6.2	71	C	1700	C
Pentaerythritol Tetranitrate	PETN	78-11-5	120	12	1200	120	100	C	1400	C
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4	5.6	5.6	24	24	7.5	C	45	C
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	479-45-8	120	1200	120	250	0.99	C	100	C
Barium	Ba	7440-39-3	15000	1500	190000	19000	330	A	150	C
Cadmium	Cd	7440-43-9	70	7	800	80	0.36	A	0.99	B
Lead	Pb	7439-92-1	400[2]	400[2]	800[2]	800[2]	11	A	35.8	B
Mercury	Hg	7487-94-7	23	2.3	310	31	0.1	B	0.174	B
Zinc	Zn	7440-66-6	23000	2300	310000	31000	46	A	121	B

[1] = USEPA Regional Screening Levels, November 2013.

[2] = Lead value based on blood lead modeling

Eco Screening Value Sources:

A - USEPA Eco SSLs

B - USEPA Region V Ecological Screening Levels

C - No Effect Ecological Screening Level, Los Alamos National Laboratory , ECORISK Database Release 3.1, 2012

MRSPP Data Quality Objective Worksheet

Site: R01, R02, R03, and R09
Project: Former Conway Bombing and Gunnery Range RI/FS
DQO Statement Number: 3 of 4

Module	Table #	Table Description	Known Data	Current Data Gap	Data Source
Explosive Hazard Evaluation (EHE)	1	Munitions Type		X	Historical Records/Findings
	2	Source of Hazard	X		Historical Maps
	3	Location of Munitions		X	Historical or Field Findings
	4	Ease of Access	X		Field Findings
	5	Status of Property	X		Historical Records
	6	Population Density		X	U.S. Census Bureau
	7	Population Near Hazard		X	Field Findings
	8	Types of Activities/Structures		X	Regional Zoning
	9	Ecological and/or Cultural Resources		X	State Historic Preservation Office
	10	Determining the EHE		X	Scores from Tables 1 through 9
Chemical Warfare Material (CWM) Hazard Evaluation (CHE)	11	CWM Configuration	X		Historical Records/Findings
	12	Sources of CWM	X		Historical Records/Findings
	13	Location of CWM		X	Historical or Field Findings
	14	Ease of Access	X		Field Findings
	15	Status of Property	X		Historical Records
	16	Population Density		X	U.S. Census Bureau
	17	Population Near Hazard		X	Field Findings
	18	Types of Activities/Structures		X	Regional Zoning
	19	Ecological and/or Cultural Resources		X	State Historic Preservation Office
	20	Determining the CHE		X	Scores from Tables 11 through 19
Health Hazard Evaluation (HHE)	21	Groundwater Data	X		Not Applicable
	22	Surface Water - Human Endpoint	X		Not Applicable
	23	Sediment - Human Endpoint	X		Not Applicable
	24	Surface Water - Ecological Endpoint	X		Not Applicable
	25	Sediment - Ecological Endpoint	X		Not Applicable
	26	Surface Soil		X	Surface Soil Sampling Results
	27	Supplemental Contaminant Hazard Factor		X	All MC Sampling Results
	28	Determining the HHE		X	Scores from Tables 21 through 27
	29	MRS Priority		X	Scores from Tables 10, 20, and 28
	A	MRS Background Information	X		DoD Databases

5.0 TPP MEETING SLIDE PRESENTATION

FORMER CONWAY BOMBING AND GUNNERY RANGE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORRY COUNTY, SOUTH CAROLINA

Technical Project Planning Meeting - 1

21 November 2013

US Army Corps of Engineers
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Meeting Agenda

- Introductions
- TPP Objectives / Basic Definitions
  - ► Project Description & Objectives
- Technical Approach Concurrence
  - ► Site Background / Project Overview
  - ► Technical Approach for each MRS
- Schedule Update
- Closing Discussions
  - ► Action Items Review

Team Member Introductions

- USAESCH, Project Manager and COR, Chris Cochrane; Technical Manager, Kelly Longberg; Geophysicist, Debra Edwards
- USACE Savannah District, Julie Hiscox
- USACE Charleston District, Shawn Boone
- SCDHEC Project Manager, Susan Byrd
- Horry County officials
- Various private Landowners
- HGL Project Manager, Kimberly Vaughn
- HGL MMRP Operations Manager, Neil Feist

US Army Engineering and Support Center, Huntsville

HGL HydroGeoLogic, Inc Exceeding Expectations

D H E C PROMOTE PROTECT PROSPER

See Advance Summary Section 2.0 Point of Contacts

Key Definitions

- MEC – Munitions and Explosives of Concern - military munitions that may pose unique explosives safety risks. Includes unexploded ordnance (UXO), discarded military munitions (DMM), and explosive concentrations of munitions constituents (MC).
- MD – Munitions Debris - Scrap metal from munitions (with no explosive safety risk)

Key Definitions

- MC – Munitions Constituents - materials originating from UXO, DMM, or other military munitions, including explosive and non-explosive materials and emission, degradation, or breakdown elements of munitions.

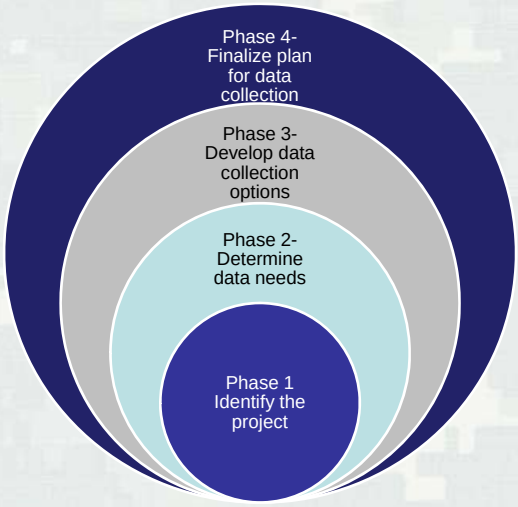
TPP Meeting Objectives

- Discuss regulator expectations
- Solicit Stakeholder Input
  - ►Identify key issues
  - ►incorporate concerns into process
  - ►Understand Local Community
- Develop Site Closeout Statement
- Concurrence to technical approach

TPP Process Overview

1. Describe site current conditions
2. Determine data needs
3. Present and discuss data collection options to fill data needs
4. Finalize data collection program for incorporation into work plans

Four Phases of TPP



Site Closeout Statement

To reduce the potential MEC and MC risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC.

After completion of the Decision Document requirements the potential risk to human health and the environment from MEC or MC will be reduced to the extent practical.

Remedial Investigation (RI) Purpose

- Determine the nature and extent of MEC and MC across each site
  - ►Collect and analyze data
- Determine potential risks to human health and/or the environment
  - ►Conduct risk assessment to quantify MC risk and a MEC hazard assessment
- Data Quality Objectives are developed to meet these goals

Feasibility Study (FS) Purpose

- The FS phase involves the development, screening, and detailed evaluation of alternative munitions response options
- Alternatives designed to protect human health, safety, and the environment.

Conway Bombing and Gunnery Range RI/FS

PROJECT OVERVIEW

Munitions Response Sites Included in RI/FS

- Munitions Response Site (MRS) - A discrete location that is known to require a munitions response.
- Four included in this project scope of work:
  - ►MRS-R01, MRS-R02, MRS-R03, and MRS-R09

See Figure 1, Page 7 of Advance Summary and webmap

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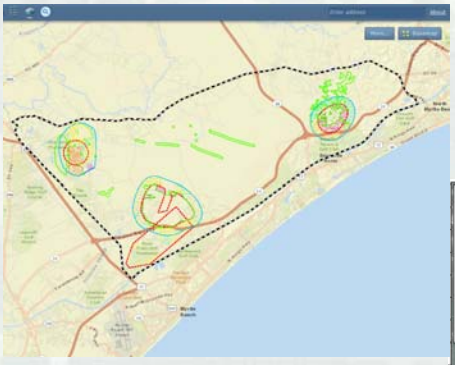


Webmap Option to view figures "live" during TPP meeting

Advance Summary Figure 1

Site Background

- Land used for timber harvest and farming prior to 1940.
- Myrtle Beach AAF used the Conway bombing and gunnery range (Conway BGR) for training
- By 1948, the leases for the majority of the property had been terminated and land had been returned to private ownership.
- 55,854 acres
- nine MRSs within Conway BGR
- four are being addressed by this project

Previous Investigations

- All four MRSs:
  - ► 1991 Archives Search Report (ASR)
  - ► 1994 Preliminary Assessment
  - ► 2003 EE/CA, Parsons
  - ► 2004 ASR Supplement
  - ► July 2012 RI, EODT, Revision 1
- Specific MRSs:
  - ► Time Critical Removal Actions (MRS-R02)
  - ► Third-party funded removal actions (MRS-R01, MRS-R02, MRS-R03)

Archives Search Reports

- Includes a historical records search and site inspection
- Interviews with onsite personnel
- Identification of current land use
- Determines if the potential of explosives hazards exists
- Confirms contaminated or uncontaminated

EE/CA

- Evaluated the sites by the defined areas
- Recommended removal actions and further investigation based on risks identified
- Time critical removal action (TCRA) performed at one MRS
- Evaluated non-time-critical response action alternatives where risk was identified

EODT 2012 RI

- RI conclusions where rights of entry (ROE) were obtained
- Limitations on ROE affected data gathered
- Additional investigation required for characterization of the four MRSs included in this project

Data Quality Objectives

- Defined for MEC hazards *(page 45)*
- Potential MC contamination *(page 46)*
- Geophysical data collection DQOs will be included in TPP Memorandum
- Other data needs, as identified
- Will be refined and reviewed in the TPP memorandum and the future work plans for stakeholder concurrence

Preliminary Conceptual Site Model

- Based on review of current site conditions and available historical data
- Will refine based on data gathered
- MEC CSM *(Figure 6)* and MC CSM *(Figure 7)*
  - ►Additional review and comment in both TPP memorandum and work plans

Remedial Investigation (RI) General Approach

- MEC contamination expected:
  - ► digital geophysical mapping (DGM) along transects
  - ► DGM of grids
  - ► Intrusive investigation (digging) in grids
  - ► Intrusive investigation transects
  - ► Munitions constituents sampling
- Outside MEC contaminated areas
  - ► Intrusive investigation in grids

Section 5.4.3.1 of The Advance Summary

Data collection methods

DGM Transects*			Intrusive of DGM Transects (Analog Mode)	Intrusive Between DGM Transects (Analog Mode)	Intrusive Transects to delineate well defined targets	Intrusive DGM Grids	MC Sampling	Comments
Golf Course and Residential Transects (Towed Array)	Overland Transects (Person Portable)	Wetlands Transects (Towed Array)						
DGM Transects with analog intrusive investigation	DGM Transects in rural vegetated areas with analog intrusive investigation	DGM Transects in wetlands or surface water areas with amphibious vehicle towed array	Analog Intrusive investigation of 50% of Overland DGM Transects to define MEC used areas to within 250ft	Analog Intrusive investigation of 50% of Golf Course and Residential DGM Transects to be conducted in non fairway areas (i.e. in adjacent wooded / rough areas) to define MEC used areas to within 250ft	Analog Intrusive Transects near areas where targets are well defined (to delineate extent of MEC at R02 and R03)	Intrusive DGM Grid Locations based on DGM Transect densities	Biased locations based on evaluated data	DGM transect spacing of 500 feet (nonintrusive investigation) Analog transect spacing of 500 feet (intrusive) Grids=20% of transect acreage

Alternate Approaches

- HGL proposes to negotiate alternate approaches based on land use
  - ► Golf courses, residential areas
  - ► Overland wooded, open, or wetlands areas
    - Amphibious vehicle for wetlands areas
- Rights-of-entry a known challenge
- Requires interaction with landowners
  - ► Minimizes impacts to gather data
- Successfully negotiated on other RIs

Figure 1

Figure 2

MEC Contaminated Areas

- DGM transects
  - Brush clearance (mechanical or hand clearance)
  - Linear transects designed to detect target areas with a 90% confidence
  - Towed array or person portable
- DGM Grids

Intrusive Investigation

- Transects:
  - Along DGM transects

  Or
  - Separate intrusive transects to delineate MEC contamination areas
- Grids
  - intrusive after DGM data is collected

Non-MEC contaminated areas

- Buffer areas of the MRSs (outside of the expected MEC presence areas)
- Grid sampling approach to confirm that MEC is not present
- HGL proposes 100 grids (100-ft x 100-ft size) in these outlying areas
- DGM and Intrusive investigation

Page 19, Advance Summary, "Basis for MEC Investigation", subparagraph (iii)

MEC Hazard Assessment

- Explosives Safety Hazard
  - ►Will be assessed using MEC Hazard Assessment (MEC HA)
- evaluates potential MEC hazards
- interim guidance document issued by EPA in 2008
- Evaluated for each MRS and documented in final reports

Munitions Constituents (MC)

- Identify MC contamination (phase 1)
- Delineate MC contamination (phase 2)
- Incremental sampling method surface soil sampling
  - ► Explosives by 8330B
  - ► compare to site-specific background concentrations for metals
- Collect additional surface or subsurface soil at locations where an MC release is confirmed

MC contamination

- Verify MC contamination presence
  - ► comparison of MC concentrations to:
    - EPA ecological screening values or
    - EPA regional screening levels for residential and industrial soil
  - ► Identified COPCs will be evaluated further in the risk assessment
- Details in TPP Memorandum and future sampling plans

See Table 1, page 47 of Advance Summary

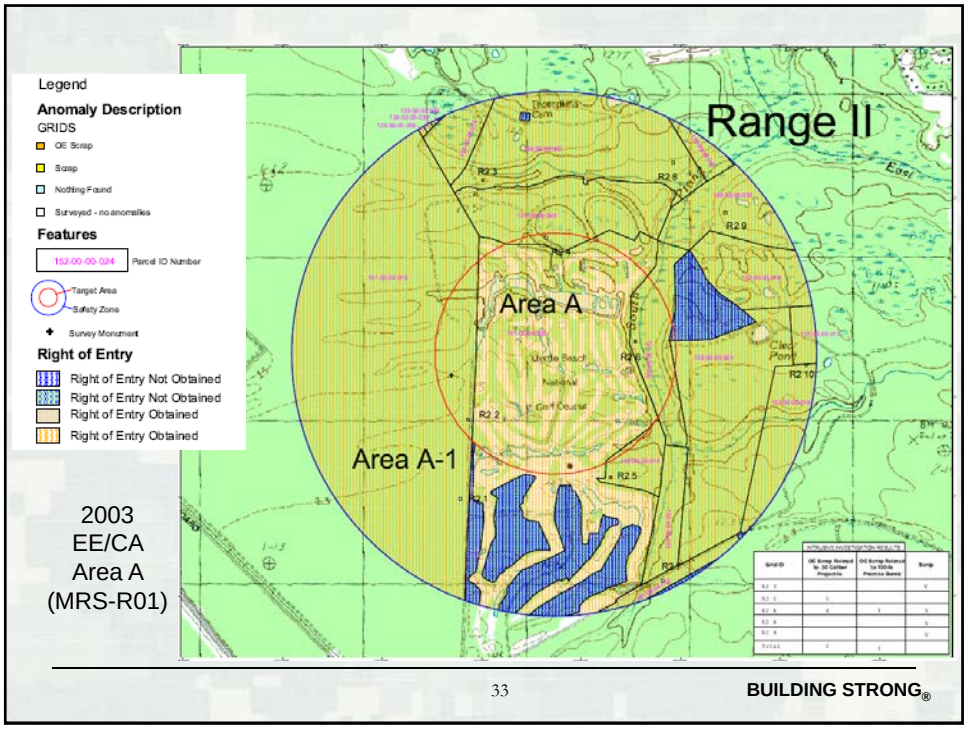
Conway Bombing and Gunnery Range RI/FS

TECHNICAL APPROACH FOR EACH MRS

MRS-R01, Range II

- Historical use:
  - Practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing.
- Identified in EE/CA
- Investigated as “Area A and A-1”
- Not delineated in previous RI/FS 2012
- Historical aerial photo analysis to identify potential impact areas

See Table 1.1, page 9 of Advance Summary


Legend
Anomaly Description
GRIDS
OE Scrap
Scrap
Nothing Found
Surveyed - no anomalies
Features
152-00-00-024
Parcel ID Number
Target Area
Safety Zone
Survey Monument
Right of Entry
Right of Entry Not Obtained
Right of Entry Not Obtained
Right of Entry Obtained
Right of Entry Obtained
Range II
Area A
Area A-1
2003
EE/CA
Area A
(MRS-R01)
33
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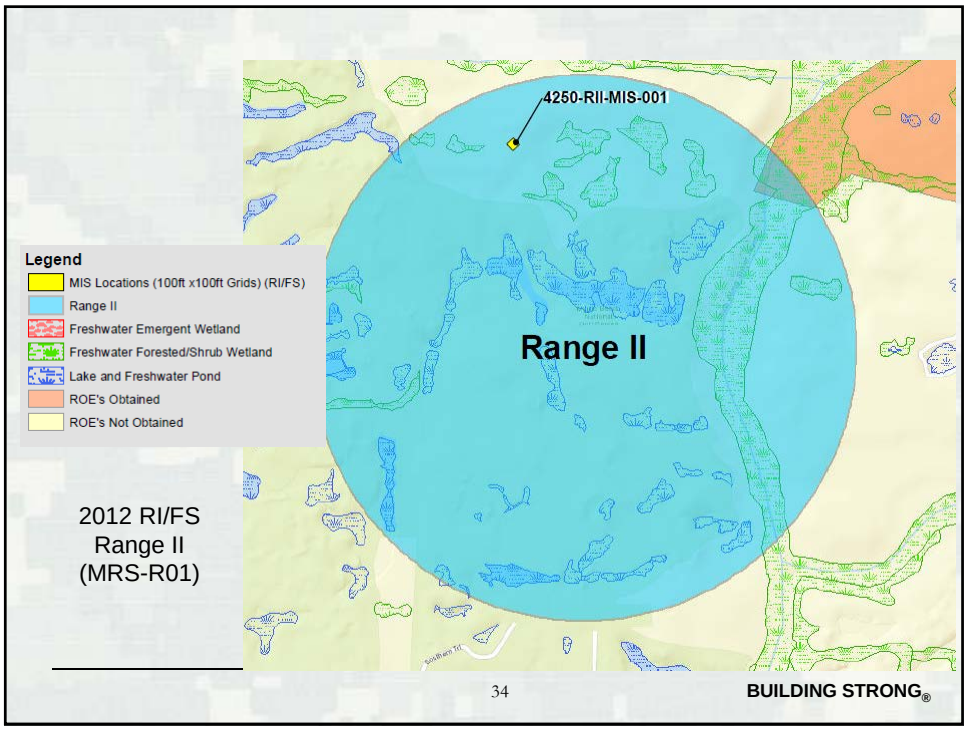
4250-RII-MIS-001
Legend
MIS Locations (100ft x100ft Grids) (RI/FS)
Range II
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Lake and Freshwater Pond
ROE's Obtained
ROE's Not Obtained
Range II
2012 RI/FS
Range II
(MRS-R01)
34
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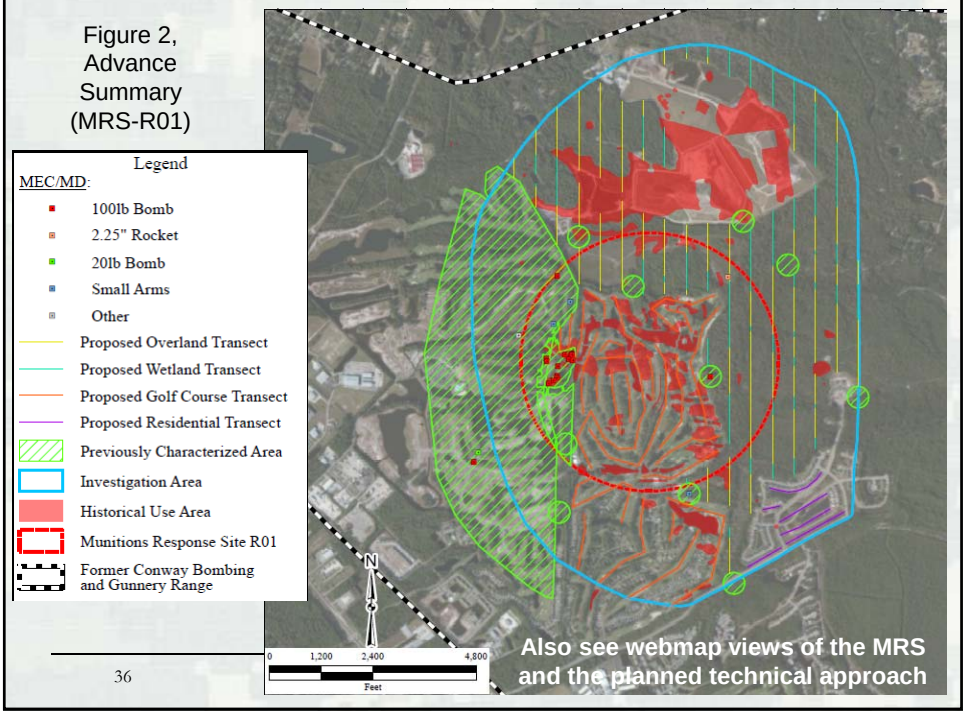
Delineate to north, northwest and east

- 1.29 miles of residential area transects
- 9.31 miles of golf course transects
- 9.31 miles of overland transects
- 4.87 miles of wetland/ponds transects
- Grids based on DGM transect densities will be proposed
- Intrusive investigation (grids & analog transects)
- Incremental soil sampling

Figure 2, Advance Summary (MRS-R01)

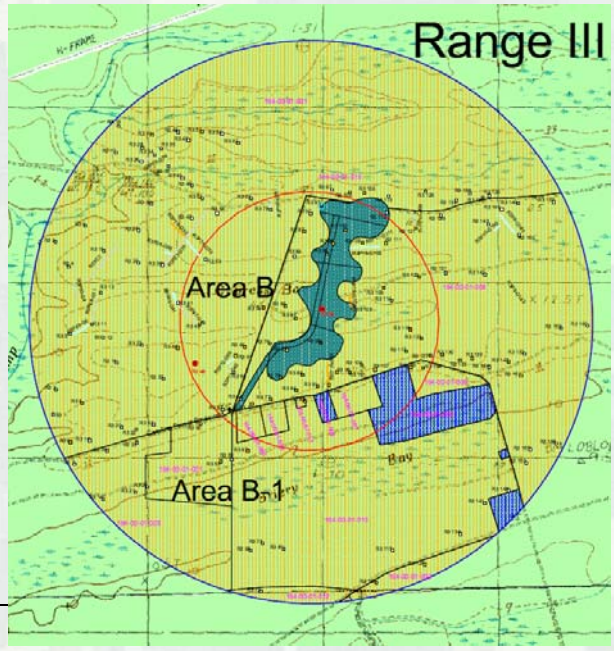


Also see webmap views of the MRS and the planned technical approach

MRS-R02, Range III

- Historical use
  - high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing
- MEC found previously: 100-pound practice bombs and 2.25-inch rockets
- Investigated as “Area B”
- TCRA on 45 acres (Parsons, 2002).
- Not delineated in previous RI/FS 2012
- Historical aerial photo analysis

See Table 1.2, page 10 of Advance Summary



Legend:

Anomaly Description

GRIDS

- OE Scrap
- Scrap
- Nothing Found
- Not Dug - underwater
- Surveyed - no anomalies
- UXO Item (Grid R3 94 - 3 Intact OE Items Were Also Recovered)

TRANSECT LINES

- OE Scrap
- Nothing Found
- Surveyed - no anomalies

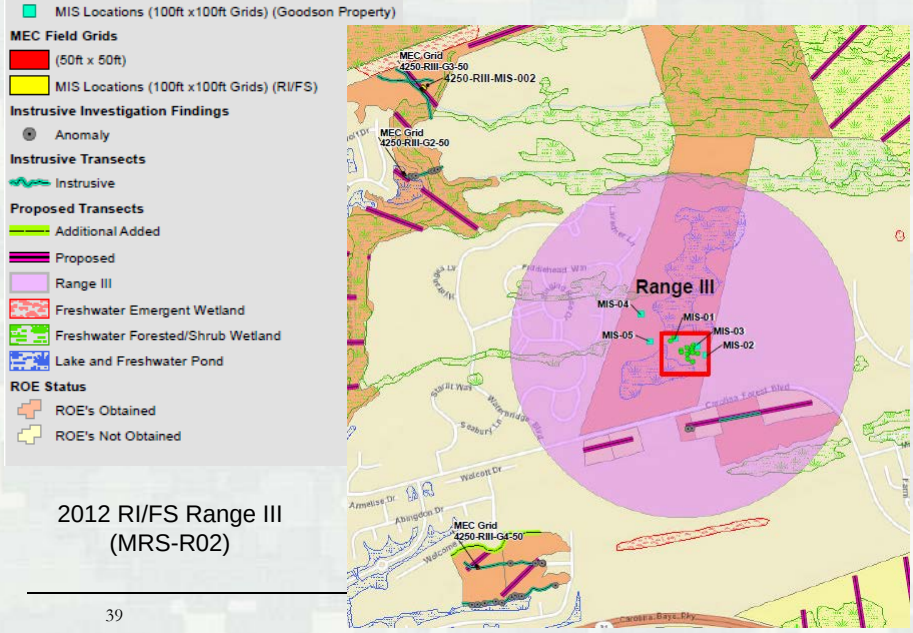
Features

- 164-00-01-008 Parcel ID Number
- Target Area
- Safety Zone

Right of Entry

- Right of Entry Not Obtained
- Right of Entry Obtained
- Proposed Lake and Access Road for Goodson Property

2003 EE/CA Area B (MRS-R02)

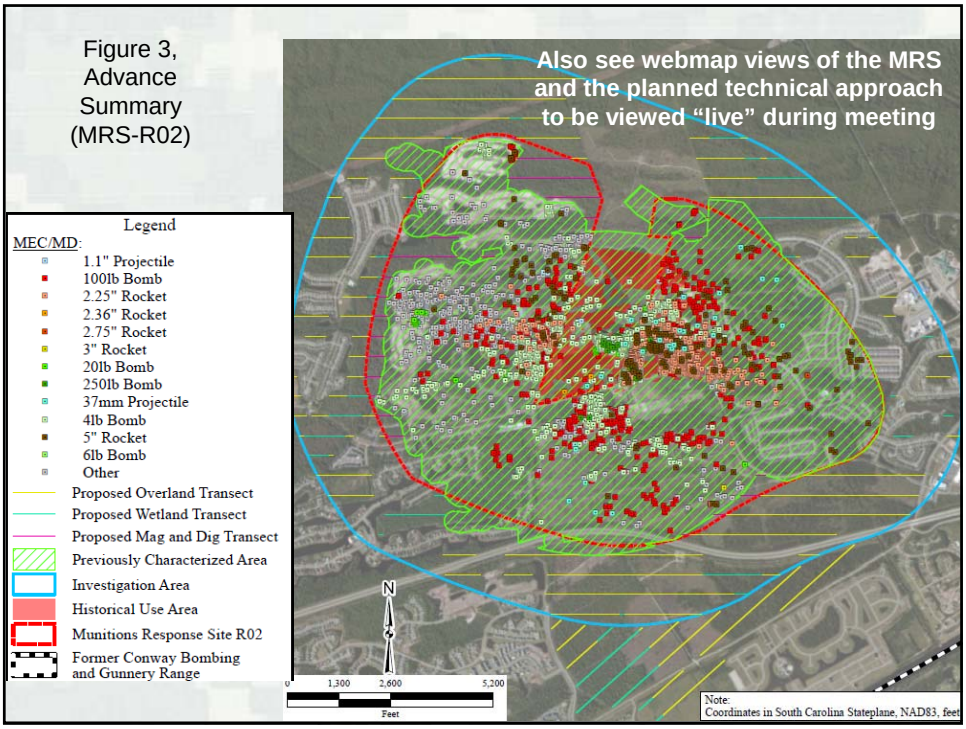


2012 RI/FS Range III (MRS-R02)

Additional delineation, MRS-R02

- 16.29 miles of overland transects
- 4.31 miles of wetland/ponds transects
- 2.47 miles of analog transects
- Grids based on DGM transect densities will be proposed
- Intrusive investigation (grids & analog transects)
- Incremental soil sampling

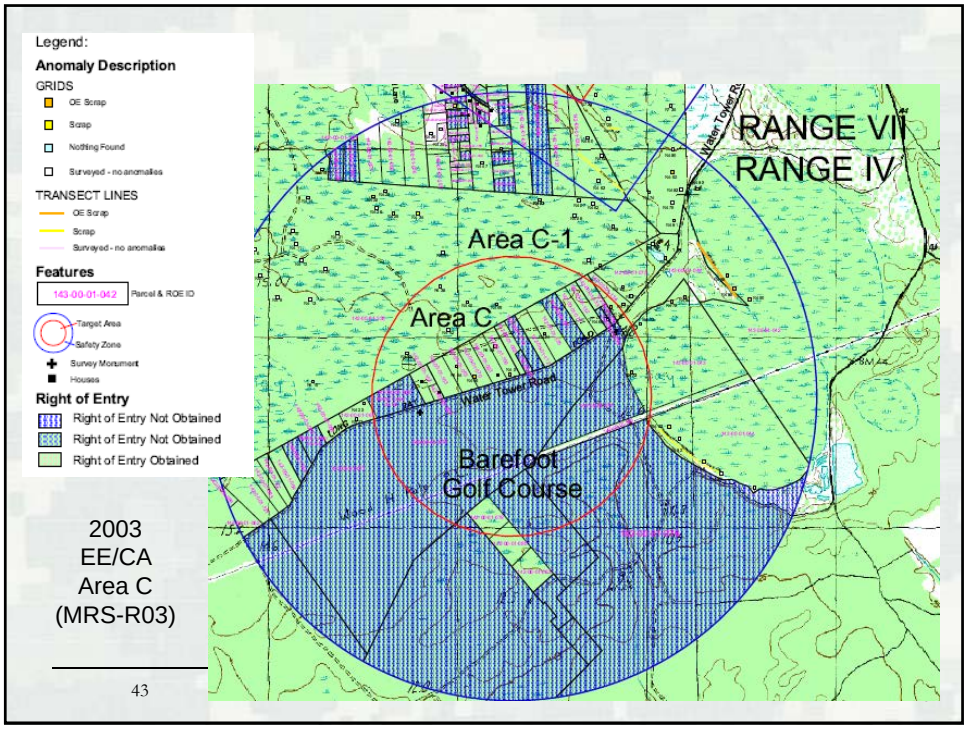
Figure 3, Advance Summary (MRS-R02)



MRS-R03, Range IV

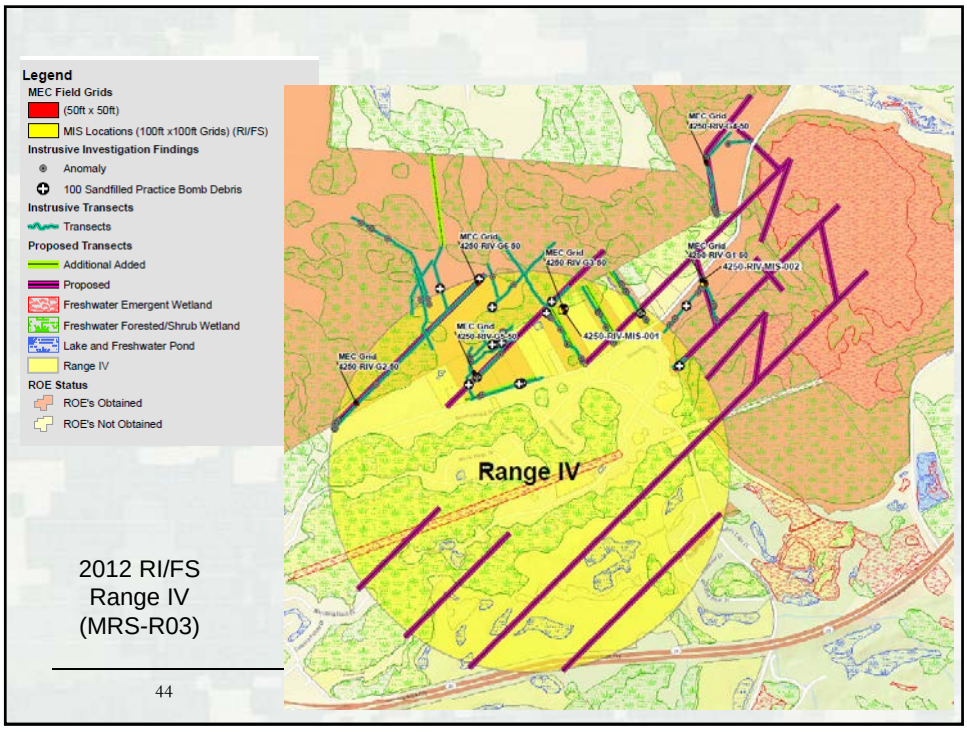
- Historical use:
  - ► practice bombing, including medium-altitude bombing
- identified in the EE/CA
- Investigated as "Area C"
  - ►MD: 4-lb incendiary bombs, 100-lb practice bomb, 20-lb fragmentation bomb
- Third-party removal actions occurred

See Table 1.3, page 11 of Advance Summary



2003
EE/CA
Area C
(MRS-R03)

43



2012 RI/FS
Range IV
(MRS-R03)

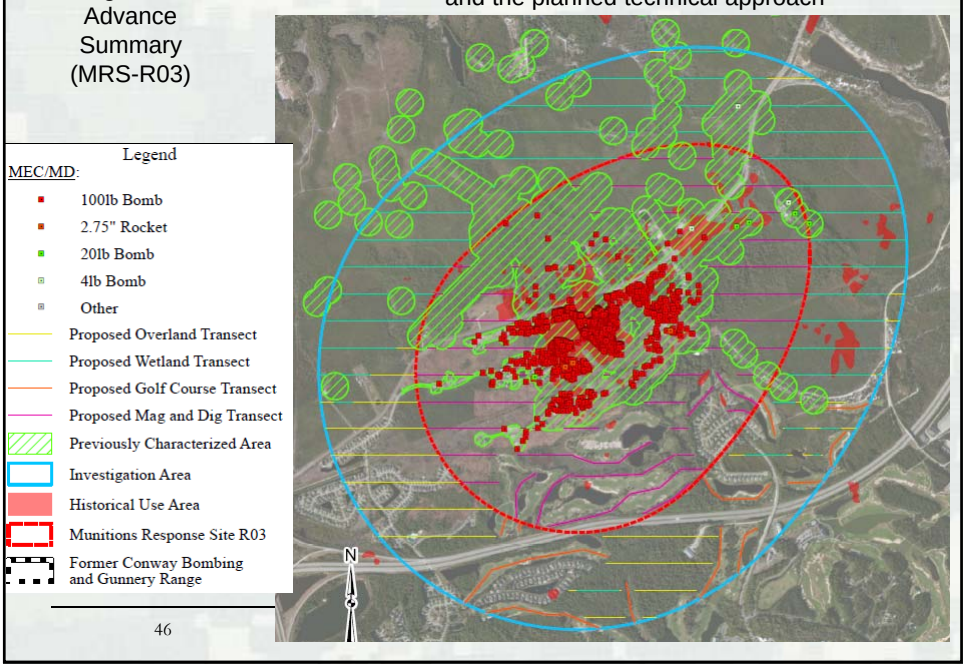
44

Delineate to northeast, southeast & southwest

- 2.54 miles golf course transects
- 4.45 mi overland transects
- 8.66 miles wetland/ponds transects
- 7.89 miles of analog transects
- Grids based on DGM transect densities will be proposed
- Intrusive investigation (grids & analog transects)
- Incremental soil sampling

Figure 4, Advance Summary (MRS-R03)

Also see webmap views of the MRS and the planned technical approach



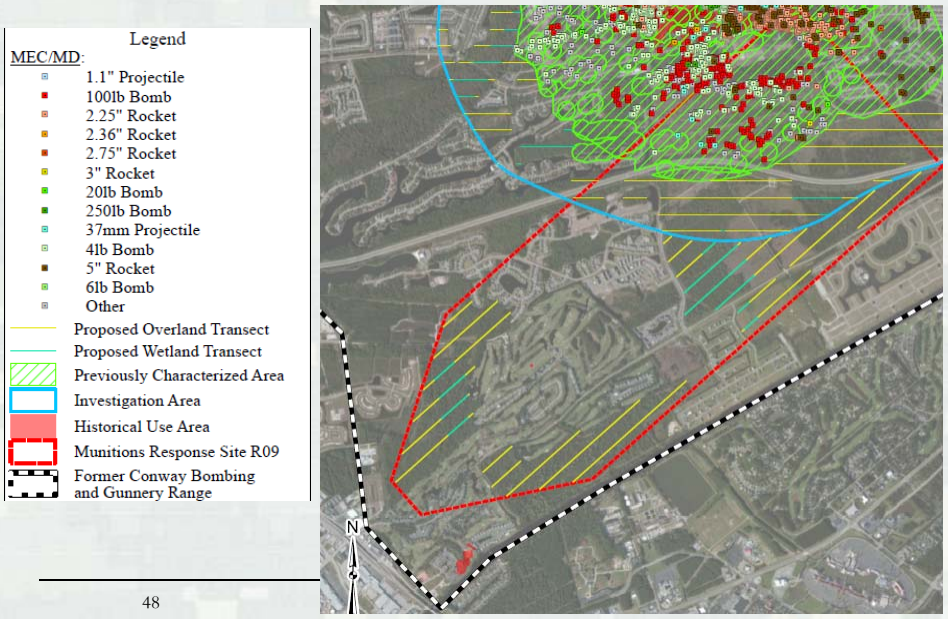
MRS-R09, Machine Gun/Rifle Range

- Historical use:
  - ►firing bomber turrets and machine guns in a ground-mounted mode, and the basic rifle marksmanship training
- EE/CA recommended NDAI
- RI indicated MEC confirmed on site

See Table 1.4 in Advance Summary

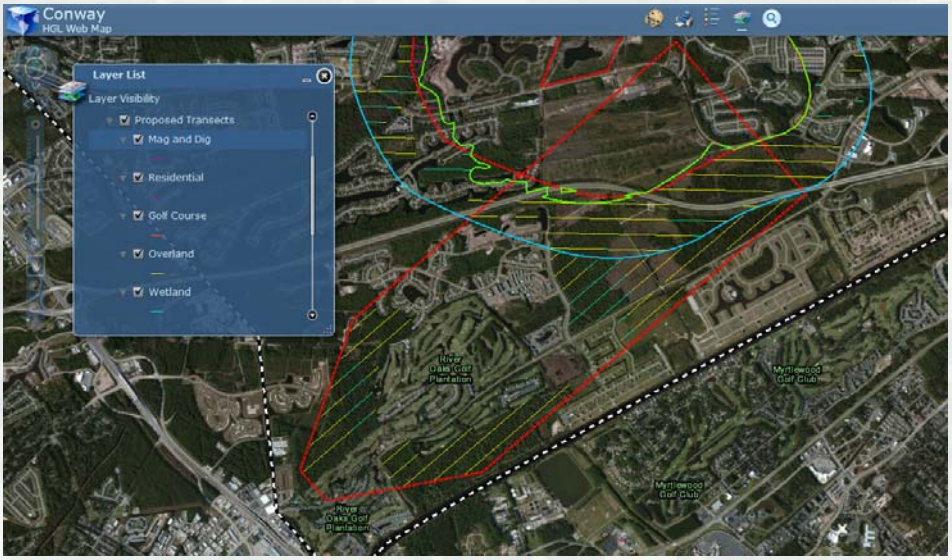
Figure 5, Advance Summary (MRS-R09)

Overlap with MRS-R02 not covered



Delineate suspected MEC contamination

- 7.49 mi overland transects
- 2.20 miles wetland/ponds transects
- Up to 50% of DGM transects mileage will be performed as analog transects, locations to be proposed in future
- Grids based on DGM transect densities will be proposed
- Intrusive investigation (grids & analog transects)
- Incremental soil sampling



Webmap views of the MRS and the planned technical approach

Right-of-Entry Support

- HGL to identify relevant parcels
- Draft lists of landowner contact information
- Current Horry County data has been incorporated in HGL's GIS
- Viewable on the webmap
  - ►Separate webmap for tracking ROE status

Community Relations Support

- Three (3) public meetings anticipated
  - ► One in support of the Proposed Plan
  - ► Others to support right-of-entry

- Community Relations Plan
  - ► Involve community leaders and citizens
- Administrative Record will be updated with final versions of documents
  - ► Horry County Memorial Library, Conway, SC

Key Reports / Documents

- Draft TPP Memorandum
- Draft Work Plan (Explosives Siting Plan)
- Community Relations Plans
- Field Activities
- RI Report / FS Report
- Proposed Plans
- Decision Documents

Moving Forward - Schedule

☑ TPP Meeting #1 (today)

❑ TPP Memorandum (December 2013)

❑ Work Plans (Draft January 2014)

► TPP Meeting #2 (March 2014)

❑ Field Work (summer/fall 2014)

❑ Draft RI Report (January 2015)

Site Closeout Statement

To reduce the potential MEC and MC risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC.

After completion of the Decision Document requirements the potential risk to human health and the environment from MEC or MC will be reduced to the extent practical.

TPP Meeting Closure Issues

- Concurrence –
  - Technical Approach, DQOs, preliminary CSM, sampling comparison criteria
  - Information to be provided in TPP Memorandum for formal comment
- Other Issues/Notes –
  - Area access limitations
  - Rights of entry (ROE)
  - Identify additional stakeholders, etc.

Closing

- Action item review
- Questions or concerns

5-inch ZUNI rocket warhead (practice)
Located in 2003 at The Farm at Carolina Forest

6.0 SCDHEC REVIEW OF ADVANCE SUMMARY

D H E C
PROMOTE PROTECT PROSPER
Catherine B. Templeton, Director
Promoting and protecting the health of the public and the environment

February 7, 2014

Julie Anne Hiscox
FUDS Senior Project Manager
US Army Corps of Engineers
Savannah District
100 W Oglethorpe Avenue
Savannah, Ga 31401-08809

Re: Technical Project Planning Meeting1
Advanced Summary
Former Conway Bombing and Gunnery Range
Remedial Investigation/Feasibility Study

Dear Mrs. Hiscox:

The Department has completed its review of the above referenced document and has no additional questions or comments at this time. If you need any additional information, feel free to contact me at (803)898-0308 or byrdsk@dhec.sc.gov.

Sincerely,

Susan K. Byrd

Susan Byrd, FUDS Project Manager
Division of Waste Management
Bureau of Land and Waste Management

FINAL
TECHNICAL PROJECT PLANNING MEMORANDUM AND ASSOCIATED DOCUMENTATION

IN SUPPORT OF:

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
TECHNICAL PROJECT PLANNING MEETING 2

Project Site:

Former Conway Bombing and Gunnery Range
Horry County, South Carolina

U.S. Army Corps of Engineers

Prepared for:

U.S. Army Engineering and Support Center, Huntsville

Prepared by:

HydroGeoLogic, Inc.
5030 Bradford Drive, Building 1, Suite 230
Huntsville, Alabama 35805

Contract No. W912DY-10-D-0023
Delivery Order No. 0018

July 2015

FINAL
TECHNICAL PROJECT PLANNING MEMORANDUM AND ASSOCIATED DOCUMENTATION

In Support of:

Remedial Investigation/Feasibility Study
Technical Project Planning Meeting 2

Project Site:

Former Conway Bombing and Gunnery Range
Horry County, South Carolina

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July 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

BGR	Bombing and Gunnery Range
BIP	blow-in-place
CESAC	U.S. Army Corps of Engineers Charleston District
CSM	conceptual site model
DoD	Department of Defense
DOJ	Department of Justice
DQO	data quality objective
FS	Feasibility Study
FUDS	Formerly Used Defense Site
GIS	Geographical Information System
HE	high explosives
HGL	HydroGeoLogic, Inc.
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
MG	Machine Gun
MMRP	Military Munitions Response Program
MRA	Munitions Response Area
MRS	Munitions Response Site
RI	Remedial Investigation
ROE	rights of entry
RR	Rifle Range
SCDHEC	South Carolina Department of Health and Environmental Control
TPP	Technical Project Planning
USACE	U.S. Army Corps of Engineers
USAESCH	U.S Army Engineering and Support Center, Huntsville
UU/UE	unlimited use and unrestricted exposure

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FINAL
TECHNICAL PROJECT PLANNING
MEMORANDUM AND ASSOCIATED DOCUMENTATION

1.0 INTRODUCTION

This document provides a record of the Technical Project Planning (TPP) Meeting 2 for four munitions response sites (MRSs) within the Former Conway Bombing and Gunnery Range (BGR), Horry County, South Carolina. The meeting occurred March 17, 2015 at the Hilton Garden Inn in Myrtle Beach, South Carolina. This second TPP meeting was held to familiarize the TPP team with the site background and the proposed Technical Approach, and ultimately, facilitate planning of the Remedial Investigation/Feasibility Study (RI/FS) at the Former Conway BGR. The meeting was attended by the Project Team members listed in Table 1.1. Attendees were presented with the meeting slides and handouts of figures and tables presented in the Draft Final Work Plan that included HydroGeoLogic's (HGL's) RI/FS Technical Approach for purposes of finalization with stakeholders. The TPP Team discussed the Technical Approach for implementation of the RI/FS at the four MRSs, including discussion of a legal settlement in some of the parcels. The Technical Approach is further detailed in the Draft Final RI/FS Work Plan, currently under review by the stakeholders. The Final Work Plan will be submitted to the TPP Team members including all revisions discussed during the TPP-2 Meeting. A list of key contacts is provided in Section 2. The sign-in sheet for the meeting is provided in Section 3. The TPP Meeting presentation slides are provided in Section 4 and figure and table handouts (updated based on discussions occurring during the meeting) are provided in Section 5.

Table 1.1 Technical Project Planning Participants

Chris Cochrane U.S Army Engineering and Support Center, Huntsville (USAESCH) Contracting Officer's Representative	Julie Hiscox USACE Savannah District FUDS Program Manager
Debra Edwards USAESCH Geophysicist	Kelly Longberg USAESCH Technical Lead
Kent Krieg South Carolina Department of Health and Environmental Control (SCDHEC) Project Manager	Susan Byrd (via teleconference) SCDHEC Project Manager
Kimberly Vaughn HydroGeoLogic, Inc. (HGL) Project Manager	Stacey French SCDHEC DoD Corrective Action Manager
Katherine Sokolic HGL Scientist	Caitlyn Martin HGL Assistant Scientist

1.1 TPP DISCUSSION TOPICS

Ms. Cochrane welcomed the group to the TPP-2 meeting and began with introductions of all attendees. Ms. Vaughn began reviewing the slide presentation shown in Section 4. The presentation began with a summary of the meeting agenda. The discussions would be divided into a description of TPP meeting objectives, a presentation of the histories of the four sites, a general

overview of the technical approach and the types of data planned for collection, and then the MRS-specific technical approaches. The meeting would conclude with a review of the current schedule and discuss the action items generated from the TPP discussions. The paragraphs below summarize specific issues and/or resolutions that were identified and discussed during the slide presentation:

- Throughout the slide presentation, the TPP team reviewed the webmap "live" during the meeting to facilitate discussion of each MRS. The Geographical Information System (GIS)-based webmap shows site boundaries, historical features, current site conditions, and rights of entry (ROE) status. The webmap can be accessed by all stakeholders, similar to browsing an online map such as Google Maps. The webmap login instructions are:

  http://gis.hgl.com/Conway/
  username "HGL\giswebmap"
  password "Gwm2011" – If using Internet Explorer.
  If using Firefox or Chrome, "HGL\" before username should be omitted.

  - An additional webmap has been created: http://gis.hgl.com/conway/ROE/ for coordination of ROE status with the U.S. Army Corps of Engineers Charleston District (CESAC). This webmap displays the status (Yes, Refused, Pending) on the ROE for the individual parcels.

- Slide 8 presents the site closeout statement for the Conway BGR. Ms. Vaughn explained that the site closeout statement is not specific to only this project which HGL is working on. This site closeout statement is presented for concurrence from the stakeholders as an overall goal for the Formerly Used Defense Site (FUDS). The projects and MRSs for which the Site Closeout Statement is applicable were discussed between Ms. French and Ms. Cochrane. The statement particularly relates to the MRSs included in this investigation, but serves as a step in the closeout of the entire Conway site (the entire Munitions Response Area [MRA]). Ms. French expressed her understanding that the Department of Defense's (DoD's) desire for the closeout statements are they be more site-specific and the final decisions will be unlimited use and unrestricted exposure (UU/UE). Ms. Cochrane explained that UU/UE is not a viable option for this site, but everyone agreed that the closeout statement should become more specific. Ms. Longberg suggested adding the underlined words "…the potential <u>of exposure to</u> MEC [munitions and explosives of concern] hazards" to the first sentence of the site closeout statement.

  - The revised Site Closeout Statement reads "To reduce the potential of exposure to MEC hazards and MC [munitions constituents] risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC. After completion of the Decision Document requirements that potential risk to human health and the environment from MEC or MC will be reduced to the extent practical."

- Slides 16, 17, and 18 were summarized by Ms. Vaughn, as presenting the historical work performed on MRS-R01. Figure B.6 and Figure B.6a from the Work Plan (see handouts) also illustrate the history and previous investigations known by the U.S. Army Corps of Engineers (USACE) to have been performed at MRS-R01. There may have been other removal actions, but USACE does not have a copy of the reports. Ms. Hiscox asked if the Sun Star subsurface removal areas within MRS-R01 now contain housing. Ms. Vaughn

stated, yes, the Sun Star removal actions were conducted in areas that are now the Wild Wing subdivision and portions of the Myrtle Beach National Golf Course and subdivision. Ms. Vaughn explained that, as shown in the Sun Star report figures, the removal was only performed where it was required for the construction of roads, home foundations, placement of utilities, etc. This resulted in data gaps that inhibit a confident delineation of the contamination. After further discussion of documentation available for the previous removals performed by Sun Star, the group decided to add transects within the Wild Wing subdivision on the western boundary of MRS-R01; where gaps exist in the privately funded removal actions.

- Mr. Krieg inquired about the MRS boundary shown in red and the expanded investigation area shown in blue. Ms. Vaughn explained that the MRS boundary was created based on the site history, usually during the Archive Search Report preparation. If the data shows that the boundary should be expanded, it can be expanded based on guidelines for focusing investigations. The expanded investigation area was created because contamination is suspected to go beyond the original MRS-R01 boundary. The data gathered during this RI will allow the contamination boundary to be drawn with more accuracy and will add more information concerning the type of contamination present.
- Slides 19, 20, and 21 and Figure B.7 and Figure B.7a from the Work Plan (see handouts) were discussed as presenting a summary of MRS-R02 history. The discussion on MRS-R02 centered on the Landbank properties' inclusion in the current investigation. Ms. French inquired about some Landbank property locations that were part of a legal settlement, including six parcels in the southern portion of MRS-R02. Based on information received by USACE from the law firm Gem McDowell on March 4, 2015, parcels: 1730001047, 1640001184, 1640001063, 1640001015, and 1640001013 were part of a previous Department of Justice (DOJ) settlement; therefore, figures shown have those parcels excluded from the current RI/FS project. The group discussed the status of these parcels and whether these parcels should be excluded or included. Ms. Longberg clarified that although the wetland transects within the Landbank property were not included on the webmap during the TPP meeting, they should be included in the current investigation. Ms. Vaughn explained that the wetland transects had been removed based on a previous discussion of the Landbank settlement agreement, based on the McDowell letter. The team agreed that the wetland transects on the Landbank property were not included in the legal settlement agreement (per Ms. French) and should be included in this investigation, ROE permitting. There will be further negotiation on which parcels will be removed from the investigation, as USACE gathers details on the previous settlement agreements.
- Ms. Vaughn presented the discussion on MRS-R02 historical efforts showing the previous findings in the area. Ms. Cochrane requested a change to Figure B.7 to expand the descriptions of the munitions found and whether they were high explosive (HE) or all practice rounds. Ms. Edwards recalled a 250 lb HE bomb located near the center of the target area at a depth of 3.5 feet below ground surface that was blown-in-place (BIP). The team agrees that the munitions listed in the figure legends should be defined by type. Ms. Vaughn added that she believes all munitions recovered were practice and HGL will further investigate this topic and clarify.

- Mr. Krieg suggested that shading in the figures be changed to designate the privately funded removal actions. Ms. Vaughn stated that the Figures B.6 through B.9 (not including the figures designated with an "a") show the historical investigations – both removals and investigations – in one layer/feature. Then, the Figures B.6a through B.9a (all four of the "a" designated figures") take the same layer and show a breakdown using either color or cross-hatching for privately funded work or USACE funded work. Ms. French requested that each privately funded investigation also be identified on the figures to include the name of the developer that paid for the work. It may be helpful to also include the name of the subdivision or golf course present currently.
- The New Harmony Presbytery, Celebration Church is a location where current work is ongoing and will be part of a future settlement with the government. Those contractor teams will be mobilizing soon to utilize the summer break of the surrounding schools for their intrusive investigation. The Presbytery is pushing for clearance up to six feet, but may have changed the language to "removal to depth of detection." No ROE was sent to this parcel for the RI/FS, as it is immediately outside of the area HGL had planned to investigate. HGL should add this parcel to a list of parcels that should not receive an ROE request.
- Ms. Cochrane inquired about planning for parcels where privately funded investigations occurred in the past, such as the wetlands on the Landbank property. These areas need to be investigated during certain times of year when they are dry. Ms. Vaughn mentioned that while HGL will not do separate mobilizations; however, we are able to do certain parcels first and this may ease some landowner's concerns. HGL will plan on performing wetlands transects first, as much as possible.
- Slides 22, 23, and 24 and Figure B.8 and Figure B.8a were discussed next. Discussion on MRS-R03 began with previous removal actions that left several data gaps. HGL would like to collect additional data in these areas and requested ROE. Ms. Vaughn mentioned that the Barefoot Resort Golf Club, LLC has refused the ROE request. Ms. Cochrane suggested that the previous removal results and data gaps be written up for discussion between Ray Livermore and the landowner. Ms. Hiscox suggested a face to face meeting with the landowner. The team agreed that this parcel is worth the extra effort to make a face to face request to discuss the ROE.
- Ms. Byrd inquired about the yellow circles that identify previously investigated grids in Figure B.8a. She would like to know why the blue outer edge of the expanded investigation area does not include some of these grids. Ms. Vaughn explained that most of the findings within the northern most grids were cultural debris only and thus HGL decided not to expand the investigation northward.
- Slides 25, 26, and 27, Figure B9 and Figure B9.a were reviewed next, covering MRS-R09. The MRS-R09 conversation began with a discussion on the overlap of MRS-R09 with MRS-R02 and the decision to separate the two. The MRS-R02 overlap portion will remain within MRS-R02 (based on munitions found within that area) and the remainder of the identified area will be MRS-R09.

- Ms. Vaughn discussed the slides contained in the Project Progress section, Slides 29 through 36. These slides highlight for the team any changes made in the Work Plan from the Draft version discussed at TPP-1 through the Draft Final version provided for review.
- Mr. Krieg was interested to know how the depth of the "surface soil" within the conceptual site model (CSM) accounts for MEC migration vertically (Slide 36 and Handout tables). As far as the potential for any MC contamination anticipated, Ms. Cochrane explained that MC releases on all FUDS sites are very minimal. At this time, the team does not anticipate that MC contamination will be present, though it will be evaluated to the appropriate depth if a release is determined to have occurred. The depth of munitions found during the removal action on the Goodson property was 26 feet. The team discussed this historical result and believed this was due to excavation that was being done at the Goodson property for use as a borrow pit. Ms. Vaughn offered that HGL will obtain more information on the average depth of historical MEC found.
- Ms. Byrd added that the wetlands are isolated and generally dry during the summer months and asked if these transects can be a priority during summer months. Ms. Vaughn agreed and plans to keep this in mind when securing ROEs and planning field work during the summer months. Field work is tentatively planned to begin August 2015.
- Mr. Krieg asked for more information on groundwater sampling. Ms. Vaughn provided that if during the investigation HGL identified a large enough horizontally contaminated area where surface or subsurface soil sampling results show there is a risk to groundwater protective screening levels, then the investigation would be expanded to include groundwater. In the case of this event, all detections would be assessed for human health.
- Ms. Byrd asked about the ROE status within MRS-R01 and the path forward for landowners that are in a significant data gap and refuse entry or do not respond. Ms. Cochrane offered that her team members can reach out directly to the landowners concerning ROE. If they do not respond to the first letter, a second letter will be sent. The USACE procedures for sending these letters, and what any final letter may say, is still not finalized by the Corps. Ms. Vaughn suggested that door-to-door contact is also an option for high priority parcels. Ms. French briefly mentioned that this information plays into the notification process and will be important during decision making at this site. Ms. Vaughn mentioned that we currently do not have the ROEs divided up by MRS, but HGL will do this for future calls and discussions.
- Ms. French asked additional questions on the crescent shaped, western portion of MRS-R01 and mentioned that we need to document the approved ROEs as accurately as possible. She also wanted to know if the results from the previous investigations are detailed in our work plan. Ms. Vaughn is hesitant to include language on "results" from an investigation when the only available information was in the form of a map. However, the data available from the previous investigations have been included in HGL's historical figures. Ms. Cochrane mentioned that the contractor, EODT is now named Sterling and we may be able to use an old contact to obtain the investigation results. Ms. Byrd pointed out that we know work was done in previously investigated areas, but not the quality of the work. In conclusion, Ms. Byrd requested that "previously characterized area" on map legends be changed to "previously investigated area" for Figures B.14 through B.17. Ms. Cochrane reiterated that we cannot put too much credence on these

investigation results because the government has not performed any quality assurance. Ms. French asked if it made sense to include this extra data. Ms. Vaughn mentioned that the data was added upon Ms. Byrd's request. It was concluded that a list should be added that includes the historical data that was available to HGL to incorporate in the planned RI technical approach. The team agreed that these previously investigated areas need to be included in the RI/FS investigation as they were not a part of government investigations, unless there has been a legal settlement that has prohibited our access.

- Ms. Byrd requested that the wetland transects be added to the LandBank parcel, as they are not included in the legal settlement per the consent agreement. The consent agreement should acknowledge that ROE will be provided since they have excluded the wetlands from the settlement. Ms. Vaughn has documentation from the McDowell law firm indicating that the area has already been investigated and should not be included; however, it is not this law firm that is currently dealing with the South Carolina Department of Health and Environmental Control (SCDHEC). Ms. French suggested that this is something that SCDHEC staff, in their negotiations with the law firm, can help resolve. Ms. Byrd and Ms. French reiterated that these environmentally sensitive areas are listed in the agreement as not having been investigated and need to be included in the current investigation. The future construction will surely encroach on the wetlands and affect the future land users.
- Mr. Krieg began discussion on sampling and pointed out that there is currently a planned soil sample within the Goodson property, which has been excluded due to the legal settlement. Ms. Vaughn concurred and the figure will be revised. Ms. Vaughn explained that HGL will adapt the proposed sampling locations to accommodate ROEs granted and results from intrusive findings as the project moves forward. Ms. Byrd offers that there were several truckloads of munitions debris (MD) removed from this area, the highest potential source of MC contaminations, and MC sampling did not reveal any detections above action levels. Thus, it is unlikely that MC exceedances would be found farther outside of the original MRS boundary and known target locations. Mr. Krieg asked if there was a benefit to sampling in areas that had been previous investigated. Mr. Vaughn responded by explaining that the sampling needs to be performed in areas where high MEC or MD concentrations are known to occur and will include historical locations and where high density of MEC or MD are identified during this investigation. The team agreed that the regulators will have input on the proposed sampling locations.

1.2 ACTION ITEMS

The changes listed below were discussed during the second TPP meeting and are reflected in the appropriate documents. All Figures revised (based on TPP-2 discussions) are included in Attachment 5 to this memorandum.

- Add the phrase "the potential of exposure to MEC hazards" to the Site Closeout Statement.
- Prepare a newly drafted ROE letter for Ray Livermore's review and signature that specifies that the ROE requested at the Sweet 16, LLC, parcel, is for the wetlands areas that were not included in the settlement agreement.

- Identify the developers associated with each private investigation on Figure B.7a (also added to Figure B.6a and Figure B.8a).
- Change legend item in Figures B.14 through B.17 from "previously characterized area" to "previously investigated area." This change was also made on Figure B.6, B.7, B.8, and B.9. This change was added to the historical investigations that were not funded by USACE. Any USACE funded investigation which received USACE quality assurance oversight will be labeled a "characterization.
- Add an appendix to the Work Plan containing the original historical data that was available to HGL (Section 6 of this TPP Memorandum). HGL has prepared the list of all historical reports and data available to HGL for incorporation into the RI planned technical approach, the full list is presented in Section 6.
- HGL will attempt to get a copy of the Federal Settlement Agreement from the appropriate federal court.
- Any landowner that desires a privately funded removal to be done, please refer them to Stacey French.
- Chris Cochrane will coordinate with her team independently to contact Barefoot Resort and Golf Course, LLC, landowner to try negotiate ROEs for these parcels (1430001055, 1420001266 and 1420001264).
- Ms. French and Ms. Byrd discussed that SCDHEC will follow up to see if the Horry County permitted landfill has any information in their files on previously found munitions.
- HGL will remove any proposed sampling locations from the figures that are on settlement agreement (excluded) parcels.
- HGL will add transects to the western side of the MRS-R01 and update the ROE requests. *HGL is currently investigating available parcels.*
- HGL will send the index of the Administrative Record contents that are located in the Horry County Memorial Library as of March 2015, to the government team.
- Ms. French (SCDHEC) would like to see ROEs summarized by MRS, in future.

ROE Response Summarized by MRS as of July 2, 2015

	Number	Feet of Transects
MRS R01, Total	117	106,711
MRS R01, Accepted	29	43,776
MRS R01, Refused	55	10,456
MRS R01 No Response	33	52,480
MRS R01% Accepted:		25%
MRS R02, Total	138	120,658
MRS R02, Accepted	67	43,435
MRS R02, Refused	20	47,959
MRS R02 No Response	51	29,265
MRS R02% Accepted:		49%
MRS R03, Total	155	121,703
MRS R03, Accepted	82	85,670
MRS R03, Refused	32	27,365
MRS R03 No Response	41	8,668
MRS R03% Accepted:		53%
MRS R09, Total	21	67,007
MRS R09, Accepted	6	14,819
MRS R09, Refused	7	38,293
MRS R09 No Response	8	13,894
MRS R09 % Accepted:		33%

- HGL has evaluated the depth of munitions found in previous investigations using the GIS data provided at the proposal phase for this project, an average depth of MD and/or MEC as well as a maximum depth of MD and/or MEC found was calculated. Of the evaluation of all electronic data available, approximately 9,900 anomalies were listed. Of these 9,900 anomalies, approximately 160 of these have no depth data recorded.
    - MEC depth: Of the anomalies where depth information was available, the average depth for MEC (listed as OE items in the OE item table) was approximately 24 inches. The maximum depth of MEC found was 72 inches, noted for an ordnance and explosive (OE) item described as a "250-lb bomb" located on the Goodson property on November 16, 2010. A total of eight OE items are reported with the nomenclature "M57 GPOS 250lb bomb" and listed as containing HE type filler. All were found in October and November 2010 on the Goodson property.
    - MD Depth: For MD, types of anomaly data reviewed included all available electronic anomaly data from the various historical sources summarized in Section 6 of this TPP Memorandum. Most MD (85%) was located on the surface. The average depth of MD located was approximately 1-inch deep. The maximum depth of MD recorded was 36 inches. Of the types of MD recorded,
- Verify that all MRSs have had practice munitions only used and no record of HE rounds used in the past. Include the munitions types in the legend of Figure B.7 (also added to Figure B.6 and Figure B.8.) To complete this action item, HGL reviewed historical data to determine whether all munitions found historically are practice items. HGL has

reviewed items listed historically as potentially having "HE" type filler. The historical documents include:

- Eight OE items are reported with the nomenclature "M57 GPOS 250lb bomb" and listed as containing HE type filler. There are approximately 595 OE items listed as "M54 4 lb. Incendiary Bomb" with mixed notes of thermite and/or HE filler. There are smaller quantities of the following OE items reported with HE filler described as: M6 2.36" Rocket Motor (one item), M6 2.36" Rocket Warhead (one item), M6 2.36" Rocket (one item), and M63 37mm Projectile (four items). All were found from May through December 2010 on the Goodson property.
- Of the MD items listed in historical reports; some notes include references to "HE", including: 250lb practice bomb HE; 37mm HE projectile; and 37mm HE Projo. No dates are available, and these items are listed from various historical sources. These items were found in MRS-R02.
- Conclusion: HGL considers it unlikely that munitions with HE filler are present within MRS-R01 and MRS-R03. Based on the historical information available, practice munitions only appear to have been used at MRS-R01 and MRS-R03. At MRS-R02, historical items described include the items listed below. These first three items listed are not practice munitions and all four may potentially be present at MRS-R02 only:
  - AN-M57, 250-Pound Bomb, General Purpose – HE filled (50-50 Amatol, TNT, or Tritonal);
  - AN-M54, 4-Pound, Incendiary Bomb – Incendiary (Thermate 1.6 pounds)
  - M6, 2.36 Inch, Rocket – HE filled (Pentolite)
  - M63, 37mm, Target Practice (TP) Projectile – Black Powder filled (.084 pounds)

2.0 LIST OF KEY CONTACTS

Key Contacts
Remedial Investigation/Feasibility Study
at the Former Conway Bombing and Gunnery Range

Name/Organization	Address	Telephone/Email
USAESCH Contracting Officer's Representative Chris Cochrane	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1696 (c) 256-990-0888 chris.cochrane@usace.army.mil
USAESCH COR Chase Hamley	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1569 (c) 256-698-4027 Chase.G.Hamley@usace.army.mil
USAESCH Technical Manager Kelly Longberg	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1408 (c) 256-541-0907 kelly.d.longberg@usace.army.mil
USAESCH Geophysicist Debra Edwards	USAESCH 4820 University Square Huntsville, AL 35816-1822	(o) 256-895-1626 debra.l.edwards@usace.army.mil
USACE Savannah District FUDS Program Manager Julie Hiscox	USACE Savannah District 100 W. Oglethorpe Avenue Savannah, GA 31401-0889	(o) 912-652-5363 (c) 912-429-1474 julie.a.hiscox@usace.army.mil
U.S. Army of Corps of Engineers, Wilmington District Project Manager Ray Livermore	Attn: CESAW-TS-EG (Ray Livermore) 69 Darlington Avenue Wilmington, NC 28402-1890	910-251-4702 Raymond.R.Livermore@usace.army.mil
SCDHEC Land and Waste Management Division Project Manager Susan Byrd	SCDHEC Land and Waste Management Division 2600 Bull Street Columbia, SC 29201	(o) 803-898-0308 byrdks@dhec.sc.gov
SCDHEC DoD Corrective Action Manager Stacey French	SCDHEC Land and Waste Management Division 2600 Bull Street Columbia, SC 29201	(o) 803-898-0238 franchsl@dhec.sc.gov
SCDHEC Risk Assessor Kent Krieg	SCDHEC Land and Waste Management Division 2600 Bull Street Columbia, SC 29201	(o) 803-898-0255 kriegkm@dhec.sc.gov
Horry County Administrator's Office	Horry County Administrator's Office 1301 Second Avenue Conway, SC 29526	(o) 843-915-5020
HydroGeoLogic, Inc. Program Manager Janardan Patel	HydroGeoLogic, Inc. 11107 Sunset Hills Road, Suite 400 Reston, VA 20190	(o) 703-736-4509 (c) 703-300-8406 jpatel@hgl.com
HydroGeoLogic, Inc. Project Manager Kimberly Vaughn	HydroGeoLogic, Inc. 1403 Balmorhea Lane Round Rock, TX 78664	(o) 512-828-6684 (c) 512-658-6828 kvaughn@hgl.com
HydroGeoLogic, Inc. MMRP Operations Manager Neil Feist	HydroGeoLogic, Inc. 5030 Bradford Drive Building 1, Suite 230 Huntsville, AL 35805	(o) 256-970-2103 (c) 256-714-5808 nfeist@hgl.com

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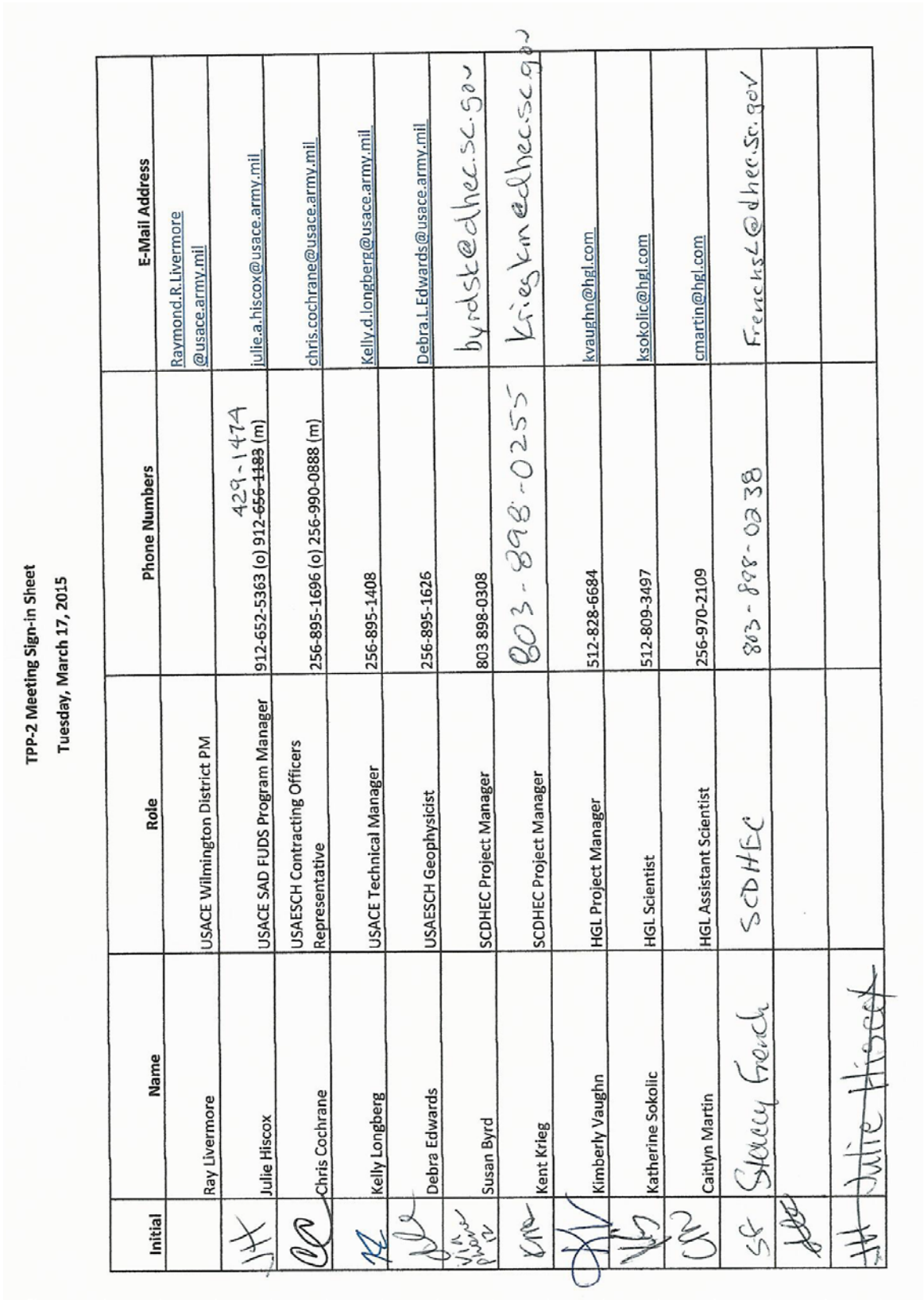
3.0 TPP MEETING ATTENDANCE SIGN IN SHEET



TPP-2 Meeting Sign-in Sheet

Tuesday, March 17, 2015

Initial	Name	Role	Phone Numbers	E-Mail Address
	Ray Livermore	USACE Wilmington District PM		Raymond.R.Livermore@usace.army.mil
JH	Julie Hiscox	USACE SAD FUDS Program Manager	912-652-5363 (o) 912-~~656-1183~~ (m) 429-1474	julie.a.hiscox@usace.army.mil
	Chris Cochrane	USAESCH Contracting Officers Representative	256-895-1696 (o) 256-990-0888 (m)	chris.cochrane@usace.army.mil
	Kelly Longberg	USACE Technical Manager	256-895-1408	Kelly.d.longberg@usace.army.mil
	Debra Edwards	USAESCH Geophysicist	256-895-1626	Debra.L.Edwards@usace.army.mil
	Susan Byrd	SCDHEC Project Manager	803 898-0308	byrdste@dhec.sc.gov
	Kent Krieg	SCDHEC Project Manager	803-898-0255	kriegkm@dhec.sc.gov
	Kimberly Vaughn	HGL Project Manager	512-828-6684	kvaughn@hgl.com
	Katherine Sokolic	HGL Scientist	512-809-3497	ksokolic@hgl.com
	Caitlyn Martin	HGL Assistant Scientist	256-970-2109	cmartin@hgl.com
	Stacey French	SCDHEC	803-898-0238	Frenchsl@dhec.sc.gov
	Julie Hiscox			

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4.0 TPP MEETING PRESENTATION SLIDES

FORMER CONWAY BOMBING AND GUNNERY RANGE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
HORRY COUNTY, SOUTH CAROLINA

Technical Project Planning Meeting - 2

March 17, 2015

US Army Corps of Engineers
BUILDING STRONG®

Meeting Agenda

- Introductions
- TPP Objectives / Basic Definitions
  - ► Project Description & Objectives
- Technical Approach Concurrence
  - ► Site Background / Project Overview
  - ► Technical Approach for each MRS
- Schedule Update
- Closing Discussions
  - ► Action Items Review

Team Member Introductions

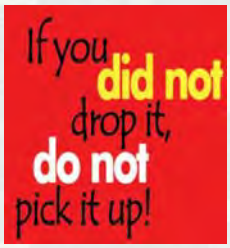
- USAESCH, Project Manager and COR, Chris Cochrane; Technical Manager, Kelly Longberg; Geophysicist, Debra Edwards
- USACE Savannah District, Julie Hiscox
- USACE Wilmington District, Ray Livermore
- SCDHEC Project Manager, Kent Krieg
- HGL Project Manager, Kimberly Vaughn
- HGL MMRP Operations Manager, Neil Feist

US Army Engineering and Support Center, Huntsville

See Work Plan Appendix C, Project Team Contacts

Key Definitions

- MEC – Munitions and Explosives of Concern - military munitions that may pose unique explosives safety risks. Includes unexploded ordnance (UXO), discarded military munitions (DMM), and explosive concentrations of munitions constituents (MC).
- MD – Munitions Debris - Scrap metal from munitions (with no explosive safety risk)

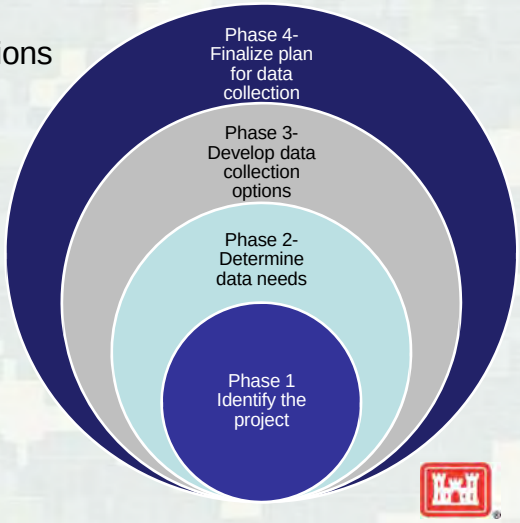


Key Definitions

- MC – Munitions Constituents - materials originating from UXO, DMM, or other military munitions, including explosive and non-explosive materials and emission, degradation, or breakdown elements of munitions.

TPP Meeting Objectives

- Discuss regulator expectations
- Solicit Stakeholder Input
  - ► Identify key issues
  - ► incorporate concerns into process
  - ► Understand Local Community
- Develop Site Closeout Statement
- Concurrence to technical approach



TPP Process Overview

1. Describe site current conditions
2. Determine data needs
3. Present and discuss data collection options to fill data needs
4. Finalize data collection program for incorporation into work plans

Site Closeout Statement

To reduce the potential MEC hazards and MC risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC.

After completion of the Decision Document requirements the potential risk to human health and the environment from MEC or MC will be reduced to the extent practical.

Remedial Investigation (RI) Purpose

- Determine the nature and extent of MEC and MC across each site
  - ►Collect and analyze data
- Determine potential risks to human health and/or the environment
  - ►Conduct a risk assessment to quantify MC risk and MEC hazards
- Data Quality Objectives are developed to meet these goals

Feasibility Study (FS) Purpose

- The FS phase involves the development, screening, and detailed evaluation of alternative munitions response options
- Alternatives designed to protect human health, safety, and the environment.

Former Conway Bombing and Gunnery Range RI/FS

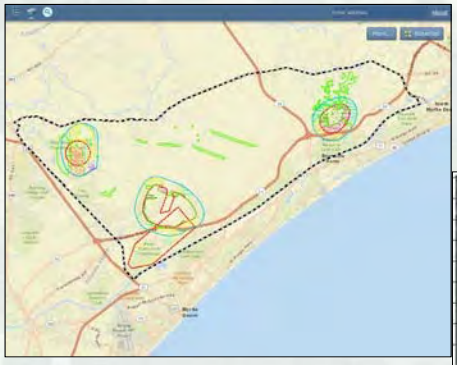
PROJECT OVERVIEW

Site Background

- Land used for timber harvest and farming prior to 1940
- Myrtle Beach AAF used the Conway bombing and gunnery range (Conway BGR) for training
- By 1948, the leases for the majority of the property had been terminated and land had been returned to private ownership
- 55,854 acres
- Nine total MRSs within the Conway BGR
- Four MRSs are being addressed by this project

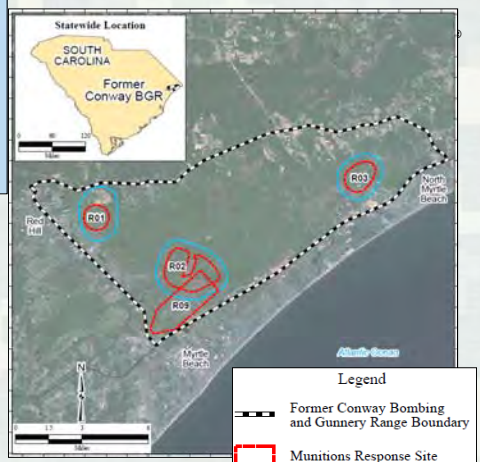
Munitions Response Sites

- Munitions Response Site (MRS) - A discrete location that is known to require a munitions response.
- Four included in this project scope of work:
  - MRS-R01, Range II
  - MRS-R02, Range III
  - MRS-R03, Range IV
  - MRS-R09, Machine Gun/Rifle Range (MG/RR)



Webmap Option to view figures "live" during TPP meeting

General Location Map



Previous Investigations

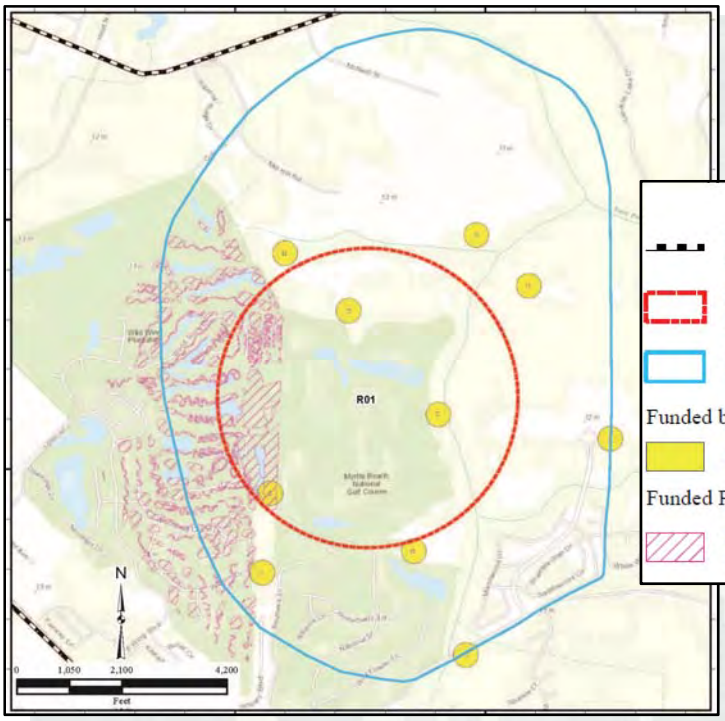
- 1991: Preliminary Assessment by Twin City Testing-St. Louis
- 1991: Final Environmental Impact Statement by U.S. DOT
- 1994: Preliminary Assessment by USACE, Charleston District
- 1995: Site Investigation and Archives Search by USACE, Rock Island District
- 2003: Engineers Evaluation/Cost Analysis (EE/CA) By Parsons
- 2012: Remedial Investigation (RI) by EODT

MRS-R01, Range II Previous Investigations

- Between the 1991 PA and 2003 EE/CA, golf course management reported encounters with munitions debris
- 2003: Parsons EE/CA recommended clearance due to potential MEC presence
- 2005: EODT Final Sampling Report (Removal Action) recommended clearance
- 2012: EODT RI was not able to delineate potential MEC presence due to lack of ROE

MRS-R01, Range II

Previous Investigations



Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Funded by USACE

- Parsons, 2003 (Investigation)

Funded Privately

- Sun Star Subsurface, 2006 (Removal)

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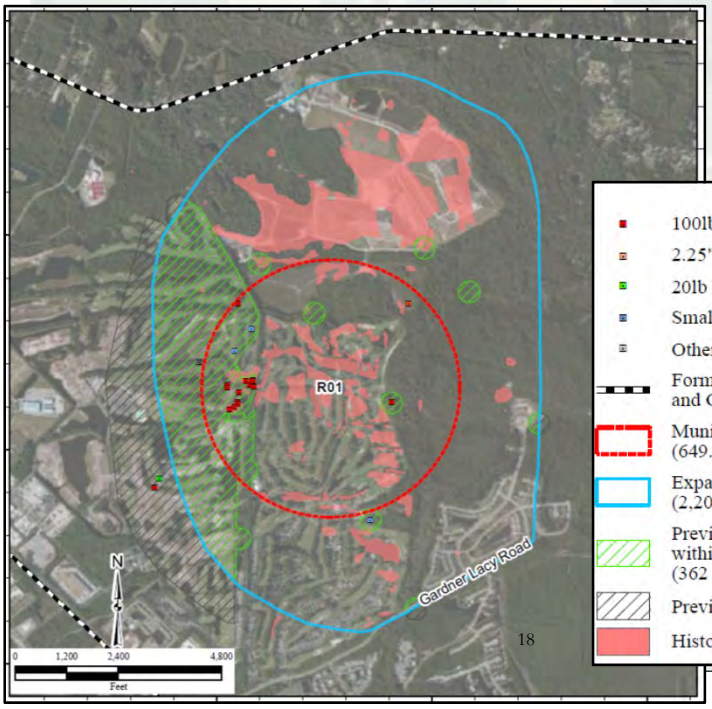
MRS-R01, Range II

Previous Investigations



Legend

- 100lb Bomb (16 Items)
- 2.25" Rocket (1 Item)
- 20lb Bomb (1 Item)
- Small Arms (3 Items)
- Other (1 Item)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Previously Characterized Area within Investigation Area (362 acres)
- Previously Characterized Area
- Historical Use Area (318.6 acres)

MRS-R02, Range III Previous Investigations

- 1997: Site Visit by Parsons
- 2002: Time Critical Removal Action by EODT
- 2003: EE/CA by Parsons confirming MEC presence
- 2005: Removal Action by ERM, including geophysical survey
- 2005: Clearance by Kestrel and others
- 2006: MC Investigation of soil and surface water by Parsons; Phase I removal for DH Horton
- 2007: Removal Action for Landbank, LLC
- 2012: EODT RI confirmed MEC presence

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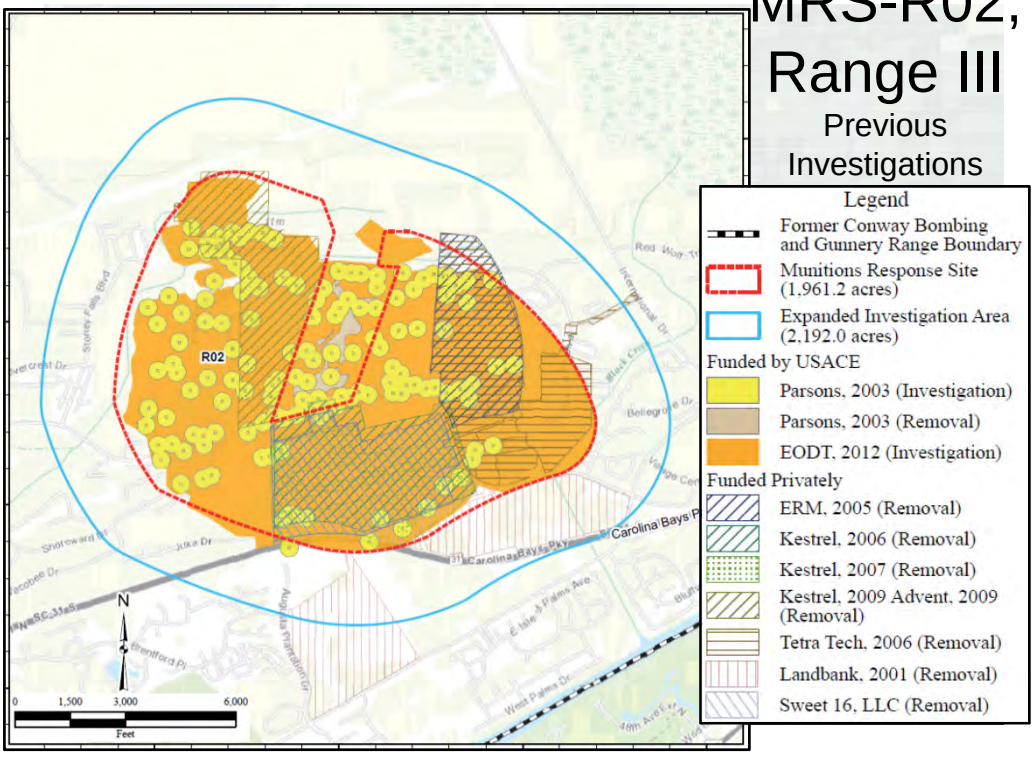
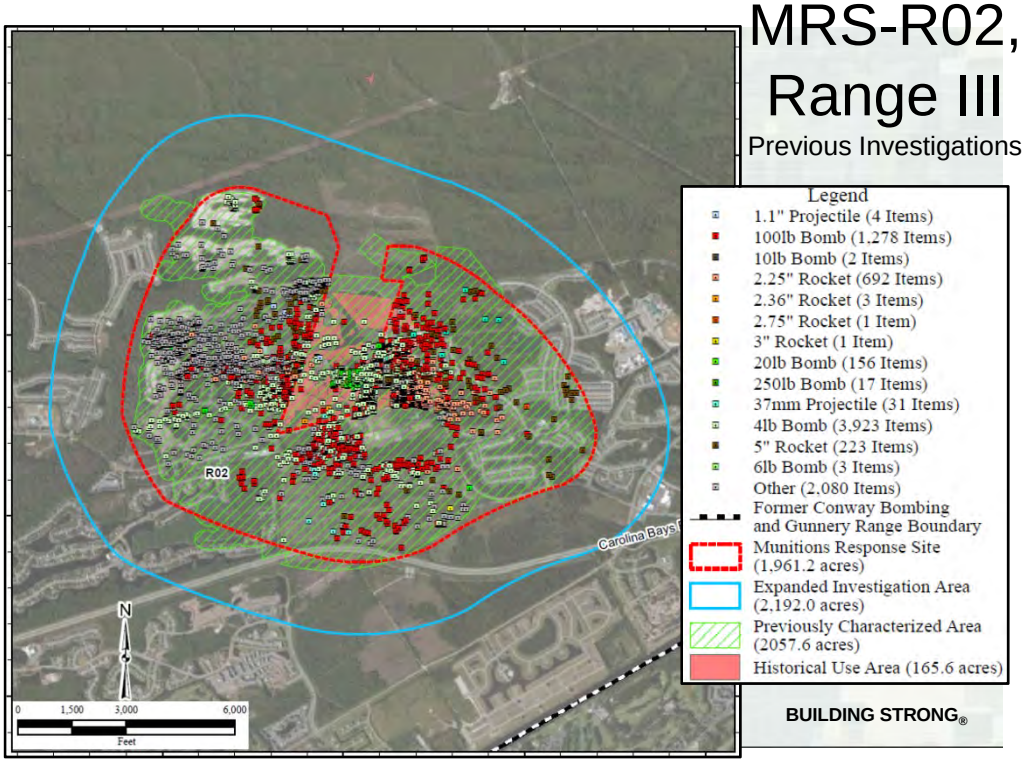
MRS-R02, Range III

Previous Investigations



MRS-R02, Range III

Previous Investigations



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MRS-R03, Range IV Previous Investigations

- 2003: Parsons EE/CA confirmed MEC
- 2004-2005: Geophysical Survey and Removals by USA Environmental
- 2006: Soil and groundwater sampling by Arcadis
- 2012: EODT RI recommended further investigation

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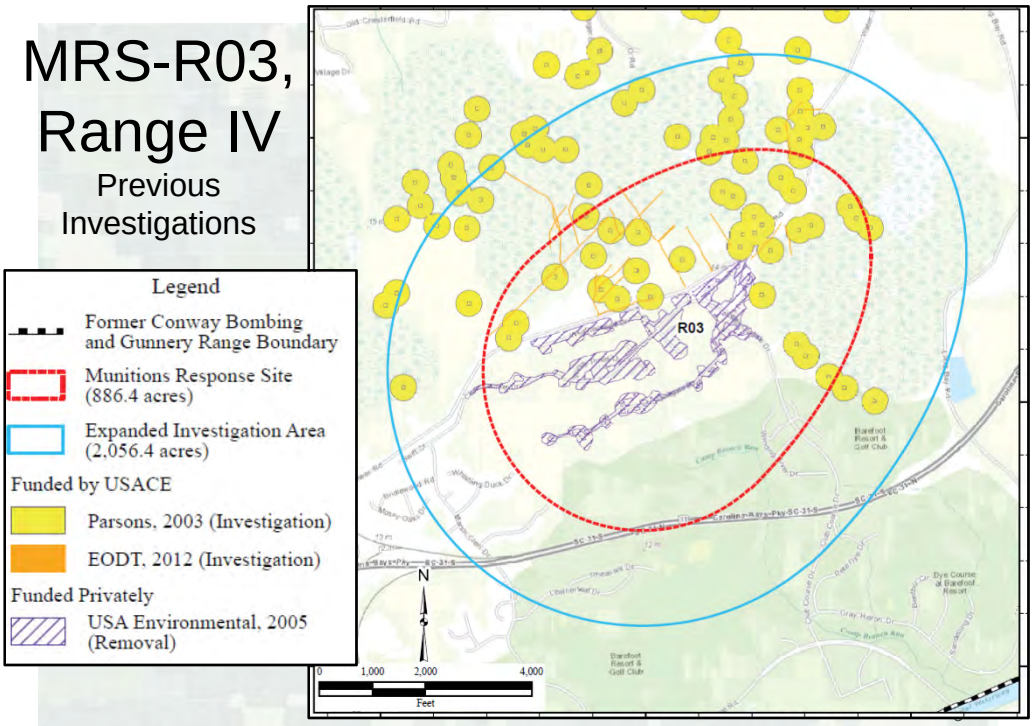
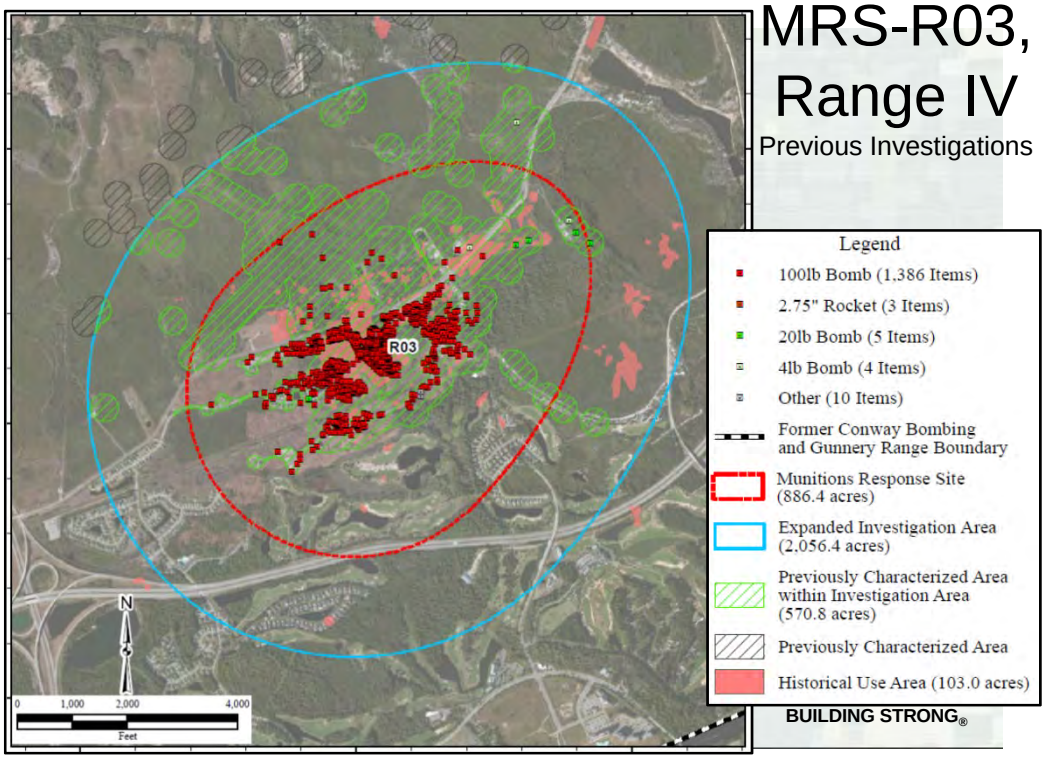
MRS-R03, Range IV

Previous Investigations



MRS-R03, Range IV

Previous Investigations

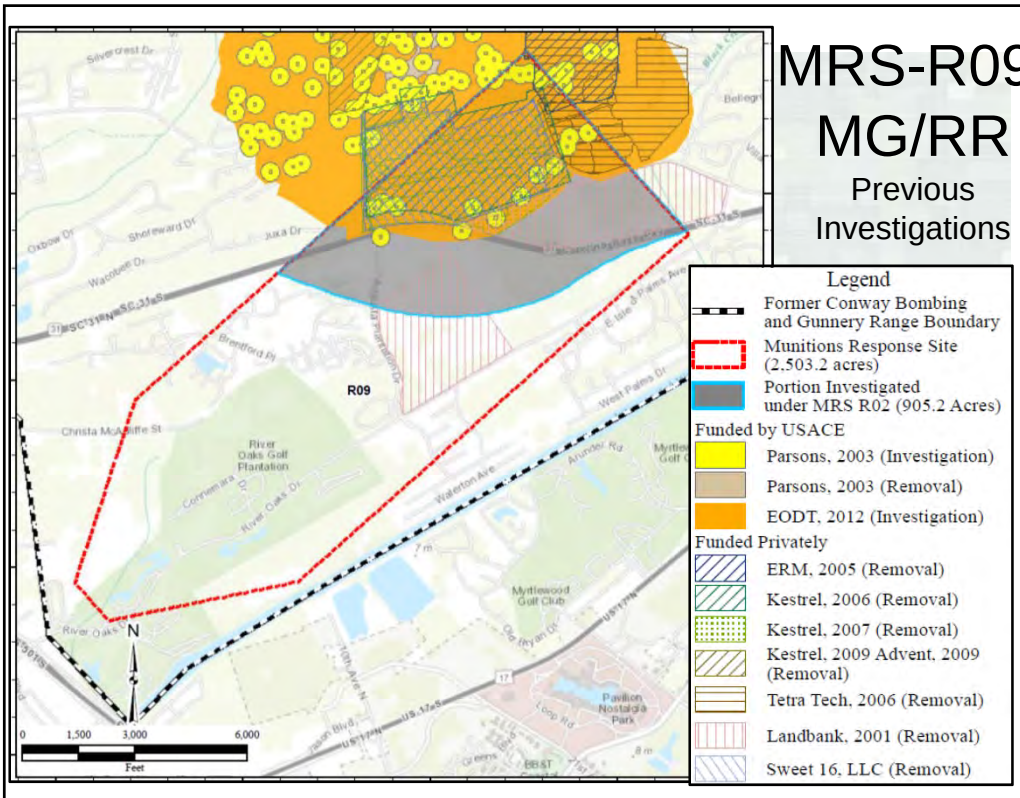


MRS-R09, MG/RR Previous Investigations

- 2003: Parsons EE/CA recommended NDAI
- 2012: EODT RI recommended further investigation due to ROE refusal allowed for delineation

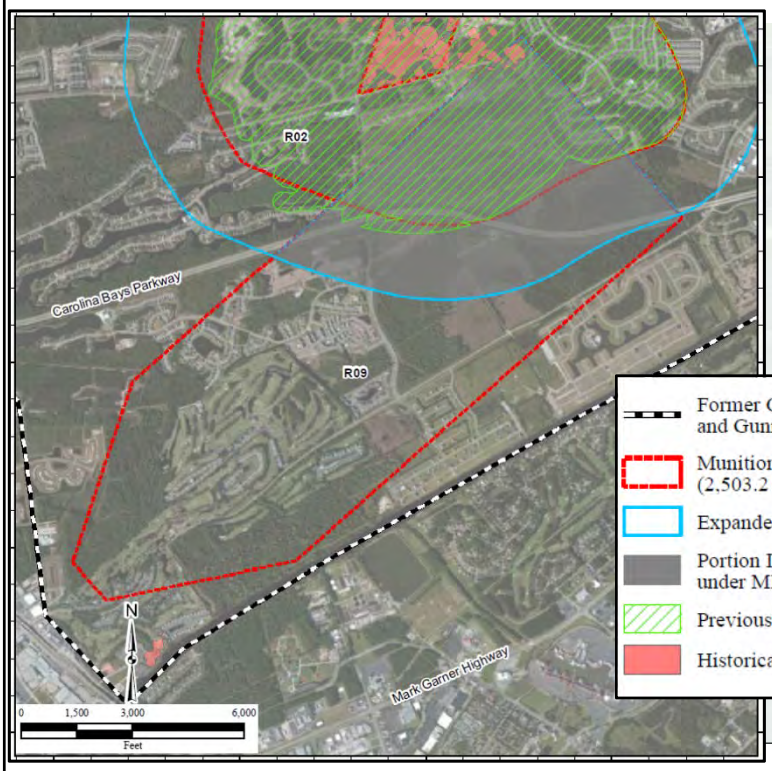
MRS-R09, MG/RR

Previous Investigations



MRS-R09, MG/RR

Previous Investigations



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EODT 2012 RI

Characterization incomplete due to Right-of-Entry refusal.

The following results and recommendations were made the in 2012 RI Report.

MRS	Potential MEC Hazard	MEC HA (Current/Future)	MC Risk	Recommendation	Conclusion
MRS-R01 (Range II)	Unlikely	Not Assessed	No MC Release has occurred	Further Investigation	MEC Nature and Extent Not Quantified
MRS-R02 (Range III)	Yes	1/1	No MC Release has occurred	Further Investigation	The area was well delineated during previous investigations. Potential MEC hazards present.
MRS-R03 (Range IV)	Unlikely	1/1	No MC Release has occurred	Further Investigation	Explosives safety hazard not present
MRS-R09 (MG/RR)	Yes	1/1	Not Assessed	Further Investigation	Potential MEC hazards present, based on previous investigations. No ROE during RI.

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Conway Bombing and Gunnery Range RI/FS

PROJECT PROGRESS

Project Progress

Additional comments on the Work Plan have led to changes within the document

- Additional information from the EODT 2012 RI, to explain reasoning behind current RI/FS initiative
- Additions to Previous Investigations
- Additions to Daily Project Reporting
- Additions to definition of MEC
- Presentation of Data Quality Objectives has changed
- Addition of anomaly avoidance during vegetation clearance
- Evacuation clause for exclusion zones added
- Sampling changes
- A list of laws and regulations that may apply to actions planned for the project was added

DQO changes

- The Data Quality Objectives are developed to meet the goals of the RI/FS purpose statements.
- The DQOs are now split into separate tables by individual MRS.
- The problem statements, locations, approach, and performance criteria have been expanded.
- *See Section 3.2 of Work Plan*

MEC DQO Summary

The goal of the RI is to define the nature and extent of MEC potentially associated with the MRSs to determine if further response actions are required to support current and future residential, commercial, and recreational land use.

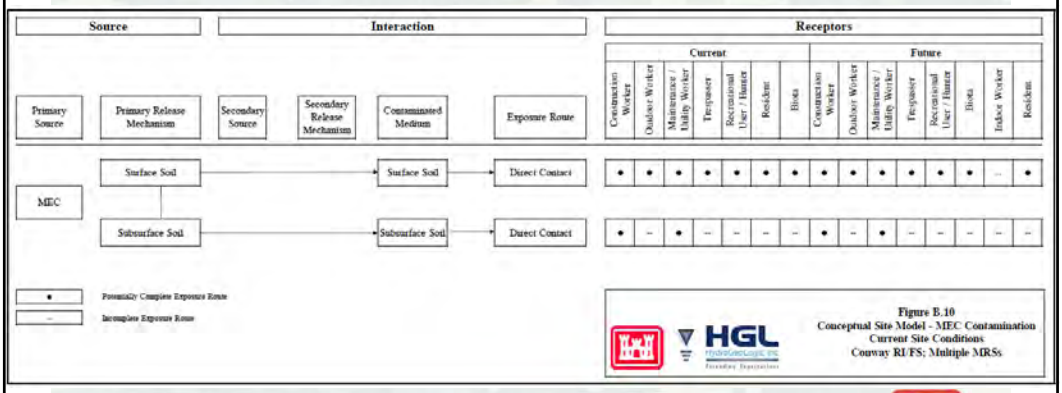
MC DQO Summary

Evaluation and determine nature and extent of MC contamination, if present, at each MRS to determine if further response actions are required to support current and future residential, commercial, and recreational land use.

Preliminary Conceptual Site Model

- Based on review of current site conditions and available historical data
- Will refine based on data gathered
- MEC CSM and MC CSM

Preliminary MEC CSM



See Figure B.10

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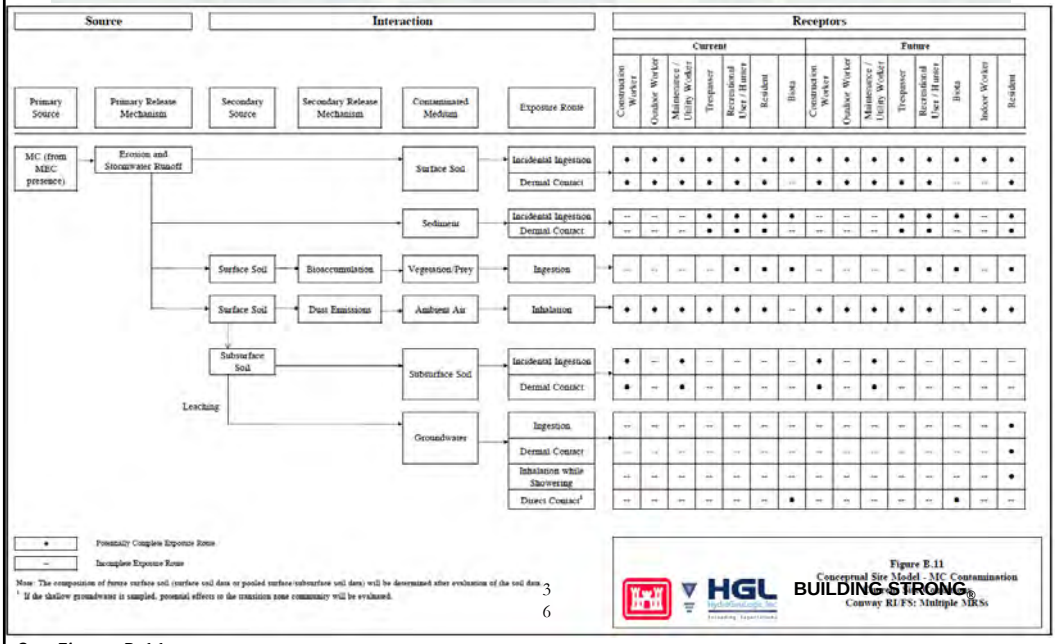
Preliminary MC CSM



See Figure B.11

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Conway Bombing and Gunnery Range RI/FS

GENERAL TECHNICAL APPROACH

Data collection methods

DGM Transects*			Intrusive of DGM Transects (Analog Mode)	Intrusive Between DGM Transects (Analog Mode)	Intrusive Transects to delineate well defined targets	Intrusive DGM Grids	MC Sampling	Comments
Golf Course and Residential Transects (Towed Array)	Overland Transects (Person Portable)	Wetlands Transects (Towed Array)						
DGM Transects with analog intrusive investigation	DGM Transects in rural vegetated areas with analog intrusive investigation	DGM Transects in wetlands or surface water areas with amphibious vehicle towed array	Analog Intrusive investigation of 50% of Overland DGM Transects to define MEC used areas to within 250ft	Analog Intrusive investigation of 50% of Golf Course and Residential DGM Transects to be conducted in non fairway areas (i.e. in adjacent wooded / rough areas) to define MEC used areas to within 250ft	Analog Intrusive Transects near areas where targets are well defined (to delineate extent of MEC at R02 and R03)	Intrusive DGM Grid Locations based on DGM Transect densities	Biased locations based on evaluated data	DGM transect spacing of 500 feet (nonintrusive investigation) Analog transect spacing of 500 feet (intrusive) Grids=20% of transect acreage

Alternate Approaches

- HGL proposes to negotiate alternate approaches based on land use
  - ► Golf courses, residential areas
  - ► Overland wooded, open, or wetlands areas
    - Amphibious vehicle for wetlands areas
- Rights-of-entry a known challenge
- Requires interaction with landowners
  - ► Minimizes impacts to gather data
- Successfully negotiated on other RIs

Figure 1

Figure 2

MEC Contaminated Areas

- DGM transects
  - ► Brush clearance (mechanical or hand clearance)
  - ► Linear transects designed to detect target areas with a 90% confidence
  - ► Towed array or person portable
- DGM Grids

Intrusive Investigation

- Transects:
  - ►Along DGM transects

  Or

  - ►Separate intrusive transects to delineate MEC contamination areas
- Grids
  - ►intrusive after DGM data is collected

Non-MEC contaminated areas

- Buffer areas of the MRSs (outside of the expected MEC presence areas)
- Grid sampling approach to confirm that MEC is not present.
- HGL proposes 100 grids (100-ft x 100-ft size) in these outlying areas
- DGM and Intrusive investigation

MEC Hazard Assessment

- Explosives Safety Hazard
  - ►Will be assessed using MEC Hazard Assessment (MEC HA)
- Evaluates potential MEC hazards
- Interim guidance document issued by EPA in 2008
- Evaluated for each MRS and documented in final reports

MC contamination

- Verify MC contamination presence
  - ►comparison of MC concentrations to:
    - EPA ecological screening values or
    - EPA regional screening levels for residential and industrial soil
  - ►Identified COPCs will be evaluated further in the risk assessment
- Details in Work Plan

Sampling Updates

- Phase I: Samples will be collected in biased locations within each MRS as either SUs (a reasonable residential lot size) or discrete samples. Additional investigation may be required if contamination is confirmed.
- A site-specific background data set will be collected for each MRS for both discrete and ISM soil samples.
- Background samples will be discrete surface soil samples outside of DoD-related impact areas.
- If Phase 2 of samples is employed, background sediment samples will be collected at upstream or up gradient locations is sediment sampling is deemed necessary.
- Only lead and zinc will be analyzed in discrete samples.
- MC background soil samples will be taken at locations agreed upon by the PDT and based on evaluation of background characteristics. Samples will be analyzed for metals.

Analytical Data Screening Updates

- Analytical results for metals will be evaluated with respect to site-specific background concentrations. If concentrations are similar to background, that chemical will not be identified as COPC. For those that represent contamination, the maximum detected concentration will be compared to risk-based screening levels.
- Groundwater samples will be screened against Federal maximum contamination levels (MCLs) as listed by the EPA. If no MCL is available, the regional screening value for tap water will be used.
- Risk characterization will qualitatively evaluate potential risks associated with background constituents present at concentrations greater than the risk-based screening values.

Conway Bombing and Gunnery Range RI/FS

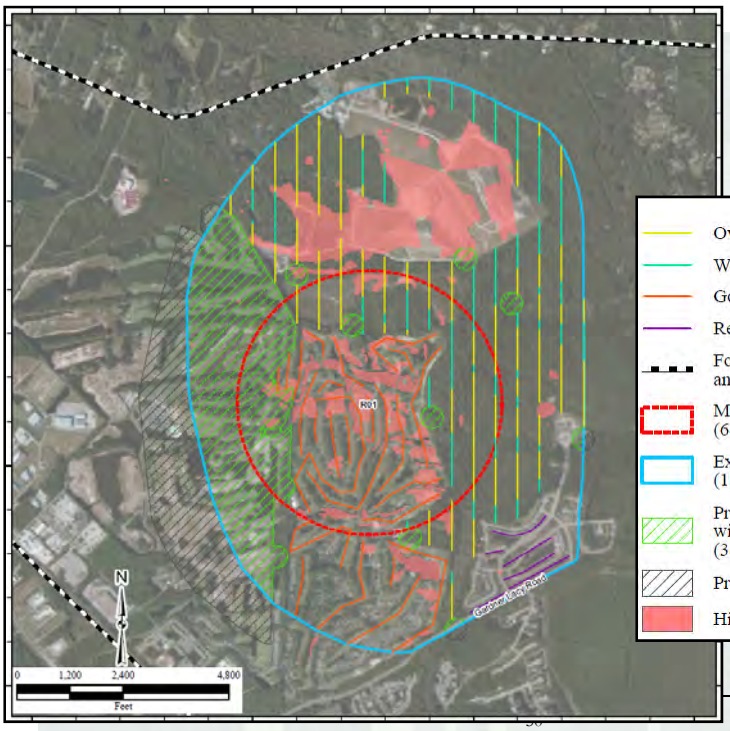
TECHNICAL APPROACH FOR EACH MRS

MRS-R01, Range II

- Historical use:
  - Practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing.
- Identified in EE/CA
- Investigated as “Area A and A-1”
- Not delineated in previous RI/FS 2012
- Historical aerial photo analysis to identify potential impact areas

MRS-R01, Range II

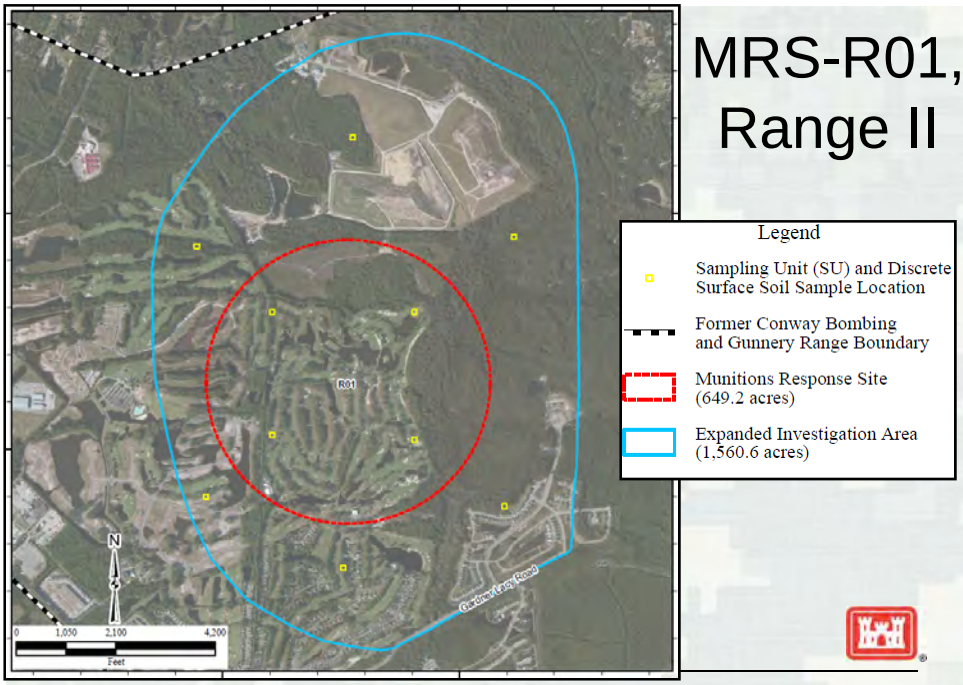
- Delineate to north, northwest and east
  - 1.29 miles of residential area transects
  - 9.31 miles of golf course transects
  - 9.31 miles of overland transects
  - 4.87 miles of wetland/ponds transects
  - Grids based on DGM transect densities will be proposed
  - Intrusive investigation (grids & analog transects)
  - Incremental soil sampling



MRS-R01, Range II

Legend
- Overland Transect (49,176.5 ft)
- Wetland Transect (25,715.2 ft)
- Golf Course Transect (49,176.5 ft)
- Residential Transect (6,816.6 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (1,560.6 acres)
- Previously Characterized Area within Investigation Area (362 acres)
- Previously Characterized Area
- Historical Use Area (318.6 acres)

MRS-R01, Range II

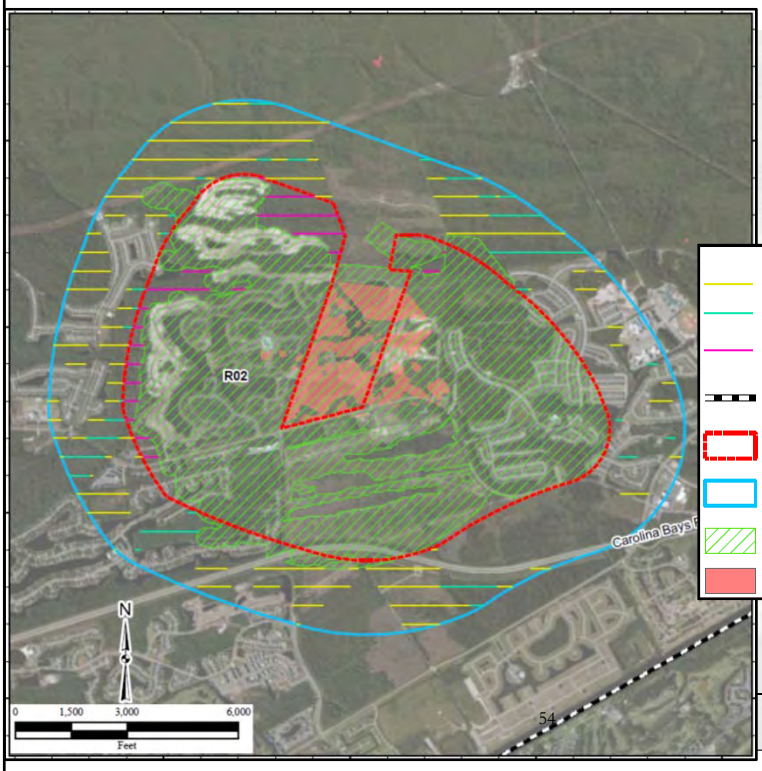


MRS-R02, Range III

- Historical use
  - high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing
- MEC found previously: 100-pound practice bombs and 2.25-inch rockets
- 37-mm projectiles and 2.36-inch rockets recovered north of MRS-09 (EODT, 2012)
- Investigated as “Area B”
- TCRA on 45 acres (Parsons, 2002).
- Not delineated in previous RI/FS 2012
- Historical aerial photo analysis

Additional delineation, MRS-R02, Range III

- 14.8 miles of overland transects
- 5.98 miles of wetland/ponds transects
- 2.47 miles of analog transects
- Grids based on DGM transect densities will be proposed
- Intrusive investigation (grids & analog transects)
- Incremental soil sampling

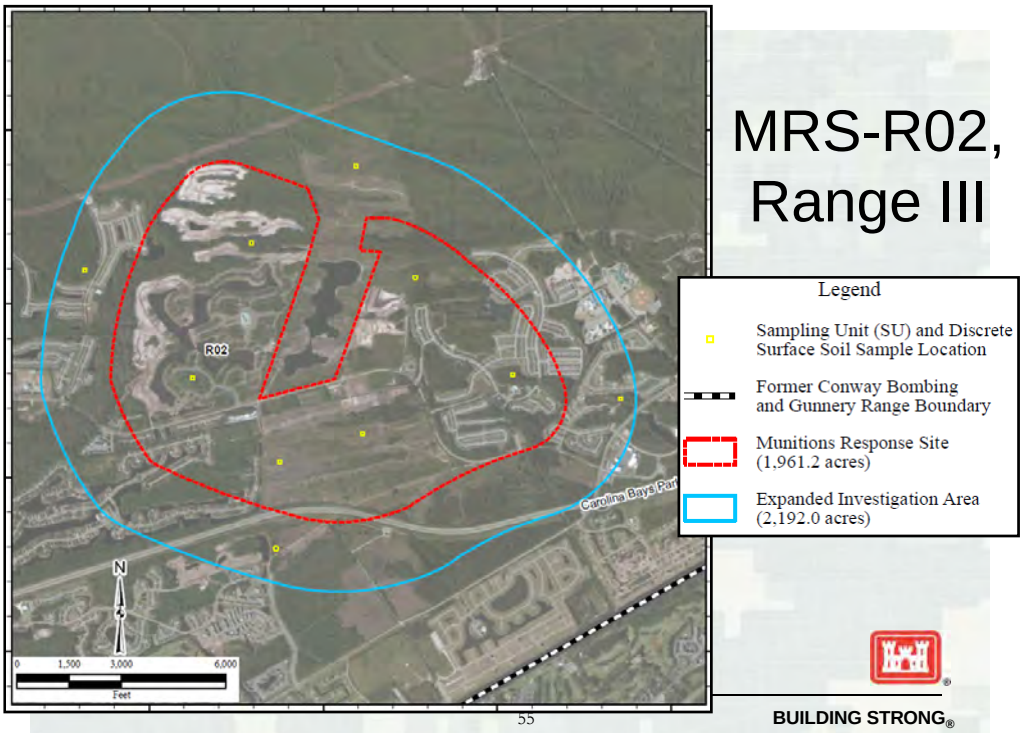


MRS-R02, Range III

Legend

- Overland Transect (78,356.6 ft)
- Wetland Transect (31,565.8 ft)
- Mag and Dig Transect (13,061.0 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Previously Characterized Area (1,966.3. acres)
- Historical Use Area (165.6 acres)

MRS-R02, Range III

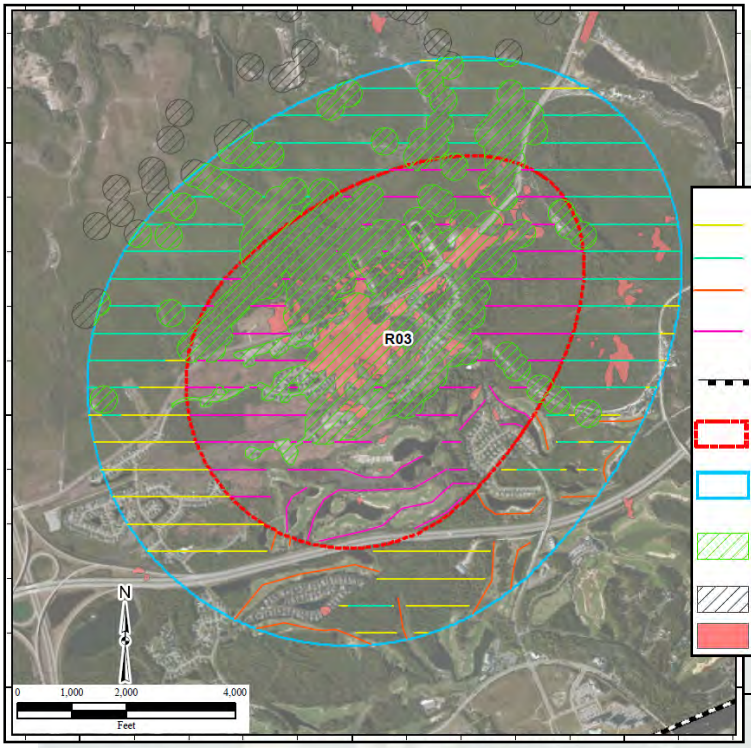


MRS-R03, Range IV

- Historical use:
  - ► practice bombing, including medium-altitude bombing
- identified in the EE/CA
- Investigated as “Area C”
  - ►MD: 4-lb incendiary bombs, 100-lb practice bomb, 20-lb fragmentation bomb
- Third-party removal actions occurred

MRS-R03, Range IV

- Delineate to northeast, southeast & southwest
  - 2.54 miles golf course transects
  - 4.45 mi overland transects
  - 8.66 miles wetland/ponds transects
  - 7.47 miles of analog transects
  - Grids based on DGM transect densities will be proposed
  - Intrusive investigation (grids & analog transects)
  - Incremental soil sampling

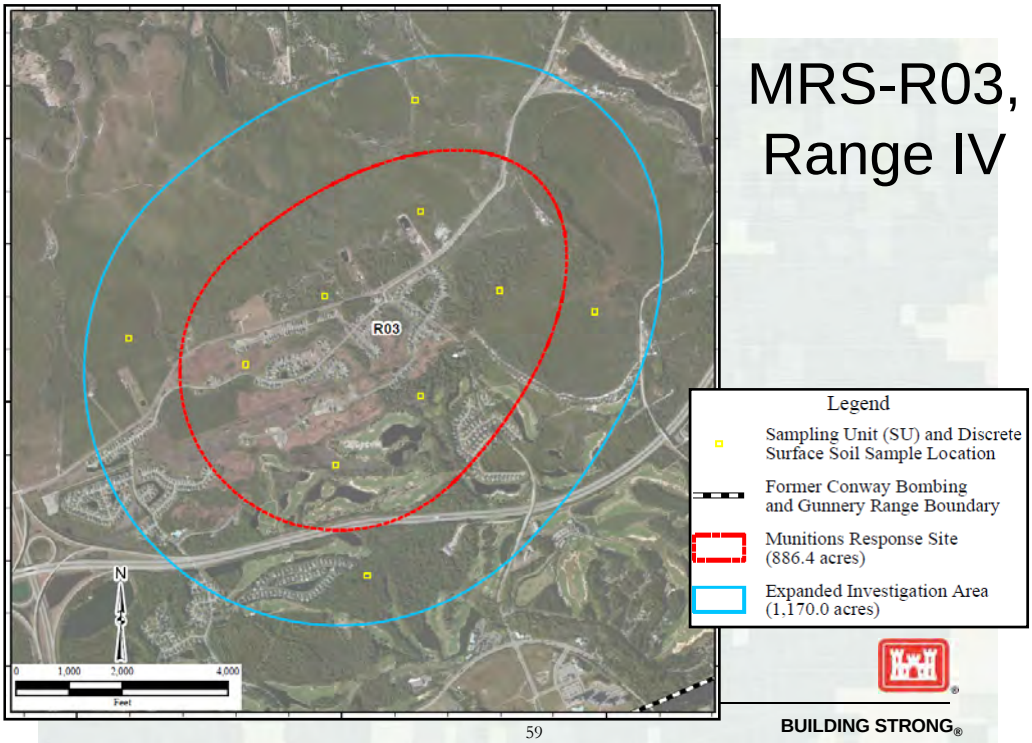


MRS-R03, Range IV

Legend

- Overland Transect (23,532.8 ft)
- Wetland Transect (45,718.2 ft)
- Golf Course Transect (13,419.8 ft)
- Mag and Dig Transect (39,428.5 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Previously Characterized Area within Investigation Area (570.8 acres)
- Previously Characterized Area
- Historical Use Area (103.0 acres)

MRS-R03, Range IV



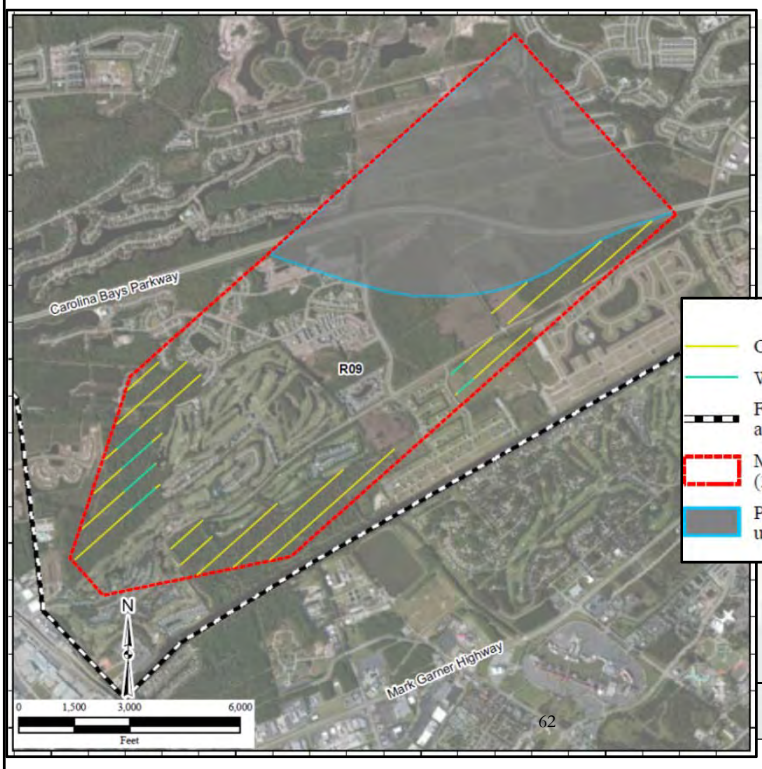
MRS-R09, MG/RR

- Historical use:
  - ►firing bomber turrets and machine guns in a ground-mounted mode, and the basic rifle marksmanship training
- EE/CA recommended NDAI
- RI indicated MEC confirmed on site

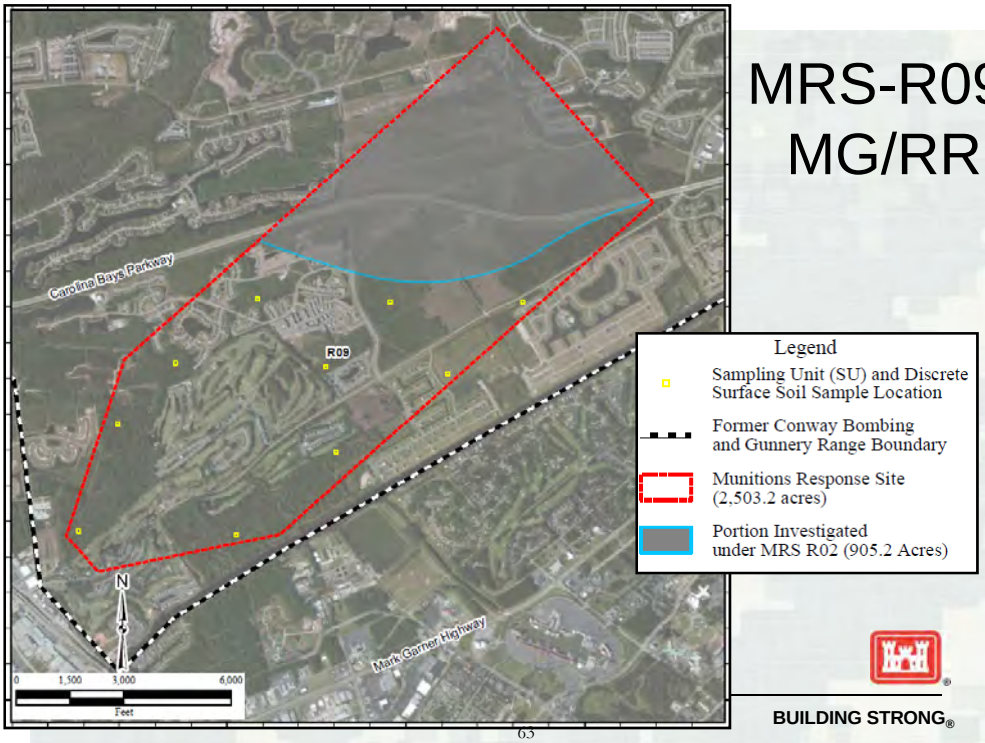
MRS-R09, MG/RR

- Delineate suspected MEC contamination
  - 7.49 mi overland transects
  - 2.20 miles wetland/ponds transects
  - Up to 50% of DGM transects mileage will be performed as analog transects, locations to be proposed in future
  - Grids based on DGM transect densities will be proposed
  - Intrusive investigation (grids & analog transects)
  - Incremental soil sampling

MRS-R09, MG/RR



MRS-R09, MG/RR



Conway Bombing and Gunnery Range RI/FS

TPP-2 CONCLUSIONS

Moving Forward - Updated Schedule

- Obtain ROE: February – August 2015
- TPP-2 Memorandum: April 2015
- Final Work Plan: March/April 2015
- Fieldwork: August 2015 – June 2016
- RI Report: July – October 2016
- Present future recommendations to the public: October – December 2016

Right-of-Entry Support

- HGL identified relevant parcels
- Lists of landowner requests for ROE
- Coordinating with Real Estate Division for mailings
- Results are viewable on the webmap
  - ►Separate webmap for tracking ROE status

Community Relations Support

- Three (3) public meetings anticipated
  - ► One in support of the Proposed Plan
  - ► Others to support right-of-entry

- Community Relations Plan
  - ► Involve community leaders and citizens
- Administrative Record will be updated with final versions of documents
  - ► Horry County Memorial Library, Conway, SC
  - ► Available on www.conwaybgr.com

Site Closeout Statement

To reduce the potential MEC hazards and MC risk and ensure hunters, workers, residents, and farmers are aware of the risk of MEC.

After completion of the Decision Document requirements the potential risk to human health and the environment from MEC or MC will be reduced to the extent practical.

TPP Meeting Closure Issues

- Concurrence –
  - ►Technical Approach, DQOs, preliminary CSM, sampling comparison criteria
  - ►discussions of revisions to the Work Plan?
- Other Issues/Notes –
  - ►Area access limitations
  - ►Rights of entry (ROE)
  - ►Identify additional stakeholders, etc.

In Closing

- Action item review
- Questions or concerns

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5.0 TPP MEETING HANDOUTS

The handouts attached here in Section 5 have been revised from the handouts presented at the TPP Meeting 2 based on input received during the meeting.

Section 5.0 includes the following tables and figures:

Table 1.1 Technical Project Planning Participants
Table 3.1a MEC DQO Summary for MRS-R01, Range II
Table 3.1b MEC DQO Summary for MRS-R02, Range III
Table 3.1c MEC DQO Summary for MRS-R03, Range IV
Table 3.1d MEC DQO Summary for MRS-R09, MG/RR
Table 3.1e MC DQO Summary for MRS-R01, MRS-R02, MRS-R03 and MRS-R09
Table 3.2 Decision Rules for MRSs, Former Conway BGR

Figure B.1 General Location Map
Figure B.2 MRS-R01 Location Map
Figure B.3 MRS-R02 Location Map
Figure B.4 MRS-R03 Location Map
Figure B.5 MRS-R09 Location Map
Figure B.6 MRS-R01 Historical Information and Previous Investigations
Figure B.6a MRS-R01 Historical Work
Figure B.7 MRS-R02 Historical Information and Previous Investigations
Figure B.7a MRS-R02 Historical Work
Figure B.8 MRS-R03 Historical Information and Previous Investigations
Figure B.8a MRS-R03 Historical Work
Figure B.9 MRS-R02 Historical Information and Previous Investigations
Figure B.9a MRS-R02 Historical Work
Figure B.10 Conceptual Site Model – MEC Contamination
Figure B.11 Conceptual Site Model – MC Contamination
Figure B.14 MRS-R01 Field Activity
Figure B.15 MRS-R02 Field Activity
Figure B.16 MRS-R03 Field Activity
Figure B.17 MRS-R09 Field Activity
Figure B.18 MRS-R01 Proposed Phase 1 Surface Soil Location Map
Figure B.19 MRS-R02 Proposed Phase 1 Surface Soil Location Map
Figure B.20 MRS-R03 Proposed Phase 1 Surface Soil Location Map
Figure B.21 MRS-R09 Proposed Phase 1 Surface Soil Location Map
Figure B.22 MRS-R01 Range II Wetlands
Figure B.23 MRS-R02 Range III Wetlands
Figure B.24 MRS-R03 Range IV Wetlands

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Table 3.1a
MEC DQO Summary for MRS-R01, Range II

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R01, Range II, because it was used as practice bombing range, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R01, Range II and to determine if further response actions are required to support current and future residential, commercial, and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-01, Range II. As listed in Section 1.7.2, these include a PA, SI, EE/CA, Removal Action and RI. The 2012 RI concluded that MEC had not been delineated and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R01, Range II RI/FS Expanded Investigation Area is 1,561 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.14.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.14 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation area will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

Table 3.1b
MEC DQO Summary for MRS-R02, Range III

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R02, Range III because it was for high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R02, Range III and to determine if further response actions are required to support current and future residential, commercial and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-02, Range III. There have been numerous investigations of this MRS, as listed in Section 1.7.3, which include: PA, SI, TCRA, EE/CA, removal actions and RI. The 2012 RI confirmed the presence of MEC, concluded that MEC had not been delineated, and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R02, Range III RI/FS Expanded Investigation Area is 4,153 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.15.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.15 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation area will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

Table 3.1c
MEC DQO Summary for MRS-R03, Range IV

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R03, Range IV, because was for practice bombing, including medium-altitude bombing The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R03, Range IV and to determine if further response actions are required to support current and future residential, commercial, and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous investigations conducted at MRS-03, Range IV. As listed in Section 1.7.4, these include a PA, SI, EE/CA, Removal Action and RI. The 2012 RI concluded that MEC had not been delineated and recommended further investigation. The boundaries of the current RI will address an expanded investigation area, which include potential source areas located outside of the original MRS boundaries in areas that were not previously characterized. The MRS-R03, Range IV RI/FS Expanded Investigation Area is composed of 1,170 acres.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.16.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.16 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the expanded investigation areas will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, frag, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

Table 3.1d
DQO Summary for MRS-R09, MG/RR

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	**Project Objectives Satisfied**	**Data User Perspectives**	**Contaminant or Characteristic of Interest**	**Media of Interest**	**Required Locations or Areas**	**Number of Samples Required**	**Reference Concentration of Interest or Other Performance Criteria**	**Sampling Method**	**Analytical Method**
MEC Characterization	There is a potential for MEC to be present at MRS-R09, MG/RR because the historical use of the range was exclusively for small arms training activities, such as basic rifle marksmanship training. The goal of the RI is to define the nature and extent of MEC potentially associated with MRS-R09 to determine if further response actions are required to support current and future residential, commercial, and recreational land use[2]	Risk, Remedy	MEC (UXO)	Surface and Subsurface soil	The analytical data inputs for this RI include the results of the previous EE/CA and RI investigation conducted at MRS-09, as discussed in Section 1.7.5. The 2012 RI concluded that there was a potential presence of MEC at MRS-R09, however it was unable to be investigated due to ROE refusal. The historical boundary of MRS-R09, encompassing 2,503 acres, was not expanded for the RI. However, the portion of MRS-R09 that overlaps with MRS-R02, approximately 748 acres, will be investigated as a part of MRS-02. The remaining 1,755 acres will be investigated as MRS-09 during the current RI.	The analytical approach for the RI will include performing: • Surface sweep in areas to undergo DGM survey; • DGM surveys (transects and grids) and; • Intrusive investigations. The delineation of DGM transects is presented in Table 3.3 and illustrated on Figure B.17.	All investigations will be conducted IAW the performance and data quality metrics outlined in the QCP (Section 4.0). The investigation set out in Figure B.17 will meet the performance standards of the PWS: • all areas with elevated anomaly density or with potential to contain UXO are traversed and that there is a 90% chance of detecting these areas; • the boundaries of all identified UXO contaminated areas have been delineated to an accuracy of at least 250 ft; • 90% confidence has been achieved for determining the potential depth of UXO; • 90% confidence in the nature (type and density) of UXO and munitions related debris, for each relatively homogeneous UXO contaminated area, has been achieved; • portions of an MRS which are unlikely to contain UXO contamination may be omitted from the above statistical requirements; and • Demonstrate areas unlikely to contain a target with elevated anomaly density, but with the potential for UXO contamination (e.g. burial pits) are capable of being located by the investigation approach.	Following the DGM surveys, the MRS will be delineated into "elevated anomaly density" areas and areas unlikely to contain UXO contamination. The intrusive investigations will be placed accordingly based on the performance criteria and decision rule applied, with project team concurrence. Evaluations of the presence of UXO, MD, and known high-density anomaly areas will be used to indicate the likelihood of contamination.	Not applicable, see analytical methods listed for MCs.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MEC is based on limiting interaction between any residual MEC and any receptors accessing the site and is anticipated to be either removal of any MEC present to a depth at which they no longer present a hazard to the anticipated human receptors, or to implement land use controls that will minimize the possibility of receptors coming into contact with MEC at the site.

Table 3.1e
MC DQO Summary: MRS-R01, MRS-R02, MRS-R03 and MRS-R09

Criteria from EPA [1]	Problem Statement /Problem Goals	Required Information Inputs			Input Boundaries	Analytical Approach	Performance Criteria	Plan for Obtaining Data	
Criteria from USACE	Project Objectives Satisfied	Data User Perspectives	Contaminant or Characteristic of Interest	Media of Interest	Required Locations or Areas	Number of Samples Required	Reference Concentration of Interest or Other Performance Criteria	Sampling Method	Analytical Method
MC Characterization	Evaluate and determine nature and extent of MC contamination [2]	Risk, Remedy	MC (as set out in "Analysis" shown in Table 3.5) to include explosives, select metals analyses in soil and sediment and analysis of metals and explosives in groundwater.	Soil, sediment, and groundwater	ISM sampling (explosives) and discrete sampling (metals) will be conducted at locations selected based on historical information, DGM data, and intrusive investigative results. If required, surface water features adjacent to impacted areas will be identified for sediment sampling. Additionally, existing groundwater wells down gradient of impacted MRSs will be sampled, if required.	See RI approach detailed in Table 3.4 and the sampling matrix provided in Table 3.5.	If MC is detected during Phase 1 sampling, results will be compared against site-specific background metals concentrations levels and screening levels to determine if MC contamination is present. Phase 2 sampling and Phase 3 sampling will then be conducted, if required. The screening levels as developed during the TPP process are set out in the Appendix E (QAPP) worksheets. Site-specific background samples will be used to assess metals concentrations. Decision rules regarding MC characterization are provided in Table 3.2a. If there are MC detections at concentrations indicating contamination is present which may constitute a risk to the public or the environment, a risk assessment will be performed.	Approach will include collection of incremental soil samples, discrete surface and shallow subsurface soil samples and may also include sediment and groundwater samples. Samples to be collected and analyzed IAW Section 3.13 and Appendix E of this WP and to meet all quality requirements of the QCP, Section 4.0.	Incremental sampling methodology (ISM) samples will be analyzed for explosives (8330B). Analysis of discrete soil and sediment samples will include select metals (6020A/7471). Analysis of groundwater will include metals (6020A/7471) and explosives. See the additional sampling matrix in Table 3.4 and Table 3.5.

(1) This table provides a summary of the DQO development conducted during the TPP process (see Appendix H) and presents an overview of the DQO statements developed. This table provides a crosswalk for each DQO element to the development steps from both the EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* EPA, EPA QA/G-4, EPA/240/B-06/001, February 2006, and USACE's *Technical Project Planning Process*, EM 200-1-2, 31 August 1998. The data collected under the DQOs summarized here will continually be evaluated during field investigations against the appropriate decision rules.

(2) For the RI/FS the preliminary remediation objective for MC is based on the screening levels agreed to by the TPP team as being protective of the identified exposure pathways shown in the CSM. The preliminary remediation objective is to ensure that any identified MC contamination at the site determined to pose an unacceptable risk to human health or the environment is addressed to minimize or mitigate those risks.

Table 3.2
Decision Rules for MRSs, Former Conway BGR, Horry County, South Carolina

Row No.	Characterization (UXO/MC) and Preliminary Status	Investigation	Decision Rule	Intermediate Status	Decision Rule	Intermediate Status	Decision Rule	Final Status and Recommendation
1	UXO characterization where **UXO contamination** is anticipated	Per Table 3.1, conduct surface sweep in areas to undergo DGM survey and conduct DGM survey (visual inspection of surface and aboveground locations for UXO or MD).	If UXO and MD are located: Modify MRS boundaries to improve boundary accuracy and expand investigations (if needed).	**UXO contamination** is anticipated.	Following completion of geophysical surveys the area will be identified as: 1) an area having elevated anomaly density or the potential to contain UXO, or 2) areas unlikely to contain UXO contamination.	1) Elevated Anomaly Density: Demonstrate that a 90% confidence has been achieved for determining both the potential depth of UXO and the nature (type and density) of UXO.	**UXO Contaminated:** Following intrusive investigation, if UXO or a significant amount of MD is found, the area will be characterized as UXO contaminated.	**UXO Contaminated:** Recommended for evaluation in FS.
						2) **Unlikely to Contain UXO Contamination**: Demonstrate that the investigation approach was capable of locating potential UXO contamination.	**Unlikely to Contain UXO Contamination:** If no MEC or MD are found, the area will be characterized as No Significant UXO Present.	**No Significant UXO Present:** No FS evaluation required, potential for NDAI.
2	UXO characterization where n**o UXO contamination is anticipated**[1]	Conduct surface reconnaissance using a Schonstedt magnetometer in non-MEC use areas.	If UXO and MD are located: Modify MRS boundaries to improve boundary accuracy and expand investigations (if needed).	**UXO contamination is anticipated.**	If UXO contamination is anticipated, the decision rules in Row 1 will apply.			
				UXO contamination is not anticipated.	If no UXO or MD is found, the area will be characterized as **no significant UXO present**.	**No significant UXO is present.** Recommended for NDAI.		
3	MC characterization	Conduct sampling as outlined in Table 3.4.	If MC is not detected during Phase 1 sampling or if concentrations are less than screening levels and/or background (as defined in the QAPP, Appendix E), then:	**No MC contamination is present.**				
			If MC are detected during Phase 1 sampling at concentrations exceeding the screening levels and/or background, then:	**MC contamination is present.**	If MC contamination is present, additional evaluations of the nature and extent of MC contamination (soil, sediment, and groundwater sampling) will be performed, and a risk assessment will be conducted to determine if a risk to human health or the environment exists.	**If MC contamination is present and there is a risk to human health or the environment, then additional evaluations of the nature and extent of the MC contamination will be performed.** Recommended for FS.		

(1) Areas where no UXO contamination is anticipated based on historical data or observed site conditions are omitted from the statistical requirements of the PWS.

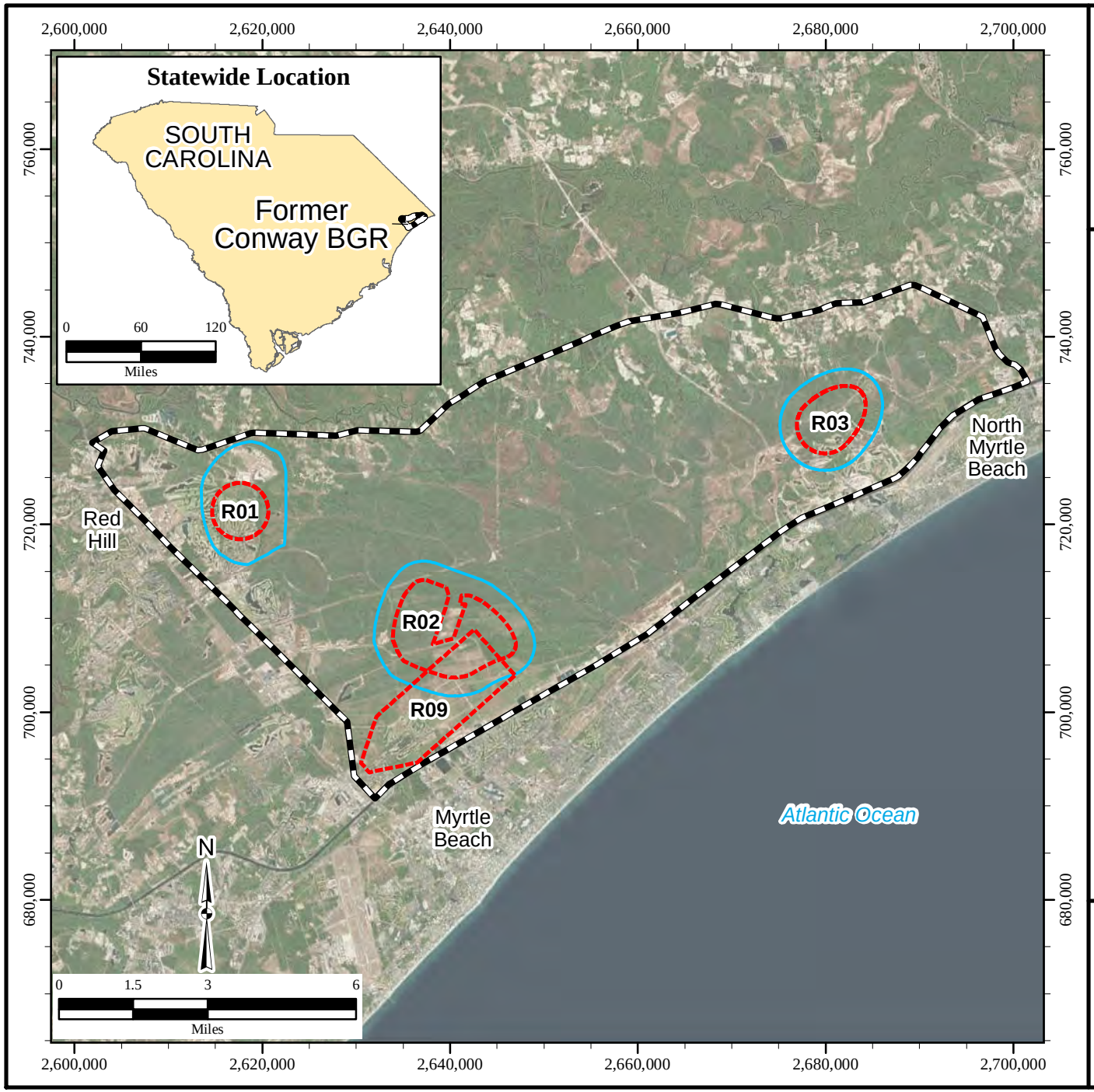

Figure B.1
General Location Map
Former Conway BGR

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range

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Source: HGL, USGS, USACE ArcGIS Online World Imagery

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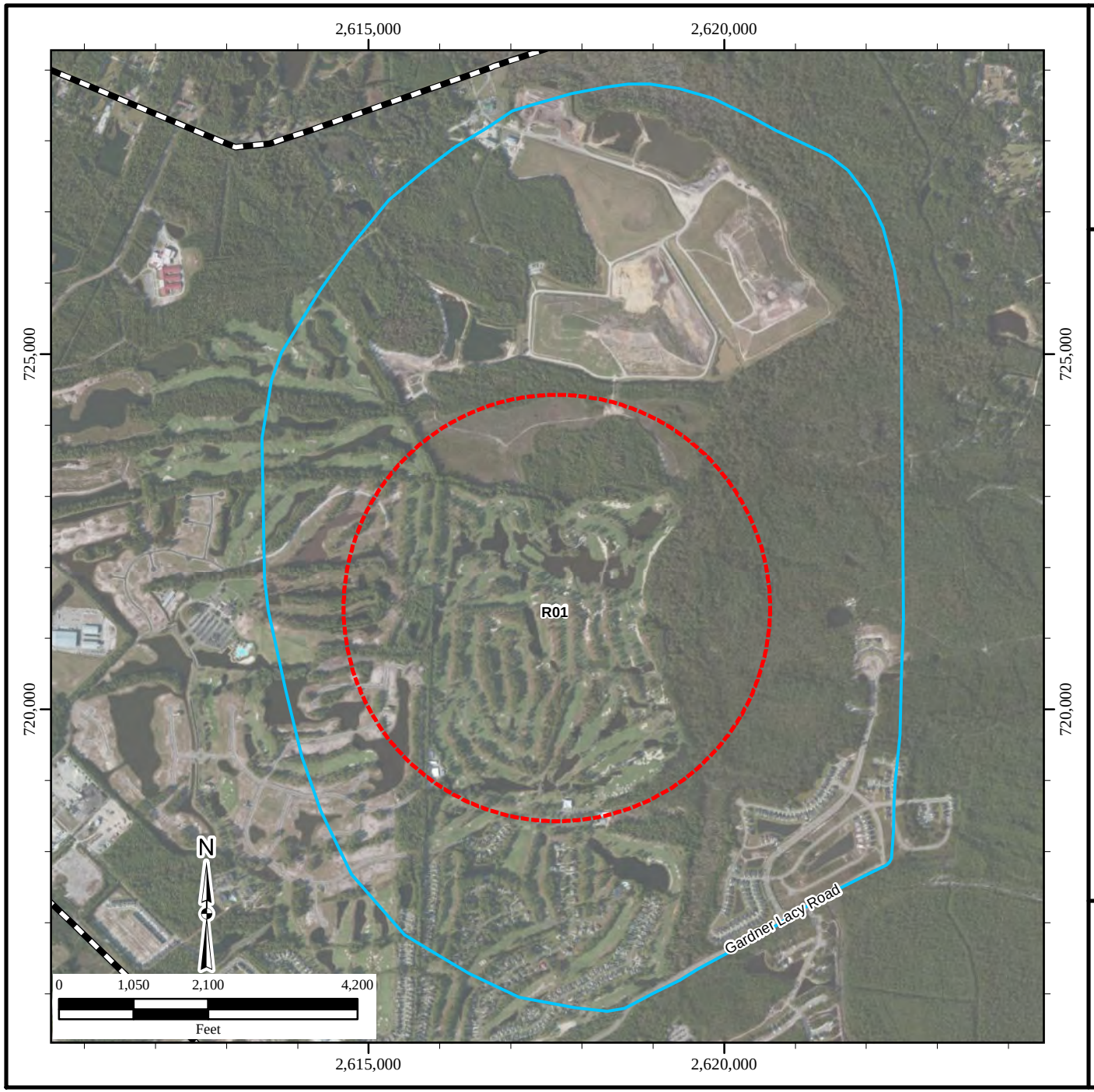

Figure B.2
MRS-R01
Range II Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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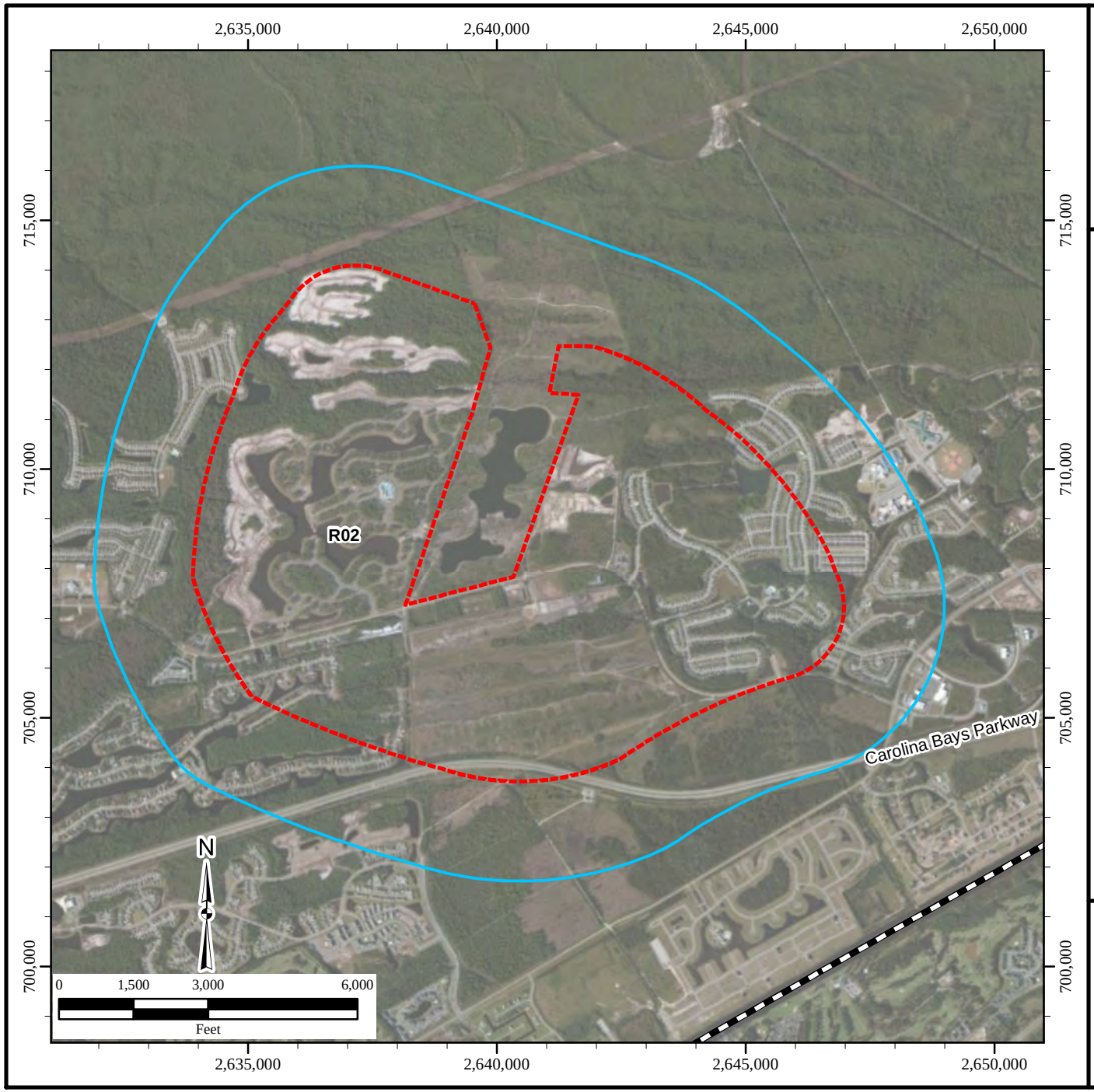

Figure B.3
MRS-R02
Range III Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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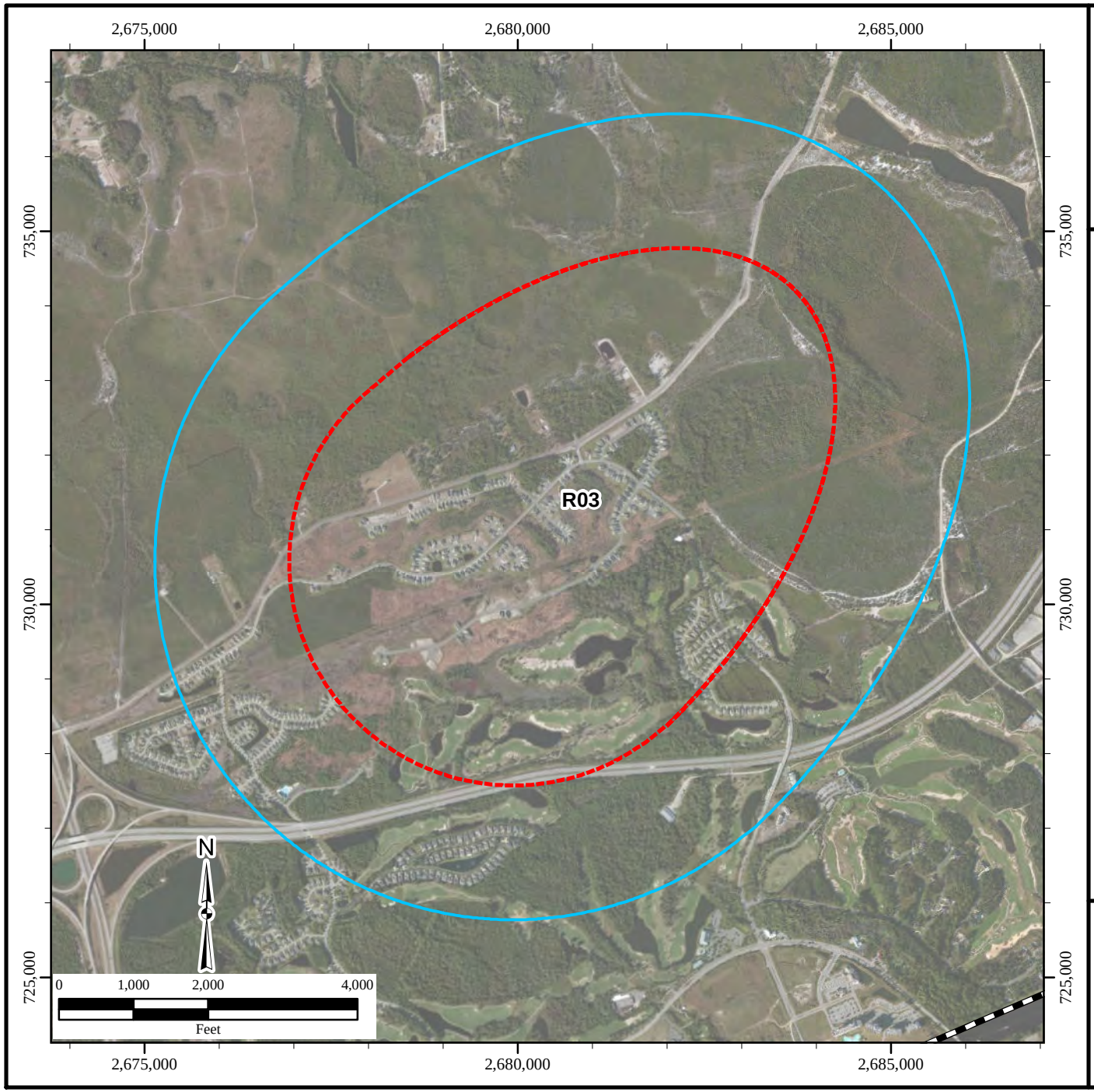

Figure B.4
MRS-R03
Range IV Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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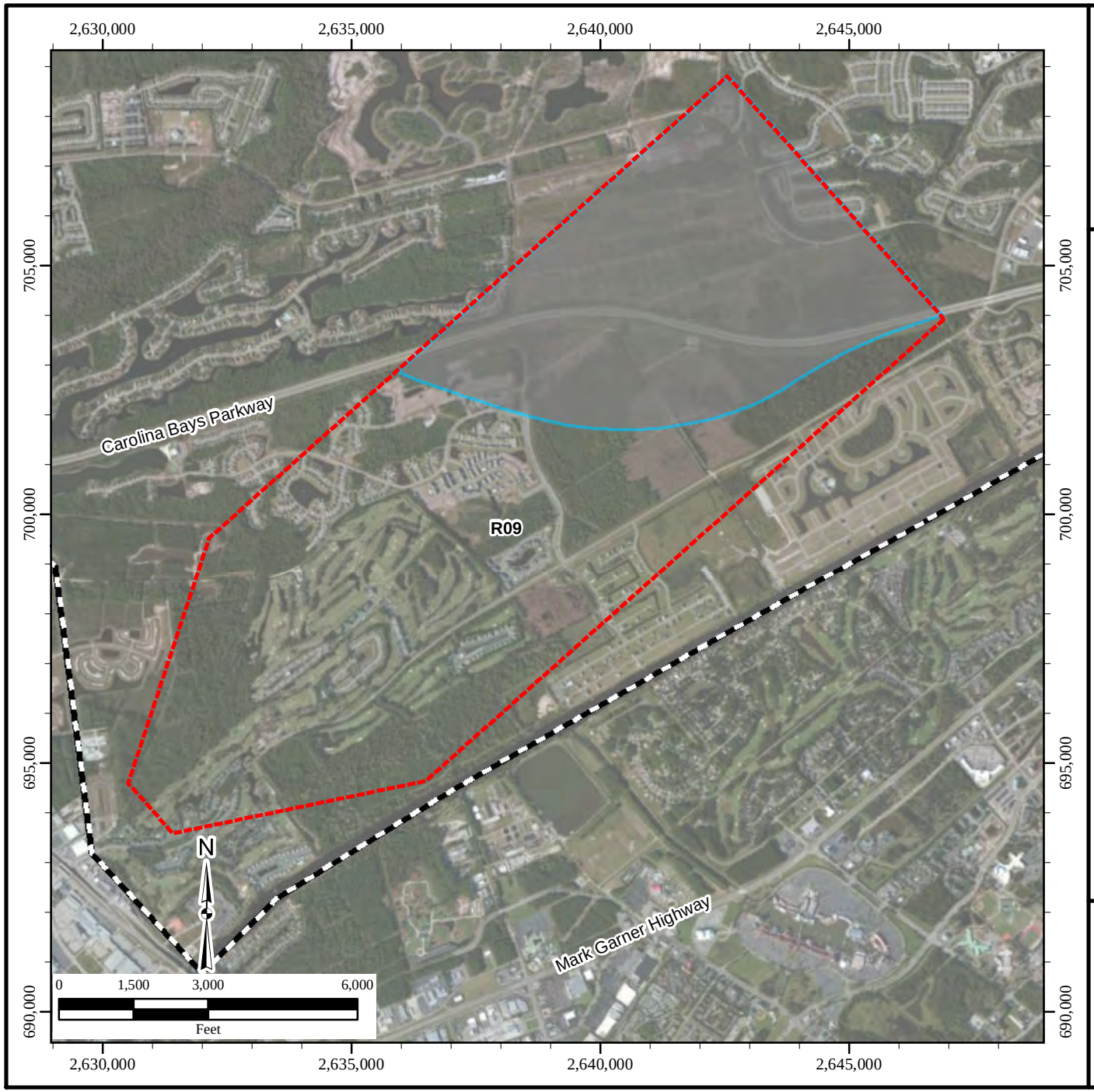

Figure B.5
MRS-R09
Machine Gun/Rifle Range
Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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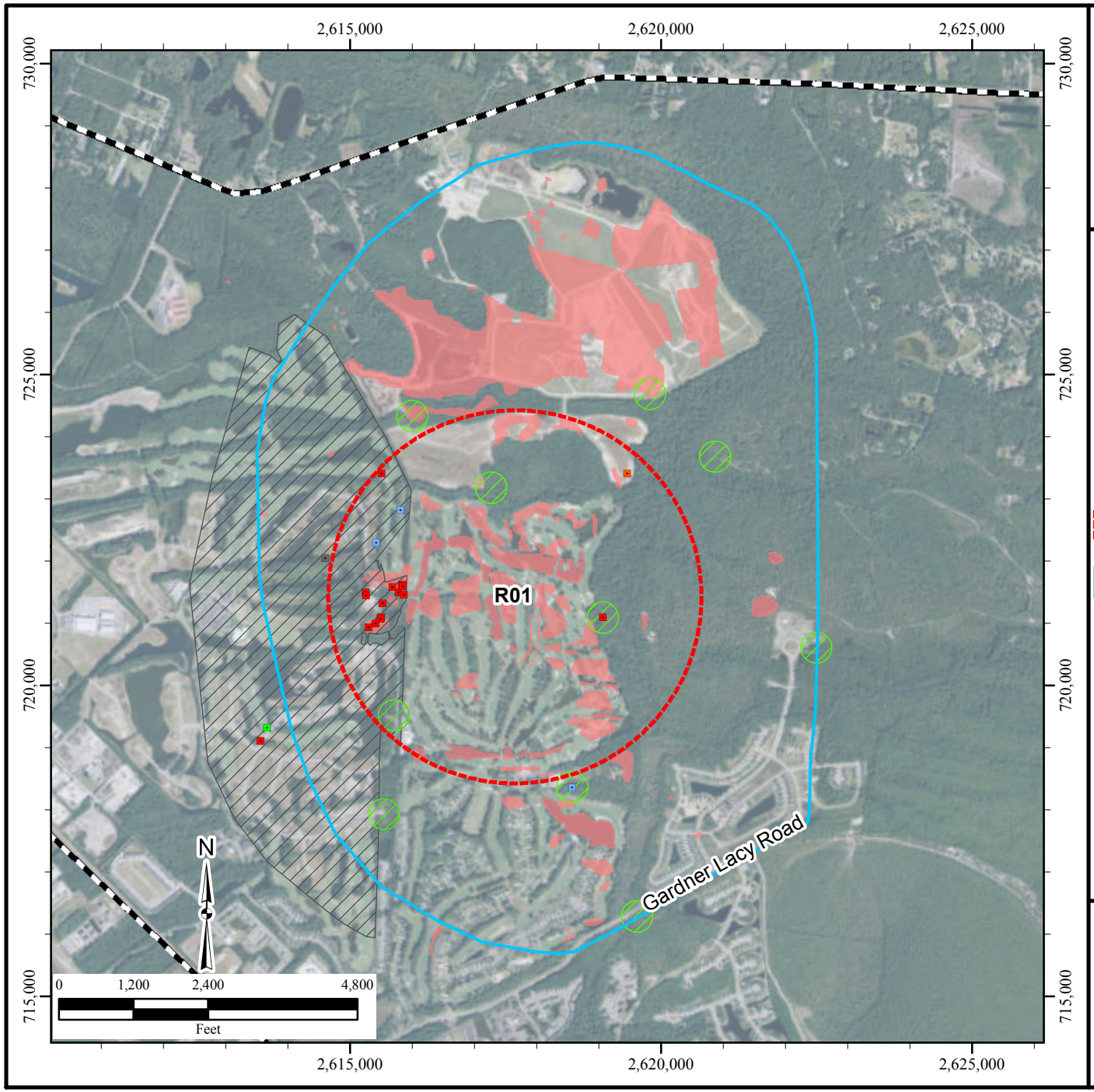

Figure B.6
MRS-R01
Range II
Historical Information and Previous Investigation

Legend

- 100lb Bomb (16 Items)
- 2.25" Rocket (1 Item)
- 20lb Bomb (1 Item)
- Small Arms (3 Items)
- Other (1 Item)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Previously Characterized Area within Investigation Area (45 acres)
- Previously Investigated Area
- Historical Use Area (318.6 acres)

Notes:
HGL considers it unlikely that munitions with HE filler are present within MRS-R01.
Coordinates in South Carolina Stateplane, NAD83, feet.
HE=high explosive
MRS=munitions response site

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Source: HGL, USGS, USACE ArcGIS Online World Imagery

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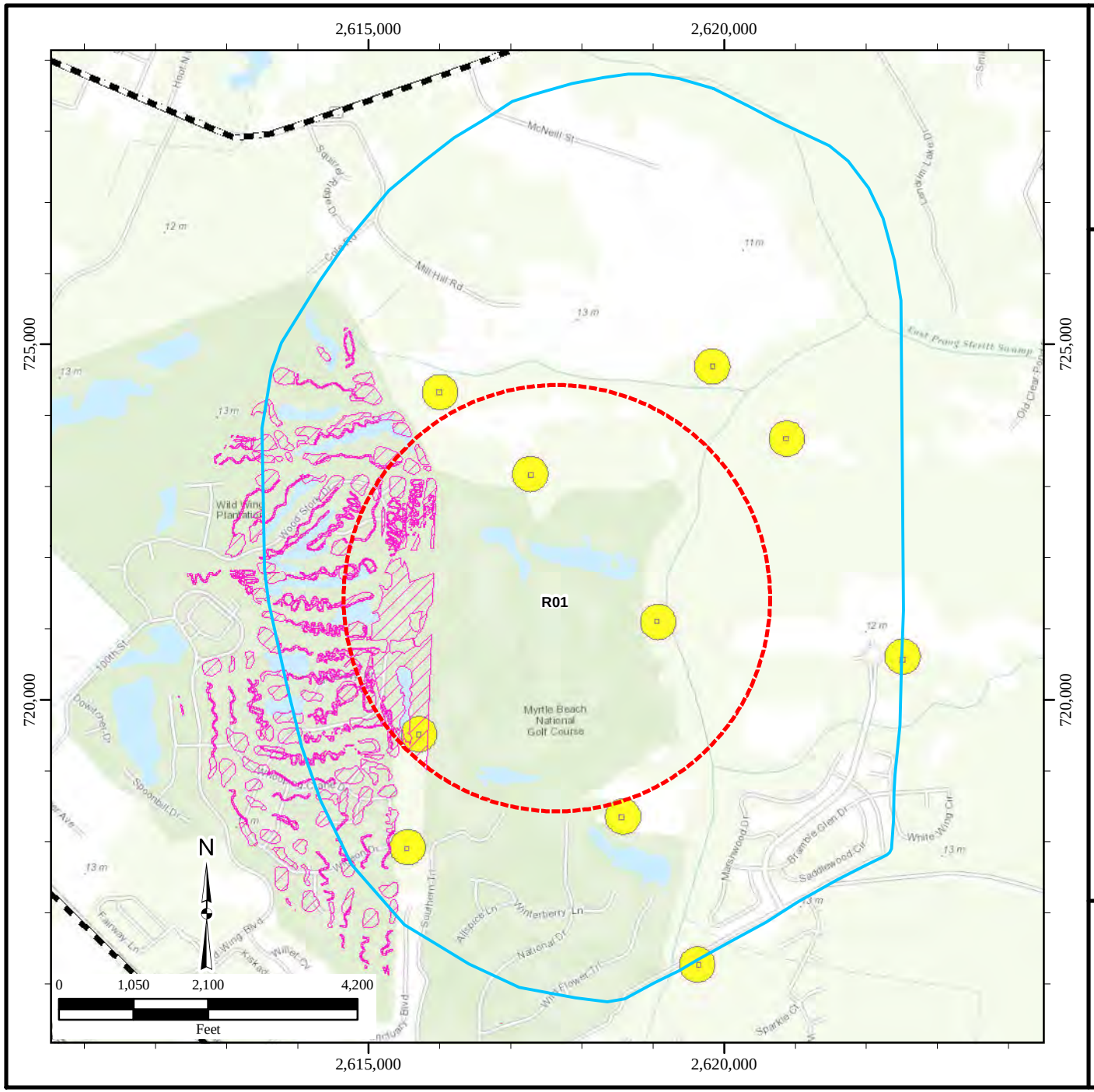

Figure B.6a
MRS-R01
Range II Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Funded by USACE

- Parsons, 2003 (Investigation)

Funded Privately

- EODT for Sun Star Subsurface 2006, (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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Source: HGL, USACE, Parsons, Sun Star ArcGIS Online Topographic Imagery

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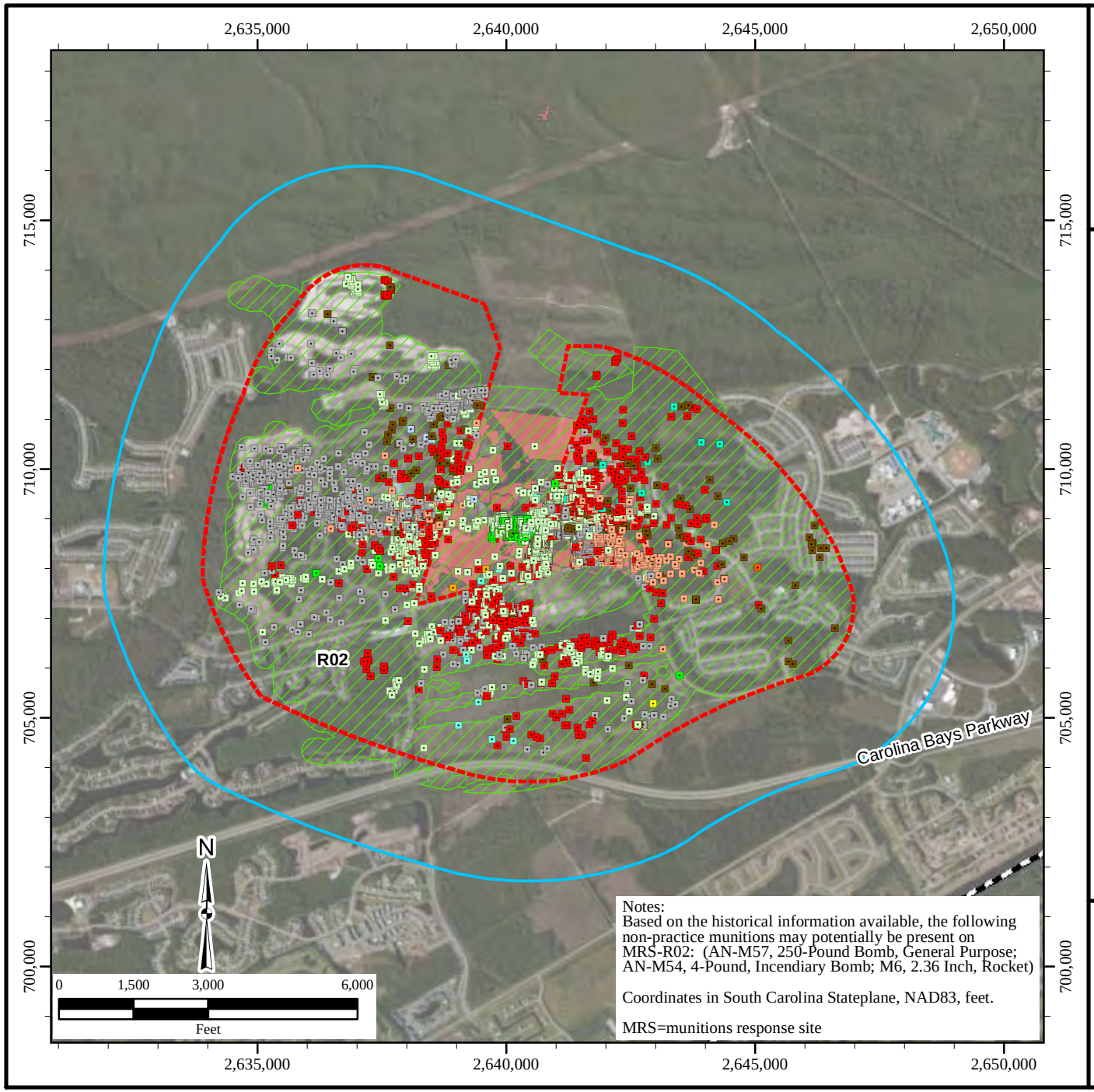

Figure B.7
MRS-R02
Range III
Historical Information and Previous Investigation

Legend

- 1.1" Projectile (4 Items)
- 100lb Bomb (1,278 Items)
- 10lb Bomb (2 Items)
- 2.25" Rocket (692 Items)
- 2.36" Rocket (3 Items)
- 2.75" Rocket (1 Item)
- 3" Rocket (1 Item)
- 20lb Bomb (156 Items)
- 250lb Bomb (17 Items)
- 37mm Projectile (31 Items)
- 4lb Bomb (3,923 Items)
- 5" Rocket (223 Items)
- 6lb Bomb (3 Items)
- Other (2,080 Items)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Previously Investigated Area (2057.6 acres)
- Historical Use Area (165.6 acres)

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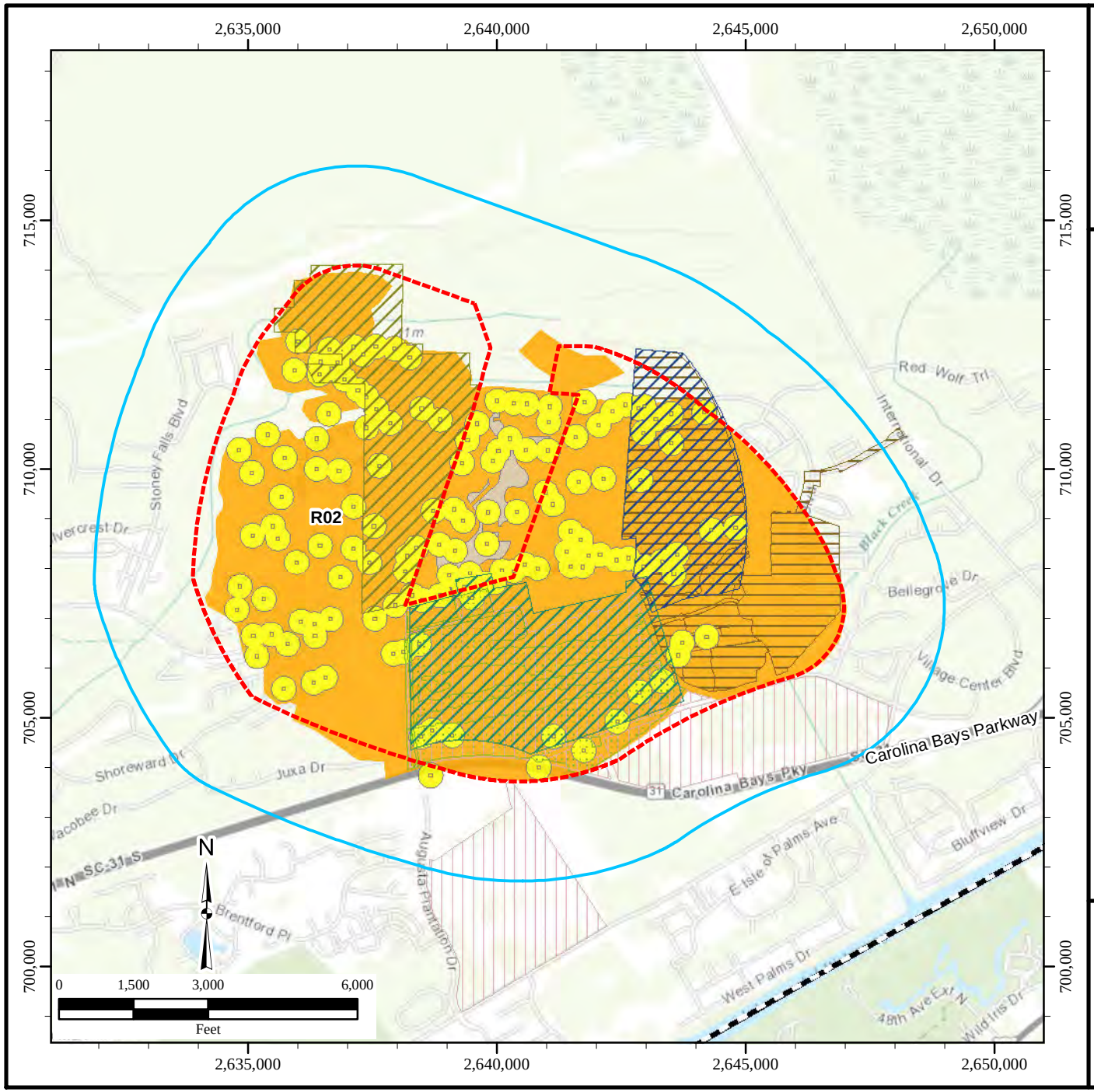

Figure B.7a
MRS-R02
Range III Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- Parsons, 2003 (Removal)
- EODT, 2012 (Investigation)

Funded Privately

- ERM for International Paper 2005, (Removal)
- Kestrel for LandBank 2006, (Removal)
- Kestrel for LandBank 2007, (Removal)
- Kestrel & Advent for Waterbridge 2009, (Removal)
- Tetra Tech for DR Horton 2006, (Removal)
- LandBank, 2001 (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
MRS=munitions response site

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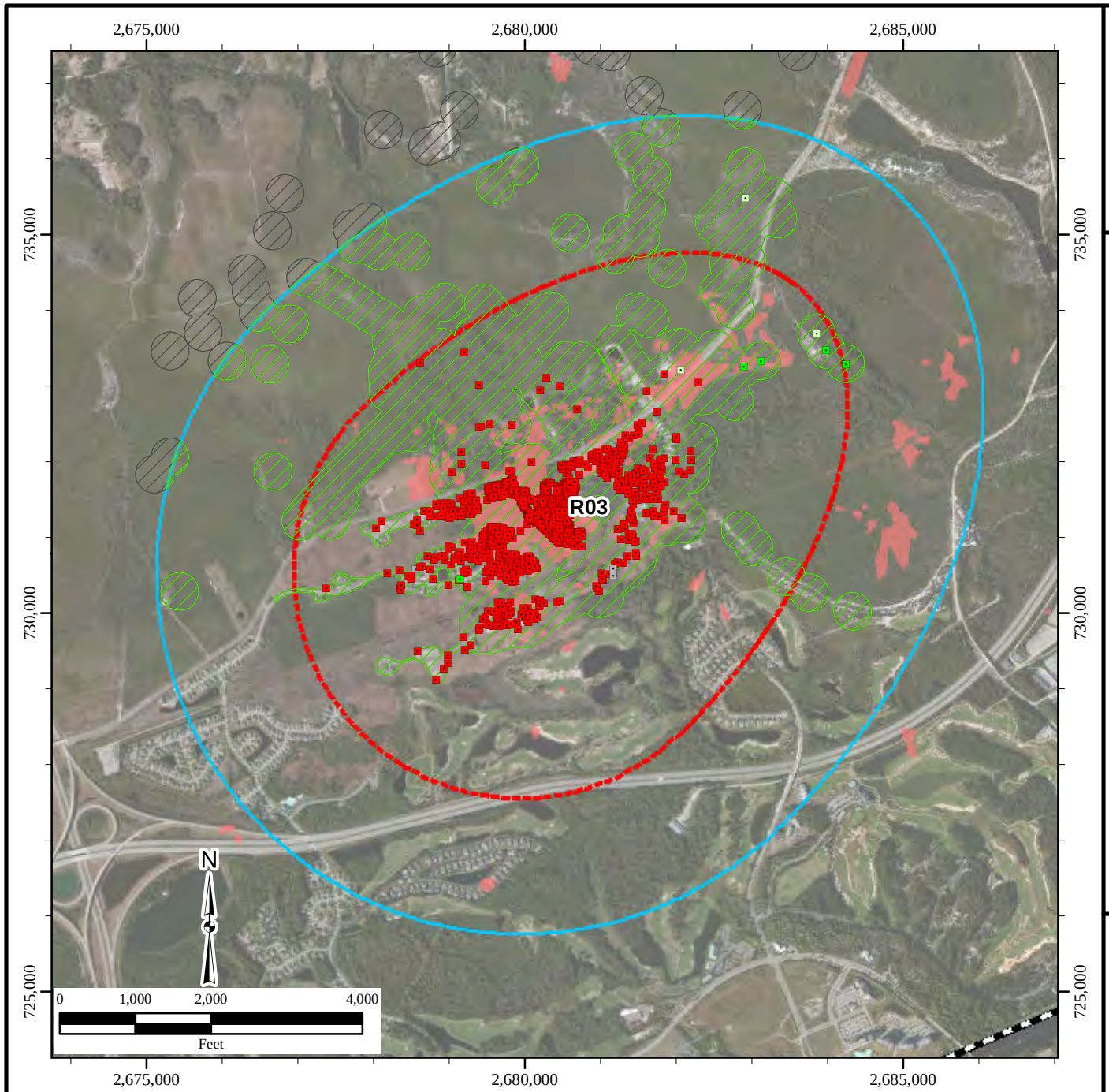

Figure B.8
MRS-R03
Range IV
Historical Information and Previous Investigation

Legend

- 100lb Bomb (1,386 Items)
- 2.75" Rocket (3 Items)
- 20lb Bomb (5 Items)
- 4lb Bomb (4 Items)
- Other (10 Items)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Previously Characterized Area within Investigation Area (570.8 acres)
- Previously Investigated Area
- Historical Use Area (103.0 acres)

Notes:
HGL considers it unlikely that munitions with HE filler are present within MRS-R03.
Coordinates in South Carolina Stateplane, NAD83, feet.
HE=high explosive
MRS=munitions response site

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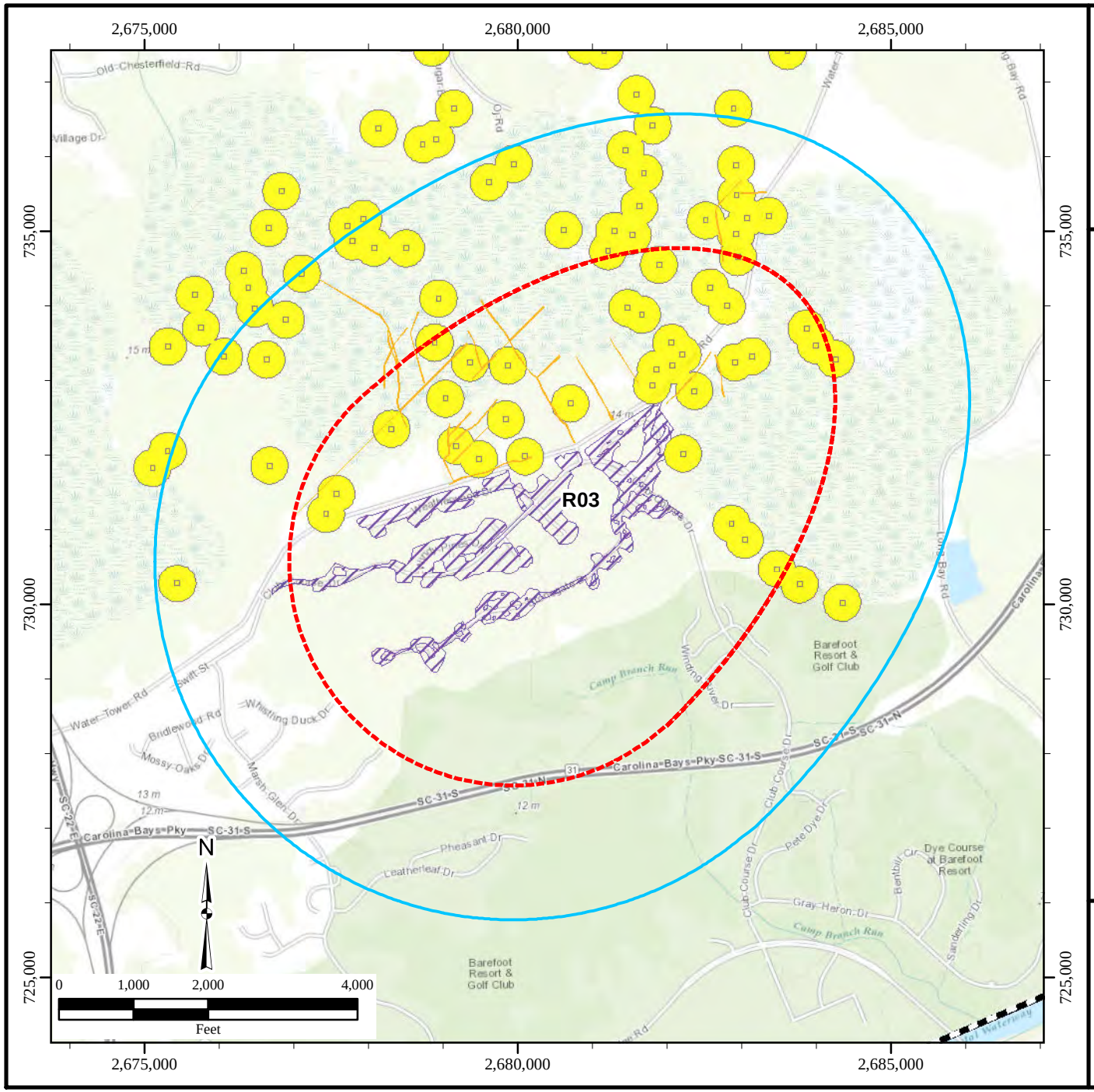

Figure B.8a
MRS-R03
Range IV Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- EODT, 2012 (Investigation)

Funded Privately

- USA Environmental for Centex 2005, (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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Source: HGL, USACE, Parsons, USA Environmental, EODT ArcGIS Online Topographic Imagery

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HGL—Work Plan—Former Conway Bombing and Gunnery Range, SC

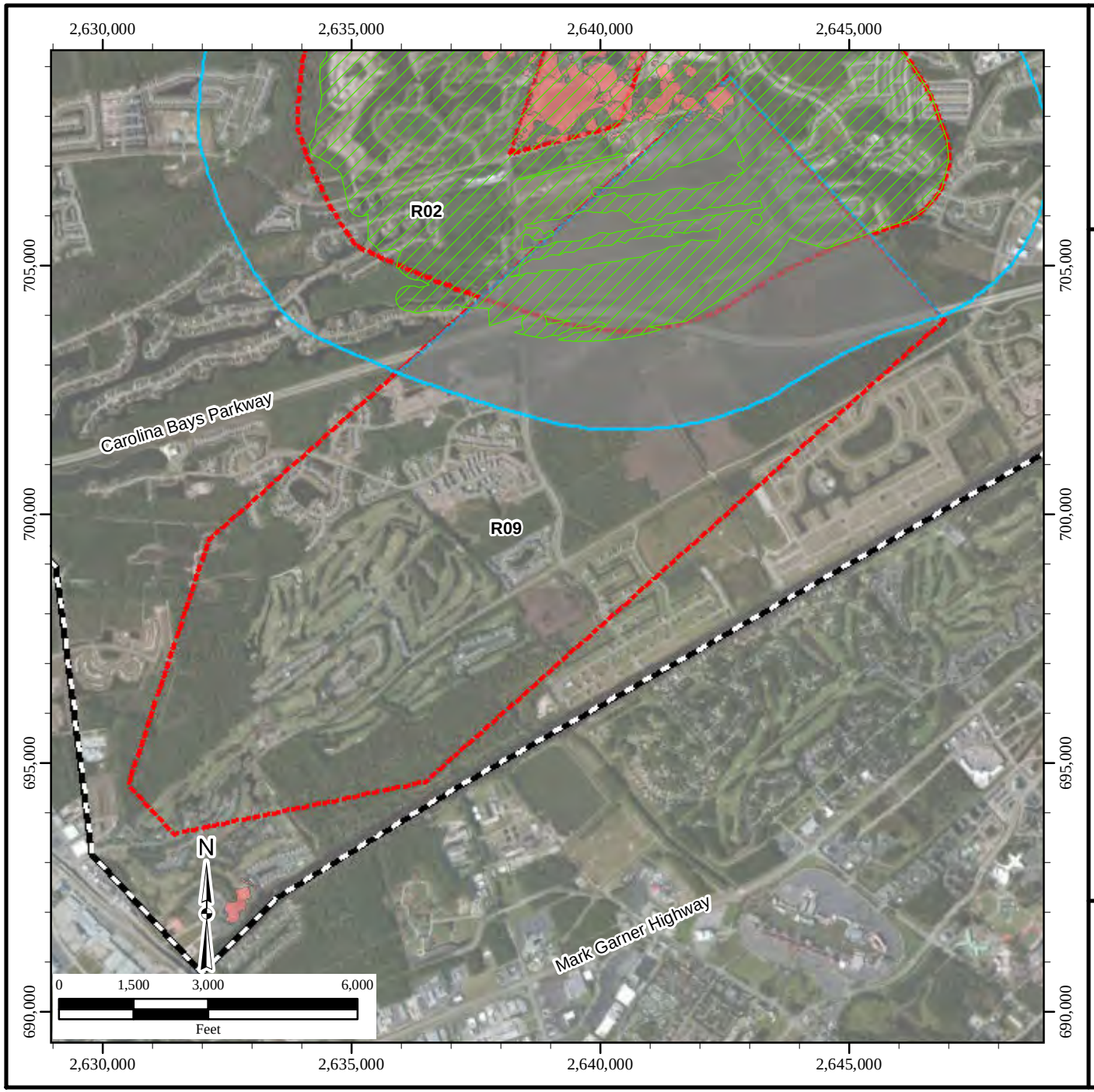

Figure B.9
MRS-R09
Machine Gun/Rifle Range
Historical Information and Previous Investigation

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Expanded Investigation Area
- Portion Investigated under MRS-R02 (905.2 Acres)
- Previously Investigated Area
- Historical Use Area

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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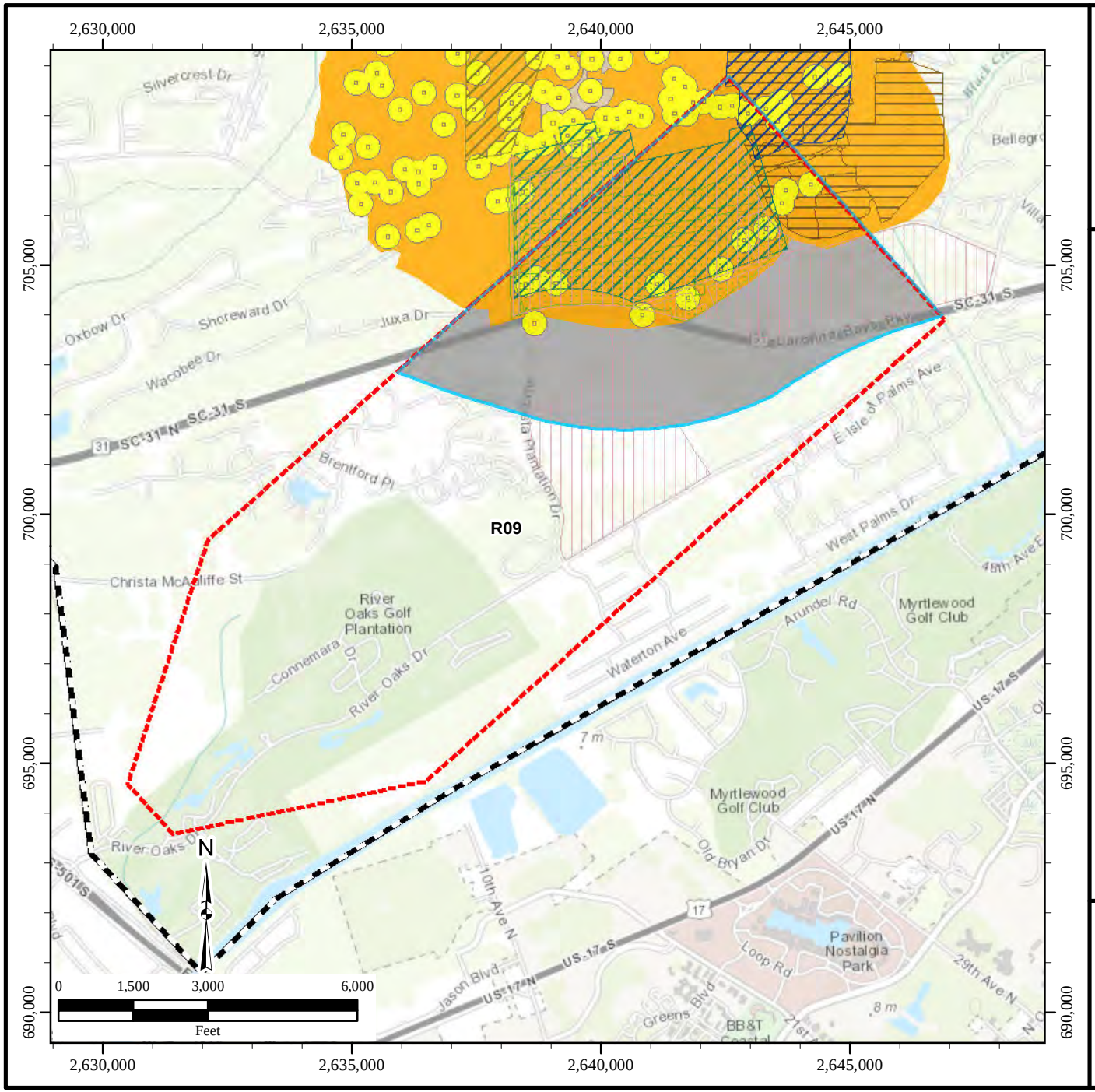

Figure B.9a
MRS-R09
Machine Gun/Rifle Range
Historical Work

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Funded by USACE

- Parsons, 2003 (Investigation)
- Parsons, 2003 (Removal)
- EODT, 2012 (Investigation)

Funded Privately

- ERM, 2005 (Removal)
- Kestrel, 2006 (Removal)
- Kestrel, 2007 (Removal)
- Kestrel, 2009 Advent, 2009 (Removal)
- Tetra Tech, 2006 (Removal)
- Landbank, 2001 (Removal)
- Sweet 16, LLC (Removal)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
MRS=munitions response site

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Source: HGL, USACE, Parsons, ERM, Kestrel, Tetra Tech ArcGIS Online Topographic Imagery

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Source		Interaction				Receptors													
						Current							Future						
Primary Source	Primary Release Mechanism	Secondary Source	Secondary Release Mechanism	Contaminated Medium	Exposure Route	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Resident	Biota	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Biota	Indoor Worker	Resident
MEC	Surface Soil			Surface Soil	Direct Contact	●	●	●	●	●	●	●	●	●	●	●	●	●	--	●
	Subsurface Soil			Subsurface Soil	Direct Contact	●	--	●	--	--	--	--	●	--	●	--	--	--	--	--

● Potentially Complete Exposure Route

-- Incomplete Exposure Route

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Exceeding Expectations

Figure B.10
Conceptual Site Model - MEC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

Source		Interaction				Receptors													
						Current							Future						
Primary Source	Primary Release Mechanism	Secondary Source	Secondary Release Mechanism	Contaminated Medium	Exposure Route	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Resident	Biota	Construction Worker	Outdoor Worker	Maintenance / Utility Worker	Trespasser	Recreational User / Hunter	Biota	Indoor Worker	Resident
MC (from MEC presence)	Erosion and Stormwater Runoff			Surface Soil	Incidental Ingestion	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
					Dermal Contact	●	●	●	●	●	●	--	●	●	●	●	●	--	--	●
				Sediment	Incidental Ingestion	--	--	--	●	●	●	●	--	--	--	●	●	●	--	●
					Dermal Contact	--	--	--	●	●	●	--	--	--	--	●	●	--	--	●
		Surface Soil	Bioaccumulation	Vegetation/Prey	Ingestion	--	--	--	--	●	●	●	--	--	--	--	●	●	--	●
		Surface Soil	Dust Emissions	Ambient Air	Inhalation	●	●	●	●	●	●	--	●	●	●	●	●	--	●	●
		Subsurface Soil		Subsurface Soil	Incidental Ingestion	●	--	●	--	--	--	--	●	--	●	--	--	--	--	--
					Dermal Contact	●	--	●	--	--	--	--	●	--	●	--	--	--	--	--
	Leaching			Groundwater	Ingestion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Dermal Contact	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Inhalation while Showering	--	--	--	--	--	--	--	--	--	--	--	--	--	--	●
					Direct Contact[1]	--	--	--	--	--	--	●	--	--	--	--	--	●	--	--

● Potentially Complete Exposure Route

-- Incomplete Exposure Route

Note: The composition of future surface soil (surface soil data or pooled surface/subsurface soil data) will be determined after evaluation of the soil data.

[1] If the shallow groundwater is sampled, potential effects to the transition zone community will be evaluated.

HydroGeoLogic, Inc
Exceeding Expectations

Figure B.11
Conceptual Site Model - MC Contamination
Current Site Conditions
Conway RI/FS; Multiple MRSs

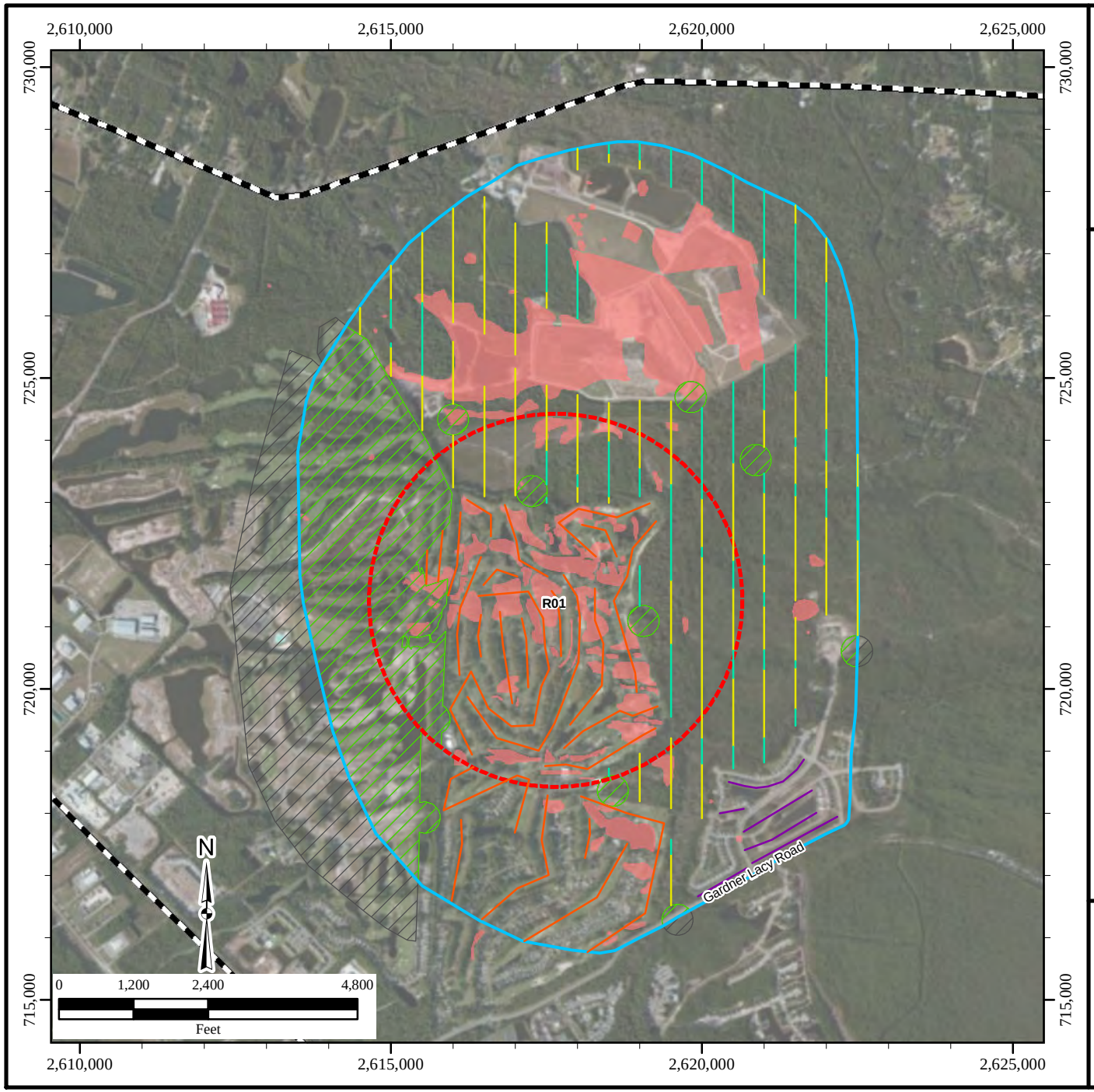

Figure B.14
MRS-R01
Range II
Field Activity

Legend

- Overland Transect (49,176.5 ft)
- Wetland Transect (25,715.2 ft)
- Golf Course Transect (49,176.5 ft)
- Residential Transect (6,816.6 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Previously Investigated Area within Investigation Area (362 acres)
- Previously Investigated Area
- Historical Use Area (318.6 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

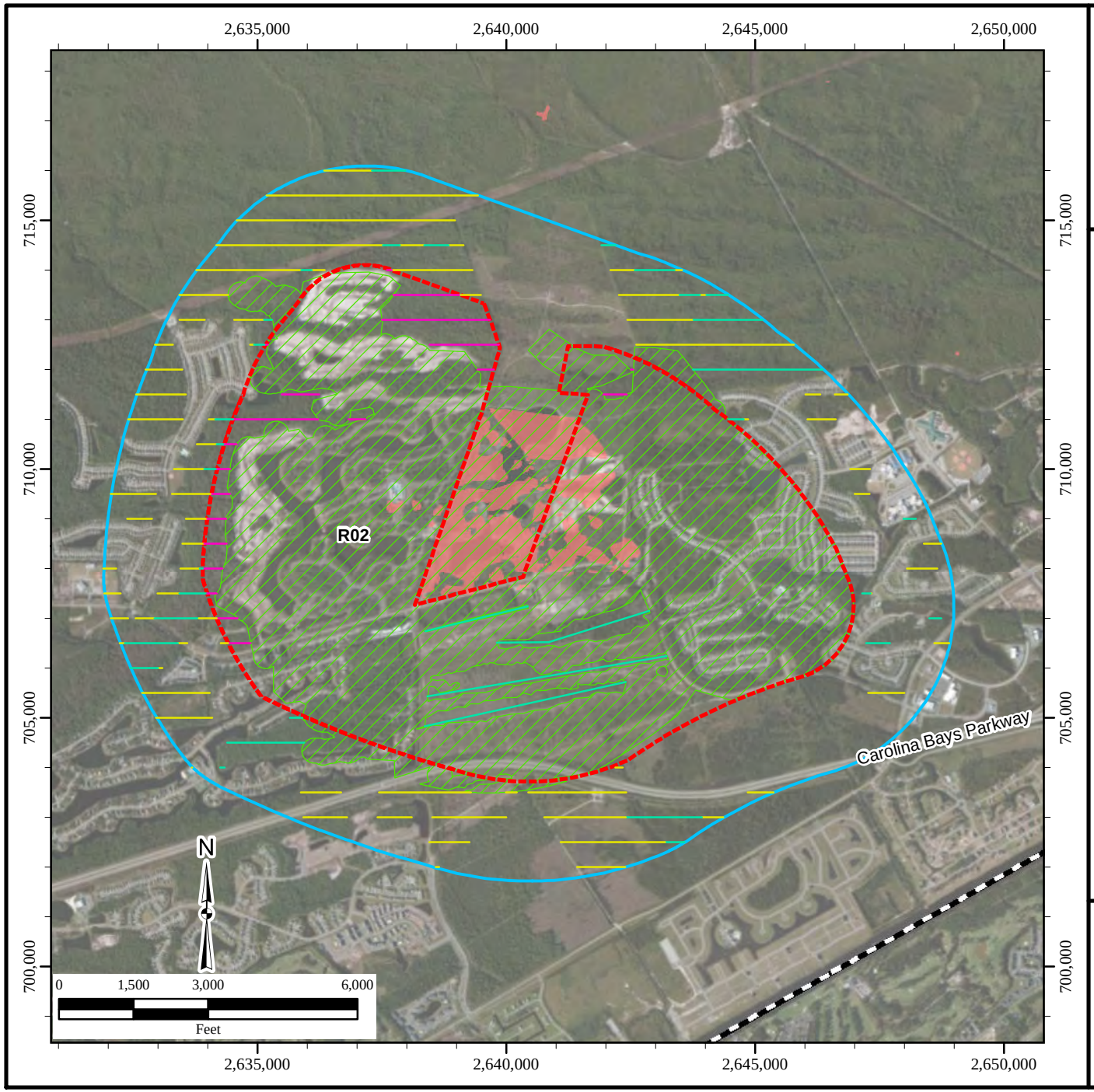

Figure B.15
MRS-R02
Range III
Field Activity

Legend

- Overland Transect (58,366.1 ft)
- Wetland Transect (31,513.7 ft)
- Mag and Dig Transect (11,893.2 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Previously Investigated Area (1,966.3. acres)
- Historical Use Area (165.6 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

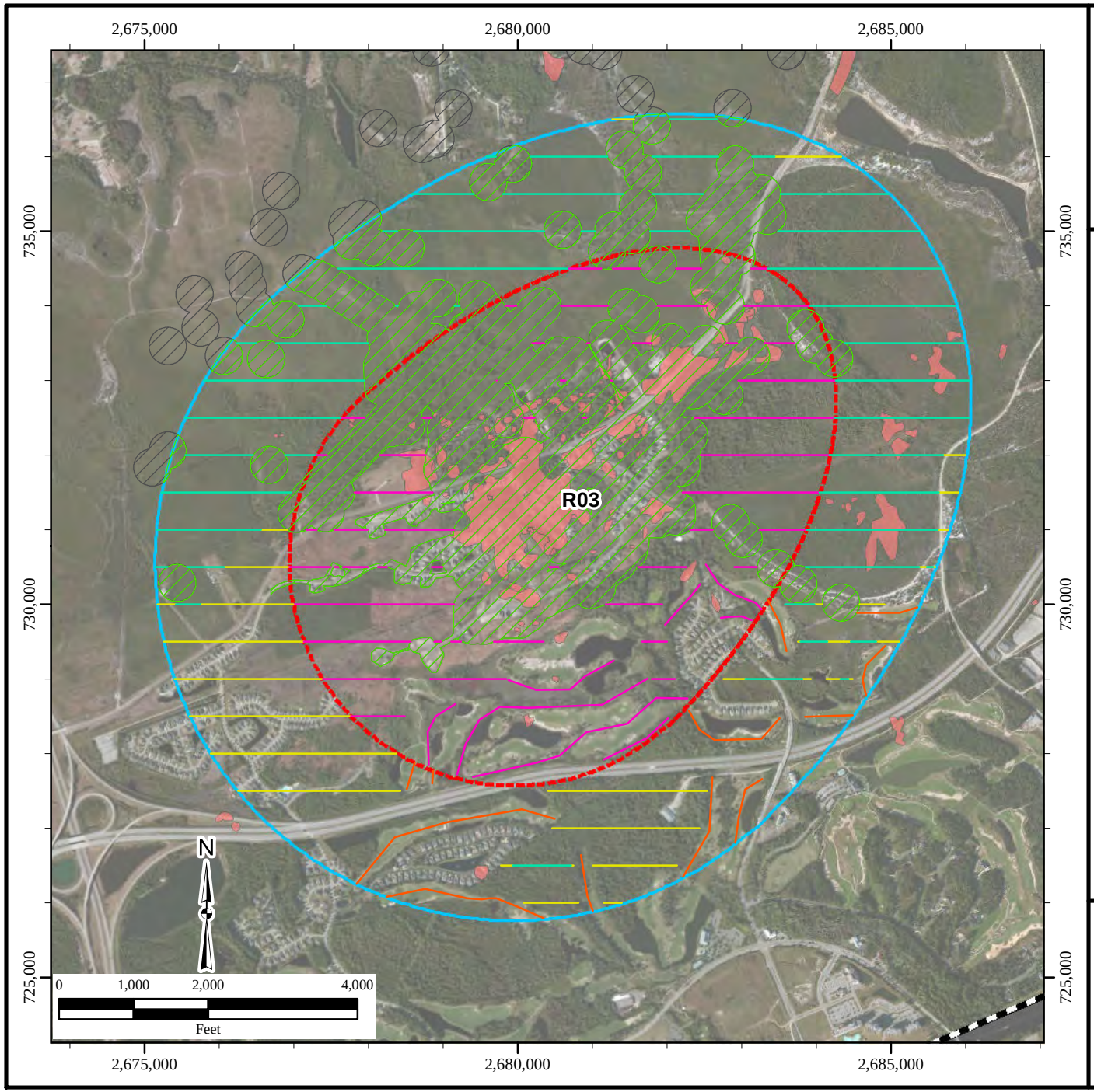

Figure B.16
MRS-R03
Range IV
Field Activity

Legend

- Overland Transect (23,532.8 ft)
- Wetland Transect (45,718.2 ft)
- Golf Course Transect (13,419.8 ft)
- Mag and Dig Transect (39,428.5 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Previously Investigated Area within Investigation Area (570.8 acres)
- Previously Investigated Area
- Historical Use Area (103.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

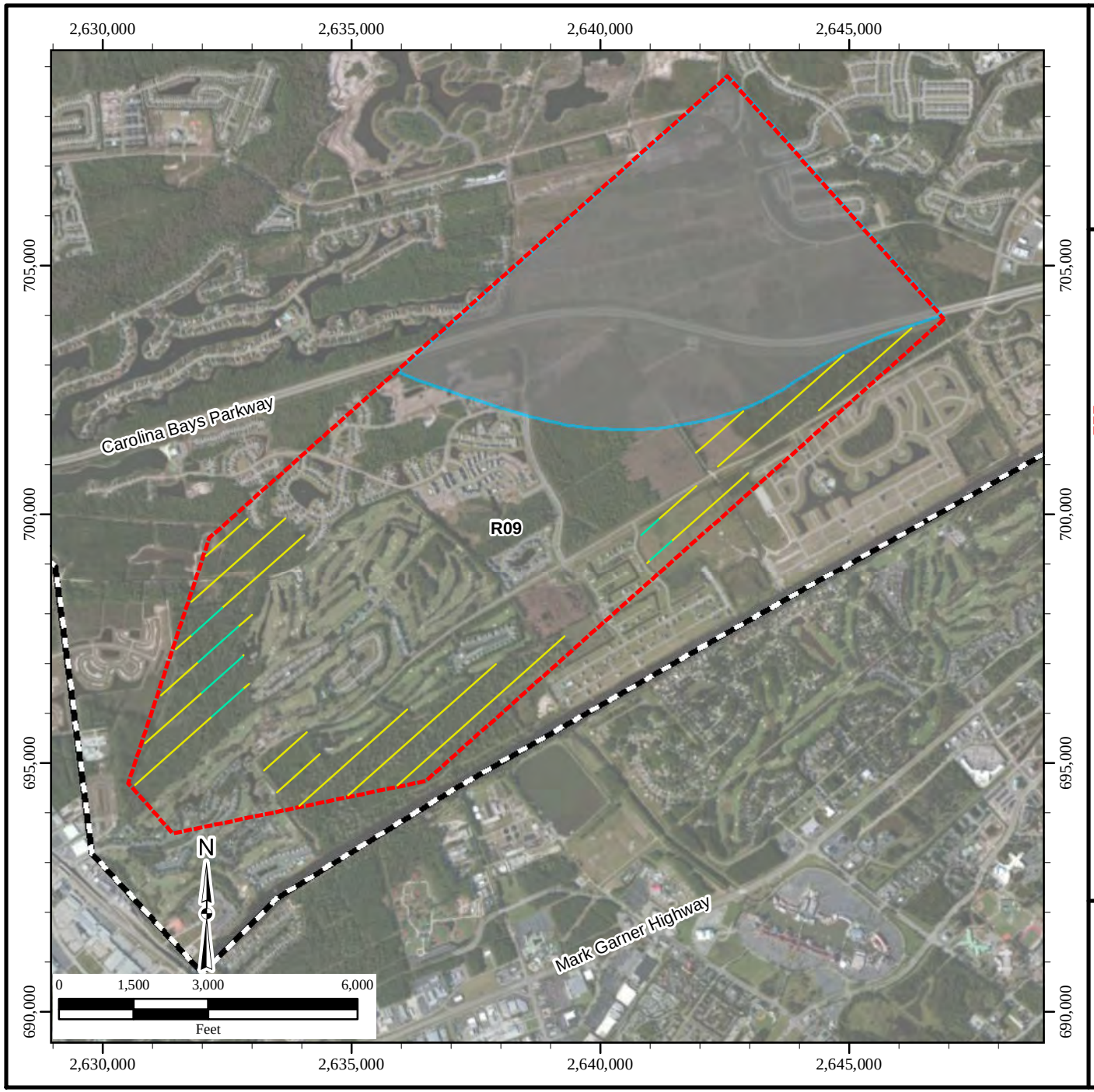

Figure B.17
MRS-R09
Machine Gun/Rifle Range
Field Activity

Legend

- Overland Transect (35,444.7 ft)
- Wetland Transect (4,873.3 ft)
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

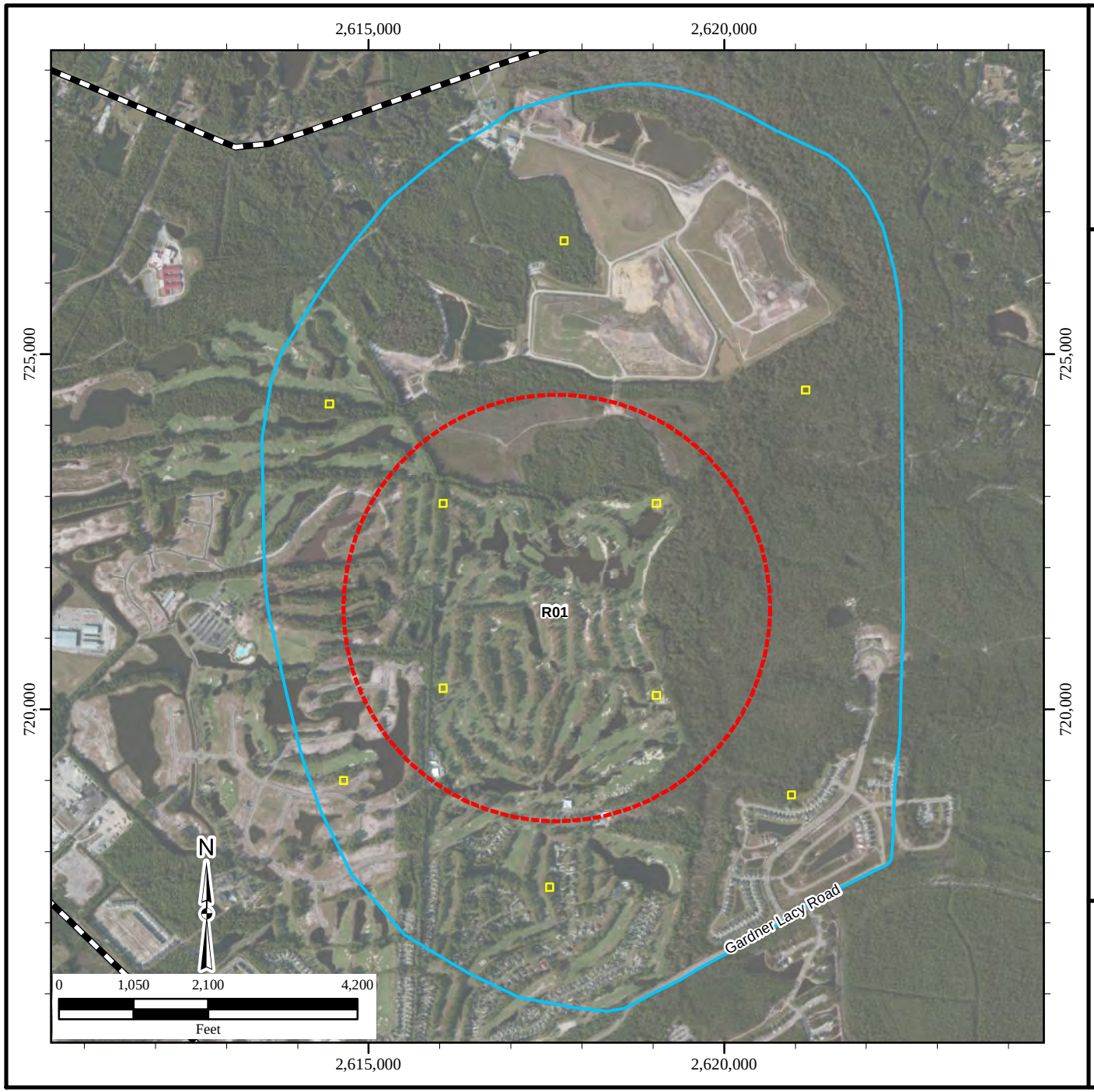

Figure B.18
MRS-R01
Range II
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

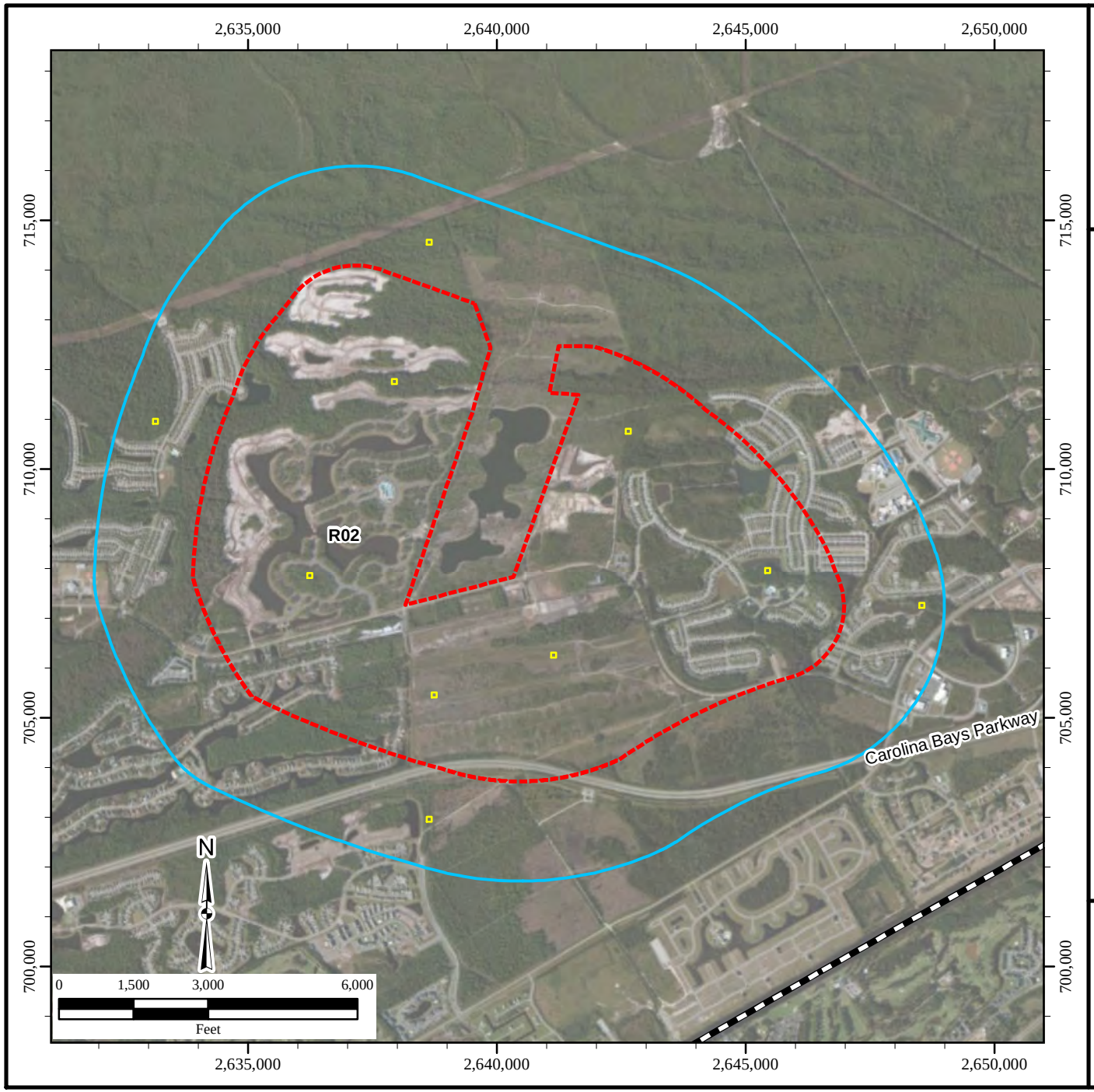

Figure B.19
MRS-R02
Range III
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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Source: HGL, USGS, USACE
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HydroGeoLogic, Inc

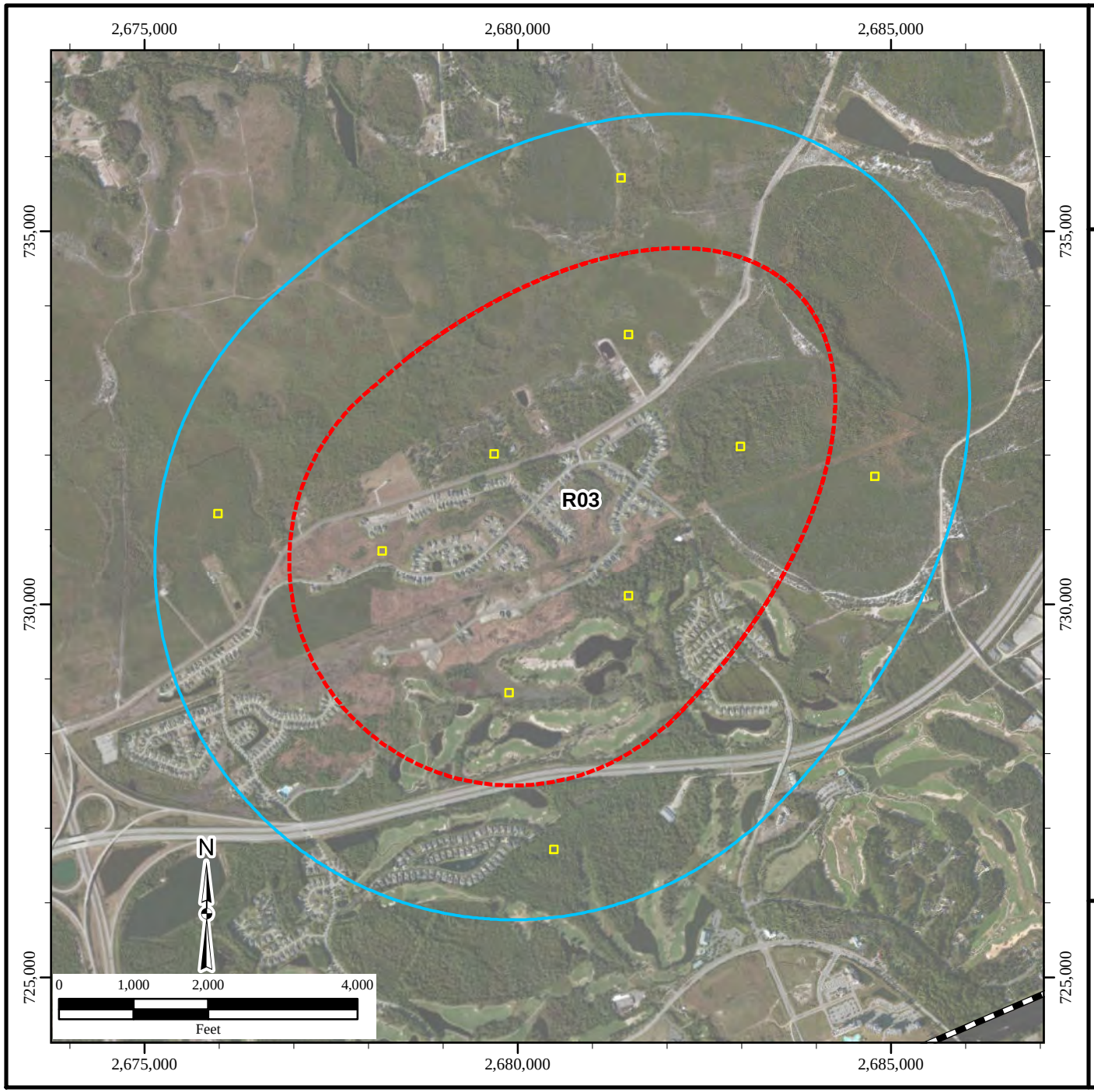

Figure B.20
MRS-R03
Range IV
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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Source: HGL, USGS, USACE ArcGIS Online World Imagery

HydroGeoLogic, Inc

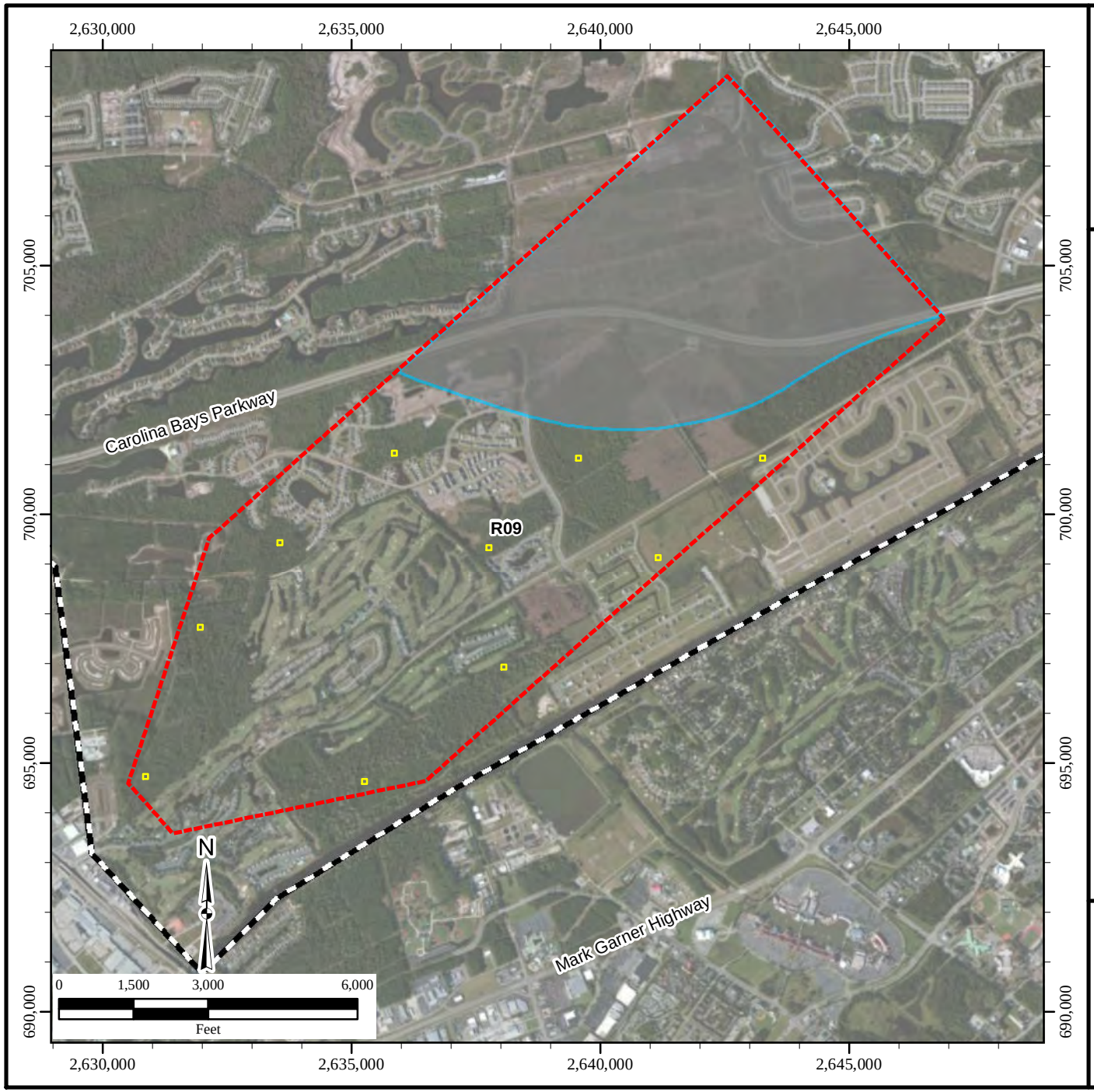

Figure B.21
MRS-R09
Machine Gun/Rifle Range
Proposed Phase 1
Surface Soil Location Map

Legend

- Potential Sampling Unit (SU) and Discrete Surface Soil Sample Location
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS-R02 (905.2 Acres)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.
Final soil sample locations will be selected based on geophysical and intrusive investigation results.

MRS=munitions response site

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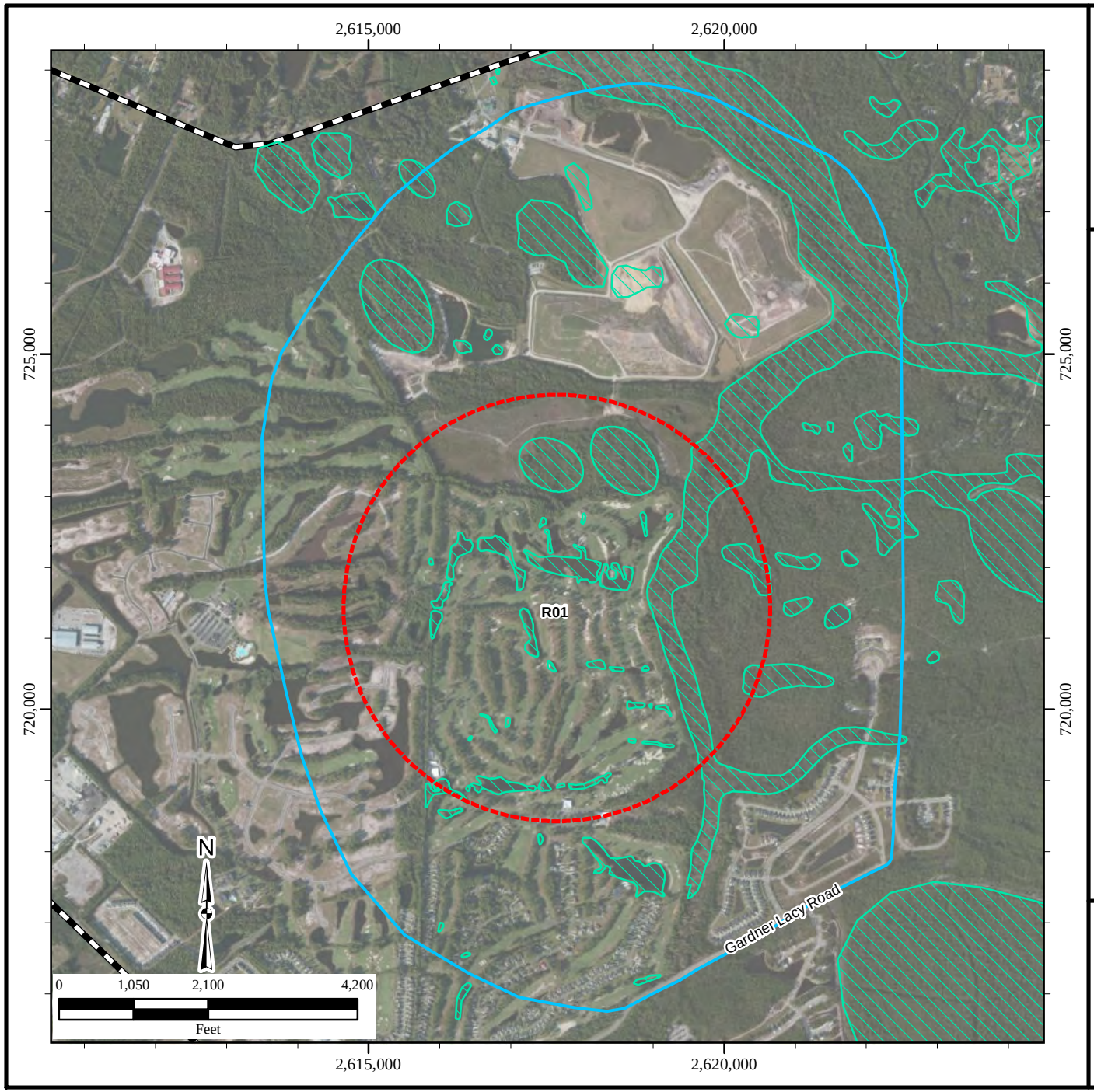

Figure B.22
MRS-R01
Range II Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (649.2 acres)
- Expanded Investigation Area (2,209.8 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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HydroGeoLogic, Inc

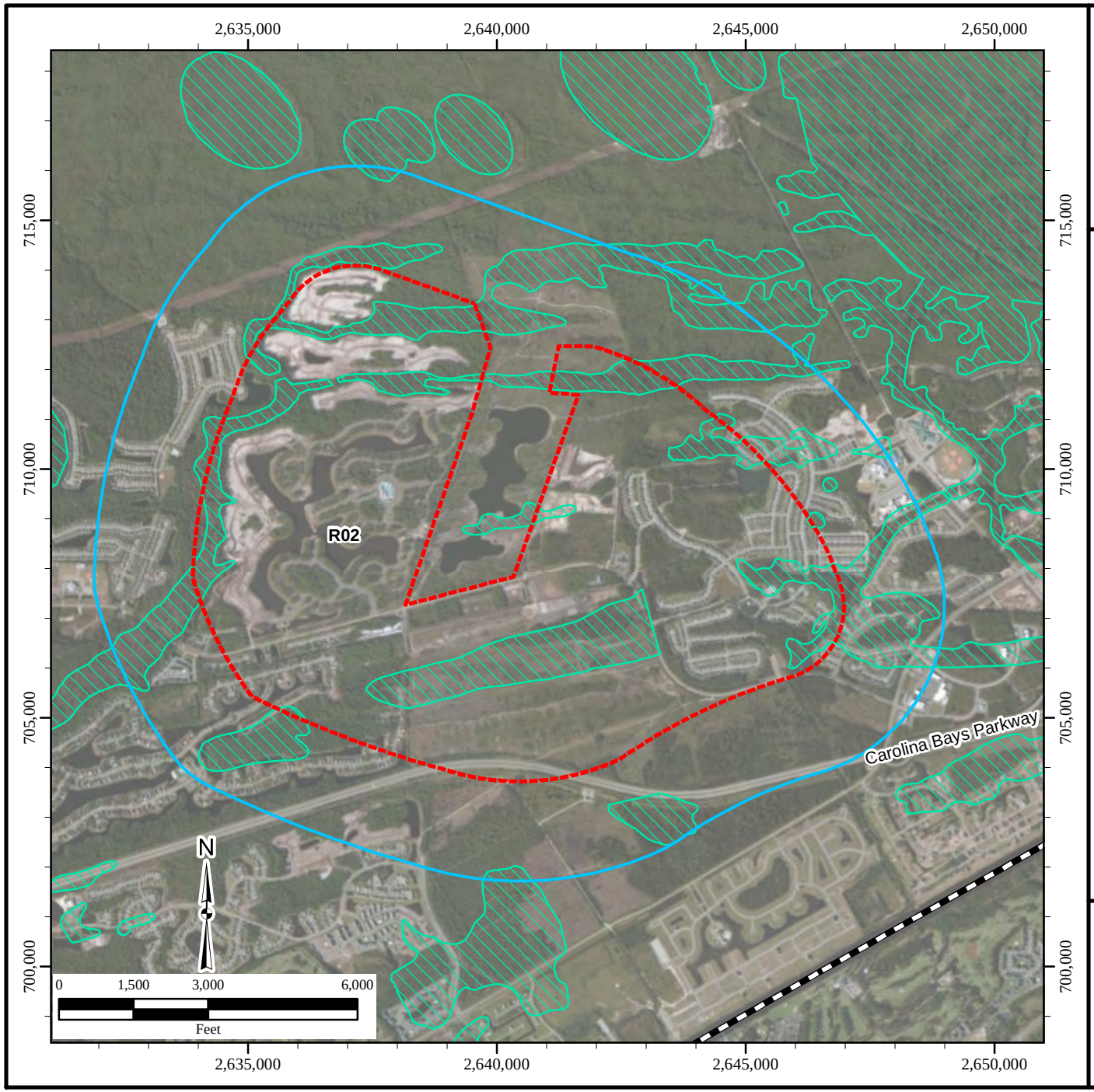

Figure B.23
MRS-R02
Range III Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (1,961.2 acres)
- Expanded Investigation Area (2,192.0 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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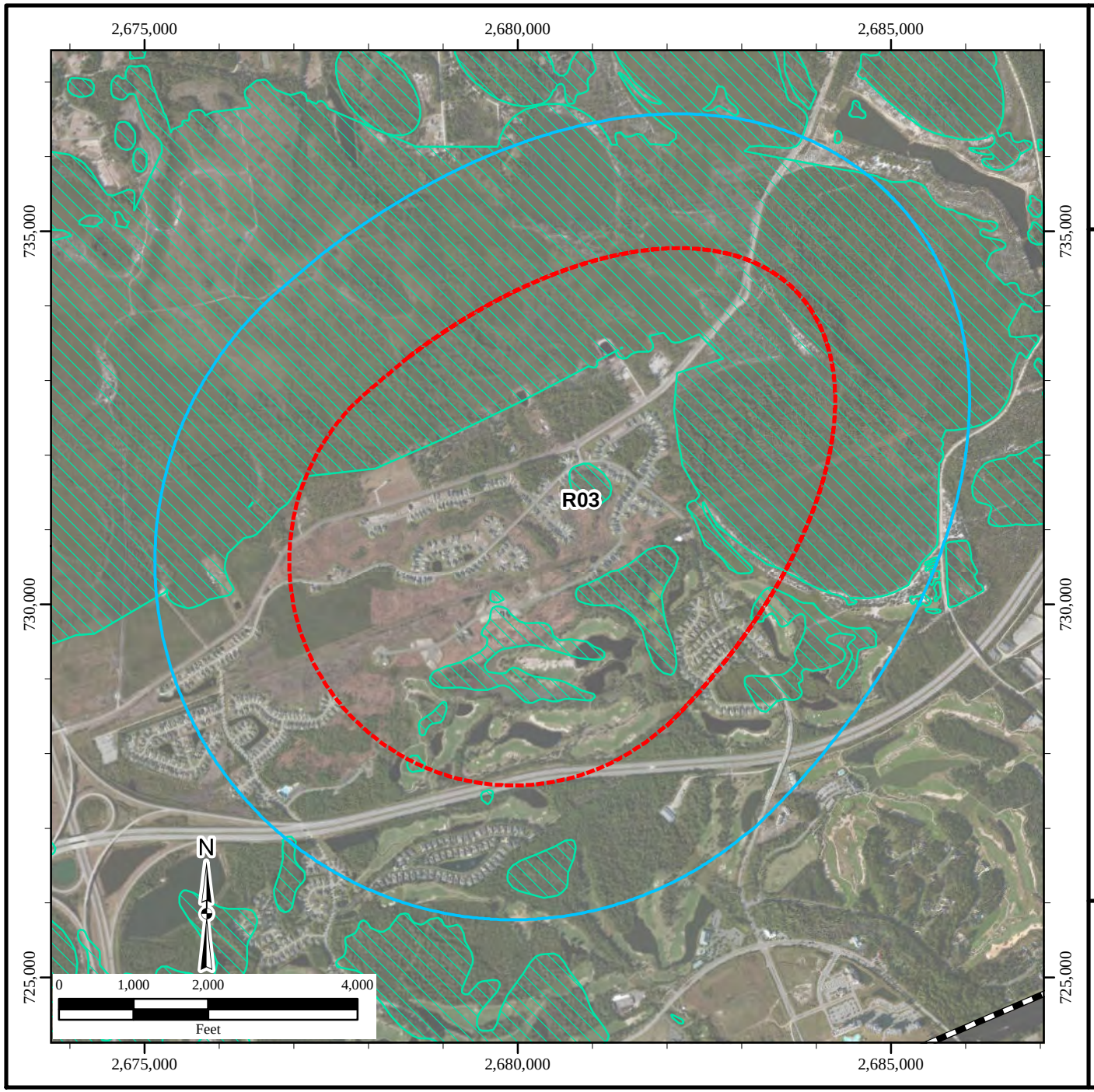

Figure B.24
MRS-R03
Range IV Wetlands

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (886.4 acres)
- Expanded Investigation Area (2,056.4 acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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(B-24)R03_Wetlands.mxd
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ArcGIS Online World Imagery

HGL

HydroGeoLogic, Inc

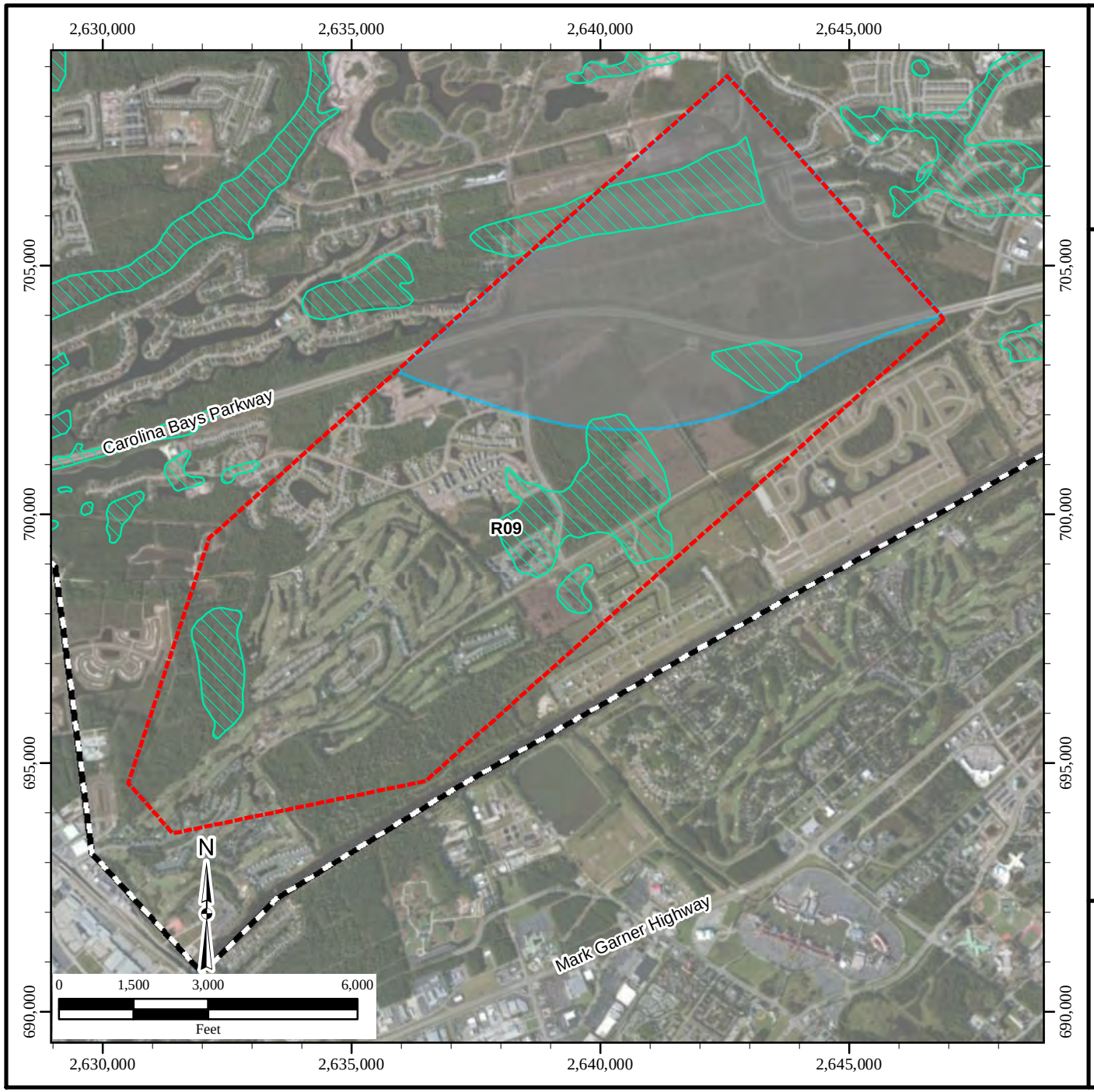

Figure B.25
MRS-R09
Machine Gun/Rifle Range
Location Map

Legend

- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site (2,503.2 acres)
- Portion Investigated under MRS R02 (905.2 Acres)
- Wetland

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

MRS=munitions response site

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4/2/2015 CNL
Source: HGL, USGS, USACE, NWI ArcGIS Online World Imagery

HydroGeoLogic, Inc

6.0 HISTORICAL REPORTS AND DATA

HGL has compiled a list of historical reports and data that was available and used to compile site history and technical approach.

Applicable MRS	Document Year	Document Month	Funding Source	Author	Developer (if applicable)	Complete Report	Document Title
All MRS	1995	09	USACE	USACE, Rock Island District	NA	Complete	Archives Search Report. Findings for the former Conway Bombing and Gunnery Range, Conway, South Carolina.
All MRS	1999	12	USACE	Prestige Court Reporting	NA	Complete	Meeting Minutes for the Former Conway Bombing and Gunnery Range Open House, North Myrtle Beach High School December 7, 1999.
All MRS	1999	12	USACE	Prestige Court Reporting	NA	Complete	Meeting Minutes for the Former Conway Bombing and Gunnery Range Open House, Carolina Forest Elementary School December 8, 1999.
All MRS	2000	04	USACE	Zapata	NA	Complete	Restoration Advisory Board Work Plan, Former Conway Bombing and Gunnery Range, Conway, South Carolina.
All MRS	2000	08	USACE	USACE, Charleston District	NA	Complete	Meeting Minutes for the Former Conway Bombing and Gunnery Range Open House, North Myrtle Beach High School August 1, 2000.
All MRS	2002	09	USACE	USACE	NA	Complete	EE/CA Public Review Meeting Minutes, Carolina Forest Elementary School, Mabry Court Reporting, September 12, 2002.
All MRS	2002	09	USACE	Mabry Court Reporting	NA	Complete	EE/CA Public Review Meeting Minutes, North Myrtle Beach High School, Mabry Court Reporting, September 13, 2002.
All MRS	2003	09	USACE	Parsons	NA	Complete	Final Engineering Evaluation/Cost Analysis (EE/CA) Conway Bombing and Gunnery Range, Conway, South Carolina
All MRS	2004	05	USACE	Parsons	NA	Complete	Engineering Evaluation and Cost Analysis, Final Action Memorandum. Former Conway Bombing and Gunnery Range. Horry County, South Carolina.
All MRS	2004	11	USACE	USACE Rock Island District	NA	Complete	Archives Search Report Supplement. Conway Bombing and Gunnery Range.
All MRS	2004	04	USACE	Prestige Court Reporting	NA	Complete	EE/CA Public Review Meeting Minutes, Carolina Forest Elementary School, Prestige Court Reporting. Tuesday, April 20.
All MRS	2004	04	USACE	Prestige Court Reporting	NA	Complete	EE/CA Public Review Meeting Minutes, North Myrtle Beach High School, Prestige Court Reporting, Wednesday, April 21.
All MRS	2009	12	USACE	EODT	NA	Complete	Draft Final Work Plan for the RI/FS at the Conway Bombing and Gunnery Range, Horry County, South Carolina

Applicable MRS	Document Year	Document Month	Funding Source	Author	Developer (if applicable)	Complete Report	Document Title
All MRS	2009	01	USACE	EODT	NA	Complete	Final Rev 02 - Technical Project Planning Memorandum and Associated Documentation in Support of Remedial Investigation/Feasibility Study for the Conway Bombing And Gunnery Range, Myrtle Beach, South Carolina.
All MRS	2009	06	USACE	EODT	NA	Complete	Explosives Site Plan, Former Conway Bombing and Gunnery Range, Ordnance and Explosives Removal Action for Remedial Investigation/Feasibility Study, Horry County, South Carolina.
All MRS	2009	01	USACE	EODT	NA	Complete	Final Rev 01 - Technical Project Planning Memorandum and Associated Documentation in Support of Remedial Investigation/Feasibility Study for the Conway Bombing And Gunnery Range, Myrtle Beach,
All MRS	2012	07	USACE	EODT	NA	Complete	Final Revision 01, Remedial Investigation, Former conway Bombing and Gunnery Range. Horry County, South Carolina
R01	2006	10	Private	EODT	Wild Wing Company, LLC	Complete Report	Interim Final Report for the UXO Clearance, Area A for Wild Wing Company, LLC Myrtle Beach, South Carolina. October.
R02	2002	12	USACE	Parsons	NA	Complete	Final Removal Report, Time Critical Removal Action, Conway Bombing And Gunnery Range, Conway, South Carolina.
R02	2003	10	Private	ERM	International Paper	Complete	Report of Phase I Geophysical Survey UXO Avoidance During Site Clearing Parcel 18 Safety Zone. October.
R02	2004	09	Private	ERM	International Paper	Text Only	Phase II Geophysical Survey Report Parcel 18, Areas B and B-1. Former Conway Bombing and Gunnery Range, Carolina Forest, South Carolina.
R02	2005	06	Private	ERM	International Paper	Text only	Phase II Geophysical Survey Report Parcel B Area U-1 of Tract 18 B of Safety Zone, Area B-1. June.
R02	2005	08	Private	ERM	International Paper	Text Only	Phase III Target Anomaly Removal Report, Parcel 22B of Safety Zone, Area B-1 within the Former Conway Bombing and Gunnery Range, Carolina Forest, South Carolina
R02	2005	06	Private	ERM	International	Text Only	Phase III Target Anomaly Removal Report Parcel B of Tract 18B of Safety and Target Zones, Areas B
R02	2006	08	USACE	Parsons	NA	Complete	Final MC Sampling, Analysis, and Evaluation of FUDS.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Magnetometer Survey/Ordnance Removal Phase I of the Farm at Carolina Forest.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Magnetometer Survey to Assess Subsurface Conditions Preliminary Phases II, III, IV, V, and VI of the Farm at Carolina Forest.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys Phases V, VI, and VIII (Lower) of the Farm at Carolina Forest
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys Phases VII and VIII.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys Extended Areas of Phases XI and XXIIIB.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys Phases XI, XII, and XXIIIA.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys Phases XV, XXIII (B, C, D), and XXV.

Applicable MRS	Document Year	Document Month	Funding Source	Author	Developer (if applicable)	Complete Report	Document Title
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys to Assess Parcel 22B Wetlands.
R02	2006	11	Private	Tetra Tech EM, Inc.	DR Horton	Complete	Final Report Geophysical Surveys to Assess Subsurface Conditions for the Continued Development of the Farm at Carolina Forest Phases XIII (A, B), XIV, XVI, and XXVI.
R02	2007	10	Private	Kestrel Horizons, GEL Geophysics,	Sweet 16 LLC/LandBank	Complete	Site Specific Final Report OE Investigation and Removal Former Conway Bombing and Gunnery Range III Areas B and B-1, Volume I. October.
R02	2007	10	Private	Kestrel Horizons, GEL Geophysics, EHSI, Thomas	Sweet 16 LLC/LandBank Fund V	Complete	Site Specific Final Report OE Investigation and Removal Former Conway Bombing and Gunnery Range III Areas B and B-1, Volume II. October.
R02	2008	09	Private	Kestrel Horizons, GEL Geophysics, EHSI, Thomas	LandBank Fund V, LLC and LandBank LLC	Complete	Site Specific Final Report OE Investigation and Removal Former Conway Bombing and Gunnery Range Portions of Carolina Forest Tract 9B, 10, 11, 15, Range III, and Area B-1
R02	2010	11	Private	ADVENT Environmental	Horry County Schools	Yes	Report for MEC Services, Berkshire Forest Tract - Conway, South Carolina. Horry County Schools Purchase Order (PO) 1000037138.
R03	2004	03	Private	USA Environmental	Centex	Complete	Phase I: Geophysical Survey of Barefoot Resort, Final Report
R03	2004	05	Private	USA	Centex	Complete	Phase II: Site Investigation Sampling and Characterization, Final Report Rev 01
R03	2005	12	Private	USA Environmental	Centex	Complete	Phase III: Site Investigation Sampling and Characterization, Final Report
R03	2006	02	Private	USA Environmental	Centex	Complete	Phase IV: Site Investigation and Sampling Characterization, Final Report
R03	2006	01	Private	ARCADIS	Centex	Figures missing	Summary of Environmental Conditions. Centex Property, Myrtle Beach, South Carolina
R04	2012	10	USACE	EODT	NA	Complete	Final Feasibility Study for MRS-R04 (Range VII), former Conway Bombing and Gunnery Range, Horry County, South Carolina.
R04	2013	03	USACE	Sterling Operations	NA	Yes	Draft Final Proposed Plan, MRS-R04 (Range VII), former Conway Bombing and Gunnery Range, Horry County, South Carolina.
R04	2014	04	USACE	Sterling Operations	NA	Yes	Final Proposed Plan, MRS-R04 (Range VII), former Conway Bombing and Gunnery Range, Horry County, South Carolina.
R04	2014	04	USACE	Sterling Operations	NA	Yes	Final Decision Document, MRS-R04 (Range VII), former Conway Bombing and Gunnery Range, Horry County, South Carolina.
All MRS	2010	12	USACE	EODT	NA		Public Involvement Plan, Remedial Investigation/Feasibility Study, Former Conway Bombing and Gunnery Range, Horry County, South Carolina.

APPENDIX I

STANDARD OPERATING PROCEDURES

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HGL HydroGeoLogic, Inc Exceeding Expectations	STANDARD OPERATING PROCEDURE
	Approved by:
Multi incremental sampling method	**SOP No.: 002**
	Revision No.: 0
	Revision Date: April 2014
	Review Date: April 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil samples by the incremental sampling method.

2.0 SCOPE AND APPLICATION

Soil samples will be collected using incremental sampling methodology (ISM) procedures and techniques in accordance with *Incremental Sampling Methodology Technical and Regulatory Guidance* (Interstate Technology & Regulatory Council, February 2012). The typical sampling unit (SU) size is anticipated to be no larger than 100 feet by 100 feet, although the size and shape of SUs may be adjusted with project team concurrence.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 METHOD

The incremental sampling method defines one or more SU to be sampled, from which multiple sample "increments" are then collected and composited into a single, representative incremental sample from each SU. The purpose of the incremental sampling method is to provide a more accurate measure of the mean concentration of contaminants in each SU by providing reproducible, scientifically defensible data. SUs will be project-specific and are set out in the work plan. While it is not necessary to record the location of each individual sample increment that are collected for an incremental sample, the four corners of each SU will be recorded using a GPS unit capable of sub-meter or better accuracy.

To ensure that all sample increments are collected without bias within the SU boundary, a systematic random sampling technique will be used. This technique is designed to collect the requisite number of sample increments at regularly spaced intervals across the entire SU, starting from a randomly selected point, and is intended to facilitate the collection of a representative multi-incremental sample from each SU. The steps in the process are described below:

- Designate the SU. The sample collection team will designate an incremental sampling collection grid within the SU. This collection grid may be all or part of the SU and will define the area within the SU boundaries that is both safe and accessible for sampling, as determined by the Sample Team Leader and the UXOSO. If the entire SU is both safe and accessible for sampling, the entire SU will be used as the collection grid. If the area of the sample collection grid is substantially different from the planned SU (e.g., bedrock exposure, developed/cultivated area, presence of man-made structure/road, etc.), GPS coordinates will be recorded to identify the perimeter of the sample collection grid.

- Determine Sampling Interval. Once the collection grid has been designated, the Sample Team Leader will determine the approximate interval at which sample increments will be collected. This interval will be designed to be regularly spaced throughout the collection grid (e.g., if 50 sample increments are being collected from a 100 feet by 100 feet collection grid, the sampling interval would be approximately 20 feet). The sampling interval for each SU will be recorded by the Sample Team Leader.

- Select Sample Collection Origin and Collect Sample Increments. Once the collection grid has been designated and the sample interval has been determined, the Sample Team Leader will randomly select the starting point for sample collection and begin the collection of individual sample increments throughout the designated collection grid, using the determined sampling interval and the collection methods described below. As described previously, the location of each individual sample increment will not be recorded. Each complete incremental sample will weigh between one and two kilograms.

The typical SU size is anticipated to be 100 feet by 100 feet. Additionally, the size of a SU may be adjusted to encompass range-related features but the total area will remain the same. Note that this will require the sample team to conduct a brief visual inspection of the area to be sampled prior to establishing each SU.

Prior to sample collection, all sample increment locations will be screened and approved with regard to potential subsurface anomalies by a UXO escort using a Schonstedt geophysical instrument. If detection is made of a subsurface anomaly, the sample will be taken from a nearby point that is cleared by the UXO escort.

Once the SU location has been established, the process for collecting each incremental sampling increment soil sample is as follows:

- A new pair of clean disposable latex or nitrile gloves will be donned by the sample team members at each SU.
- The same sampling tool will be used for all sample increments collected within the same SU (this includes sample increments for replicate incremental samples within the same SU). The sample tool will be designed not to discriminate in size, shape or concentration of particles collected for the range of particle sizes of interest.
- Each incremental sample will consist of the number of sample increments designated in the work plan collected from the top 2 inches of soil within each SU. It is very important to ensure that the sample increments collected from a single SU are of approximately equal weight. The same sampling tool may be used within the same SU; however a new tool (or decontaminated tool) must be used for a separate SU.
- The initial sample increment will be collected at a random location within the SU and then all other samples will be collected at the selected sample interval (see above) throughout the entire SU.
- Sample increments shall be collected in the same manner at each sample location.
- If chunks of explosive residue (raw high explosive) are present at a sample location, they will be marked/flagged and documented, and an alternative sampling site will be located.
- The collected soil will be placed in clean and certified plastic bags; the total weight of all the increments from each SU, regardless of the total number of sample increments collected, shall be at least 1 kilogram but no more than 2 kilograms.
- Once all sample increments have been collected, the bag will be sealed and sent to the analytical laboratory for processing and analysis for required parameter for each SU. The incremental sample preparation conducted by the laboratory includes drying and sieving for all analyses. The procedures are described in SW846 method 8330B. Processed soil will be ground for explosive analyses.
- The incremental samples will be collected in triplicate.
- The sampling tool will be decontaminated before being used to collect sample increments from additional DUs.

5.0 EQUIPMENT

The equipment required will include the CRREL* MULTI INCREMENT® Sampling Tool (CMIST). The use of specifically manufactured equipment intended for incremental sampling by the CRREL method is preferred. Sampling tools and equipment should be protected from contamination sources before sampling and decontaminated before and between sampling locations, as specified in SOP 2.01: Sampling Equipment Cleaning and Decontamination.

Package, label, and prepare samples for shipment in accordance with procedures listed in the work plan and SOP WAFB-0003, Sample Tracking.

Sampling Equipment Cleaning and Decontamination	SOP No.: 2.01 SOP Category: HTRW Revision No.: 1 Date: December 2010

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe decontamination methods and related issues involving the physical process of removing chemical and radioactive contaminants from sampling equipment.

2.0 SCOPE AND APPLICATIONS

This procedure is specifically applicable to decontaminating the surfaces of sampling equipment that come in direct contact with actual samples during sample collection and processing. This SOP describes the procedures to be followed to achieve effective decontamination as follows: (1) remove contaminants from contaminated surfaces, (2) minimize the spread of contamination to uncontaminated surfaces, (3) avoid any cross-contamination of samples, and (4) minimize personnel exposures. The intent is to accomplish the required level of decontamination while minimizing the generation of additional solid and liquid waste.

Other decontamination procedures may apply to a specific project; refer to the work plan for project-specific decontamination methods and schedules.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan. Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS

Deionized Water: Tap water treated by passing through a standard deionizing resin column. The deionized water should contain no heavy metals or other inorganic compounds (in other words,

compounds at or above analytical detection limits) as defined by a standard inductively coupled argon plasma spectrophotometer scan.

Equipment: Those items (variously referred to as "field equipment" or "sampling equipment") necessary to conduct sampling activities, but that do not directly contact the samples.

Laboratory Detergent: A standard brand of phosphate-free laboratory detergent, such as Liquinox®, or the equivalent.

Organic-Free Water: Tap water treated with activated carbon and deionizing units or water from a Milli-Q® system (or equivalent). This water should not contain pesticides, herbicides, extractable organic compounds, and less than 50 micrograms per liter of purgeable organic compounds as measured by a low-level gas chromatography/mass spectrometry scan. Organic-free water should be stored only in glass or Teflon® containers and dispensed from only glass, Teflon, or stainless steel containers.

Sampling Devices: Utensils and other implements that come into direct contact with samples during their collection and processing.

Solvent: Substance capable of dissolving other substances. Pesticide-grade isopropanol is the most common solvent used to decontaminate equipment. Using any other solvent must be justified and approved by the responsible project personnel and documented on the Daily Field Report forms or in the field logbooks.

Tap Water: Water from a tested and approved water system.

5.0 PROCEDURES

5.1 GENERAL

Decontamination of sampling devices will be performed in a designated decontamination area, removed from any sampling location. This designated area must also be in a location free of direct exposure to airborne and radiological surface contaminants, and downwind of the location where clean field equipment, clean sample devices, and sample containers are stored.

As a minimum, nitrile or equivalent gloves will be worn while decontaminating equipment. Safety glasses or goggles, uncoated Tyvek® coveralls, laboratory coat, or splash apron will be worn if justified by the contaminant concentration and potential adverse effects. If cleaning with steam or high-temperature water, a face shield, heavy-duty polyvinyl chloride (PVC) or equivalent gloves, coated Tyvek or equivalent coveralls will be worn. Ground-fault circuit interrupters will be used to supply power to any portable electrical equipment in the equipment decontamination area. Solvent rinsing will be conducted in an open, well-ventilated area or under a fume hood. No eating, smoking, drinking, chewing, or hand-to-mouth contact will be permitted during

decontamination activities. A 15-minute eyewash will be available within 100 feet if corrosive (concentrated acids or bases) decontamination fluids are used.

- Contaminated or dirty sampling devices/equipment should not be stored with clean (decontaminated) sampling devices/equipment.
- Clean, decontaminated sampling devices should be segregated from all other equipment and supplies.
- Paint or any other coatings must be removed from any part of a sampling device that may either contact a sample or may otherwise affect sample integrity. After such coatings are removed, the sampling device will then require decontamination by the appropriate method.
- The brushes used to clean sampling devices must not be of the wire-wrapped type.
- For any of the specific decontamination methods that may be used, the substitution of higher-grade water is permitted (for example, using organic-free water in place of deionized water). However, it must be noted that deionized water and organic-free water are less effective than tap water in rinsing away the detergent during the initial rinse.
- Decontaminated sampling devices and all filled and empty sample containers will be stored in locations that are protected from exposure to any contaminant.
- The method for decontaminating sampling devices and the exterior of sample containers that have been exposed to radioactive material is based on the material contaminated, the sample medium, the radiation levels, and the specific radionuclides to be removed.
- The release of decontaminated sampling devices and sample containers for unrestricted use is based on site-specific criteria. These site-specific criteria should be detailed in the project-specific work plan.
- Rags used during decontamination activities may become a hazardous waste and require segregation. Refer to the project work plans for hazardous waste disposal requirements.

5.2 DECONTAMINATION SCHEDULES

- Sampling devices must be decontaminated before being used in the field to prevent potential contamination of a sample.
- Sampling devices must be decontaminated between samples to prevent cross-contamination.
- Sampling devices must be decontaminated at the close of the sampling event before being taken off site.

- An acceptable alternative to cleaning and decontaminating sampling devices is using items cleaned or sterilized by the manufacturer that are discarded after use. Care must be exercised to ensure such previously cleaned or sterilized items do not retain residues of chemical or radioactive sterilizing agents that might interfere with analytical techniques.
- Whenever visible dirt, droplets of liquid, stains, or other extraneous materials are detected on the exterior of a sample container, the exterior surfaces must be decontaminated. This step should be performed before the container is placed in a sample cooler or shipping container.
- For sample containers used in controlled access areas, a more rigorous cleaning and/or radiation monitoring may be required before removal from the site. Refer to the project-specific work plan for details.

5.3 DECONTAMINATION METHODS

The following decontamination methods are examples of some of those most commonly used in field investigations. Note that the decontamination methods described in this section are for guidance only; the field operations manager will adjust decontamination practices to fit the sampling situation and applicable requirements.

- The exterior of sample containers This decontamination will be performed at the sample location before the sample container is placed in the sample cooler or shipping container as follows:
    - The exterior surfaces of the sample container must be wiped with disposable rags/toweling, or rinsed with deionized water.
    - If rinsing with deionized water, the exterior of the sample container must be wiped dry with disposable rags/toweling, or allowed to air dry.
    - All visible dirt, droplets of liquid, or other extraneous materials must be removed.
    - For containers used in controlled-access areas or where the sample media are difficult to remove (for example, sludge), a more rigorous cleaning and/or radiation monitoring may be required. Refer to the project-specific work plan for details.
- Decontaminating stainless steel, Teflon, or metal sampling devices used to collect samples for trace organic compounds and/or metals analyses:
    - Clean with a tap water and laboratory detergent solution. Use phosphate-free detergent, such as Liquinox or equivalent. Use a brush to remove particulate matter and surface film.
    - Rinse thoroughly with organic-free water.

- Rinse twice with solvent (pesticide-grade isopropanol).
- Allow to air dry for 24 hours, if possible.
- If it is not possible to air dry for 24 hours, then rinse twice with organic-free water and allow to air dry as long as possible.
- Wrap sampling devices with aluminum foil (with shiny side facing outward).

Note: When a sampling device is used to collect samples that contain oil, grease, or other hard-to-remove materials, it may be necessary to rinse the device several times with an approved solvent (one that meets the requirements of the work plan) before initiating decontamination. In extreme cases, it may be necessary to steam clean, brush, or sandblast the sampling device before using this decontamination method. If the sampling device cannot be adequately cleaned using the above means, it must be discarded.

- Decontaminating glass sampling devices used for the collection of samples for trace organic compounds and/or metals analyses
  - Wash thoroughly with laboratory detergent and hot water using a brush to remove any particulate matter or surface film.
  - Rinse thoroughly with hot tap water.
  - Rinse thoroughly with tap water.
  - Rinse twice with solvent and allow to air dry for at least 24 hours, if possible.
  - Wrap with aluminum foil (shiny side facing outward) to prevent contamination during storage and/or transport to the field.

Note: When a sampling device is used to collect samples that contain oil, grease, or other hard-to-remove materials, it may be necessary to rinse the device several times with an approved solvent (one that meets the requirements of the work plan) before initiating decontamination. In extreme cases, it may be necessary to steam clean, brush, or sandblast the sampling device before using this decontamination method. If the sampling device cannot be adequately cleaned using the above means, it must be discarded.

5.4 QUALITY CONTROL

The quality of the deionized and organic-free water used may be monitored by collecting samples in standard precleaned sample containers and submitting them to the laboratory for a standard inductively coupled plasma scan. Organic-free water should be submitted for low-level pesticide, herbicide, extractable, or purgeable compounds analyses, as appropriate.

The effectiveness of the decontamination procedures is monitored by submitting samples of rinse water to the laboratory for low-level analyses of the parameters of interest. An attempt should be made to select different sampling devices each time devices are decontaminated to ensure a representative sampling of all devices is obtained over the length of the project. Note on the Daily Field Report Form or in the field logbooks the devices being used for the rinsate samples.

6.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements specified in the work plan.

ATTACHMENTS

Below is Attachment 1, Field Checklist

ATTACHMENT 1
FIELD CHECKLIST

_____ Daily Field Report Forms or Field Logbooks	_____ Gloves
_____ Safety Glasses or Monogoggles	_____ Safety Shoes
_____ Black, Indelible Pen	_____ Plastic Sheeting
_____ Decontamination Equipment	_____ Health and Safety Plan
_____ Work Plan	_____ Monitoring Instruments
_____ Appropriate Containers for Waste and Equipment	

Hand-Operated Auger Soil Sampling	SOP No.: 2.03 SOP Category: HTRW Revision No.: 0 Date: December 2010

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the standard method and equipment used to collect soil samples at the surface or in shallow excavations using a hand auger.

2.0 SCOPE AND APPLICATION

This procedure yields a disturbed sample and applies to a wide variety of soil types including sands, clays, and silts. A hand auger is a small, lightweight metal auger. Diameters typically range between 1 and 4 inches. The use of an auger is of limited value in rocky soil. This procedure is not appropriate for collecting samples at a discrete depth, but may be used to collect samples at an approximate depth.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 EQUIPMENT

The equipment required may include hand-operated, spiral-type, ship-type, open-tubular, orchard-barrel, open-spiral, closed-spiral, post-hole, clamshell, or Iwan augers. Augers typically are used with 3- to 4-foot-long metal extension rods and T-handles. The use of stainless steel augers is preferred. Augers plated with chrome or coated with other materials, except Teflon®, must not be used.

Sampling tools and equipment should be protected from contamination sources before sampling and decontaminated before and between sampling locations, as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.

5.0 PROCEDURES

1. Don clean gloves. Using a decontaminated stainless steel spoon or other approved utensil, remove surface vegetation and debris from the immediate area around the marked sampling point.
2. Use plastic sheeting around work area, as necessary, to prevent equipment from coming in contact with potentially contaminated surfaces.
3. Record the appropriate information and observations about the sample location in the field logbook.
4. Assemble decontaminated auger, extension, and T-handle, if necessary, and advance the auger into the soil to the desired depth.
5. Withdraw the auger from the soil.
6. If a sample is not being collected, remove the soil from the auger and repeat Steps 4 and 5. If a sample is to be collected in the next boring, replace the auger bucket with a decontaminated bucket and repeat Steps 2 through 4.
7. Perform any field monitoring required in the health and safety plan.

If collecting samples for analyses other than volatile organic compound (VOC) analyses, refer to Steps 8 and 9.

8. Using a decontaminated stainless steel spoon, spatula, or disposable scoop, remove soil from the auger and place in a stainless steel bowl on a polyethylene sheet or a glass tray. Discard the top 2 or 3 inches of soil in the auger. Mix or composite soil as directed by the work plan. Using a decontaminated spoon or other approved utensil, remove any large rocks or other organic material (worms, grass, leaves, roots, etc.).
9. Using a decontaminated stainless steel spoon, spatula, or disposable scoop, as appropriate, place soil samples in compatible containers. Place samples in containers defined according to analytical needs specified in the work plan, label samples, and then (when appropriate) pack on ice as soon as possible. Skip to Step 11.

If collecting samples for VOC analysis, refer to Step 10.

10. Remove hand auger from boring. Fit a slide-hammer to the top of the appropriate number of extension rods to reach the total depth of the hole. Attach an impact sampler to the bottom of the extension rod(s) and drive the impact sampler into the soil to a depth of at least 6 inches. Remove the sampler from the borehole and immediately drive an Encore® sampler into the soil in the sampler, then remove the Encore sampler and immediately cap the sample. Collect as many Encore samples

as required by the work plan, label samples, and then (when appropriate) pack in ice as soon as possible

11. Package, label, and prepare samples for shipment in accordance with procedures listed in the work plan.

12. If changes in lithology are observed, consult the work plan.

Soil Sample Compositing	SOP No.: 2.04 SOP Category: HTRW Revision No.: 02 Date: April 15, 2009

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to outline methods that may be used for field compositing soil samples before they are submitted to an analytical laboratory.

2.0 SCOPE

This procedure applies to compositing soil. This procedure does not apply to sample collection, but rather to combining samples in preparation for submittal for testing. Samples for volatile organic compound analyses must NOT be composited.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

Solid material that is to be sampled must be mixed as thoroughly as possible before transferring to the sample container. Anomalous or suspected highly contaminated samples will be brought to the attention of the field manager.

- Solid material that is composited must meet the following requirements:
  - uniform collection techniques must be used to retrieve sample aliquots;
  - samples must be of equal or known proportion, and;
  - the material must be well mixed.
- The most common method of mixing (compositing) is referred to as quartering. The material in the pan is divided into quarters. Each quarter is mixed, and then all quarters are mixed into the center of the pan. This procedure is repeated

several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material over. Samples are homogenized before placing in containers, except for volatile organic analyses.

- Sampling tools, instruments, and equipment are protected from contamination sources before use and decontaminated after use as specified in SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.
- Composite samples will be packaged, labeled, and prepared for shipment in accordance with the work plan.
- The field logbook will be completed in accordance with procedures detailed in SOP 4.02: *Documentation – Field Logbook Entries*.

5.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements specified in the work plan.

- Document all field activities on a daily field activity report in accordance with procedures listed in SOP 4.01: *Documentation – Daily Field Activity Reports*.
- Complete the field logbook in accordance with procedures listed in SOP 4.02: *Documentation – Field Logbook Entries*.

Surface and Shallow Depth Soil Sampling	SOP No.: 2.13 SOP Category: HTRW Revision No.: 0 Date: December 2010

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the equipment and operations used for sampling surface and shallow depth soils. This procedure outlines the methods for soil sampling with routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the assigned project manager and the HydroGeoLogic, Inc. (HGL) Quality Assurance/Quality Control Manager.

2.0 SCOPE AND APPLICATIONS

The objective of surface and shallow depth soil sampling is to ascertain the nature and extent of soil contamination at a site. The data can be used to identify contaminant sources, evaluate potential threats to human health or the environment, to evaluate potential exposure pathways, or to calculate environmental risks. For the purposes of this SOP, soil is defined as all unconsolidated materials above bedrock; surface soils are those that occur 0 to 6 inches below ground surface; and shallow depth soils are soils located above the bedrock surface and from 6 inches to 2 feet below ground surface.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan. Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

4.1 SAMPLING EQUIPMENT

Typically equipment required for surface and shallow depth soil sampling equipment should be specified in the project field sampling plan or work plan. Equipment includes the following:

- stainless steel mixing bowl
- stainless steel trowels or spoons
- stainless steel hand auger
- stainless steel core sampler that uses stainless steel or Lexan® liners (optional)
- stainless steel shovel
- appropriate sample containers

4.2 DECONTAMINATION

Before initial use, and after each subsequent use, all nondedicated sampling equipment must be decontaminated using the procedures outlined in HGL SOP 2.01, *Sampling Equipment Cleaning and Decontamination*.

4.3 SAMPLING LOCATION/SITE SELECTION

Follow the sample design criteria outlined in the project plan for each sampling event. Relocate the sample sites when conditions dictate, such as when natural or artificial obstructions are present at the proposed sample location (such as boulders or asphalt). Document the actual sample locations on a topographic map or site sketch and photograph all sample locations.

4.4 SAMPLING APPROACHES

It is important to select an appropriate sampling approach for accurate characterization of site conditions. Before commencing any soil sampling program, it is necessary to establish appropriate measurement and system data quality objectives. Refer to the U.S. Environmental Protection Agency (EPA) Soil Sampling Quality Assurance User's Guide (EPA, 1989) for guidance in establishing data quality objectives, statistical sampling methodologies, and protocols for each of the sampling approaches. Each approach is defined below.

4.4.1 Judgmental or Biased Sampling

Judgmental or biased sampling is used primarily for documenting an observed release to a groundwater, surface water, air, or soil exposure pathway. This form of sampling is based on the subjective selection of sampling locations where contamination is most likely to be found. Locations are selected using pertinent historical site information and on-site investigation results.

There is no randomization associated with this sampling approach because samples are primarily collected at areas of suspected highest contaminant concentrations. Any statistical calculations based on the results of this sampling technique will be biased.

4.4.2 Random Sampling

Random sampling, used for the characterization of a heterogeneous non-stratified waste, involves arbitrary collection of samples within a defined area. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for random sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table, an example of which can be found in the text of any basic statistics book. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample. Refer to Attachment 1, Figure 1, for the random sampling approach.

4.4.3 Stratified Random Sampling

Stratified random sampling, used for the characterization of a heterogeneous stratified waste, involves arbitrary collection of samples within a defined area and strata. This method is most effective and accurate if the chemical heterogeneity of the waste remains constant from batch to batch. The easiest method for stratified random sampling is to divide the area for sampling into an imaginary grid, assign a series of numbers to the units of the grid, and select the numbers or units to be sampled through the use of a random-numbers table, an example of which can be found in the text of any basic statistics book. A random sample is then collected from each stratum at the selected numbers or units on the grid. Note that haphazardly selecting sample numbers or units is not a suitable substitute for a randomly selected sample. Refer to Attachment 2.13-1, Figure 1, for the random sampling approach. Attachment 1, Figure 2, illustrates a stratified random sampling approach.

4.4.4 Systematic Grid Sampling

Systematic grid sampling involves dividing the area of concern into smaller sampling areas using a square or triangular grid. Samples are then collected from the intersection of the grid lines or "nodes." Grid placement should be selected by using an initial random point. The distance between nodes depends on the size of the site or area of concern and the number of samples to be collected. Generally, a larger distance is used for a large area of concern. Refer to Attachment 1, Figure 3, for the systematic grid sampling approach.

4.4.5 Systematic Random Sampling

Systematic random sampling involves dividing the area of concern into smaller sampling areas. Samples are collected within each individual grid cell using random selection procedures. Attachment 1, Figure 4, illustrates a systematic random sampling approach.

4.4.6 Search Sampling

Search sampling utilizes a systematic grid or systematic random sampling approach to define areas where contaminants exceed cleanup criteria. The distance between the grid lines and number of

samples to be collected depend on the acceptable level of error (that is, the chance of missing a hot spot). This sampling approach requires that assumptions be made regarding the size, shape, and depth of hot spots. Attachment 1, Figure 5, illustrates a search sampling approach.

4.4.7 Transect Sampling

Transect sampling involves establishing one or more transect lines, parallel or non-parallel, across the area of concern. If the lines are parallel, this sampling approach is similar to systematic grid sampling. The advantage of transect sampling over systematic grid sampling is the relative ease of establishing and relocating transect lines versus an entire grid. Samples are collected at regular intervals along the transect line at the surface and/or at a specified depth(s). The distance between the sample locations is determined by the length of the line and the number of samples to be collected. Refer to Attachment 1, Figure 6, for the transect sampling approach.

4.5 GENERAL

All boreholes and pits will be filled in with the material removed during sampling unless otherwise specified in the project plan. Where a vegetative turf has been established, fill in with native soil or potting soil and replace the turf if practical in all holes or trenches when sampling is completed.

4.5.1 Homogenizing Samples

Homogenizing is the mixing of a sample to provide a uniform distribution of the contaminants. Proper homogenization ensures that the containerized samples are representative of the total soil sample collected. All samples to be composited or split should be homogenized after all aliquots have been combined. **Do not homogenize (mix or stir) samples for volatile compound analysis.**

4.5.2 Compositing Samples

Compositing is the process of physically combining and homogenizing several individual soil aliquots of the same volume or weight. Compositing samples provide an average concentration of contaminants over a certain number of sampling points. Refer to HGL SOP 2.04 *Soil Sample Compositing*.

4.5.3 Splitting Samples

Splitting samples is performed when multiple portions of the same samples must be analyzed separately. After preparation, fill the sample containers for the same analyses one after another in a consistent manner (parent sample for volatile organic compounds [VOCs], then split samples for VOCs; parent sample for semivolatile organic compounds [SVOCs], then split sample for SVOCs, and so forth).

4.6 SURFACE SOIL SAMPLING

Perform the following steps for surface soil sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel of disposable sampling spoon.
- Label the lid of the sample container with an indelible pen or affix the sample label to the side of the jar. Tape over the label to seal out dirt and water before filling the container with soil.
- Collect surface soil samples with a decontaminated stainless steel trowel, spoon, or hand auger and transfer them to a decontaminated stainless steel bowl for homogenizing. If VOC analyses are to be conducted, fill the appropriate VOC sample containers and then proceed to transfer the appropriate aliquot of soil to the decontaminated stainless steel bowl for homogenizing.
- Collect samples in the order of volatilization sensitivity. The most common collection order is as follows:
    - VOC
    - purgeable organic carbon
    - purgeable organic halogens
    - total organic halogens
    - total organic carbon
    - extractable organics
    - total metals
    - phenols
    - cyanide
    - radionuclides
- Immediately transfer the sample into a container appropriate to the analysis being performed.
- Place the samples in a cooler with ice. The temperature in the cooler must be maintained at approximately 4 degrees Celsius (EC) (if appropriate for analyses) for transport to an analytical laboratory.
- Place all excess soil sample media in the soil boring or pit and fill it to grade with native soil or potting soil.
- Decontaminate all sampling equipment (HGL SOP 2.01, *Sampling Equipment Cleaning and Decontamination*).

4.7 SURFACE SOIL SAMPLING (COMPOSITE SAMPLES ONLY)

Perform the following steps for surface soil (composite) sampling:

- Before sampling, remove leaves, grass, and surface debris from the area using a decontaminated stainless steel trowel.
- Collect surface soil aliquots with a decontaminated stainless steel spoon, trowel, or hand auger and add to a stainless steel bowl and homogenize. Before homogenizing, remove an aliquot for VOC analysis (if appropriate) and then homogenize in accordance with HGL SOP 2.04 *Soil Sample Compositing*.
- Label the sample container and ice to 4 EC. Complete the chain of custody record and pack in the sample cooler.
- Decontaminate all nondedicated sampling equipment (HGL SOP 2.01, *Sampling Equipment Cleaning and Decontamination*).

4.8 SHALLOW DEPTH SOIL SAMPLING

Perform the following steps to collect shallow depth soil samples:

- Use a decontaminated stainless steel shovel to remove the top layer of soil and leaves, grass, and surface debris.
- Excavate soil to the pre-determined sampling depth by using a decontaminated hand auger. Periodically remove the cuttings from the auger.
- When the proper sample depth is reached, remove the hand auger and all cuttings from the hole.
- Lower the decontaminated core sampler or hand auger to the bottom of the hole. When using a core sampler, it must contain a decontaminated liner appropriate for the constituents to be analyzed.
- Mark the sample interval on the hammer stem or auger.
- Operate the slide hammer on the core sampler to drive the sampler head into the soil, or advance the auger until it is flush with the interval mark at ground level.
- Record weight of hammer, length of slide, blow counts, and geologic soil data for all samples collected with a core sampler in the field logbook as outlined in HGL SOP 4.07, *Field Logbook Use and Maintenance*. This information may also be entered on Attachment 2, Surface/Shallow Soil Sampling Log.
- When the core sampler liner or auger has been advanced to the total depth of the required sample, remove it from the bottom of the hole.
- Immediately remove the liner from the core sampler and transfer the sample into a container or stainless steel bowl for compositing and homogenizing as specified in the project-specific field sampling plan appropriate to the analysis being performed using a stainless steel spoon or trowel. Before compositing and homogenizing, fill the appropriate

aliquot for VOC analysis (if conducted) and then composite and homogenize in accordance with HGL SOP *Soil Sample Compositing*.

- Label the sample container and preserve it on ice to 4 EC. Complete the chain of custody record and pack in the sample cooler.
- Decontaminate all sampling nondedicated equipment (HGL SOP 2.01, *Sampling Equipment Cleaning and Decontamination*).

4.9 ABANDONMENT PROCEDURES

Abandon boreholes and fill to grade with the material removed for sampling or clean fill.

5.0 DOCUMENTATION

Record applicable sampling information in the field logbook as outlined in HGL SOP 4.07, *Field Logbook Use and Maintenance*. This information can also be entered on Attachment 2, Surface/Shallow Soil Sampling Log.

The project manager or an approved designee shall check all field sheets and field logbooks used to record information during sampling for completeness and accuracy. Any discrepancies will be noted, and the documents will be returned to the originator for correction. The reviewer will acknowledge that these review comments have been incorporated by signing and dating the "checked by" and "date" blanks on the field sheets and at the applicable places in the logbook.

6.0 REFERENCES

U.S. Environmental Protection Agency. 1989. "Soil Sampling Quality Assurance User's Guide." EPA/600/8-89/046, Washington, DC.

ATTACHMENTS

Attachment 1 Figures for Different Forms of Grid Sampling
Attachment 2 Surface/Shallow Soil Sampling Log

ATTACHMENT 1
Figures for Different Forms of Grid Sampling

Soil Sampling

Figure 1: Random Sampling**

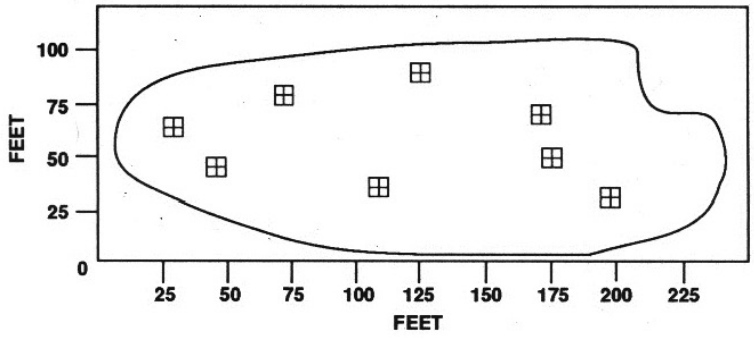


Figure 2: Stratified Random Sampling

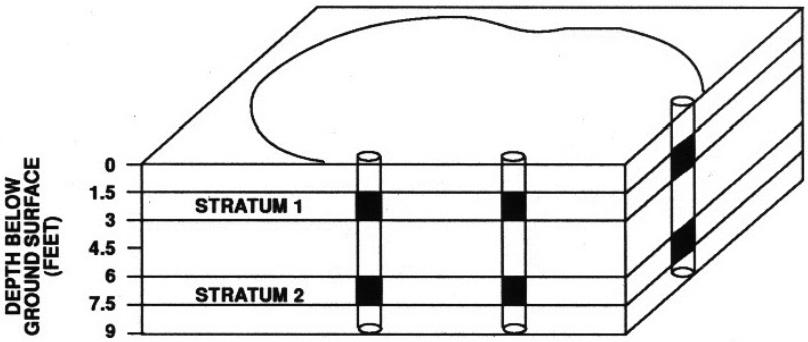
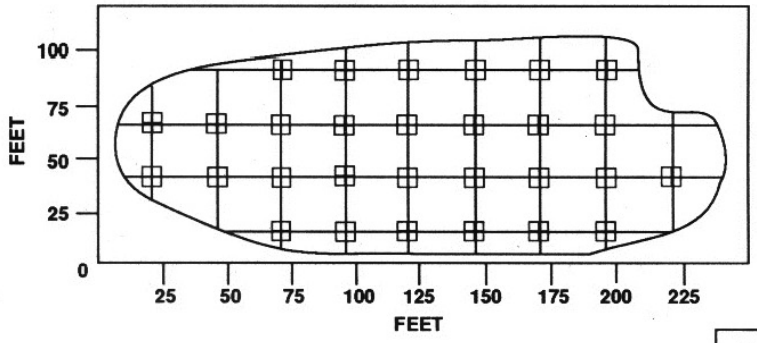
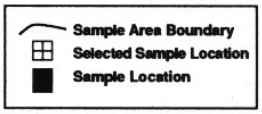


Figure 3: Systematic Grid Sampling**





** After U.S. EPA, February, 1989

ATTACHMENT 1 (Continued)
Figures for Different Forms of Grid Sampling

Soil Sampling

Figure 4: Systematic Random Sampling

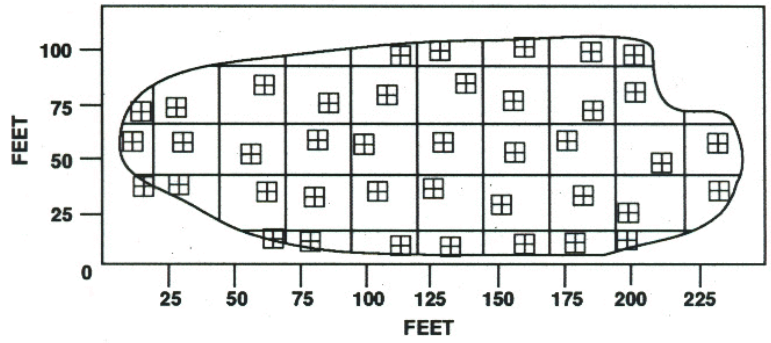


Figure 5: Search Sampling

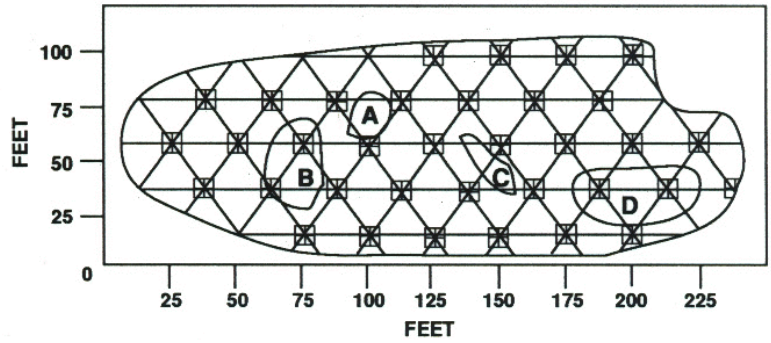
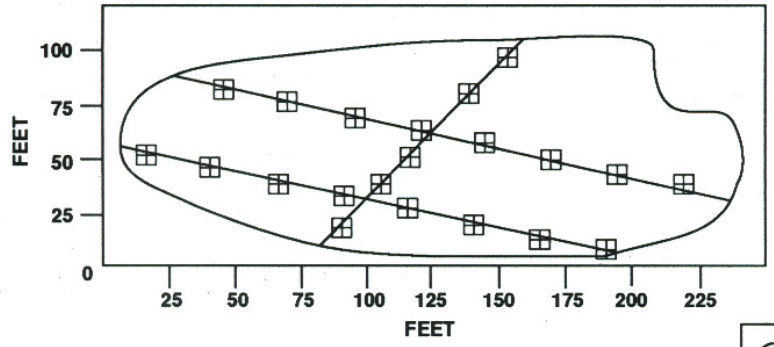
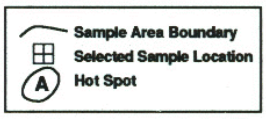


Figure 6: Transect Sampling



After: U.S. EPA, February, 1989



ATTACHMENT 2
Surface/Shallow Soil Sampling Log

HGL HydroGeoLogic, Inc Exceeding Expectations	**Surface and Shallow Soil Sampling Log**	Records Management Data
Project Number	Project Name	Page ____ of _____

General Info	Location		
	Surface Elevation ft.	Date Started	Date Completed
	Field Investigator		C of Cr
	Sampling Excavation Method	Sampling Method	
	Depth of Excavation ft.	Depth Water First Encountered ft.	Backfill Material

	Sample Number	**Depth (ft)**	**Lithologic Description**[1]	**Sample Container**	**Analyses Requested**
Sampling Info					

Plan View		**Legend**
		Soil Sampling Location

Recorded By:	Date	Checked By:	Date:

[1] Include such data as OVM, pH, blow counts, or other physical reading observations.

Geologic Borehole Logging	SOP No.: 2.14 SOP Category: HTRW Revision No.: 0 Date: December 2010

1.0 PURPOSE

This Standard Operating Procedure (SOP) defines the methodology for conducting lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by HGL.

2.0 SCOPE AND APPLICATIONS

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. Following the guidelines presented in this SOP will help ensure that pertinent data is collected so that all borehole logs made while installing these devices at a site can be standardized to create a consistent, uniform database from which interpretive conclusions can be made with minimal decision error. A borehole log provides lithologic descriptions to characterize the physical subsurface and the geologic and hydrologic processes operating at the site. A properly prepared borehole log serves as an essential tool for evaluating and correlating these processes.

This SOP provides guidance for routine field operations on environmental projects, and was derived from *A Compendium of Superfund Field Operations Methods*, U.S. Environmental Protection Agency (EPA/540/P-87/001 [OSWER Directive 9355.0-14]); U.S. Geologic Survey standards; and other industry standards. Site-specific deviations from the methods presented herein must be approved by the Project Manager and HGL Quality Assurance Officer, and detailed in the Field Sampling Plan or Work Plan for the project.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan. Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

4.1 INTRODUCTION

Boreholes should be logged by a trained geologist, or other earth scientist under the supervision of a geologist. Large-scale inferences such as vertical and horizontal extent of strata, facies changes, attitude of bedding or layering, structural features (faults, folds, fractures, dikes, etc.), location of the water table, lithologic characterizations, and the extent of subsurface contamination are made from small-scale observations recorded on the borehole log. These observations include bedding, grain size, degree of sorting, shape of grains, color, hardness, organic vapor levels, and other observable physical characteristics including visible evidence of contamination.

Logging should document both general and specific lithologic information about the borehole. In all cases, the lithologic log should be identified with the following:

- Specific site number;
- well/boring number;
- Drilling method;
- Location;
- Date of drilling;
- Individual logger (geologist);
- Drilling contractor;
- Significant organic vapor reading;
- Visible evidence of contamination, such as staining or odor;
- Depth to water first encountered:
- Final depth of water level;
- Well/boring elevation (if data is available);
- Total depth in feet;
- Graphic log, and;
- Lithologic description.

Lithologic descriptions for unconsolidated materials often use the Unified Soil Classification System (USCS) or standard geologic field description methods (Compton, 1962). Descriptions of bedrock should follow applicable U.S. Geologic Survey standards.

Lithologic descriptions of unconsolidated material should contain the following characteristics when possible:

- Soil or formation name;
- Gradation degree of sorting;
- Principal constituent;

- Specific descriptors for principal constituents (for example, plasticity, grain size, and shape);
- Firmness/hardness;
- Minor constituents;
- Moisture content;
- Color;
- Particle morphology; and
- Other descriptors (such as, visual evidence of contamination, specific monitoring equipment readings including photoionization detector [PID]/organic vapor analyzer [OVA] readings).

4.2 CLASSIFICATION SYSTEM

The following subsections describe in detail the parameters and descriptive terminology used to classify each sample for the bore log.

4.2.1 Soil or Formation Name

The soil or formation name will include the major constituent(s) and may be preceded by a single-word modifier indicating the subordinate constituent. Percentages of each constituent will be used to classify the material without actually recording constituent percentage. The textural terms used to classify a soil are shown in Attachment 1, Triangular Diagram Showing Percentage of Sand, Silt, and Clay in Each Textural Class.

4.2.2 Gradation (Degree of Sorting)

Size sorting describes the extent to which grain size is uniform. The comparison chart listed in Attachment 2, "Comparison Chart for Estimating Degree of Sorting," will be used to describe soils being logged from a borehole.

4.2.3 Principal Constituent

Principal constituents recorded during borehole logging include an identification of the following unconsolidated material types:

- Clay;
- Sand;
- Cobbles;
- Silt;

- Gravel; and
- Boulders.

If known, an identification of the potential source of the material should be made (such as, alluvium, colluvium, artificial fill, or residual material).

4.2.4 Principal Constituent Descriptors

Additional descriptors for the principal material constituents may be added to the log in order to further delineate or accurately record subtle changes in the lithologic structure. Modifiers such as grain size, shape, and plasticity of materials (high, medium, and low plasticity). (Note: Plasticity is the property of permanently changing shape without movement on any visible fractures.)

4.2.5 Consistency/Density/Rock Hardness

The characteristics of unconsolidated material are often determined by the Standard Penetration Test (SPT). The SPT involves driving a split-spoon sampler into the material by dropping a 140 pound weight from a height of 30 inches. The resistance of the material is reported in the number of blows of the weight required to drive the spoon one foot and translates into the following descriptors:

Number of Blows/Foot	Cohesive Consistency (Clay)
0-2	Very soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very stiff
30+	Hard

Number of Blows/Foot	Cohesive Consistency (Gravel)
0-4	Very loose
4-10	Loose
10-30	Medium dense
30-50	Dense
50+	Very Dense

Number of Blows/Foot	Rock Hardness
<20	Weathered
20-30	Firm
30-50	Medium Hard
50-80	Hard
80+	Very Hard

4.2.6 Minor Constituents

Constituents not previously described in the principal constituent description may be described as a percentage or by weight. Typically, modifiers for minor constituents conform to the following standards:

- No modifier < 5 percent
- Slightly 5 to12 percent
- Moderately (add '-y' or '-ey' such as silty clay) 12 to 40 percent
- Very 40 to 50%

4.2.7 Moisture Content

The terms used to describe the relative moisture content of a field soil sample are:

- Dry - The sample is completely without moisture. Dry, silty sands, for example, will produce suspended particles when dropped by hand.
- Damp - Samples containing a very slight amount of water.
- Moist - Soils in this range are near the maximum water content for their maximum compactibility or density. Moist soils will form a ball when compressed in the hand.
- Wet - The soil samples are wet enough to produce free water upon shaking but still contain unoccupied air voids. Fine-grained soils close to the liquid limit would be termed wet.
- Saturated - Soils with no air voids. Samples placed in sample jars or bags will probably have standing water after a short period of time.

4.2.8 Color

The color of soil and associated materials will be recorded on the borehole log. Color descriptors should include but are not limited to the following descriptors: black, grey-black, brown, olive, mottled, streaked, etc. Color charts should be used to provide general logging guidance but specific use is not necessary for adequately describing lithology.

4.2.9 Particle Morphology

The key elements of particle morphology are roundness and sphericity. Roundness is a measure of the curvature of grain corners. Sphericity is a measure of how equal the three axial lengths (x, y, z) of an object are. Determination of both properties is facilitated by the use of a hand lens. Estimate grain roundness and sphericity by using the American Geologic Institute (AGI) Data Sheet (Attachment 4).

4.2.10 Other Descriptors

Field screening data collected during the drilling process may help further characterize site conditions during subsurface investigations. Readings from on-site monitoring equipment such as PIDs, OVAs and Oxygen/Explosimeters should be recorded at each sample interval. Other useful information includes the organic content and the presence or absence of waste material in samples.

4.2.11 Particle Size Distribution

An estimate of particle sorting by grain size is often useful for borehole logging purposes. Precise estimates of percent composition of the sample is not necessary.

USCS Grain Size Categories

Exact Size Limits	Approximate Inch Equivalents	Name of Loose Aggregate
>256 mm	>10 in.	Boulder gravel
64 – 256 mm	2.5 – 10 in.	Cobble gravel
32 – 64 mm	1.2 – 2.5 in.	Very coarse pebble gravel
16 – 32 mm	0.6 – 1.2 in.	Coarse pebble gravel
8 – 16 mm	0.3 – 0.6 in.	Medium pebble gravel
4 – 8 mm	0.15 – 0.3 in.	Fine pebble gravel
2 – 4 mm	0.08 – 0.15 in.	Granule (or very fine pebble) gravel
1 – 2 mm	0.04 – 0.08 in.	Very coarse sand
1/2 – 1 mm	0.02 – 0.04 in.	Coarse sand
1/4 – 1/2 mm	0.01 – 0.02 in.	Medium sand
1/8 – 1/4 mm	0.005 – 0.01 in.	Fine sand
1/16 – 1/8 mm	0.002 – 0.005 in.	Very fine sand
1/256 – 1/16 mm	0.00015 – 0.002 in.	Silt
<1/256 mm	<0.00015 in.	Clay (clay-size materials)

mm = millimeters
Source: Wentworth Scale; Compton 1962

The Comparison Chart for Estimating Percentage Composition (Attachment 3) can be used to estimate the percentage of various grain sizes present in a sample. However, visual estimates usually provide sufficient information for characterizing site lithology.

4.3 BOREHOLE LOGS

Record data collected during exploratory boring soil logging in the field logbook and on Attachment 5, Borehole Log. Use this log on all applicable field drilling and subsurface sampling operations.

Geologic correlation and aquifer properties prediction are dependent on good exploratory boring sample descriptions. Rotary drilling with fluids is generally unacceptable since the drilling fluids may potentially contaminate the aquifer under investigation. High quality borehole data are

generally acquired with a split-spoon or pitcher core barrel. This method of sampling provides detailed logging. The lithofacies interpreted from cuttings logs may lack the accuracy necessary for detailed correlation. Where possible, techniques such as geophysical borehole logging will be used to supplement cuttings descriptions. Note on the log any geologic description determined from borehole cuttings. The cuttings are often mixed over the entire length of the boring.

In bedrock formations, cuttings may be acquired from a reverse circulation, air rotary or from a dual wall rotary boring. These cuttings do not provide information on the in situ properties of the materials, but do provide adequate sample description information.

In summary, close sample spacing or continuous sampling in a boring provide the best material for descriptive geology. Use traditional geologic terminology and supplement with the USCS descriptive system when appropriate. Provide sufficient data on layering and other sedimentary structures and undisturbed textures. Sample numbers, depths, and analytes should be included in each description. The applicable field methods described by Compton (1962) and AGI (1982) are recommended. These methods are fully referenced in Section 5.0.

4.4 REVIEW

Personnel conducting borehole logging of soil will record field data on Attachment 5, Borehole Log, and will record a chronological summary in the project log book. The applicable methods outlined in this procedure shall be used to record the data on this Attachment. The personnel conducting these operations will sign and date the "logged by" and "date" blanks on Attachment 5, Borehole Log.

The Project Manager or designee shall check all field generated data and Attachment 5, Borehole Log, for completeness and accuracy. Any discrepancies will be noted and the Attachments will be returned to the originator for correction. The reviewer will acknowledge that corrections have been incorporated by signing and dating the "reviewed by" and "date" blanks on Attachment 5, Borehole Log.

5.0 REFERENCES

American Geological Institute, 1982. "AGI Data Sheets." Falls Church, Virginia.

ASTM International, 1984. ASTM D1586, Description and Identification of Soils, Visual-Manual Procedure" in the Annual Book of ASTM Standards. V.04.08

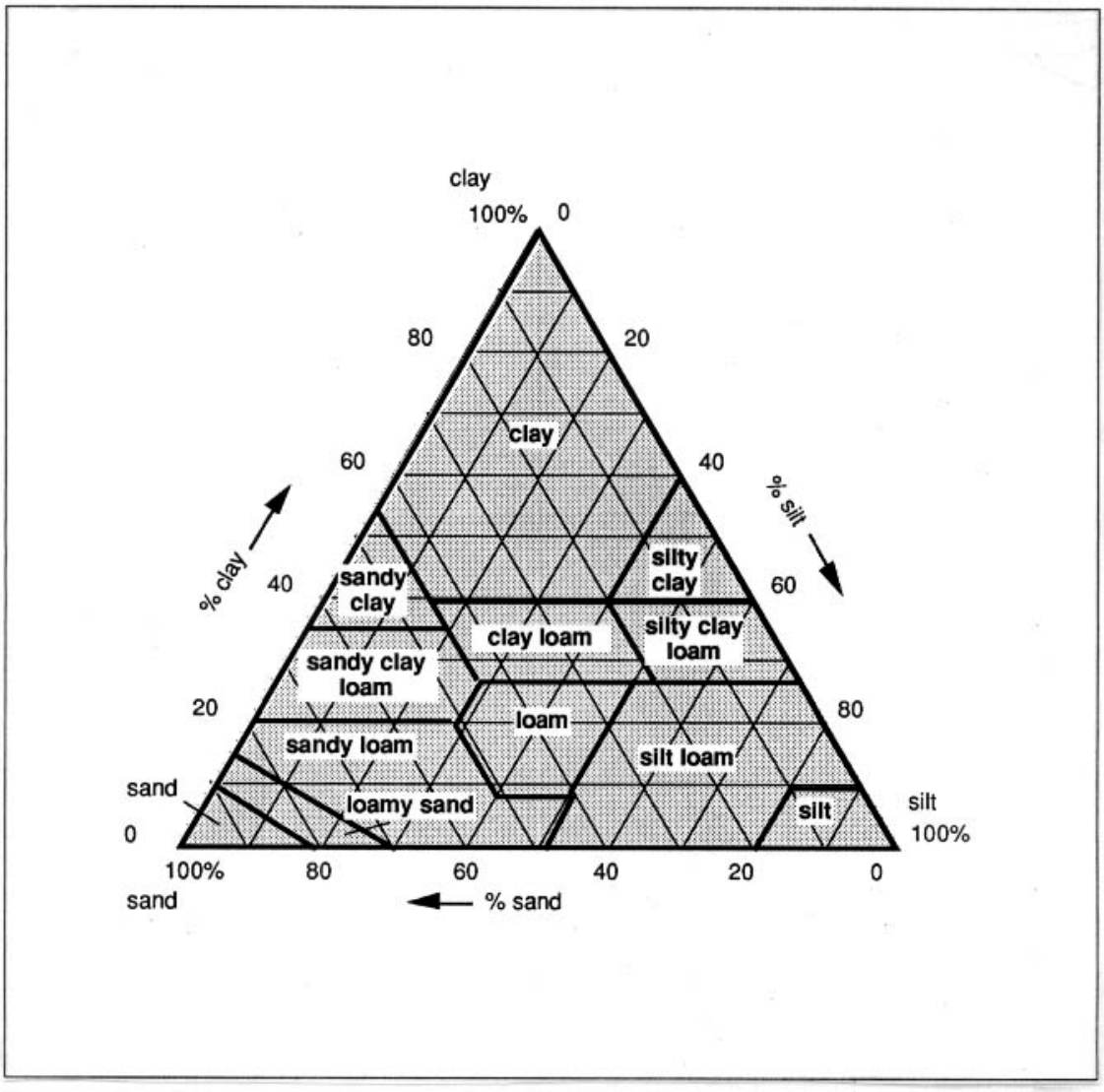
Compton, Robert R., 1962. *Manual of Field Geology*. John Wiley and Sons, Inc. New York, New York.

Munsell, 1988. Munsell Soil Color Charts. Macbeth Division, Kollmorgen Instruments Corporation, Baltimore, Maryland.

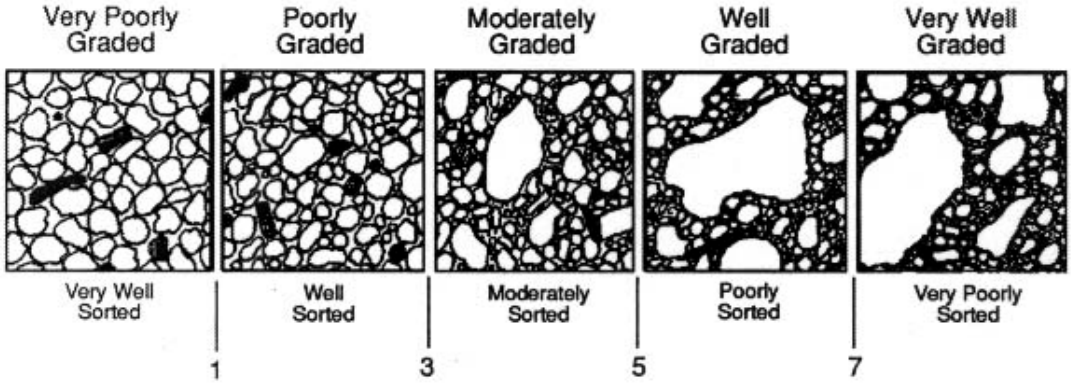
6.0 ATTACHMENTS

Attachment 1 Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class
Attachment 2 Comparison Chart for Estimating Degree of Sorting
Attachment 3 Comparison Chart for Estimating Percentage Composition
Attachment 4 Comparison Chart for Estimating Roundness and Sphericity
Attachment 5 Borehole Log

ATTACHMENT 1
Triangular Diagram Showing Percentage of Sand, Silt and Clay in Each Textural Class



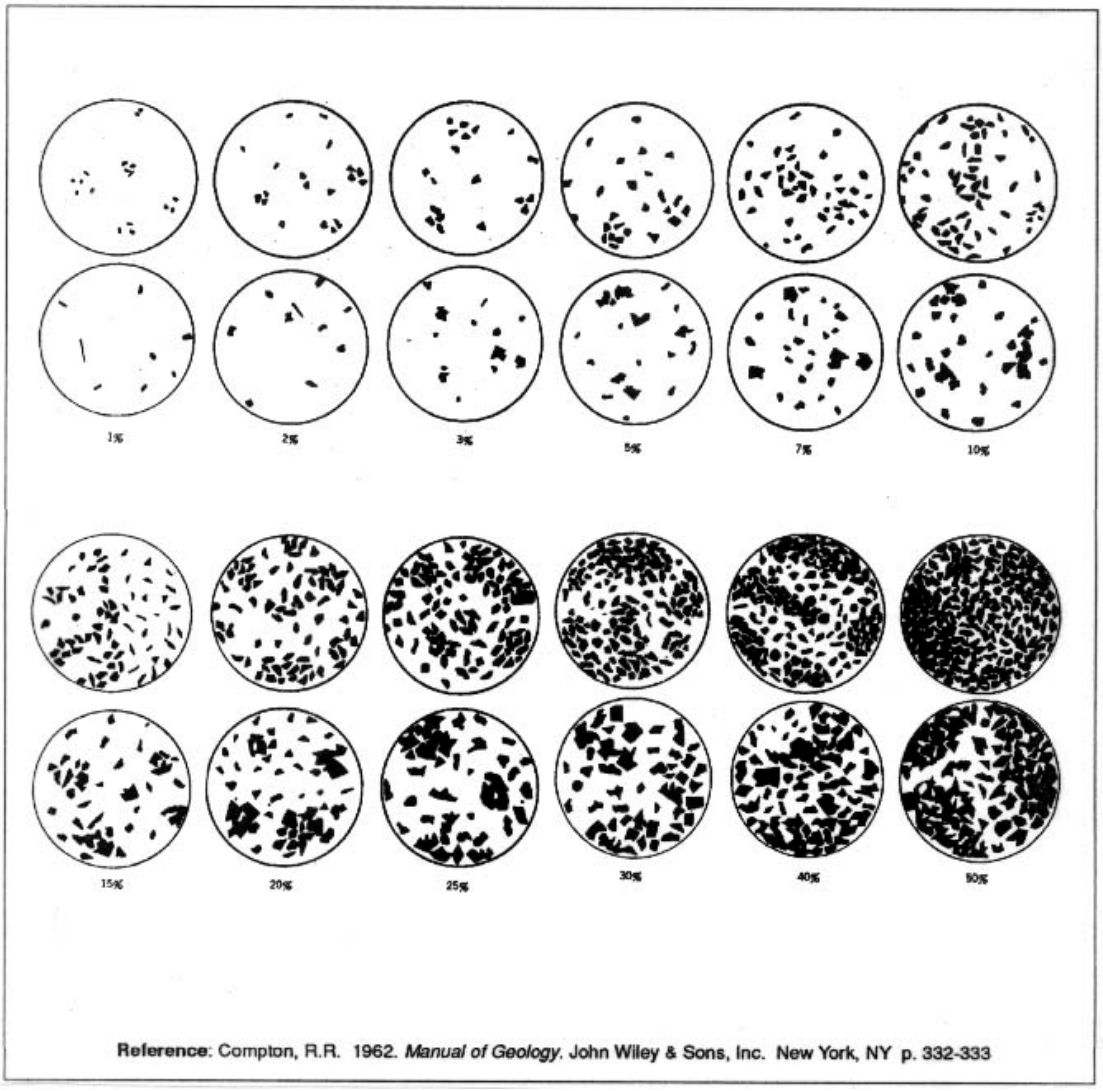
ATTACHMENT 2
Comparison Chart for Estimating Degree of Sorting



Terms for degrees of sorting. The numbers indicate the number of size-classes included by the bulk (80 percent) of the material. The drawings represent sandstones as seen with a hand lens. Silt and clay-size materials are shown diagrammatically by the fine stipple.

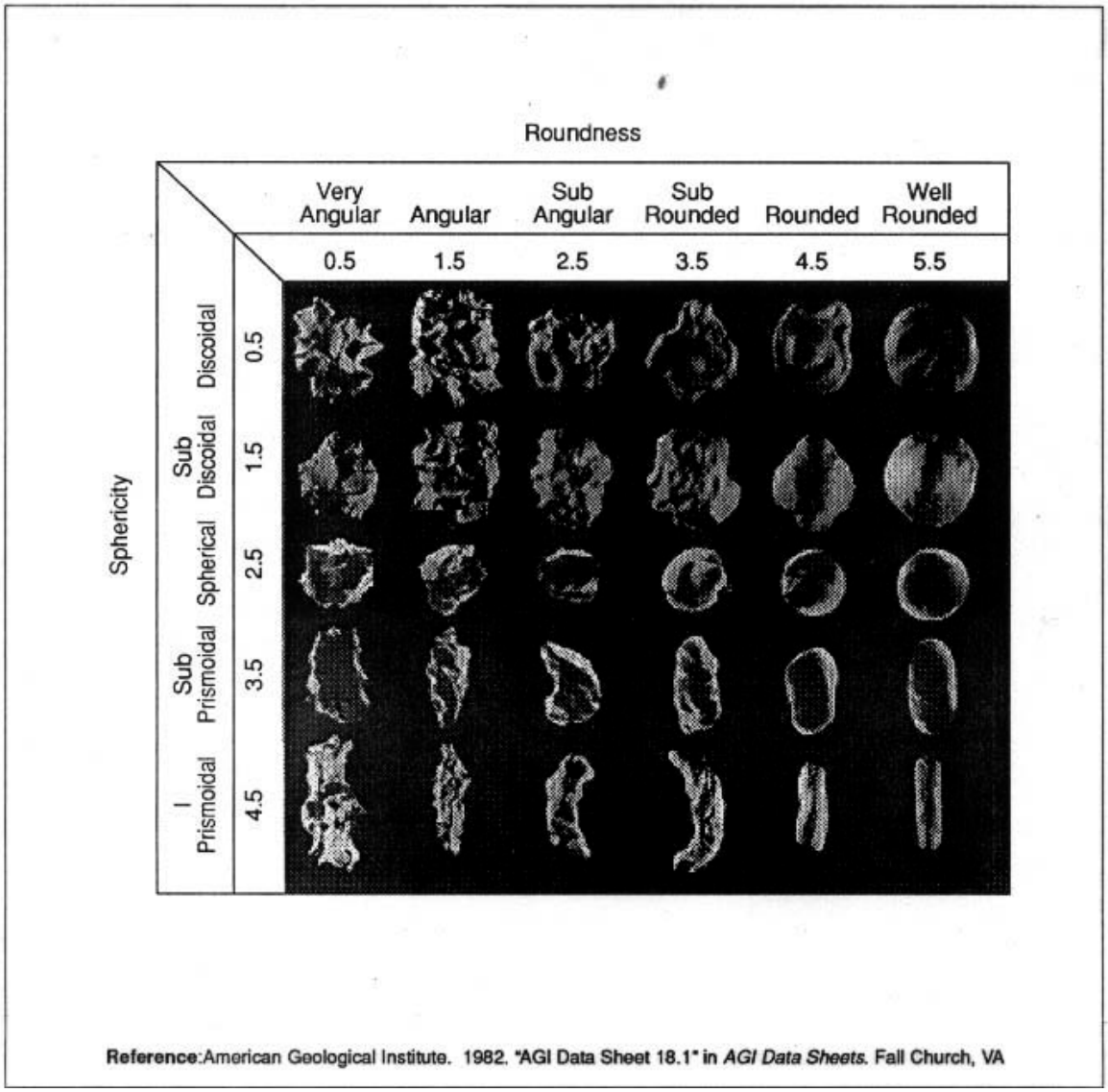
Reference: Compton, R.R. 1962. *Manual of Geology.* John Wiley & Sons, Inc. New York, N p. 214

ATTACHMENT 3
Comparison Chart for Estimating Percentage Composition



Reference: Compton, R.R. 1962. *Manual of Geology*. John Wiley & Sons, Inc. New York, NY p. 332-333

ATTACHMENT 4
Comparison Chart for Estimating Roundness and Sphericity



Reference:American Geological Institute. 1982. "AGI Data Sheet 18.1" in *AGI Data Sheets*. Fall Church, VA

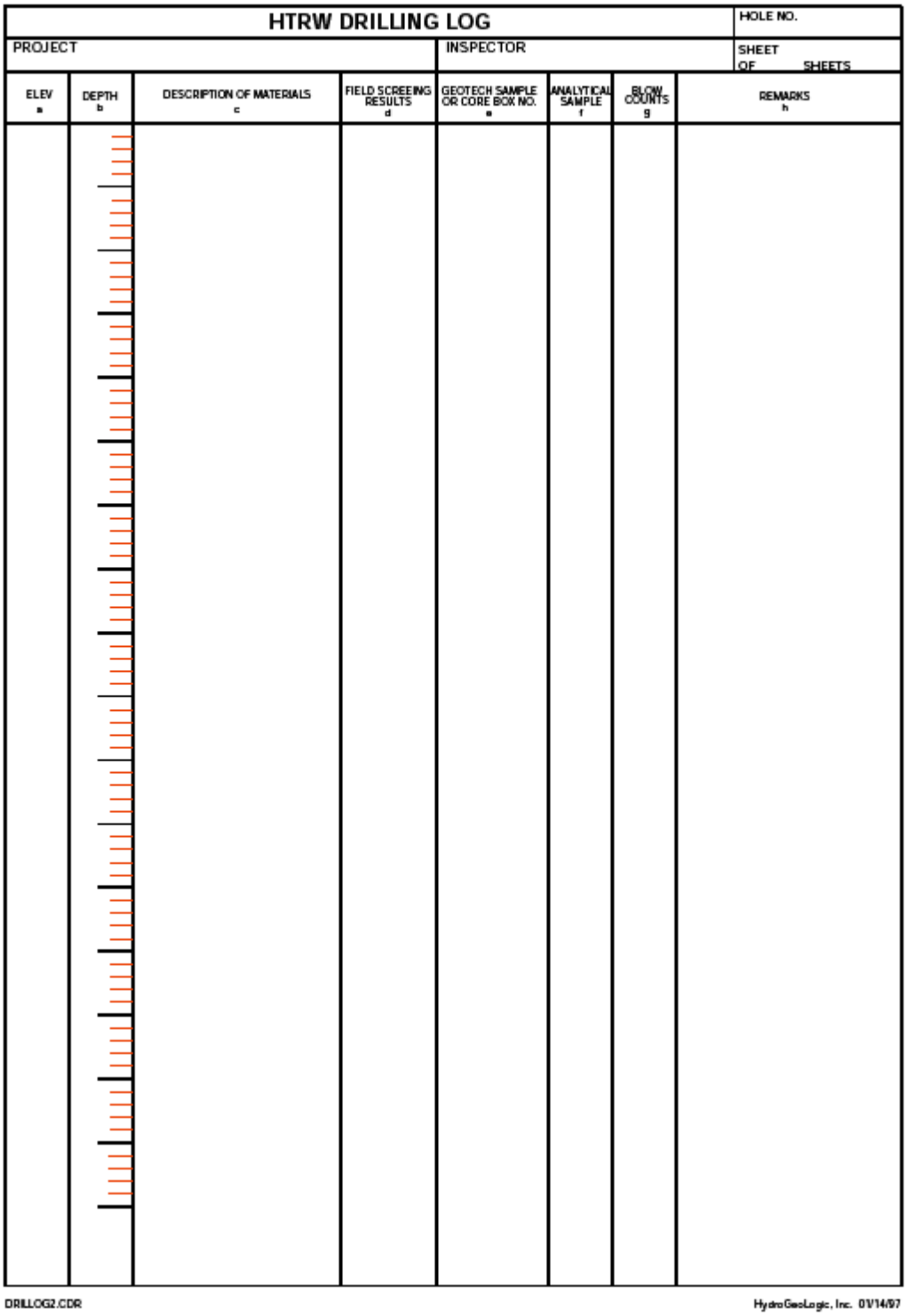
ATTACHMENT 5
Borehole Log

HTRW DRILLING LOG							HOLE NO.
1. COMPANY NAME			2. DRILLING SUBCONTRACTOR				SHEET OF SHEETS
3. PROJECT			4. LOCATION				
5. NAME OF DRILLER			6. MANUFACTURER'S DESIGNATION OF DRILL				
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT			8. HOLE LOCATION				
			9. SURFACE ELEVATION				
			10. DATE STARTED		11. DATE COMPLETED		
12. OVERBURDEN THICKNESS			15. DEPTH GROUNDWATER ENCOUNTERED				
13. DEPTH DRILLED INTO ROCK			16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED				
14. TOTAL DEPTH OF HOLE			17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)				
18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES				
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %	
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR			

ELEV a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREEING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE f	BLOW COUNTS g	REMARKS h

DRILLOG2.CDR

HydroGeoLogic, Inc. 01/14/97


HTRW DRILLING LOG
HOLE NO.
PROJECT
INSPECTOR
SHEET
OF SHEETS
ELEV a
DEPTH b
DESCRIPTION OF MATERIALS c
FIELD SCREENING RESULTS d
GEOTECH SAMPLE OR CORE BOX NO. e
ANALYTICAL SAMPLE f
BLOW COUNTS g
REMARKS h
DRILLOG2.CDR
HydroGeoLogic, Inc. 01/14/97

Sediment Sampling	SOP No.: 2.15 SOP Category: HTRW Revision No.: 0 Date: December 2010

1.0 PURPOSE

This standard operating procedure (SOP) establishes the guidelines for sediment sampling using a variety of sampling devices. Methods for preventing sample and equipment cross-contamination are included. Proper sediment sampling ensures that any evaluations of sediment contamination are based on actual contaminant levels and are not based on improper sampling techniques.

This SOP provides guidance for routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the HGL project manager.

2.0 SCOPE AND APPLICATIONS

Field personnel collecting sediment samples are responsible for performing the applicable tasks outlined in this procedure when conducting work related to environmental projects.

The project manager or an approved designee is responsible for checking all work performed and verifying that the work satisfies the applicable tasks required by this procedure. This verification will be accomplished by reviewing all documents (attachments) and data produced during work performance.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and documented in the planning documents. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 SAMPLING EQUIPMENT AND TECHNIQUES

Sediment samples may be obtained using on-shore or off-shore techniques. Sediment sampling equipment and techniques must be designed to minimize the risk of dilution or loss of material as the sample is moved through the water column. For situations where boats are required for sampling, extra precautionary measures must be employed. At a minimum, life preservers must

be provided and two individuals will undertake the sampling; an additional person will remain in visual contact on-shore to observe the operations. If sampling from a commercial vessel, the captain must have all appropriate licenses to operate the vessel. The additional on-shore person to observe operations is not needed if sampling occurs from a commercial vessel and the vessel is equipped with a marine radio to contact the Coast Guard or another vessel if case of emergency.

Sediment sampling devices are described below.

4.1 DIP SAMPLER

A dip sampler consists of a pole with a jar or scoop attached. The pole may be made of bamboo, wood, Teflon, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is attached by a clamp.

The dip sampler is operated by submerging the jar or scoop and pulling it through the sediments to be sampled. The samples retrieved are then transferred into the appropriate sample container after decanting the liquid. Further decanting can occur while the sample is present in the sample jar. Avoid contact with sampler's gloves. Transferring the sample may require the use of a stainless steel or Teflon® spoon/spatula.

4.2 HAND OPERATED CORE SAMPLERS

Hand operated sediment core samplers are used to obtain sediment samples in shallow water (less than three feet). These samplers operate in a manner similar to soil core samplers. However because of the saturated conditions of most sediments, provisions must be made to retain the sample within the core. Core samplers are generally constructed of a rigid metal outer tube into which a two-inch plastic core sleeve fits with minimum clearance. The cutting edge of the core sampler has a recessed lip on which the plastic sleeve rests and which accommodates a core retainer. This retainer is oriented such that when the sampler is pressed into the sediment, the core is free to move past the retainer. Due to construction of the retainer, the core will not fall through the retainer upon removal of the sampler from the sediment.

When the sampler is removed from the sediment, the plastic sleeve is removed. The sediment is removed from the sleeve and placed in the appropriate sample container. Chlorinated organics will not be collected using core samplers because core sleeves and retainers are generally made of plastic. The hand operated core sampler will not be useful for obtaining samples of gravelly, stony or consolidated sediments

4.3 GRAVITY CORE SAMPLERS

Gravity core samplers are used to obtain sediment samples in water bodies or lagoons with depths of greater than three to five feet. These types of samplers can be used for collecting one- to two-foot cores of surface sediments at depths of up to 100 feet beneath the water surface.

As with all core type samplers, gravity core samplers are not suitable for obtaining samples of coarse, gravelly, stony, or consolidated deposits. They are, however, useful for fine grained inorganic sediment sampling.

The gravity core sampler operates in a manner similar to the hand operated core in that a two-inch plastic sleeve fits within a metal core housing fitted with a cutting edge. Plastic nests are used to retain the core within the plastic sleeve. An opening exists above the core sleeve to allow free flow of water into and through the core as it moves vertically downward to the sediment. The sampler has a messenger-activated valve assembly which seals the opening above the plastic sleeve following sediment penetration. This valve is activated by the messenger creating a partial vacuum to assist in sample retention during retrieval.

Samples are obtained by allowing the sampler, which is attached to approximately 100 feet of aircraft cable, to drop to the benthic deposits. The weight of the sampler drives the core into the sediment to varying depths depending on the characteristics of the sediments. The messenger is then dropped on the taut aircraft cable to seal the opening above the plastic sleeve. The sampler is then carefully retrieved.

Upon retrieval of the sampler, the plastic core sleeve is removed and the sample placed in the appropriate sample container. Care should be exercised in labeling in order to properly identify sample orientation.

4.4 DREDGES

Dredges are generally used to sample sediments that cannot easily be obtained using coring devices or when large quantities of materials are required. Various dredge designs are available for sampling in deep or turbulent waters and for obtaining samples from gravelly, stony or dense deposits.

Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Dredges are commonly quite heavy and may require use of a winch and crane assembly for sample retrieval.

Upon retrieval of the dredge, the sample can either be sieved or transferred directly to a sample container for labeling and storage. Dredge types that could be used for sampling include Ponar, Petersen and Ekman dredges.

4.5 HAND AUGER

Sediment samples may be collected using a hand auger. When using a hand auger, provisions must be made to ensure that sediment samples remain in the auger. Hand augers are best utilized when sampling non-subaqueous sediments.

5.0 PROCEDURES

5.1 SAMPLING SEDIMENT WITH NO OVERLYING SURFACE WATER

Sediment samples obtained from areas with no overlying surface water will be collected in accordance with the following procedures:

- Record all data in the field logbooks in accordance with SOP 4.07: *Documentation – Field Logbook Use and Maintenance*.
- Insert a decontaminated Teflon® or stainless steel spoon, scoop, or trowel into the sediment to the desired depth and remove the collected sample, or rotate and push down a decontaminated auger into the sediment to the desired depth and remove collected sample. A disposable scoop may be used for specified media and analytical parameters, in accordance with the site-specific work plan.
- Collect samples for volatile organic compounds (VOC) analyses from the sampling device or from unmixed sediment placed into a stainless steel bowl.
- Place the sample in a decontaminated stainless steel bowl. Stir sample thoroughly (non-VOC samples only) with a decontaminated stainless steel spoon or spatula—or with a dedicated disposable scoop—to provide a homogeneous mixture before filling sampling containers.
- Follow the guidelines in the site-specific work plan and Quality Assurance Project Plan (QAPP) for aliquot size (mass), container type, storage conditions, and holding times. Fill the appropriate sample containers as detailed in the site-specific work plan. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Label the sample containers and place the filled sample containers on ice immediately.
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific QAPP for sample custody procedures).

5.2 SUBAQUEOUS SEDIMENT SAMPLING

Subaqueous sediment sampling from lakes, ponds, lagoons, and surface impoundments will consist of the following:

- Select the most appropriate sediment sampling device (as described in Section 4).

- Decontaminate all sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.
- If sampling from a boat equipped with an engine, attempt to collect the sample with the boat engine off or attempt to ensure that all exhaust fumes are directed away from the sample collection area until the sample has been collected.
- Lower the sampler at a controlled descent of approximately 1 foot per second until the sampler reaches the bottom, as indicated by a slackening of the cable. Slowly retrieve the sampler and raise it at a controlled speed. When the sampler is at the water surface, attach a tag line(s) to steady and pull the sampler back into the boat. If large samplers are used, a motorized winch is required for retrieval.
- Open and tie back any vent flaps on the sampler and carefully siphon off any overlying water over the side of the boat.
- Visually inspect the sample for acceptability for example, determine if an undisturbed surface layer is evident, the overlying water is not excessively turbid, and adequate penetration is achieved). If the sample is not acceptable, discard it and collect another sample from an adjacent location.
- Carefully extrude the sediment from the sampler by slowly lifting on the winch cable and sliding the sample out the bottom of the sampler. If using core liners, remove the front face of the core liner to expose the side of the core.
- Visually inspect the side of the sample to identify any obvious stratification (such as different sediment types, sizes, or colors). If no patterns are evident, collect a sample from the surface and mid-core depth. During some investigations, it may be necessary to collect separate samples from the surface and mid-core depths. This may best be accomplished by gently scraping the side of the core with a decontaminated stainless steel scraper or knife. Scrape from the bottom to the top of the core only. If the sediment is unconsolidated, do not scrape.
- Remove the upper 2 centimeters (cm) of the sample using a decontaminated Teflon or stainless steel scoop—or dedicated disposable scoop—and place it in the sample container. From an undisturbed area of the sample surface, scoop a 2-cm sample only if grain size analysis is required. After grain size analysis samples are collected, scrape off the upper sediment layer and discard overboard. Collect samples from the mid-section of the sediment. Sediment must be removed with caution to avoid contaminating the sample (that is, from exposure to engine exhaust, rust, or grease);
- Do not include nonrepresentative materials, such as twigs or debris, in the sample. Do not include sediments contacting the side of the sampler or core liner for analysis.

- Follow the guidelines in the site-specific work plan and QAPP for aliquot size (mass), container type, storage conditions, and holding times. Fill the appropriate sample containers as detailed in the site-specific work plan. Identify or label samples carefully and clearly, addressing all the categories or parameters;
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific QAPP for sample custody procedures).

5.3 STREAM SEDIMENT SAMPLING

Stream sediment sampling will be conducted in accordance with the following procedures. Note that if co-located surface water samples are being collected, the surface water sample should be collected first.

- Collect the sample in an area of sediment accumulation, such as the inside of stream meanders, quiet shallow areas, and low-velocity zones. Avoid areas of net erosion, such as high-velocity, turbulent flow zones.
- If possible, collect the sample while remaining on the stream bank. If the sample cannot be obtained from the bank, enter the stream from a point downstream of the sediment sampling location. Consult the site health and safety plan before entering the river to avoid potential hazards. Collect the sediment sample by reaching into the stream with a decontaminated stainless steel spoon or Teflon scoop and scooping a sample in an upstream direction. Attempt to minimize the loss of fine material. A disposable scoop may be used for specified media and analytical parameters, in accordance with the site-specific work plan.
- Place sample in a stainless steel bowl and gently mix with a stainless steel spoon or dedicated disposable scoop (non-VOC samples only). Transfer the sediment samples to the appropriate sample containers using the stainless steel spoon or dedicated disposable scoop. Do not mix samples for volatile organic analyses.
- Follow the guidelines in the site-specific work plan and QAPP for aliquot size (mass), container type, storage conditions, and holding times. Fill the appropriate sample containers as detailed in the site-specific work plan. Identify or label samples carefully and clearly, addressing all the categories or parameters.
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable scoops are not used. Don new clean gloves before beginning sampling activities and at each sampling point.

- Complete all chain of custody documents and record information in the field logbook (see the project specific QAPP for sample custody procedures).

6.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements detailed in the site-specific work plan.

- Document all daily field activities on a daily field activity report in accordance with procedures listed in SOP 4.01: *Documentation – Field Activity Reports*.
- Complete the field logbook in accordance with procedures listed in SOP 4.07: *Field Logbook Use and Maintenance*.

Surface Water Sampling	SOP No.: 2.16 SOP Category: HTRW Revision No.: 0 Date: December 2010

1.0 PURPOSE

The purpose of this procedure is to describe the methods for surface water sampling. It describes the procedures and equipment to be used to obtain representative surface water samples that are capable of producing accurate quantification of water quality.

2.0 SCOPE AND APPLICATIONS

This procedure provides guidance for routine field operations on environmental projects. Procedures are included for collecting grab and composite surface water samples from flowing water bodies (streams, rivers, and creeks) and from standing water bodies (lakes, lagoons, and ponds).

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS

Aliquot: Fractional amount.

Composite Samples: Samples composed of more than one aliquot collected at various sampling sites and/or at different times.

Epilimnetic zone: The uppermost layer of water in a lake, characterized by an essentially uniform temperature that is generally warmer than elsewhere in the lake and by a relatively uniform mixing caused by wind and wave action. Specifically, the epilimnetic zone is the light (less dense), oxygen-rich layer of water in a thermally stratified lake.

Grab Samples: Samples that are collected at one particular point and time.

Hypolimnetic zone: The lowermost layer of water in a lake, characterized by an essentially uniform temperature (except during turnover) that is generally colder than elsewhere in the lake and is often characterized by relatively stagnant or oxygen-deficient water.

Rinsate: Wastewater generated as a result of rinsing sampling equipment during decontamination procedures.

Surface water samples: Samples of water collected from streams, ponds, rivers, lakes, or other impoundments open to the atmosphere.

5.0 PROCEDURE

5.1 INTRODUCTION

The objective of surface water sampling is to evaluate the surface water quality entering and/or leaving a site. It is also used to obtain data on waste loads, water quality and characteristics that will permit prediction or modeling of the water system (to describe probable water quality), and effects on uses under a variety of conditions.

5.2 SAMPLING EQUIPMENT

Sampling equipment includes all sampling devices and containers that are used to collect or contain a sample prior to final sample analysis. All surface water sampling equipment shall have a design that will maintain sample integrity and to provide the desired level of quality in achieving desired analytical results. There is a variety of equipment available for surface water sampling. Because each site may contain varied surface water conditions, collection of a representative sample may be difficult. In general, a sampling device will include the following characteristics:

- Be constructed of disposable or non-reactive material (Teflon® or stainless steel); and
- Have a minimum capacity of 500 milliliters (ml) to minimize sample disturbance.

5.3 DECONTAMINATION

Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*, after use and between sampling if dedicated disposable equipment is not used.

5.4 SAMPLING LOCATION/SITE SELECTION

Before sampling, consideration must be given to the specific sampling locations to provide a representative sample. This and other considerations are detailed in the project-specific Work Plan.

The general determining factors in the selection of a sampling device for sampling liquids in lakes, ponds, lagoons, and surface impoundments are listed below:

- Accessibility:
  - Boat: If the water is navigable, any sampling location is accessible by boat.
  - Bridges: Provide ready access, are readily identifiable, and permit water sampling at any point across the width of the water body.
  - Wading: Personnel safety must be paramount. Wading is not recommended in areas where bottom deposits are easily disturbed, thereby increasing the possibility of increased sediment in the samples.
- Rivers, streams, and creeks:
  - Sampling stations will be located wherever a marked physical change occurs in the stream channel. For example, between rapids/deep water transitions, as well as at both ends of a reach.
  - Sampling stations will be located short distances above and below dams and weirs, to determine the artificial increase in dissolved oxygen.
  - A minimum of three sampling locations will be established between any two points of major change in a stream.
  - Sampling stations will be located upstream and downstream of any waste discharge site. Since the inflow frequently hugs the stream bank with very little lateral mixing, care must be taken to establish the sampling station after complete mixing with the main stream.
  - A tributary sampling station will be established near the mouth and upstream of any effects from the main stream. The station on the main stream will be just upstream from the confluence.
  - Sample as close as is practical to areas or points of important water uses.
  - At stations where wastes and tributary waters are well-mixed, one sampling point near mid-channel is usually adequate. At stations where mixing is inadequate, the station will be sampled at quarter points across the width of the station.

- Lakes, ponds, lagoons, and impoundments:
  - A single station at the deepest point may be sufficient for naturally formed ponds (near the center) and for impoundments (near the dam or spillway).
  - A sampling grid is the most representative for lakes and large impoundments.
  - In lakes with irregular shapes and with several bays and coves that are protected from the wind, sampling stations should be established in these areas.
  - A control station above a waste source is usually necessary to compare background water quality. It should be carefully selected and it may be necessary to have two or three control stations to establish the rate at which unstable material is changing. The time of travel between stations should be sufficient to permit accurate measurement of the change in the constituents under consideration.

5.5 SAMPLING METHODS

5.5.1 General

The specific sampling method utilized will depend on the accessibility to, the size, and the depth of the water body, as well as the type of samples being collected.

In most ambient water quality studies, grab samples will be collected. However, the objectives of the study will dictate the sampling method and will be specified in the project specific work plan.

For rivers, streams and creeks, the type of samples collected will be dependent upon the size and the amount of turbulence in the water body. Approximate the depth and location of samples in order to assure consistency. Flow rates will be measured in accordance with SOP 2.08: *Stream Flow Measurement*.

- With small streams less than 20 feet wide, a single grab sample collected at mid-depth in the center of the channel is usually adequate to represent the entire cross-section. In small streams and creeks less than 10 feet wide, a single grab sample can be collected by immersing the bottle directly under the surface of the water as close to the center of the channel as possible.
- For slightly larger streams, a vertical composite sample in the center of the channel may be required. The composite sample consists of samples taken just below the surface, at mid-depth, and just above the bottom.
- For rivers, several vertical composite samples are collected across the water body. The vertical composite samples will be collected at points in the cross section

approximately proportional to flow. The number of vertical composites required and the number of depths sampled for each are usually determined in the field. This determination is based on a reasonable balance between two considerations:

- The larger the number of subsamples, the more nearly the composite sample will represent the water body; but
- Taking many subsamples is time-consuming and increases the chance of cross-contamination.

- For lakes, ponds, lagoons, and impoundments, the greater tendency to stratify and the relative lack of adequate mixing usually requires that more subsamples be collected.
  - In ponds, lagoons, and small impoundments, a single vertical composite sample at the deepest point is usually adequate.
  - In lakes and larger impoundments, several vertical composites should be combined into a single sample. In some cases, it may be useful to form several composites of the epilimnetic and hypolimnetic zones. Normally, however, a composite consists of several verticals with subsamples collected at various depths.

5.5.2 Sample Bottle

Collecting a representative sample from small streams and creeks less than 10 feet wide, a single grab sample can be collected by immersing the sample bottle directly under the surface of the water as close to the center of the channel as possible. This method reduces the potential for cross contamination as it does not require the decontamination of equipment. The following procedures will be followed when sampling with a sample bottle:

- If sampling from within the stream, always sample from the furthest down stream location and work up stream;
- When wading to location, move slowly to minimize the amount of sediment stirred up from the bottom:
- Stand facing up stream;
- A single grab sample can be collected by immersing the bottle directly under the surface of the water as close to the center of the channel as possible ensuring the sample is collected up stream of the sampler.
- If preservatives are required for sample preservation, add preservative after samples have been collected. If pre-preserved bottleware is to be used, first collect the sample in an unpreserved bottle and decant the water to the pre-preserved bottle.

- Raise the sampler, seal, wipe clean, label or identify and prepare the bottle for transport in accordance with project guidelines;
- Identify or label samples carefully and clearly, addressing all the categories or parameters;
- After labeling of the sample bottles has been completed, place the filled sample containers on ice immediately;
- All field crew members handling the sampling equipment and/or sample bottles shall don new clean gloves prior to beginning sampling activities and between each successive sample point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific Quality Assurance Project Plan [QAPP] for sample custody procedures).
- Mark sample location and approximate depth, if possible, and note on maps and in field log book.

One additional grab sample from each location will be collected and a water quality probe will be used to collect pH, conductivity, temperature, turbidity, and salinity (where applicable) data. This sample will not be submitted for laboratory analysis. Other odors and significant characteristics will also be documented on the field sampling sheet and in the field logbook.

5.5.3 Weighted Bottle Sampler

Collecting a representative sample from a larger body of water requires the gathering of samples from various depths and locations. A weighted bottle sampler is typically utilized for this type of sampling. The sampler consists of a Teflon® bottle, a weighted sinker, a bottle stopper and a wire cord used to raise, lower and open the samples. This type of sampler can be fabricated or purchased. The following procedures will be followed when sampling with a weighted bottle sampler (Attachment 1, Weighted Bottle Sampler):

- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*;
- Assemble the weighted bottle sampler in accordance with the sampler instruction manual;
- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely. Do not let sampler disturb bottom sediments;
- Pull out the stopper with a sharp jerk of the sampler line;
- Allow the bottle to fill completely, as evidenced by the cessation of air bubbles;

- Raise the sampler, seal, wipe clean, label or identify and prepare the bottle for transport in accordance with project guidelines;
- Identify or label samples carefully and clearly, addressing all the categories or parameters;
- After labeling of the sample bottles has been completed, place the filled sample containers on ice immediately;
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*;
- All field crew members handling the sampling equipment and/or sample bottles shall don new clean gloves prior to beginning sampling activities and between each successive sample point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific QAPP for sample custody procedures).
- Mark sample location and approximate depth, if possible, and note on maps and in field logbook.

One additional grab sample from each location will be collected and a water quality probe will be used to collect pH, conductivity, temperature, turbidity, and salinity (where applicable) data. This sample will not be submitted for laboratory analysis. Other odors and significant characteristics will also be documented on the field sampling sheet and in the field log book.

5.5.4 Pond Sampler

The pond or dip sampler (Attachment 2, Pond Sampler) consists of a scoop or container attached to the end of a telescoping or solid pole. The sampler will be of non-reactive material such as wood, plastic, or stainless steel. The sample will be collected in a jar or beaker made of stainless steel or Teflon®. Preferably, a disposable beaker that can be replaced before each sampling will be used at each station. Liquid wastes from water courses, ponds, pits, lagoons or open vessels will be ladled into the sample container.

Perform the following procedures when sampling with a pond sampler:

- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*;
- Assemble pond sampler in accordance with manufacturer's instructions;
- Extend pole to length that will allow safe access to desired sample location;
- Submerge pond sampler to desired sample depth. Submerge the sampler very slowly to minimize surface disturbance;

- Allow the sampler to fill very slowly;
- Retrieve the sampling device with minimal surface water disturbance;
- Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the sampler edge;
- Empty the sampler slowly, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence. Fill sample bottle to appropriate headspace, if any;
- Identify or label samples carefully and clearly, addressing all the categories or parameters;
- After labeling of the sample bottles has been completed, place the filled sample containers on ice immediately;
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.
- All field crew members handling the sampling equipment and/or sample bottles shall don new clean gloves before beginning sampling activities and between each successive sample point.
- Complete all chain of custody documents and record information in the field logbook (see the project specific QAPP for sample custody procedures).
- Mark sample location and approximate depth, if possible, and note on maps and in field log book.
- Collect additional grab samples to acquire field measurements such as temperature, pH, conductivity, turbidity, salinity (where applicable) and other significant characteristics;

5.5.5 Manual Hand Pumps

Manual pumps are available in various sizes and configurations. Manual hand pumps are commonly operated by peristaltic, bellows or diaphragm, and siphon action. Manual hand pumps that operate by a bellows or diaphragm, and siphon action should not be used to collect samples that will be analyzed for volatile organics (Attachment 3, Manual Hand Pump). These types of pumps should be constructed of inert materials, such as Teflon® or stainless steel.

Perform the following procedures when collecting surface water samples with a manual hand pump:

- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination;*
- Assemble and operate the pump in accordance with the manufacturer's instructions;

- The inlet hose and any surface of the pump used for sampling will be constructed of materials that are operable and non-reactive;
- To avoid agitation, insert the sampling tube into the liquid sample prior to pump activation;
- Insert a liquid trap (preferably the sample container) into the sample inlet hose to collect the sample and to prevent pump contamination;
- Identify or label samples carefully and clearly, addressing all the categories or parameters;
- After labeling of the sample bottles has been completed, place the filled sample containers on ice immediately;
- Decontaminate the sampling equipment in accordance with SOP 2.01: *Sampling Equipment Cleaning and Decontamination*.
- All field crew members handling the sampling equipment and/or sample bottles shall don new clean gloves prior to beginning sampling activities and between each successive sample point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific QAPP for sample custody procedures).
- Mark sample location and approximate depth, if possible, and note on maps and in the field logbook. Record applicable data in the field logbook such as color, turbidity, pH, temperature, turbidity (where appropriate), degree of turbulence, and weather conditions).

5.5.6 Peristaltic Pump

Gathering surface water samples with the assistance of a peristaltic pump is another commonly used sampling technique. In this method the sample is drawn through heavy-walled tubing and pumped directly into the sample container. This system allows the operator to extend into the liquid body to sample from depth, or sweep the width of narrow streams. Medical-grade silicon tubing is often used in the peristaltic pump and the system is suitable for sampling almost any parameter, including most organics (Attachment 4, Peristaltic Pump).

Peristaltic pumps are available with a range of power sources. For field use the battery operated units have proven most convenient and very reliable.

Perform the following procedures when sampling with a peristaltic pump:

- Prepare the peristaltic pump in accordance with manufacturer's instructions. When using a battery-operated pump, be sure battery is fully charged prior to entering the field.

- In most situations, it is necessary to change the Teflon® suction line and the silicon pump tubing between sample locations to avoid cross-contamination.
- Gently lower the pump intake tube to the desired sample depth. Avoid unnecessary agitation (aeration) of the liquid to be sampled and bottom sediments.
- Prior to activating the pump, note in which direction the pump will be rotating. (Most peristaltic pumps are capable of rotating in two directions.) Accidental reverse rotation of the pump will cause aeration of the liquid to be sampled.
- Run the pump until no air bubbles are noted in the discharge.
- Discharge water shall be released down stream from sampling area during sampling event.
- To prevent excess agitation and/or aeration of the sampler, fill the sample containers by tilting the container and flow the sample water down the side of sampling container.
- Identify or label samples carefully and clearly, addressing all the categories or parameters;
- After labeling of the sample bottles has been completed, place the filled sample containers on ice immediately;
- In most cases, no specific decontamination procedures are required due to the use of disposable tubing. However, site-specific sample procedures may require additional decontamination and will be specified in the project-specific work plan.
- All field crew members handling the sampling equipment and/or sample bottles shall don new clean gloves prior to beginning sampling activities and between each successive sample point.
- Complete all chain of custody documents and record information in the field logbook (see the project-specific QAPP for sample custody procedures).
- Mark sample location and approximate depth, if possible, and note on maps and in field log book. Record applicable data in the field log book such as color, turbidity, pH, salinity (where applicable), degree of turbulence, and weather conditions).

When medical grade silicon tubing is not available for analytical requirements, the system can be altered as illustrated in Attachment 5, Peristaltic Pump - Modified. In this configuration, the sample volume accumulates in the vacuum flask and does not enter the pump. This system will provide excellent sample integrity for most analyses; however, the potential for losing volatile fractions to the reduced pressure of the vacuum flask renders this method unacceptable for sampling of volatiles.

It may sometimes be necessary to sample large bodies of water where a near-surface sample will not sufficiently characterize the body as a whole. In this instance, the above-mentioned pump is appropriate. It is capable of lifting water from slightly deeper than six meters. It should be noted that this lift ability decreases somewhat with higher density fluids and with increased wear on the silicone pump tubing. Similarly, increases in altitude will decrease the ability of the pump to lift from depth. When sampling a liquid stream that exhibits a considerable flow rate, it may be necessary to weight the bottom of the suction line.

5.5.7 Optional Sampling Methods

The above-mentioned methods of surface water sampling will be used most often on HGL environmental projects; however, choice of sampling equipment depends on site specific conditions. Additional types of samplers available are:

- Kemmerer sampler;
- Wheaton sampler;
- Bacon Bomb sampler;
- Open tube sampler;
- D.O. Punker sampler; and
- Bailer.

Prior to any field work, the Project Manager or designee will review the available sampling equipment and choose the sampling device that will best suit the project requirements. The sampling device to be used will be specified in the project-specific work plan.

6.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements specified in the project-specific work plan.

- Document all daily field activities on a daily field activity report in accordance with procedures listed in SOP 4.01: *Documentation – Daily Field Activity Reports*.
- The Surface Water Sampling Data form contained in Attachment 6 must be filled out for each surface water sample collected; and
- Complete the field logbook in accordance with procedures listed in SOP 4.07: *Field Logbook Use and Maintenance*.

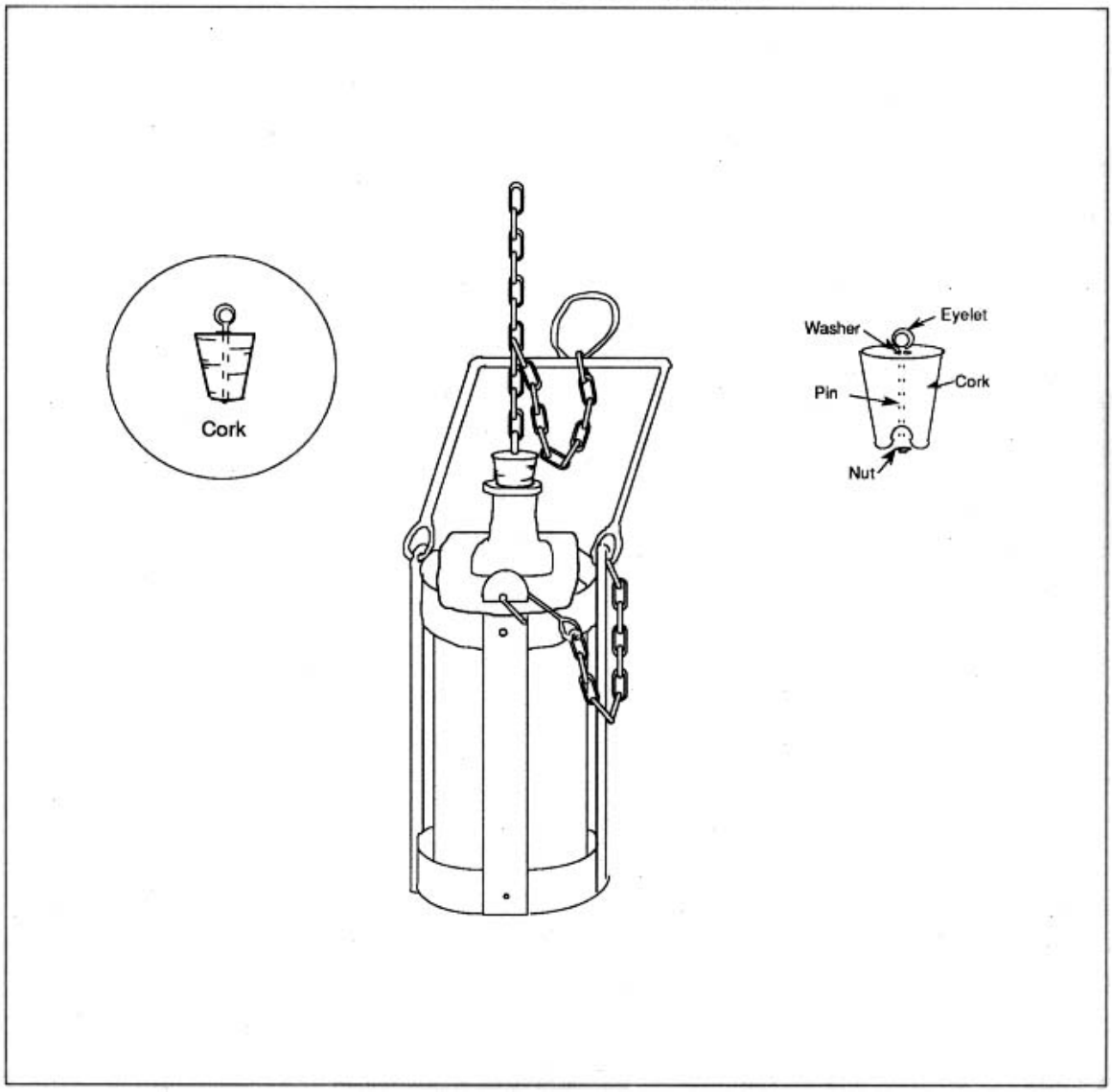
7.0 REFERENCES

U.S. Army Corps of Engineers, 2001. *Requirements for the Preparation of Sampling and Analysis Plans* (EM200-1-3). Appendix C.3.

8.0 ATTACHMENTS

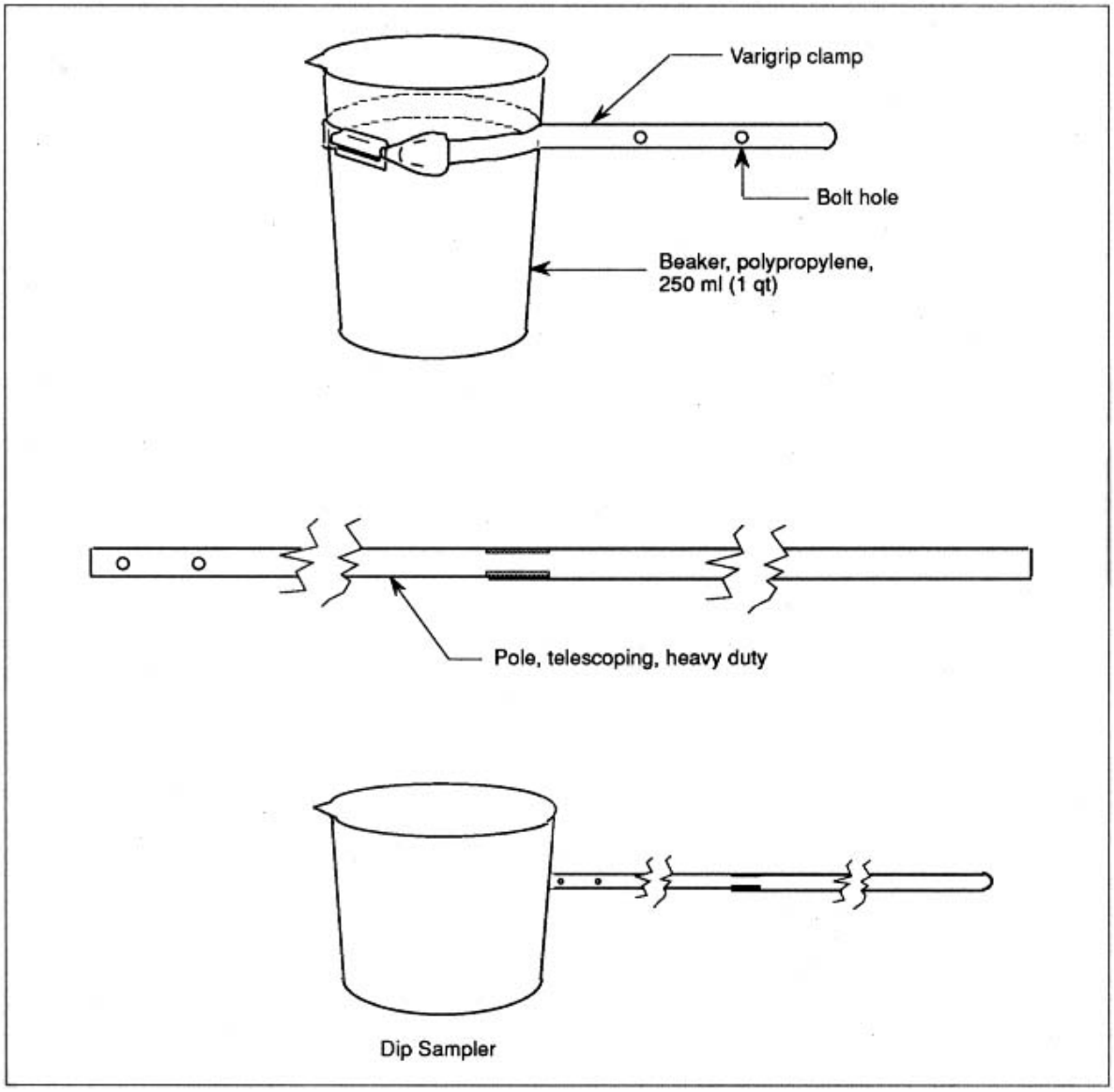
Attachment 1 Weighted Bottle Sampler
Attachment 2 Pond Sampler
Attachment 3 Manual Hand Pump
Attachment 4 Peristaltic Pump
Attachment 5 Peristaltic Pump - Modified
Attachment 6 Surface Water Sampling Data

ATTACHMENT 1
Weighted Bottle Sampler



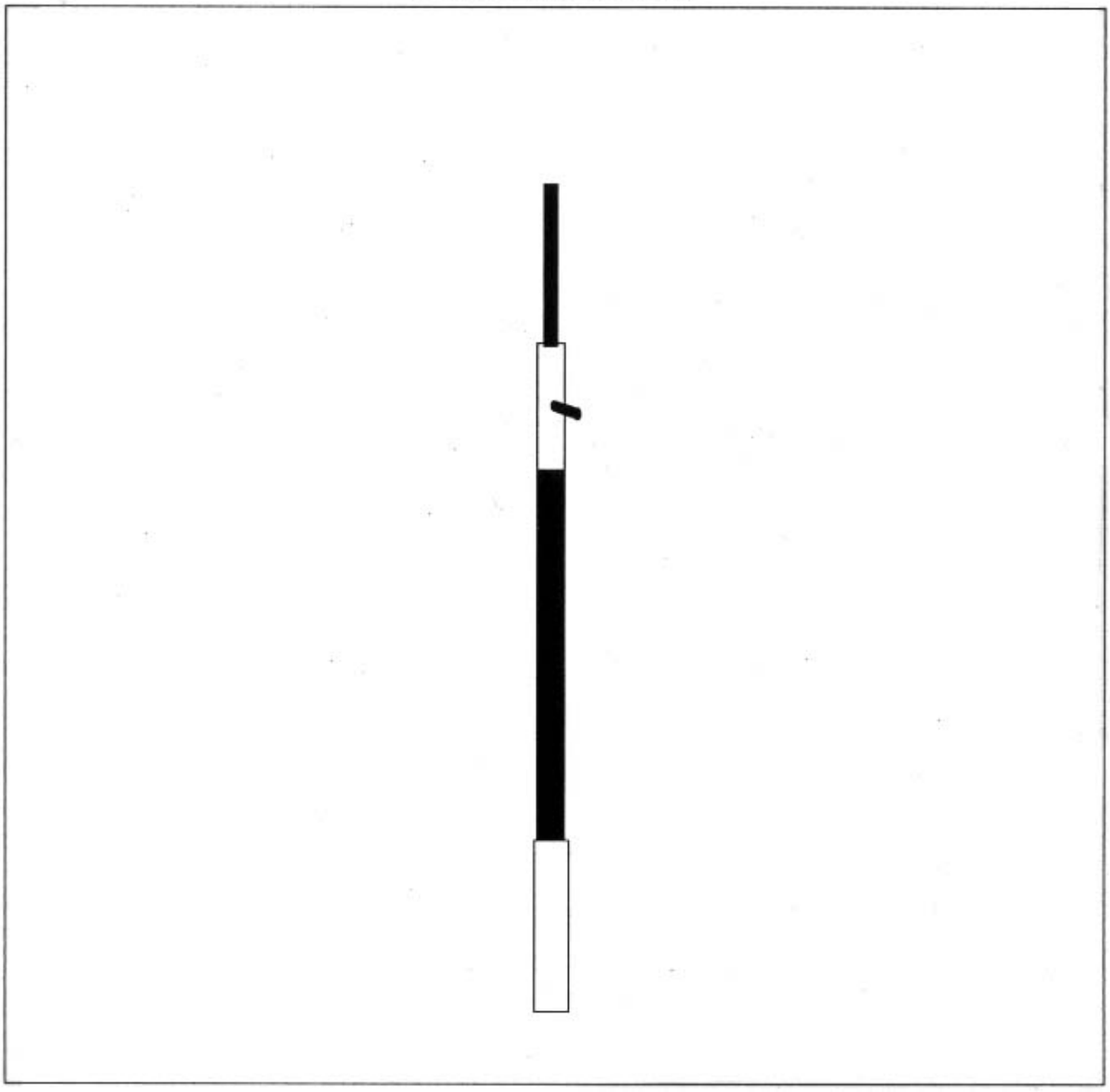
ATTACHMENT 2
Pond Sampler

POND SAMPLER



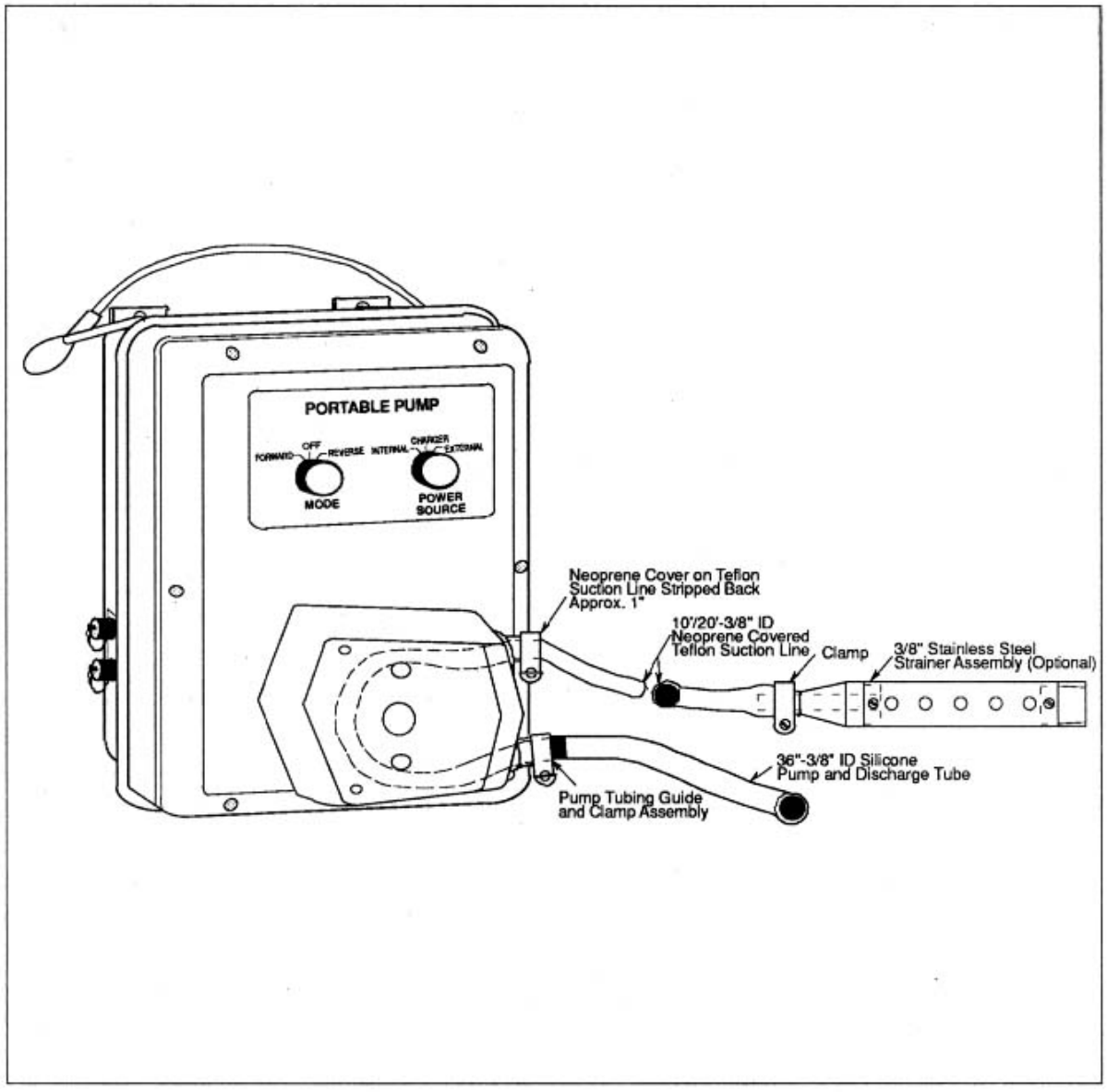
ATTACHMENT 3
Manual Hand Pump

MANUAL HAND PUMP

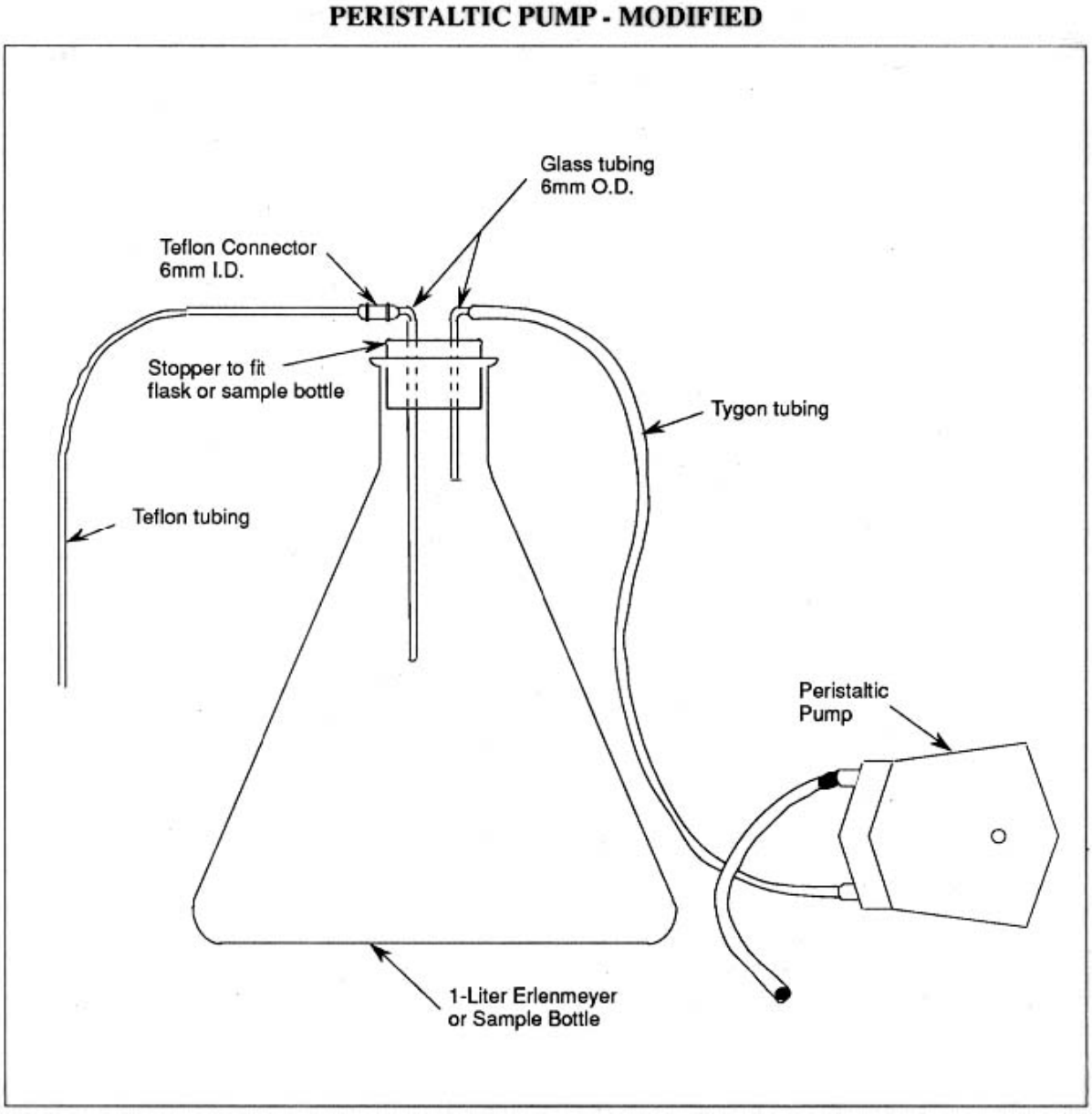


ATTACHMENT 4
Peristaltic Pump

PERISTALTIC PUMP



ATTACHMENT 5
Peristaltic Pump - Modified



ATTACHMENT 6
Surface Water Sampling Data

HGL HydroGeoLogic, Inc Exceeding Expectations

Surface Water Sampling Data Records Management Data

Project Number | Project Name | Page ____ of ____

Time/Date: _____ Elevation: _____

Sample No.: _____ Weather: _____

Location: _____ Amb. Temp (°F): _____

Sampling Method: _____

WATER SAMPLE DATA

Water Temp: _____ °C Method of Measurement: _____

Specific Conductance: _____micromhos Method of Measurement: _____

pH: _____ Method of Measurement: _____

Containers Used (VOA Vial, 1 liter jar, etc.): _____

Physical Appearance: _____

Contamination Observed: _____

Remarks: _____

Location Sketch

Recorded By:	Date	Checked By:	Date:

Domestic and Public Well Sampling

SOP No.: 2.32
SOP Category: HTRW
Revision No.: 0
Date: December 2010

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the standard method and equipment used to perform sampling of private and public wells that are used for water supply.

2.0 SCOPE AND APPLICATIONS

The general techniques described in this procedure are in general agreement with the procedures outlined in the California Department of Pesticide Regulation, Environmental Hazards Assessment Program SOP Number FSWA001.00 and the Wisconsin Department of Natural Resources Groundwater Sampling Desk Reference, PUBL-DG-037 96, 1996.

This SOP emphasizes the need to care for the property of the owner and obtain the highest quality sample possible given the limitations of sampling wells that are outfitted with water delivery systems that are not designed for such sampling. Some jurisdictions have local regulations or guidelines and training/certification requirements that may differ from those described in this SOP. Before using this SOP, location-specific requirements should be evaluated.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan. Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

4.1 OBTAIN PERMISSION TO SAMPLE WELL

A signed access agreement for permission to sample well must be obtained from the property owner before sampling is conducted. Permission to sample each location will be coordinated with

the property owner through the Client, the HGL Project Manager, and Field Manager. Only after gaining explicit permission through these sources will the well owner be contacted and the sampling scheduled.

4.2 SAMPLING PREPARATION

Before departing for the field, the field team leader will disseminate information to the field samplers regarding specific well locations on the property, well depths, holding tank volumes, and other pertinent information.

4.3 INITIAL CONTACTS WITH PROPERTY OWNER

Ring the doorbell and identify yourself and your purpose. Offer your identification badge and/or business card to the property owner for inspection. Describe the sampling procedure to the property owner and ask if they have any questions or concerns. It is very important to listen to the owner's concerns and address questions in a professional and courteous manner. If any issues/concerns are encountered that cannot be resolved, sampling personnel should consult the Project Manager before proceeding.

Determine if the sample will be obtained from an indoor or an outdoor source. If the sample is collected from an outdoor source, ask if the owner has a preference for where to direct the purge water. If the information has not already been provided, the property owner should be questioned as to the well depth and holding tank capacity, if known. Additionally, the owner should be asked if they have a water filtration or conditioning unit in their system. If a water filter is connected to the water system, permission should be asked to obtain the sample before the water passes through such systems. If the property owner is not home but has given permission to sample, consult the sampling instructions for the location of the outside spigot.

4.4 PURGING AND SAMPLING

The equipment and supplies necessary to conducted domestic and private well sampling are listed in Attachment 3.

4.4.1 Small Water Supply Systems (private water supply and distribution systems)

Sample private and non-community wells as close to the well pump as possible; preferably before the water passes through any softener, heater, storage or pressure system, or tank. A sample tap is usually located just before the pressure tank. Remove any aerators, filters or other devices from the tap before collecting samples. If aerators are to be removed, wrap the aerator with a nitrile glove to protect the finish before using pliers to remove the fitting. If the sample must be collected from an outside tap, remove any hoses.

Determine the flow rate using a graduated bucket. Record the flow rate. Record oxidation reduction potential (ORP), pH, temperature, turbidity, and dissolved oxygen (DO) at frequent

intervals during purging (at least every 5 minutes). Note any unusual odors or coloration in the water. Enter all data on the Field Sampling Data Sheet. Acquire samples and draw a diagram of where the sample was collected.

4.4.2 Sampling Tap Located after the Pressure Tank

If the sampling tap is located after the pressure tank, allow the water to run for at least five minutes and to become cold before collecting samples. This should allow stagnant water to be flushed out of the pressure tank and be replaced by freshly pumped water. For large pressure tanks, a longer period may be necessary. Either calculate the necessary flushing time based on the pressure tank volume and purging flow rate, or allow the pump to cycle at least two or three times and wait until the water is cold before collecting samples. Document that samples were collected after the pressure tanks. Record the purging time and tap location. Determine the flow rate using a graduated bucket and record that rate. Record ORP, pH, temperature, turbidity, DO at frequent intervals during purging and enter the data into the Field Sampling Data Sheet (Attachment 2). Acquire samples and draw a diagram of where the sample was collected.

5.0 DECONTAMINATION

Decontamination of non-dedicated sampling equipment should be conducted in accordance with SOP 2.01 *Cleaning and Decontaminating Sampling Equipment*.

6.0 FIELD QUALITY CONTROL

Quality control (QC) samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field QC samples must be collected and prepared in the same manner as regular investigation samples with regard to sample volume, containers, and preservation. Unless specified otherwise in the Quality Assurance Project Plan for the project, the following QC samples should be collected at the rates specified below. Trip blanks are required for samples being submitted for volatile organic compound (VOC) analysis at a frequency of one set per VOC sample cooler.

- Field duplicate (at least 1 for every 10 samples collected)
- Matrix spike (at least 1 for every 20 samples collected)
- Matrix spike duplicate (at least 1 for every 20 samples collected)
- Equipment blank (only needed if additional non-deposable sampling equipment is used to acquire the samples after the tap, at least 1 for every 20 samples collected or one per day)
- Trip blank (one per sample cooler containing VOC samples)
- Temperature blank (one per sample cooler)

- Split samples (samples sent to an alternate laboratory. Sample rate to be specified in the project Work Plan)

The equipment blank will be acquired through use of organic-free deionized water poured over or pumped through the non-disposable sampling equipment used for sampling after it has been decontaminated. If tubing is dedicated to the well, the equipment blank will include only the pump in subsequent sampling rounds. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect a duplicate for each analyte group in consecutive order (VOC original, VOC duplicate semivolatile organic compound (SVOC) original, SVOC duplicate, etc.).

If split samples are to be collected, collect the split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation will be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of ORP, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated at the above frequency. They should be checked for accuracy before field use according to EPA methods and the manufacturer's instructions.

7.0 FIELD LOGBOOK

A field logbook should be maintained in accordance with SOP 4.07 *Use and Maintenance of Field Logbooks*. The following information should be recorded:

- Well identification.
- Well depth, and measurement technique.
- Static water level depth, date, time and measurement technique.
- Presence and thickness of immiscible (nonaquaeous phase) liquid layers and detection method.
- Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.
- Well sampling sequence and time of each sample collection.

- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations during sampling event.
- Name of sample collector(s).
- Weather conditions.
- Quality assurance (QA)/QC data for field instruments.
- Any problems/issues encountered or unusual conditions observed.
- Description of all sampling equipment used, including trade names, model number, diameters, material composition and so forth.

8.0 RECORDS

Complete the Groundwater Field Sampling Data Sheet (measurement times, parameter values, purge volume, water levels, etc.). Record purge information in field logbook.

9.0 QUALITY CONTROL

The project QA Coordinator is responsible for ensuring that all equipment is calibrated daily before use and recording the calibration results on the Calibration Log. The QA Coordinator is responsible for periodically reviewing these results.

10.0 ATTACHMENTS

Attachment 1 Field Sampling Equipment and Supplies
Attachment 2 Groundwater Field Sampling Data Sheet
Attachment 3 Calibration Log

ATTACHMENT 1

Page __ of __

GROUNDWATER FIELD SAMPLING DATA SHEET

Well No.:		Site:	
Sampler(s):		Project No.:	
Well Depth:		Date:	Time:
DTW (ft):	DTP (ft):	Courier: ___UPS ___Hand ___Other	
MP Ht. Above/Below Ground Surface:		Sampling Method (G=grab, B=bailer, SP=submersible pump	
Condition of Bottom of Well:		Type of Pump:	
Screen Interval (ft):		Weather (sun/clear, overcast/rain, wind direction, ambient temperature):	
Well Diameter (in):			
Placement of Pump (ft):			

TIME	DEPTH TO WATER (FT)	FLOW RATE (GPM)	TOTAL VOLUME (GAL)	PH	TEMP. (°C)	COND. (UMHOS/ CM)	ORP	D.O. (MG/L)	TURB (N.T.U.)	COMMENTS

OBSERVATIONS

Color: Clear Other (describe):
Odor: None Low Medium High Very strong H2S Fuel-like
Notes:
PURGE VOLUME CALCULATIONS For: well casing volume = J $(Rc)^2$ (well depth - static H_2O depth) x (conversion 7.48 gal/ft3)
Signed/Sampler(s):

ATTACHMENT 2
CALIBRATION LOG

Page __ of ____

Project Name: _____

Project No. _____

Date/Time	Calibrated by	Instrument	Standard/ Manufacturer Lot #	Standard Concentration	Instrument Reading	Comments

ATTACHMENT 3
EQUIPMENT AND SUPPLIES

Equipment	
Horiba U-22 or YSI-556 water quality analyzer (with flow-thru cell)	Calculator for determining purge volume
Watch with second hand or stopwatch	PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and to provide qualitative field evaluations
Camera (and film if not digital)	
Supplies	
Flow measurement supplies (e.g. graduated cylinder, stopwatch)	Trash bags
Plastic sheeting	Sponges
Paper towels	Decontamination supplies
Locking pliers	5-gallon bucket, 2-gallon bucket
Teflon®tape	Coolers
Sample bottles (with labels and/or tags)	Sample preservation supplies
Chain of custody forms	Personal protective equipment (PPE), Nitrile gloves, Tyvek, over boots, etc.
Garden hose or tubing with fitting to discharge water if not sampling in a drain.	Field logbook
Groundwater field sampling data sheet	Site-specific Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)

Field Logbook Use and Maintenance	SOP No.: 4.07 SOP Category: HTRW Revision No.: 1 Date: December 2010

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the methods for use and maintenance of field logbooks. This procedure outlines methods, lists examples for proper data entry into a field logbook, and provides the standardized HydroGeoLogic, Inc. (HGL) format.

2.0 SCOPE AND APPLICATIONS

This procedure provides guidance for routine field operations on environmental projects. Site-specific deviations from the methods presented herein must be approved by the assigned HGL project manager and the HGL project quality assurance/quality control officer. Consult the project-specific planning documents for other documentation requirements that apply to the project.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements.

Personnel who use this procedure must provide documented evidence to the program manager or project manager that they have been trained on the procedure. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and documented in the planning documents. Deviations from requirements will be sufficiently documented to re-create the modified process.

All field personnel who travel to a site to conduct work related to environmental projects are responsible for documenting field investigation activities in project field logbooks in a legible manner and maintaining field logbooks over the course of the project in accordance with this SOP. Daily logs will be kept during field activities by the HGL field team leader, or approved designee, to provide daily records of significant events, observations, and measurements taken in the field.

The project manager or an approved designee is responsible for checking the field logbooks and verifying that they have been completed in accordance with this SOP.

4.0 PROCEDURE

4.1 INTRODUCTION

Field logbooks provide a means for recording observations and activities at a site. Field logbooks are intended to provide sufficient data and observation notes to enable participants to reconstruct events that occurred while performing field activities and to refresh the memory of field personnel when writing reports or giving testimony during legal proceedings. As such, all entries will be as factual, detailed, and as descriptive as possible so that a particular situation can be reconstructed without reliance on the collector's memory. Field logbooks are not intended to be used as the sole source of project or sampling information. A sufficient number of logbooks will be assigned to a project to ensure that each field team has a logbook at all times.

4.2 FIELD LOGBOOK IDENTIFICATION

Field logbooks shall be bound books with consecutively numbered pages. Logbooks will be permanently assigned to field personnel for the duration of a project, or sampling event. When not in use, the field logbooks are to be stored in site project files. If site activities stop for an extended period of time (2 weeks or more), field logbooks will be stored in the project files in the appropriate HGL office.

The cover of each logbook will contain the following information:

- Organization to which the book is assigned (HGL)
- Project number (if different than site number)
- Book number
- Site name

4.3 LOGBOOK ENTRY PROCEDURES

Every field team will have a logbook, and each field activity will be recorded in the logbook by a designated field team member to provide daily records of significant events, observations, and measurements during field operations. Beginning on the first blank page and extending through as many pages as necessary, the following list provides examples of useful and pertinent information that may be recorded (optional).

- Serial numbers and model numbers for equipment that will be used for the project duration
- Formulas, constants, and example calculations
- Useful telephone numbers

- County, state, and site address

Entries into the logbook may contain a variety of information. At a minimum, logbook entries must include the following information at the beginning of each day:

- Date
- Site name, site location, and project number
- Start time
- Weather
- All field personnel and subcontractors present and directly involved
- Level of personal protective equipment being used on the site
- Equipment used and calibration procedures followed
- Any field calculations

In addition, information recorded in the field logbook during the day will include, but is not limited to, the following:

- Sample description including sample numbers, time, depth, volume, containers, preservative, and media sampled
- Information on field quality control samples (e.g., duplicates)
- Sample courier airbill numbers and associated chains-of-custody
- Observations about site and samples (odors, appearances, etc.)
- Information about any activities, extraneous to sampling activities, that may affect the integrity of the samples
- Any public involvement, visitors, or press interest, comments, or questions; as well as times present at site
- Equipment used on site including time and date of calibration along with calibration gas/fluid lot numbers and expiration dates
- Background levels of each instrument and possible background interferences
- Instrument readings for the borehole, cuttings, or samples in the breathing zone and from the specified depth of the borehole, etc.
- Field parameters (pH, specific conductivity, etc.)
- Unusual observances, irregularities, or problems noted on site or with instrumentation used

- Maps or photographs acquired or taken at the sampling site, including photograph numbers and descriptions
- A description of the investigation-derived waste (IDW) generated, the quantity generated, and the manner of IDW storage employed
- A photograph log that lists subject and persons, distance to subject, person taking photograph, distance, direction, time, photograph number, and noteworthy items for each photograph
- Forms numbers and any information contained therein used during sampling (Note that a form does not take the place of the field logbook.)

All logbook entries will be made in indelible black or blue ink. No erasures are permitted. If an incorrect entry is made, the data will be crossed out with a single strike mark and initialed and dated by the originator. Entries will be organized into easily understandable tables if possible. A sample format is shown in Attachment 1.

All logbook pages will be initialed and dated at the top of each page. Times will be recorded next to each entry. No pages or spaces will be left blank. If the last entry for a day is not at the end of a page, a diagonal line will be drawn through the remaining space and the line will be initialed and dated.

Logbooks can become contaminated when used in the field. Every effort should be made by the field team to avoid contaminating the logbook. Logbooks can be kept in seal-top poly bags or temporary plastic covers may be used.

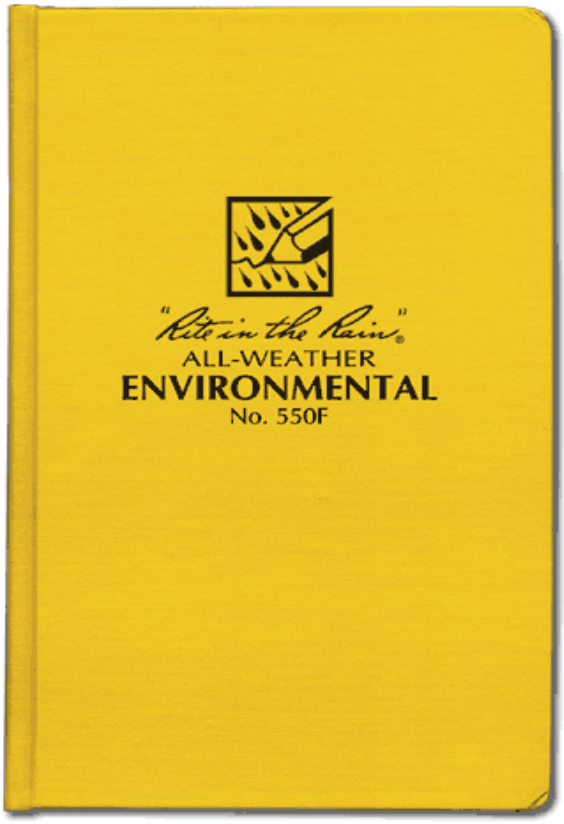
4.4 REVIEW

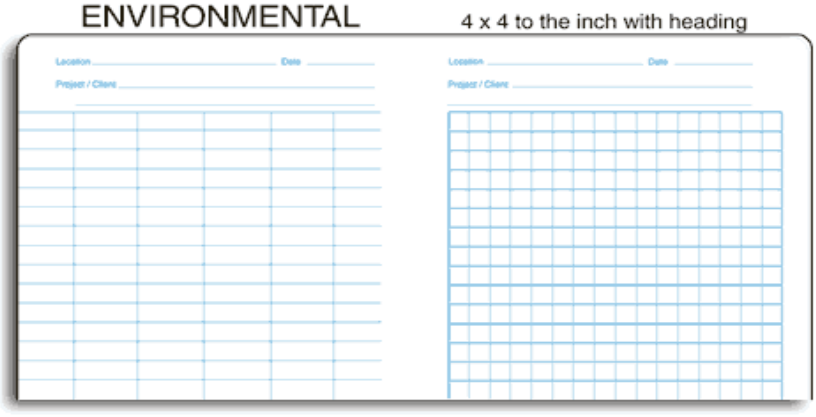
The assigned project leader or an approved designee will check field logbooks for completeness and accuracy on an appropriate site specific schedule determined by the project leader. Any discrepancies in these documents will be noted and returned to the originator for correction. The reviewer will acknowledge that these review comments have been incorporated by signing and dating the applicable reviewed documents.

5.0 ATTACHMENTS

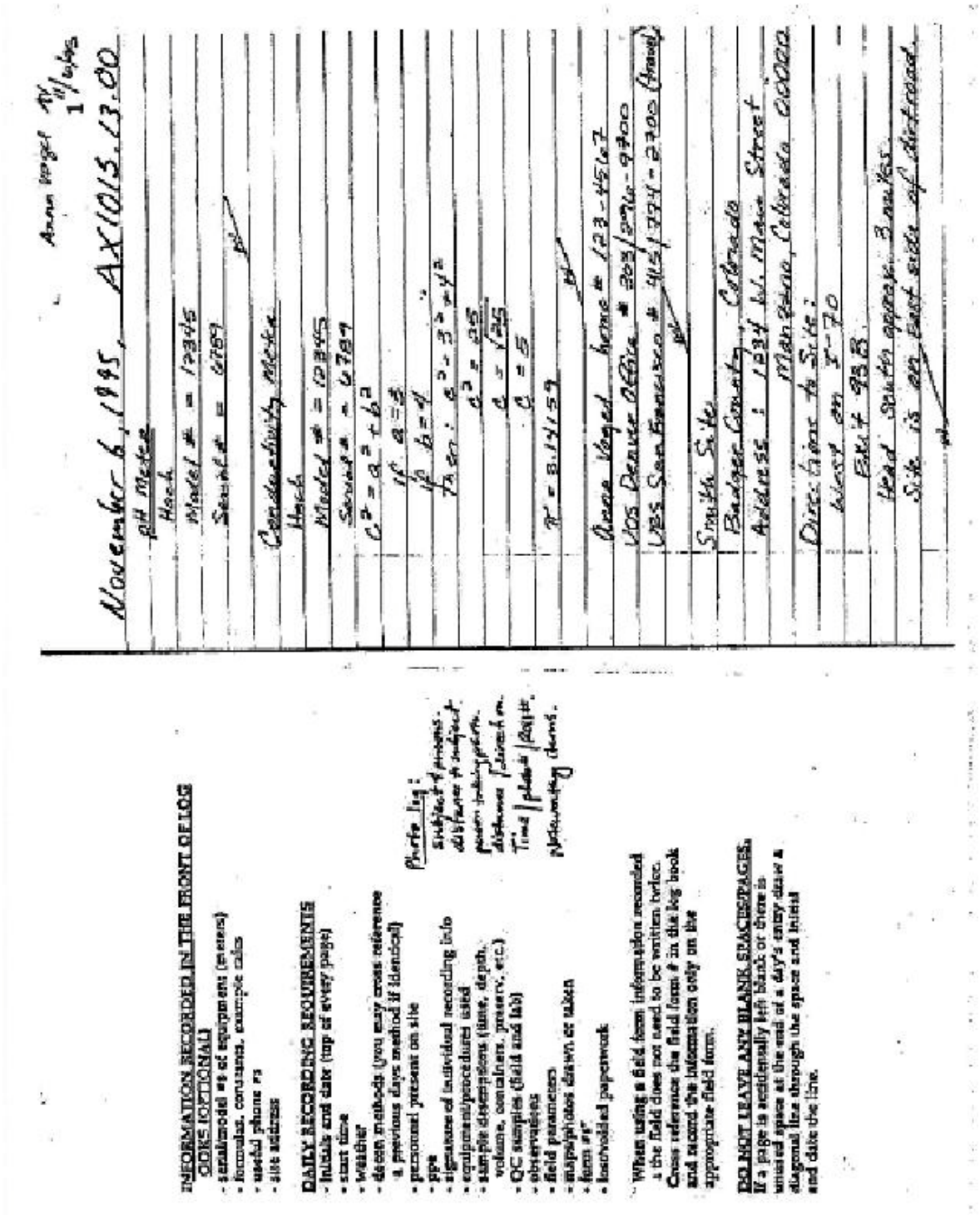
Attachment 1 Example Field Logbook

ATTACHMENT 1
Example Field Logbook

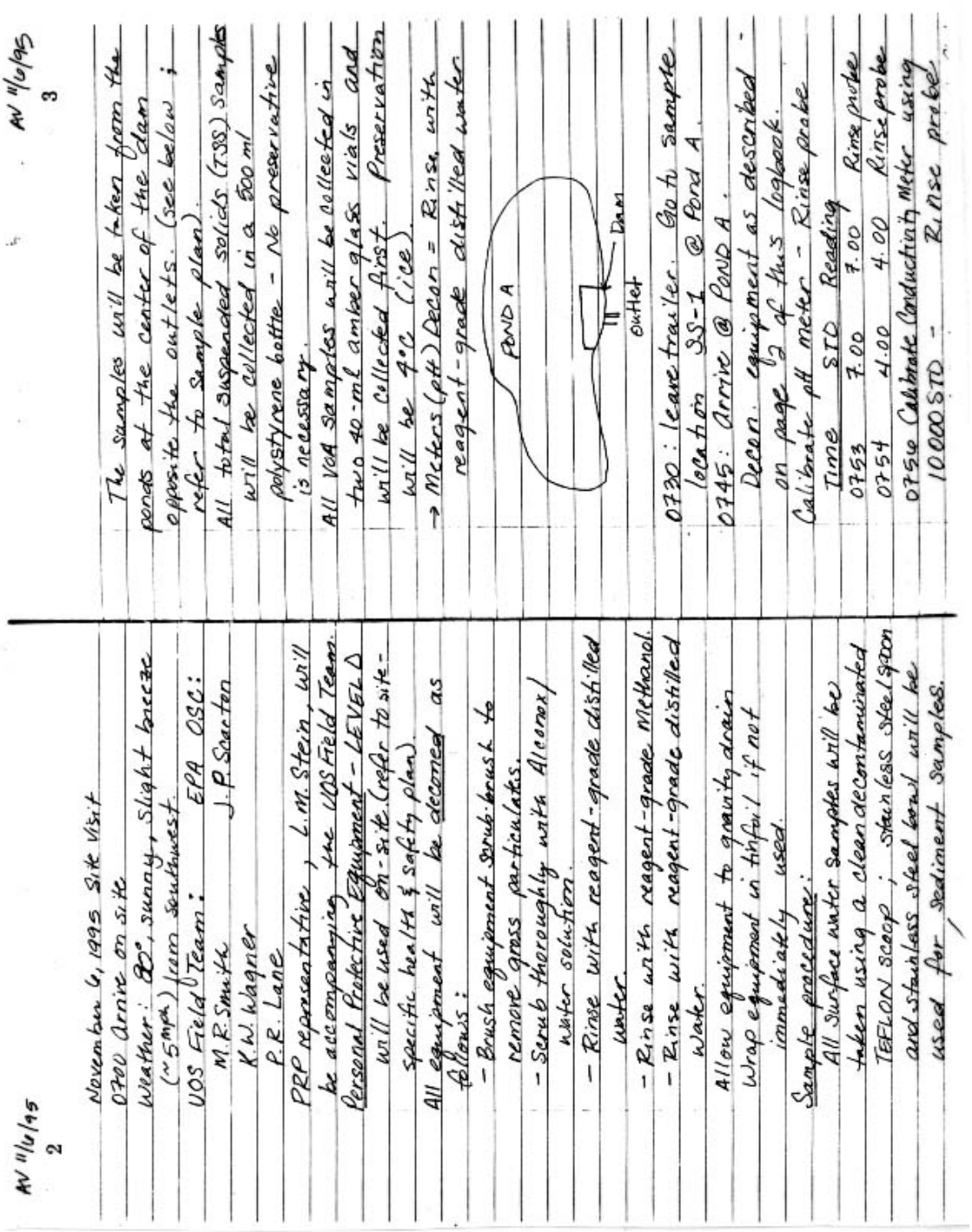




ATTACHMENT 1 (continued)
Example Field Logbook



ATTACHMENT 1 (continued)
Example Field Logbook



AV 11/6/95
2

November 6, 1995 Site Visit
0700 Arrive on site
Weather: 80°, sunny, slight breeze (~5mph) from southwest.
UOS Field Team: EPA OSC:
M.R. Smith J.P. Starten
K.W. Wagner
P.R. Lane
PRP representatives, L.M. Stein, will be accompanying the UOS Field Team.
Personal Protective Equipment - LEVEL D
will be used on-site. (refer to site-specific health & safety plan)
All equipment will be deconed as follows:
- Brush equipment scrub brush to remove gross particulates.
- Scrub thoroughly with Alconox/ water solution.
- Rinse with reagent-grade distilled water.
- Rinse with reagent-grade Methanol.
- Rinse with reagent-grade distilled water.
Allow equipment to gravity drain
Wrap equipment in tinfoil if not immediately used.
Sample procedure:
All surface water samples will be taken using a clean decontaminated TEFLON scoop; stainless steel spoon and stainless steel bowl will be used for sediment samples.

AV 11/6/95
3

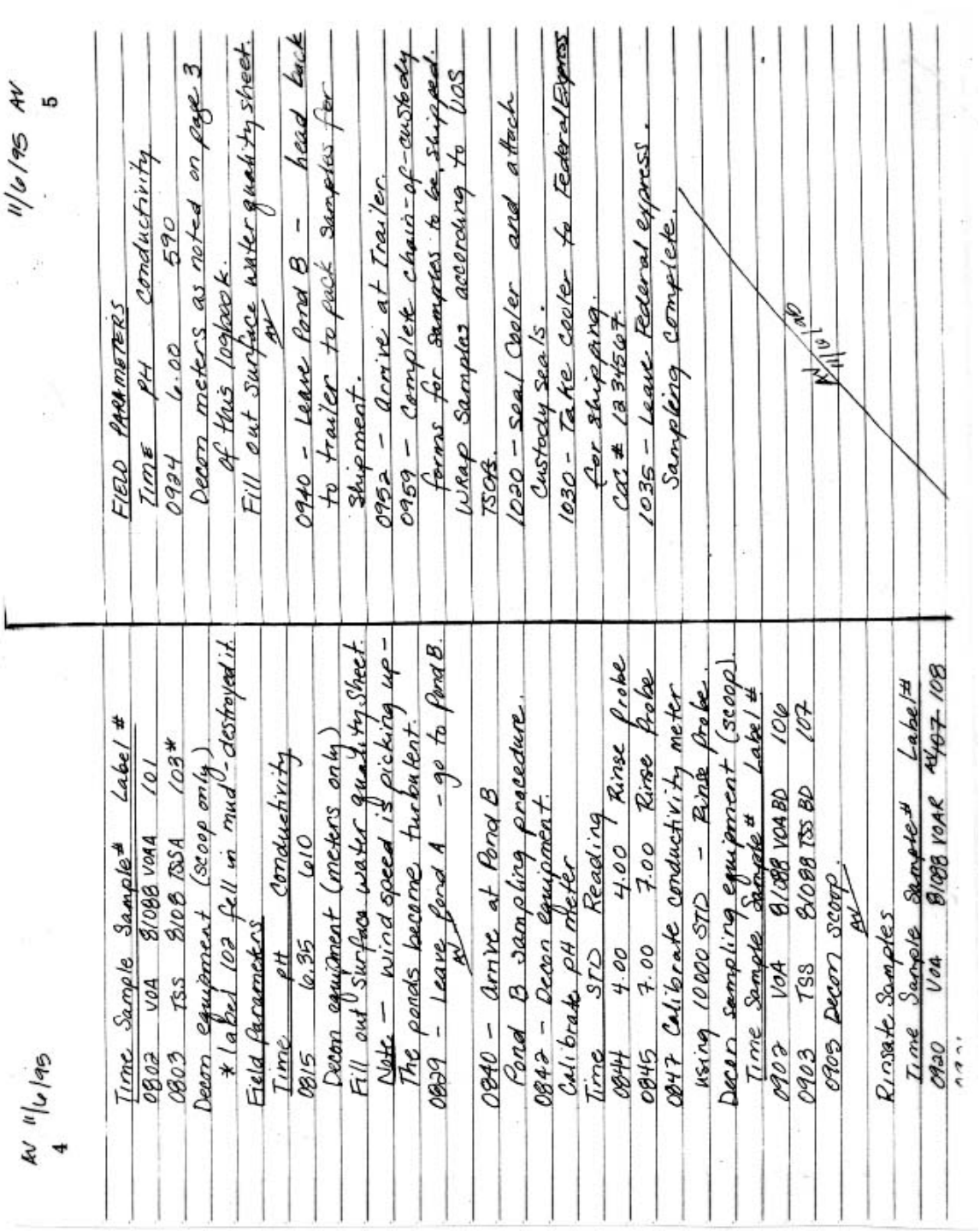
The samples will be taken from the ponds at the center of the dam opposite the outlets. (see below; refer to Sample plan).
All total suspended solids (TSS) samples will be collected in a 500 ml polystyrene bottle - No preservative is necessary.
All VOA samples will be collected in two 40-ml amber glass vials and will be collected first. Preservation will be 4°C (ice).
→ Meters (pH) Decon = Rinse with reagent-grade distilled water

0730: Leave trailer. Go to sample location SS-1 @ Pond A.
0745: Arrive @ Pond A.
Decon. equipment as described - on page 2 of this logbook.
Calibrate pH meter - Rinse probe

Time	STD	Reading	
0753	7.00	7.00	Rinse probe
0754	4.00	4.00	Rinse probe

0756 Calibrate Conductivity Meter using 10,000 STD - Rinse probe

ATTACHMENT 1 (continued)
Example Field Logbook



11/6/95 AV 5

FIELD PARAMETERS

Time	PH	Conductivity
0924	6.00	590

Decon meters as noted on page 3 of this logbook.

Fill out surface water quality sheet. AV

0940 - Leave Pond B - head back to trailer to pack Samples for Shipment.

0952 - Arrive at Trailer.

0959 - Complete Chain-of-custody forms for Samples to be shipped. Wrap Samples according to DOS TSOP.

1020 - Seal Cooler and attach Custody Seals.

1030 - Take Cooler to Federal Express for shipping.

CAC # CA 3165677.

1035 - Leave Federal express. Sampling complete.

AV 11/6/95 4

Time Sample Sample# Label #
0802 VOA B1088 VOAA 101
0803 TSS B108 TSSA 103*
Decon equipment (scoop only)
*Label 103 fell in mud - destroyed it.
Field Parameters
Time pH Conductivity
0815 6.35 610
Decon equipment (meters only)
Fill out Surface water quality Sheet.
Note - wind speed is picking up - The ponds became turbulent.
0839 - Leave Pond A - go to Pond B. AV
0840 - Arrive at Pond B
Pond B sampling procedure.
0842 - Decon equipment.
Calibrate pH meter
Time STD Reading
0844 4.00 4.00 Rinse probe
0845 7.00 7.00 Rinse probe
0847 Calibrate conductivity meter using 10,000 STD - Rinse probe.
Decon sampling equipment (scoop).
Time Sample Sample # Label #
0902 VOA B1088 VOA BD 106
0903 TSS B1088 TSS BD 107
0905 Decon scoop. AV
Rinsate Samples
Time Sample Sample# Label/#
0920 VOA B1088 VOAR AV07-108

HydroGeoLogic, Inc Exceeding Expectations	STANDARD OPERATING PROCEDURE	
	Approved by: M. McSwain CSP, CIH	Corporate QA Manager Technical Lead
Heat Stress Monitoring	**SOP No.: 7.22**	
	SOP Category: 200 - Health and Safety	
	Revision No.: 0	
	Revision Date: November 2013	
	Review Date: November 2015	

1.0 PROCEDURES

This standard operating procedure (SOP) provides the basic responsibilities and procedures for the evaluation and protection of HydroGeoLogic, Inc. (HGL) employees, subcontractors, and U.S. Government employees during field operations.

HGL is committed to the health and safety of project personnel and will institute this standard operating procedure to protect personnel from heat stress related illnesses. Project personnel will be trained to the requirements of HGL's Heat Stress Program and this SOP before and during operations. Personnel will be retrained as needed during operations to insure compliance.

1.1 SCOPE AND APPLICABILITY

This procedure applies to all HGL personnel, subcontractors, and U.S. Government employees that will be present during field operations where exposure to heat stress is a concern. This SOP is a supplement to the Corporate Safety and Health Manual Section 14.1 Heat Stress Program plus Appendices A (Warning Signs, Symptoms, and Emergency Response) and Appendix B Site Safety and Health Officer (SSHO) (Wet Bulb Globe Thermometer (WBGT) Log) and to the corresponding project site safety and health plan (SSHP).

1.2 SUMMARY OF METHOD

This SOP provides guidance on risk factors, mitigation strategies, and recognizing signs and symptoms as an aid to avoiding heat stress and illnesses. Working in heat, stresses the body and can lead to illness or even death in severe cases. Exposure to heat can also increase the risk of other injuries because of sweaty palms, fogged-up safety glasses, dizziness, and burns from hot surfaces.

1.3 DEFINITIONS

Acclimatization: refers to the physiological changes taking place after prolonged exposure to heat, which partly involves increased sweat production. Core body temperature can be controlled within acceptable limits and the body then becomes accustomed to a hot environment. Acclimatization takes place over several days, with the greatest benefit occurring during the first four to five days. However, acclimatization is reversible following cessation of exposure.

Convection: is the process of heat exchange between the body and the surrounding air as a result of air moving over the skin.

Core body temperature: is generally considered to be the temperature of the vital organs. These organs are maintained within a narrow range of temperatures by thermoregulatory mechanisms.

Dehydration: is the loss or deficiency of water in body tissues, which may be caused by perspiration, vomiting, or diarrhea. Symptoms include excessive thirst, nausea, and exhaustion.

Heat stress: is the sum of heat generated in the body (metabolic heat) plus heat gained from the environment minus heat lost from the body to the environment. The risk of heat related disorders and accidents increases substantially with increasing heat stress.

Heat strain: is the series of physiological responses to heat stress. These responses reflect the degree of heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and finally a heat disorder may ensure. The severity of the strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Radiation (heat): is the transfer of heat to or from surrounding objects that are not in direct contact with the body.

Humidity (relative): is the ratio of the water vapor content of air to the maximum possible water vapor content of air at the same temperature and air pressure.

WBGT Index: is used to measure occupational heat exposure, which combines several environmental factors that contribute to heat load. Environmental factors include air temperature and movement, radiant heat and evaporation.

1.4 ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
EMT	emergency medical technicians
HGL	HydroGeoLogic, Inc.
RSSP	responsible site safety personnel
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
SSHO	site safety and health officer
WBGT	wet bulb globe temperature

1.5 HEALTH AND SAFETY WARNINGS

The risk of heat stress is relative to temperature, humidity, sunlight, and wind speed. High temperature, high humidity, direct sunlight, and low wind speed make the worst combination.

Indoors, try to provide ventilation/enhance air movement. The risk of heat stress increases with physical demands. A worker who is lifting and carrying heavy items is at the greatest risk.

1.6 CAUTIONS

Older workers, obese worker, and persons taking certain types of medication, such as antihistamines, are at a greater risk for heat illness.

1.7 INTERFERENCES

Workers should avoid overexertion, work at a steady pace, heed the body's signals, and take plenty of breaks in shaded or cooler areas. When possible, difficult work tasks in hot conditions should be rotated between two or more employees.

1.8 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

1.8.1 HGL Personnel

HGL personnel will be responsible for following the guidelines of this SOP and all guidelines established in the SSHP.

1.8.2 Subcontractors

All HGL subcontractors will be responsible for following the guidelines of this SOP and all guidelines established by the SSHP.

1.8.3 U.S. Government Personnel

All U.S. Government personnel will be responsible for following the guidelines of this SOP, the guidelines established by the SSHP, and the guidelines established by individual agencies.

1.8.4 Emergency Medical Technicians (EMT)

EMT personnel (if present) will monitor worker core temperatures and record this data during daily operations. EMT personnel will record base line information, provide and review medical questionnaires and examine each person before and after field operations. EMT personnel will have authority to recommend to the responsible site safety personnel (RSSP) and U.S. Army Corps of Engineers' ordnance and explosives safety specialists the removal of individuals who are not medically fit for field operations.

1.8.5 Responsible Site Safety Personnel

RSSP (SSHO, unexploded ordnance safety officers, or other named personnel) are responsible for confirming that HGL personnel, subcontractors, and U.S. Government employees have received heat stress prevention training and understand the elements of this SOP. RSSP will conduct training prior to operations and will confirm compliance during operations.

The RSSP will take the following actions as necessary to protect the health of site personnel:

- Observe employee actions and behaviors to detect early signs of heat stress;
- Adjust work schedules as determined by climate;

  NOTE: Split work days, early start up, or night work may be necessary for certain tasks and in times of excessive heat and/or humidity.

- Modify work/rest schedules according to WBGT monitoring results and workloads;
- Mandate work slowdowns as needed;
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods;
- Confirm workers are acclimated to weather conditions and are experienced in using the selected level of personal protective equipment in hot environments. Unprepared workers will be acclimatized by gradually increasing the workload over a period of days and shall be carefully observed to avoid excessive heat stress;
- Encourage workers to maintain worker's body fluids at normal levels for normal cardiovascular system function;

  NOTE: Daily fluid intake must approximately equal the amount of water lost in sweat, [e.g. 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of water weight loss]. The normal thirst mechanism is not sensitive enough to ensure that enough water will be ingested to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day is recommended, but more may be necessary to maintain body weight.

- Maintain drinking water temperature between 50 to 60 °F (10 to 16.6 °C) to prevent cramping;
- Provide small disposable cups that hold about 4 ounces (0.1 liter);
- Counsel workers to drink 16 ounces (0.5 liters) of fluid (preferably water or diluted drinks) before beginning work;
- Intersperse drinking electrolyte drinks with drinking water;
- Re-train workers to recognize the symptoms of heat-related illnesses; and
- Rotate personnel and alternate job functions.

1.9 EQUIPMENT AND SUPPLIES

A wet bulb globe temperature (WBGT) monitor will be used to monitor for conditions that may pose a threat of heat stress to workers.

A clinical thermometer or similar device (e.g. temperature strip) will be used to measure the oral temperature of workers at the end of the work period (before drinking).

1.10 PROCEDURE

1.10.1 Ambient Temperature Monitoring

WBGT monitoring will be conducted by the RSSP when the ambient temperature exceeds 75 degrees Fahrenheit (°F). Once the WBGT has been determined, the SSHO can estimate workers' metabolic heat load using the tables provided in Table 7.22-1, American Conference of Governmental Industrial Hygienists (ACGIH) Screening Criteria for Heat Stress Exposure to determine the appropriate work-rest regimen.

Table 7.22-1
ACGIH Screening Criteria for Heat Stress Exposure

Hourly Work Requirement	Physical Demand of the Task			
	Light	Moderate	Heavy	Very Heavy
100% Work	85.1 °F	81.5 °F	78.8 °F	-
75% Work 25% Rest	86.9 °F	83.3 °F	81.5 °F	-
50% Work 50% Rest	88.7 °F	85.1 °F	83.3 °F	81.5 °F
25% Work 75% Rest	90.5 °F	87.8 °F	86.0 °F	85.1 °F

1.10.2 Heart Rate Monitoring

- The worker's heart rate and temperature will be tracked by the RSSPs to evaluate the effectiveness of the work-rest schedule. The results of down range worker monitoring will be recorded and reviewed by the SSHO. The work-rest schedule will be shortened or extended based on the recommendations of the RSSPs for individuals or entire teams.

- To monitor a worker's heart rate, the designated person will count the radial pulse of the worker during a 30-second period, as early as possible in the rest period.

- If the worker's heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle should be shortened by one-third (the rest time will remain constant).

- If the worker's heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be shortened again by a third.

1.10.3 Body Temperature Monitoring

- A clinical thermometer or similar device (e.g. temperature strip) will be used to measure the oral temperature of workers at the end of the work period (before drinking).

- If the oral temperature of a worker increases >2 °F during the work period, the following work cycle will be shorten by one-third.

- If the oral temperature continues to be elevated >2 °F, the next work cycle will again be shortened by a third. This process will continue until elevated temperatures are no longer observed.

- Based upon data and the judgment of the RSSP, the work cycle may be extended if oral temperatures of the team remain within 1 °F and heart rates are below 110 beats per minute.

- Workers can return to work after heart rate and temperature return to normal (usually after 15-minute rest period).

- Modification to the work-rest schedule can be instituted by the RSSP based on physiological monitoring data.

1.11 DATA AND RECORDS MANAGEMENT

Documentation generated as a result of this procedure is collected and maintained in accordance with requirements specified in the site-specific work plan.

2.0 QUALITY ASSURANCE AND QUALITY CONTROL

The effectiveness of quality assurance and quality control measures taken are evident in the outcomes of personnel monitored for heat stress.

3.0 REFERENCES

ACGIH, ***Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,*** Cincinnati, OH, 2012.

Occupational Safety and Health Administration, ***Technical Manual***, Section III, Chapter 4, Heat Stress, Washington, DC, January 20, 1999.

4.0 EXHIBITS

Not applicable.

Accountability and Management of Explosive Materials	SOP No.: 15.00 SOP Category: MMRP Revision No.: 04 Date: January 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide HydroGeoLogic, Inc. (HGL) employees specific guidance and procedures for the accountability and management of explosive materials. These procedures are established to ensure all explosive operations are conducted in compliance with the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) Publication 5400.7, Federal Explosives Law and Regulations and the Department of Defense (DoD) Manual 6055.09-M, DoD Ammunition and Explosives Safety Standards.

2.0 SCOPE AND APPLICATION

This SOP applies only to those HGL employees who have been assigned to Military Munitions Program Response (MMRP) project-specific explosive operations. Only those individuals who are listed as "*cleared*" on the most recent ATF Federal Explosive Licensing Center (FELC) Notice of Clearance will be authorized direct physical access to explosive materials during explosive operations. The current FELC Notice of Clearance is held on file at the HGL Huntsville, AL Office if needed for verification of individual clearance status.

Personnel who use this procedure must provide written documentation to the Unexploded Ordnance (UXO) Safety Manager and project Senior UXO Supervisor (SUXOS) that they have read and understand this SOP by completing the Acknowledgement Sheet, Attachment 1. This documentation will be retained by the UXO Quality Control Specialist (UXOQCS) in the project file.

Any deviations from specified requirements will be justified and authorized by the MMRP Operations Manager, and discussed in the approved project plans. Deviations from these requirements will not compromise Federal Law and will be sufficiently documented to re-create the modified process.

3.0 DEFINITIONS

Responsible Person: An ATF "Responsible Person" (RP) is an employee under HGL's explosive license who has the power to direct the management and policies pertaining to explosive materials.

Employee Possessor: An ATF "Employee Possessor" (EP) is any employee under HGL's explosive license who has or will have actual physical possession (direct access) of explosive materials or who has or will have constructive possession of explosive materials. This includes HGL employees assigned to UXO positions who directly handle explosive materials as part of the production process; employees who handle explosive materials in order to ship or transport them; and employees, such as blasters and their helpers who actually use explosive materials.

Constructive Possessor: A "*Constructive Possessor*" is any person who has access to explosive materials, without physically handling them. For example, a Demolition Supervisor providing munitions and explosives of concern (MEC) support during construction activities who keeps keys for storage magazines in which explosives are stored or who directs the use of explosive materials by other employees has constructive possession of explosives.

4.0 EXPLOSIVE ACCOUNTABILITY AND MANAGEMENT PROCEDURES

For the purpose of this SOP, the SUXOS position will also refer to all instances when a UXO Technician III is assigned the Demolition Supervisor responsibilities on HGL projects involving MEC support during construction activities. All explosive operations will be performed in a manner that is consistent with ATF Publication (ATFP) 5400.7, DoD 6055.09–M, and this SOP. All HGL project sites where explosive operations will be conducted will have a section within the work plan that provides specific procedures for accountability and management of explosive materials associated with that site.

– W A R N I N G –

Every HGL employee who transports, stores or uses explosive materials must clearly understand their responsibilities for properly safeguarding, securing, and storing explosive materials.

Any disregard of these procedures will result in being denied physical access to explosive materials and possible termination of employment.

Any violation of the Federal Explosive Law and Regulations could result in being charged with a criminal offense.

4.1 GENERAL

This section outlines the procedures that will be followed by HGL employees for maintaining proper accountability and management of explosives materials purchased, stored, transported, and used on HGL project sites. These procedures were developed using the following references:

- ATFP 5400.7 (27 CFR Parts 555 and 841 § A–K)
- ATFP 5400.14
- ATFP 5400.17
- ATFP 5400.20
- DoD 6055.09-M
- 49 CFR parts 146–149

4.2 EXPLOSIVE LICENSE

HGL holds an ATF Type 20–Manufacturer of High Explosives License to purchase and use explosives on project sites, Attachment 2. The original license is posted at the HGL office in Huntsville, AL.

– N O T I C E –

A copy of this license will be posted at each HGL project site where explosive materials are stored and used, and will be available for Federal, State, or local inspections.

4.3 HGL AUTHORIZED INDIVIDUALS

Only HGL employees who are listed on the FELC Notice of Clearance will be authorized to have direct access to explosive materials. The SUXOS will coordinate with the UXO Safety Manager in determining the project personnel who will be require to have direct access to explosive materials and confirm these individuals are listed on the FELC Notice of Clearance.

HGL is required to provide commercial explosives suppliers with a list of employees who are authorized to receive and issue explosives. For HGL projects this individual will be the SUXOS, and if the SUXOS is not available, it will be an identified and authorized UXO Technician.

4.3.1 Responsible Person

HGL employees who are designated by the HGL Chief Operating Officer to fill a "Responsible Person" position must complete and submit the following items/documents to the UXO Safety Manager:

- ATF E-Form 5400.28 Employee Possessor Questionnaire (EPQ),
- Completed FD–258 Fingerprint Card, and
- A 2–inch by 2–inch color photograph.

The UXO Operations Manager will verify all forms are properly completed and submitted to the FELC.

4.3.1.1 Employee Possessor

HGL employees who are required by their position to have direct access to explosive materials will complete and submit the ATF E-Form 5400.28 EPQ to the UXO Safety Manger. The UXO Safety Manager will verify this form is properly completed and submitted to the FELC. Once the EPQ is received by FELC, the employee will be authorized to have direct access to explosive materials unless denied by the ATF.

4.4 ACQUISITION OF EXPLOSIVE MATERIALS

All explosive materials acquisitions will be recorded on the day of the acquisition, manufacture, or receipt using the Manufacturer of Explosives Record of Acquisition (MERA) form, (refer to the example, Attachment 3) in accordance with (IAW) 27 CFR §555.123(b). Arrangements and coordination with the acquisition sources (commercial explosive supplier) will be coordinated in the project work plan. An electronic copy of this form will be submitted within 48 hours of the acquisition to the UXO Safety Manager.

4.4.1 Binary Explosives

When binary explosive materials are mixed together into a single solution and held for storage, this is considered "*manufacturing explosives*". This action will be recorded as an "*acquisition*" within 24 hours of mixing on the MERA by following the procedures outlined in Section 4.4.

– E X C E P T I O N –

IAW 27 CFR §555.123(d)(3) a licensed manufacturer is exempt from recordkeeping requirements if the explosive materials are manufactured (for example, mixing binary explosives) for their own use and used within a 24–hour period at the demolition shot site.

4.4.2 Order Quantity

Each project site's SUXOS will coordinate with the project manager to ensure an initial quantity of commercial explosives has been purchased and is on hand before commencing MEC demilitarization and disposal operations. Based on usage requirements and demand, the quantity in stock may increase, but at no time will the explosive weight (NEW) exceed the storage limit established by the project site's DDESB-approved Explosive Safety Submission (ESS) or Explosive Site Plan (ESP).

4.4.3 Acquisition Source and Delivery

HGL will only purchase commercial explosives from ATF licensed explosive dealers who will deliver explosive materials to the project site. The SUXOS will coordinate with the UXO Safety Manager to ensure that:

- All project explosive materials acquisition sources are identified;
- A listing of explosive material requirements is developed during the project planning phase;
- Purchase orders are submitted to the explosive dealer(s) for the required amount of explosive materials;

- The explosive dealer receives a copy of the HGL Authorized Agent list for those site employees who are authorized to purchase and receive explosive materials,
- The explosive dealer receives a copy of the HGL Manufacturer of Explosive–Type 20 License with the original signature of an HGL "*cleared*" "*Responsible Person*"; and
- Explosive material delivery arrangements are established.

4.5 INITIAL RECEIPT OF EXPLOSIVE MATERIALS

Upon receipt of explosive materials at a project site the SUXOS will immediately check the lot number or manufacture's marks and nomenclature/description of each explosive item against the explosive delivery manifest/invoice and will record this information on the MERA and the Daily Summary of Magazine Transactions (DSMT), Attachment 4.

A copy of the original delivery invoice/manifest receipt document will be maintained on site by the SUXOS. The completed DSMT record will remain in the magazine with the explosive materials and will be annotated and updated upon each issue, receipt, and weekly/yearly inventory. A duplicate DSMT record will be kept by the SUXOS in the project files. An electronic copy of the DSMT will be submitted within 48 hours of any transaction entry to the UXO Operations Manager.

4.5.1 Explosive Materials Accountability

All explosive material receipts, issues, turn-ins, and inventories will be properly documented and verified through physical count by the SUXOS and confirmed by the UXOQCS on the DSMT and the Explosive Material Disposition Record, Attachment 5.

4.5.2 Request for Explosives

The SUXOS will review all requests for explosives from the individual operating sites; only the sufficient amount of explosives for the day's operations will be issued. Explosive issues will be recorded using the Explosive Material Disposition Record; will be deducted from the DSMT record; and will be annotated in the UXO Team Leader's daily field log. This procedure will ensure that all issued explosive materials are accounted for while they are in the possession of individual users.

The end user of explosive materials will certify by affixing their signature on the Explosive Material Disposition Record that the explosives were expended for their intended purpose. Entries made on the Explosive Material Disposition Record and the DSMT record will be verified through physical count by the Demolition Supervisor and SUXOS when drawing from or turning in the explosive materials. All explosive transactions will be verified for accuracy by the UXOQCS or the UXOSO.

4.5.3 Reconciling Receipt Records

When necessary, the SUXOS will reconcile the delivery shipping documentation with the requested amounts ordered and received. Any shortages or overages will be reported to the project manager immediately, who in turn will contact the explosives dealer and reconcile any differences.

At the end of each explosive demolition operation, the UXOQCS or the UXOSO and the Demolition Supervisor will reconcile the entries on the Explosive Material Disposition Record with the DSMT record, and will turn these records over to the SUXOS for final verification and acceptance.

4.6 STORAGE

4.6.1 Establishment of Explosive Storage Magazines

The establishment of explosive storage magazines at HGL project sites will be IAW 27 CFR, Subpart K–Storage, DoD 6055.09–M and the applicable DDESB-approved ESS/ESP. All explosive materials will be properly stored and secured when not in us in a Type 2 portable outdoor magazine(s) meeting the design specifications of 27 CFR §555.203(b) and ATFP 5400.17 and placarded with the appropriate Department of Transportation (DOT) hazard class/division and fire symbols, and emergency notification information clearly posted. Explosive materials stored on DoD facilities will comply with the local DoD components explosive safety, security and siting requirements. When site security conditions necessitate additional safeguarding of explosive materials, the explosive storage area will be fenced using a minimum 8-foot high fence with a lockable gate or a suitable intrusive detection system.

HGL will comply with all ATF, Federal, DoD, State and local storage and compatibility criteria and procedures when siting explosives storage magazines. This also includes locating, installing, and maintaining the magazine(s) to comply with the magazine criteria and quantity distance requirements established in 27 CFR, Subpart K–Storage and DoD Ammunition and Explosives Safety Standards, DoD 6055.9-M, Volume 3.

4.6.2 Physical Security of Explosive Materials

Strict physical security and safeguarding of explosive materials will be maintained at all times on HGL project sites where these materials are being used and stored. The SUXOS and UXOQCS will enforce access, control, transportation and security of all explosives materials on site. Explosive storage magazines will be placed in the most secure locations practical IAW:

- 27 CFR §555.207 and §555.208;
- ATFP 5400.15–*Volunteer Security Checklist*;
- DOD 6055.9-M; and
- HGL SOP 15.02–*Explosive Storage Inspections and Security*.

4.6.3 Physical Security of MEC

On known MR sites where intentional physical contact with MEC or chemical warfare material is planned, the physical security of all MEC discoveries will be in compliance with the DDESB-approved ESP or ESS, and recorded on the MEC Demilitarization/Disposal by Detonation Accountability Record, Attachment 6. On project sites where intentional physical contact is not planned, but MEC is discovered, the site supervisor will immediately notify the project manager who in turn will immediately notify the client to obtain safeguarding instructions. All discovered MEC items will be recorded using the MEC Demilitarization/Disposal by Detonation Accountability Record, Attachment 6.

4.6.4 Required Notifications

The SUXOS will coordinate with the UXO Operations Manager to ensure the local ATF office is notified in writing five days in advance of an explosive storage magazine being added to the project location IAW 27 CFR §555.63. The following information will be included in the written notification:

- HGL's Huntsville office telephone number and address;
- HGL's explosive license number;
- Explosive storage magazine address/location (latitude/longitude coordinates);
- The magazine identification number; and
- Emergency contact name, address and telephone number.

The SUXOS will notify local fire authorities orally before the end of the day on which storage of the explosive materials began and in writing within 48 hours from the time such storage began IAW 27 CFR §555.21. Both oral and written notifications will include the following information:

- Type(s) of explosive materials;
- Magazine capacity (NEW amount); and
- Location of each storage site where explosive materials are stored.

The SUXOS will notify the HGL MMRP Operations Manager when all notifications have been completed.

4.6.5 Access and Control

A key-control system will be established by the SUXOS and the UXOQCS. Keys to explosive storage magazines and trucks loaded with explosives will be issued only to authorized personnel who have been granted access by the MMRP Operations Manager. Keys not in use will be kept secured in an unmarked area located separately from other keys at the premises. Procedures for magazine key control, access restriction, and accountability are provided in HGL SOP 15.02–*Explosives Storage Inspection and Security*.

Only those HGL employees who are listed as "*cleared*" on the current FELC Notice of Clearance, and on the HGL Authorized Agent list will be permitted to purchase and receive explosive materials.

4.7 TRANSPORTATION

Transportation of explosive materials will comply with all DOT 49 CFR, Parts 171-173, 383 and 397, State and local regulations. Permits are not required when transporting explosive materials within the project site and off of public transportation routes (PTR). The most expeditious route will be selected and used at all times when transporting explosive materials on or off a PTR. Procedures for transporting explosive materials to disposal locations and transportation vehicle requirements are described below.

4.7.1 Procedures for Transportation from Storage to Disposal Location

When transportation of explosive materials requires travel on public highways and transportation routes, the SUXOS and UXOSO will coordinate together to provide the explosive driver with a safe transportation route plan. Every effort will be made to take a route with the least public exposure. For transportation of demolition explosive materials, HGL will comply with the following:

- Initiating explosives, such as blasting caps, will remain separated from other explosives at all times. Blasting caps may be transported in the same vehicle as long as they are in a separate container conforming to the Institute of Makers of Explosives (IME) 122 box and secured away from other explosive items.
- An IME 122 box will be used to transport blasting caps; high explosives will be placed in a Type 3 magazine (day-box) meeting the design specification of 27 CFR §555.203(c). The two containers will be placed in the bed of a vehicle, blocked and braced separately using sand bags or other suitable means to keep the containers from shifting. If the explosive load being transported is in an open vehicle, the load will be covered with a tarp.
- Compatibility requirements will always be observed.
- Only UXO-qualified personnel who are listed on the FELC Notification of Clearance will have direct access to explosive materials. The receiving party will sign the receipt documents.
- Explosive vehicle operators transporting explosives on public roads will be:
    - A UXO-qualified HGL employee;
    - Listed on the FELC Notice of Clearance, and
    - Possess a valid state driver's license,
    - When transport vehicle is classified as a commercial motor vehicle (CMV) the operator will possess a commercial *Class-C* driver's license with a hazardous material (HAZMAT) endorsement.

- Vehicle operators will comply with posted speed limits but will not exceed a safe and reasonable speed for road/field conditions. Vehicles transporting explosives off-road will not exceed 25 mph.
- Personnel will not ride in the cargo compartment of a vehicle transporting explosives.

4.7.2 Explosive Transportation Vehicle Requirements

Explosives will be transported in closed vehicles whenever possible. The load shall be blocked, braced, covered with a fire-resistant tarpaulin, or stored in an appropriate shipping container (if not in an enclosed vehicle). Minimum requirements for vehicles transporting explosives are listed below:

- The HGL employee assigned to operate the motor vehicle transporting explosive material will be qualified IAW DOT 49 CFR Parts 387 and 391 and will possess a current state driver's license and when needed for operation of CMV possess a valid commercial *Class-C* driver's license with a hazardous material (HAZMAT) endorsement.
- Inspected using the Motor Vehicle Inspection-Hazardous Material, Attachment 7;
- Properly placarded on all sides and at each end per DOT 49 CFR;
- Equipped with a first aid kit, two 10–BC fire extinguishers, and a means of communication with the UXOSO;
- The engine will be shut off when loading or unloading of explosive materials;
- The wheels will be chocked during loading and unloading to prevent movement;
- At no time will any bare explosive come into contact with spark-producing metal. Vehicle cargo beds will have wooden or plastic liners, dunnage, or sand bags to protect the explosive materials from coming into contact with the metal bed and fittings;
- Explosives may be transported in vehicles with plastic bed liners if the explosives are in an authorized original shipping container.
- All explosive materials are properly segregated IAW their hazard/class division compatibility requirements.
- The vehicle operator will ensure all explosive materials being transported are properly recorded using the Bill of Lading, Attachment 5.

4.8 RECEIPT PROCEDURES AND AUTHORIZED ACCESS

The SUXOS will ensure strict accountability and control of all explosive materials from the time of initial receipt until expenditure, or returned to an authorized explosive dealer, or relieved of accountability by an authorized agent.

4.8.1 Procedures for Reconciling Inventory Discrepancies

If a discrepancy exists between inventoried and on-hand quantities of explosive materials, a review of the DSMT record and the Explosive Material Disposition Record will be completed by the SUXOS and UXOQCS to verify the accuracy of the inventory records. If the records review does not reconcile the discrepancy:

- The SUXOS will immediately report the discrepancy to the project manager and the UXO Safety Manager.
- The appropriate government representative will be notified when the project is under government contract. For example, on a U.S. Army Corps of Engineers (USACE) project, the Ordnance and Explosive Safety Specialist, or the Contracting Officer will be notified.
- The project manager will immediately initiate an investigation to determine the cause of the discrepancy.
- Discrepancies that cannot be reconciled within a 24-hour period will be reported IAW 27 CFR §555.30.

4.9 INVENTORY

4.9.1 Special Inventories

A true and accurate physical inventory of all explosive materials on hand at HGL project sites will be conducted by the SUXOS and the UXOQCS, or the UXOSO when the SUXOS or UXOQCS is not available. Special inventories are required under the following conditions:

- On initial physical receipt of explosive materials at a project site;
- When permanently changing location of the premises to another project site;
- When project field operations are temporarily suspended;
- When project field operations resume;
- Annually;
- When required by the ATF or an HGL RP.

The purpose of these inventories will be annotated on the DSMT record. For example, the annual inventory will be annotated as "Annual Inventory", and a project field season completion will be annotated as "Field Season Suspended". Each special inventory will be prepared in duplicate. The original will be submitted to the UXO Safety Manager and will be forwarded to the ATF regional office.

4.9.2 Physical Inventory

A true and accurate physical inventory of all explosive materials stored at HGL project sites will be conducted once **every seven days** by the SUXOS and the UXOQCS, or the UXOSO

when the SUXOS or UXOQCS is not available. The results of this inventory will be recorded on the DSMT form by writing in "Weekly Inventory" through both the "Quantity Received" blocks. Complete inventories will also be conducted after any issues/turn-ins of demolition material. Inventory procedures and controls are described in the following subsections.

4.10 REPORTING LOSS OR THEFT OF EXPLOSIVE MATERIALS

Upon discovery of any theft or loss of explosive materials the SUXOS will immediately notify the following points of contact in the order listed below:

1. HGL UXO Operations Manager[1,2]	256-970-2103	7:30 a.m. – 4:30 p.m. CDT
	256-714-5808	After hours
2. ATF[1]	1-800-461-8841	8:00 a.m. – 5:00 p.m. EST
	1-800-800-3855	After hours
3. Local law enforcement office[1,2]		24 hours
4. Project client representative[1]		8:00 a.m. – 5:00 p.m. local
5. ATF U.S Bomb Data Center (BDC)	1-866-927-4570 (fax)	5:00 p.m. – 8:00 a.m. EST
	USBDC@atf.gov	

Notes:

1. Notification will be made by telephone.
2. Fax or email the completed ATF Form 5400.5, Report of Theft or Loss-Explosive Materials within 24 hours from the item of the incident, refer to Attachment 8.

– N O T E –

1. *Failure to report the theft or loss of any explosive materials missing from stock **within 24 hours** of discovery to the appropriate federal and local authorities is a felony offense.*
2. *For munitions response project's under contract to the USACE, the USACE Contracting Officer will be notified by the project manager immediately by telephone and in writing within 24 hours of the discovery.*
3. *The completed Report of Loss or Theft-Explosive Materials form will be submitted to the BDC **within 24 hours** of discovery of any theft or loss of explosive materials. Submission of the report will be coordinated with UXO Safety Manager.*

Additional reporting procedures are provided in ATF Safety and Security Information for Federal Explosive Licensees and Permittees, ATF Publication 5400.15.

Explosive materials that were issued for use but were not expended will be returned to the magazines at the completion of explosive demolition operations for that day (classified as "turn-ins"). The demolition team leader will return the unused explosives to the storage magazine and record the transaction on the Explosive Disposition/Usage Record and DSMT.

4.11 DISPOSAL OF REMAINING EXPLOSIVES

ATF requires an accurate accounting of all explosive materials purchased and used, therefore when work is completed or temporarily suspended at a project site all unused explosives will be either:

- Disposed of by detonation;
- Returned to the ATF licensed explosives dealer (original acquisition source) where the explosive materials were originally purchased; or
- Properly stored IAW 27 CFR § 555, the work plan and the ESS or ESP.

4.12 DISASTER PREPAREDNESS

Many natural disasters such as flood, forest fire, hurricane, or tornado occur with little or no warning, therefore it is critical to anticipate and prepare for response actions. When a natural disaster threatens a HGL project site, the SUXOS will take all necessary precautions to ensure the security of explosive materials from potential loss. The following preliminary measures will be taken to prepare for a pending natural disaster:

1. Develop a contingency plan for immediately relocating explosive materials to a compliant explosives magazine in an area less susceptible to weather-related damage if possible.
2. Notify the nearest ATF field office and provide the following information:
    - HGL project location;
    - Licensed premise, HGL Huntsville Office telephone number and address;
    - Explosive license number;
    - Explosive storage magazine address/location (latitude/longitude coordinates);
    - Magazine identification number; and
    - Emergency contact name, address and telephone number.
3. In an emergency, the local ATF field supervisor may verbally authorize HGL to immediately move stored explosives to compliant storage magazine in an alternate location.
4. Ensure the back-up copies of critical records are collected and maintained in an off-site location when a significant risk or disaster is predicted for the project area.

5. In the event explosives are missing or stolen, make the required notifications immediately IAW Section 4.10. If the missing or stolen explosives are found or recovered and returned, notify the USBDC, and any investigating agency personnel, of all recovered explosives. The BDC is responsible for tracking all stolen, lost, and recovered explosives. Prompt reporting of the recovery of explosives previously reported as missing or stolen saves valuable investigative time and resources.
6. If damaged explosive materials are an immediate threat to public safety, contact local law enforcement authorities and the ATF 24-hour hotline. ATF hotline personnel will notify the appropriate ATF Field Division, who will coordinate the ATF field response.
7. If the damaged explosive materials are not an immediate threat to public safety, contact the manufacturer for instructions on the appropriate means of destruction. Contact the local ATF office for any additional guidance.
8. If ATF required records have been damaged, lost or destroyed, explosive materials will be immediately inventoried and an effort made to reconstruct any records destroyed, lost, or rendered illegible. Additionally, the acquisition source/explosive dealer will be contacted to obtain copies of recent sales and acquisition records. Contact the local ATF office for assistance or further information.

5.0 QUALITY CONTROL

5.1 RESPONSIBILITIES

Proper and careful execution of explosive accountability and management is critical to the success and safety of all explosive operations involving HGL employees, the public and properties. Primary responsibility, accountability, and use of the explosives will rest with each project site's assigned SUXOS. This section outlines the responsibility of those employees who have direct administrative and operational management responsibility on HGL projects involving the security, storage, transportation and use of explosive materials.

Since HGL could be engaged in multiple MR projects at any given time, the explosive accountability and management positions lines of authority and responsibility are outlined below:

5.1.1 Chief Operating Officer

The Chief Operating Officer is responsible for overseeing HGL's accountability and management of explosive materials program and policy and ensuring all explosive operations are conducted in compliance with all Federal, state and local regulations under HGL's Manufacturer of High Explosives License. This position is designated as a RP IAW 27 CFR §841(s).

5.1.2 Military Munitions Response Program Director

The Military Munitions Program Director responsible for directing and enforcing the accountability and management of explosive materials program to ensure all explosive material purchases, use, storage, and transportation operations are conducted IAW all Federal, state and local regulations. This position is designated as a RP IAW 27 CFR §841(s).

5.1.3 MMRP Operations Manager

The MMRP Operations Manager is responsible for implementing and executing the HGL accountability and management of explosive materials program and providing direct administrative, operational, quality control, safety and security oversight on all munitions projects and explosive operations. The MMRP Operations Manager will coordinate all explosives logistical requirement through the UXO Safety Manager. This position is designated as a RP IAW 27 CFR §841(s).

5.1.4 UXO Safety Manager (Currently filled by Operations Manager)

The UXO Safety Manager is responsible for:

- The overall explosive accountability, administrative quality control, safety and security oversight of the accountability and management of explosive materials program;
- Communicating directly with the Military Munitions Response Director and MMRP Operations Manager on all matters concerning this program;
- Ensuring that all explosive operations procedures are in compliance with this SOP and applicable regulations;
- Coordinating with the project manager to stop any explosive operation deemed unsafe, and not allowing operations to resume until the unsafe condition is corrected; and
- Performing periodic quality assurance, safety and security audits at HGL MR project sites where explosive materials are used and stored.

This position is designated as a RP IAW 27 CFR §841(s).

5.1.5 Project Managers

Project managers are responsible for ensuring all munitions projects under their direction are conducted in compliance with this directive and the associated work plan and the requirements of this SOP. The project manager will provide direct oversight of all field activities involving explosive operations.

5.1.6 SUXOS

The SUXOS is directly responsible for safe and secure execution of all field activities involving explosive operations. All explosive operations will be carried out under the direct

supervision of the SUXOS and in compliance with this SOP, work plan, and the applicable DDESB-approved ESP/ESS (when applicable). The SUXOS will act as the single point of contact for receipt and release of explosive materials to an authorized ATF licensed explosives dealer or agents, including safeguarding and the security of explosive material purchased and stored on the project site. The SUXOS will coordinate all explosive materials logistical support through the HGL Senior Operations Manager and UXO Safety Manager. This position is designated as an RP or EP position.

5.1.7 UXOSO

The UXOSO provides direct explosive safety and security oversight on the MR project site to which assigned. The UXOSO will communicate directly with the UXO Safety Manager, or, if not readily available, the MMRP Operations Manager on all matters concerning explosive safety and security. The UXOSO is responsible for ensuring all explosive safety procedures and regulations are being performed IAW this directive, associated site SOPs, the work plan, and the approved ESP/ESS. The UXOSO has the authority to stop any explosive operation deemed unsafe and will not resume operations until the unsafe condition is corrected. This position is designated as an EP position.

5.1.8 UXOQCS

UXOQCS are directly responsible for maintaining explosive management quality control on the MR project assigned. The UXOQCS will liaise directly with the Site Managers and SUXOS concerning proper administration of the explosive management program. Additionally, the UXOQCS is responsible for the overall quality control of all site explosive operations procedures, inventories, stock cards and compliance with this directive, SOPs, the work plan, approved ESP/ESS, and all Federal, DoD, state and local regulations. This position is designated as an EP position.

5.1.9 Demolition Supervisor

The Demolition Supervisor is responsible for planning, directing and executing the project site explosive demolition operation for the destruction or demilitarization of MEC/MDEH. The Demolition Supervisor will ensure positive control, security of the explosive material, and the safe conduct of explosive operations. The SUXOS may delegate the Demolition Supervisor responsibilities to a UXO Technician III qualified individual. This position is designated as an EP position.

5.1.10 Explosives Driver

HGL employees assigned the responsibility for transporting explosive materials (explosives driver) on HGL project sites will possess a current state driver's license, a valid DOT commercial *Class-C* driver's license with a hazardous materials endorsement IAW CFR 49 Parts 383 and 397. Explosives drivers are responsible for ensuring compliance with all

federal, state, local and HGL requirements when operating explosive laden vehicles. This position is designated as an EP position.

5.1.11 Demolition Team Members

Demolition team members will work under the direct supervision of an ATF RP or EP, the SUXOS or Demolition Supervisor. Employees are allowed to handle explosive materials without an ATF clearance when directly supervised by an ATF RP or EP.

6.0 SECURITY

Before establishing explosive storage or operations on an HGL project site, an explosive security survey will be conducted jointly by the SUXOS and UXOQCS IAW HGL SOP 15.0–*Explosive Storage Inspection and Security*. The inspection, identification of any discrepancies, and their disposition will be documented in the SUXOS daily log and the UXOQC quality control daily report.

The local law enforcement or security agency closest to the project site WILL BE NOTIFIED when explosive materials are stored in magazines on-site. As an added security measure, the local law enforcement or security agency will be notified of the project site business hours.

7.0 RECORDS

7.1 PERMANENT RECORDS

As an explosive licensee HGL is required to keep permanent records of explosive materials for five years from the date of the transaction. These transactions include importation, production, shipment, receipt, sale, or other disposition, whether temporary or permanent, of explosive materials as regulated by 27 CFR §555.121. ATF officers may examine or inspect these records at any time.

7.2 RECORD MAINTENANCE

It is the SUXOS responsibility to ensure that all explosive recordkeeping is accurate and complete and information is properly document on all applicable explosive record forms. Attachment Maintaining accurate explosive recordkeeping is essential to preventing errors. Whenever an error does occur on any explosive record or transaction the individual making the error will:

1. Draw a single line through the error;
2. Write in the correct information in the adjacent space closest to the error;
3. Write in initials and date adjacent to the corrected error; and
4. Have an individual witness the correction by writing their initials and date next to the corrected error.

7.3 SPECIAL INVENTORY

Whenever a special inventory is required to be conducted as specified by 27 CFR §555.123(a), the UXO Safety Manager will prepare a record of the inventory in duplicate and submit the original to the ATF regional director's office as specified by 27 CFR §555.123(a)(4). HGL will take a true and accurate physical inventory:

1. At the time of changing location of the business premises to another ATF region;
2. At the time of discontinuing business; and
3. Any time the ATF regional director may direct in writing.

7.4 RECORDKEEPING

All explosive material acquisitions, purchases, receipts, issuance, usage transaction and inventories records will be maintained on-site by the SUXOS and will be available for inspection by authorized agencies. Explosive items will be tracked by their respective lot number or manufacturer's marks of identification until the items are expended, transferred to another ATF licensee, or are returned to the original explosive acquisition source. All documentation and records generated as a result of all explosive material transactions will be record and maintained using the forms list below. Attachment 9 provides additional instruction for using and maintaining explosives records.

7.4.1 Manufacturer of Explosives Record of Acquisition

The MERA will be completed by the SUXOS upon receipt of any explosive materials by HGL IAW 27 CFR §555.123. An electronic copy of this form will be submitted within 48 hours of the acquisition to the UXO Operations Manager.

7.4.2 Daily Summary of Magazine Transactions

All issues, returns, and inventories will be properly recorded using the DSMT and IAW 27 CFR §555.123, and 555.127. This record will to be kept with each explosive item stored at each magazine. A duplicate DSMT records will be maintained and updated at the same time as the original record and kept separately with the project files. DSMT records will be updated not later than the close of the next business day with the manufacturer's name or brand name, the total quantity received in and removed from each magazine during the day of transaction, and the total remaining on hand at the end of the day. An electronic copy of the DSMT will be submitted within 48 hours of any transaction to the UXO Operations Manager.

7.4.3 Explosive Material Disposition Record – Bill of Lading

The Explosive Material Disposition Record–Bill of Lading serves two purposes, recording all explosive material:

1. Issued for demilitarization/demolition operations;

2. Expended by detonation;
3. Returned to the magazine for storage; and
4. Used as a Bill of Lading whenever explosive materials are being transported by vehicle on HGL project sites.

7.4.4 Munitions and Explosives of Concern/Unexploded Ordnance Accountability Record

The MEC Demilitarization/Disposal by Detonation Accountability Record will be used to record the demilitarization/disposal of all MEC items discovered on HGL project sites.

7.4.5 Motor Vehicle Inspection-Hazardous Materials

The Motor Vehicle Inspection-Hazardous Materials, Attachment 7 will be used when hazardous materials are transported by vehicle on HGL project sites and following the procedures shown in Section 4.6.2.

7.5 RECORDS DISTRIBUTION

Upon completion of project field operations all explosive material and MEC records will be distributed as indicated below:

– N O T I C E –

As required by the ATF, an electronic copy of the most recent explosive record transaction will be sent to the HGL Huntsville Office (premise location) within 24 hours from the time the transaction occurred.

1. Original records will be sent to the HGL Huntsville, Attention UXO Operations Manager and maintained on file or a period of five years from the time of the latest transaction IAW 27 CFR § 555.121(a)(2).
2. Records older than five years will be archived throughout the life of HGL's Manufacturer of Explosives License.
3. Records will distributed as shown below:

Record	Huntsville Office	Project Manager
Manufacture of Explosive Record of Acquisition–Form 15.02	Original	
DSMT–Form 15.03	Original	
Explosive Material Disposition Record–Form 15.04	Original	

Bill of Lading–Form 15.04	Original	
MEC Demilitarization/Disposal Accountability Record–Form 15.05	Original	Copy
Report or Theft or Loss of Explosive Material	Original	Copy

8.0 REFERENCES

Bureau of Alcohol, Tobacco, Firearms and Explosives ATFP 5400.7, 2007, Federal Explosives Laws and Regulations (27 CFR, Part 555—Commerce of Explosives), November.

Bureau of Alcohol, Tobacco, Firearms and Explosives ATFP 5400.15, 2007, ATF Safety and Security Information For Federal Explosives Licensees and Permittees, March.

Bureau of Alcohol, Tobacco, Firearms and Explosives Publication 5400.18, 2011, Daily Summary of Magazine Transactions, October.

Bureau of Alcohol, Tobacco, Firearms and Explosives Publication 5400.19, 2011, Recordkeeping Requirements for Explosive Material Manufacturers, October.

Department of Defense Manual 6055.9-M, 2010, DoD Ammunition and Explosives Safety Standards, February.

Department of Defense Explosive Safety Board Technical Paper 18, 2004, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, December.

Department of Transportation (DOT), 49 CFR Parts 100-199.

U.S. Army Corps of Engineers, Engineer Manual 385-1-97, 2008, Explosives Safety and Health Requirements Manual, September.

HydroGeoLogic, Inc., HGL SOP 15.02, 2014, Explosives Storage Inspections and Security, January.

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform IAW the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name

ATTACHMENT 2

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Federal Explosives License/Permit
(18 U.S.C. Chapter 40)

In accordance with the provisions of Title XI, Organized Crime Control Act of 1970, and the regulations issued thereunder (27 CFR Part 555), you may engage in the activity specified in this license or permit within the limitations of Chapter 40, Title 18, United States Code and the regulations issued thereunder, until the expiration date shown. **THIS LICENSE IS NOT TRANSFERABLE UNDER 27 CFR 555.53.** See "WARNINGS" and "NOTICES" on reverse.

Direct ATF Correspondence To	ATF - Chief, FELC 244 Needy Road Martinsburg, WV 25405-9431	License/Permit Number	1-AL-089-20-4F-00632
Chief, Federal Explosives Licensing Center (FELC)	Christopher R. Reeves	Expiration Date	June 1, 2014

Name
HYDROGEOLOGIC, INC MUNITIONS RESPONSE TEAM

Premises Address (Changes? Notify the FELC at least 10 days before the move.)
5030 BRADFORD DRIVE BLDG 1, SUITE 230
HUNTSVILLE, AL 35805-

Type of License or Permit
20-MANUFACTURER OF EXPLOSIVES

Purchasing Certification Statement
The licensee or permittee named above shall use a copy of this license or permit to assist a transferor of explosives to verify the identity and the licensed status of the licensee or permittee as provided by 27 CFR Part 555. The signature on each copy must be an original signature. A faxed, scanned or e-mailed copy of the license or permit with a signature intended to be an original signature is acceptable. The signature must be that of the Federal Explosives Licensee (FEL) or a responsible person of the FEL. I certify that this is a true copy of a license or permit issued to the licensee or permittee named above to engage in the business or operations specified above under "Type of License or Permit."

Mailing Address (Changes? Notify the FELC of any changes.)

HYDROGEOLOGIC, INC
HYDROGEOLOGIC, INC MUNITIONS RESPONSE TEAM
5030 BRADFORD DRIVE BLDG 1, SUITE 230
HUNTSVILLE, AL 35805-

Licensee/Permittee Responsible Person Signature | Position/Title

Printed Name | Date

Previous Edition is Obsolete HYDROGEOLOGIC, INC:5030 BRADFORD DRIVE BLDG 1, SUITE 230:35805:1 AL 089-20 4F 00632:June 1, 2014:20 MANUFACTURER OF EXPLOSIVES

ATF Form 5400.14/5400.15 Part 1
Revised October 2011

Federal Explosives License (FEL) Customer Service Information

Federal Explosives Licensing Center (FELC)
244 Needy Road
Martinsburg, WV 25405-9431

Toll-free Telephone Number: (877) 283-3352
Fax Number: (304) 616-4401
E-mail: FELC@atf.gov

ATF Homepage: www.atf.gov

Change of Address *(27 CFR 555.54(a)(1))*. Licensees or permittees may during the term of their current license or permit remove their business or operations to a new location at which they intend regularly to carry on such business or operations. The licensee or permittee is required to give notification of the new location of the business or operations not less than 10 days prior to such removal with the Chief, Federal Explosives Licensing Center. The license or permit will be valid for the remainder of the term of the original license or permit. **(The Chief, FELC, shall, if the licensee or permittee is not qualified, refer the request for amended license or permit to the Director of Industry Operations for denial in accordance with § 555.54.)**

Right of Succession *(27 CFR 555.59)*. (a) Certain persons other than the licensee or permittee may secure the right to carry on the same explosive materials business or operations at the same address shown on, and for the remainder of the term of, a current license or permit. Such persons are: (1) The surviving spouse or child, or executor, administrator, or other legal representative of a deceased licensee or permittee; and (2) A receiver or trustee in bankruptcy, or an assignee for benefit of creditors. (b) In order to secure the right provided by this section, the person or persons continuing the business or operations shall furnish the license or permit for for that business or operations for endorsement of such succession to the Chief, FELC, within 30 days from the date on which the successor begins to carry on the business or operations.

(Continued on reverse side)

ATTACHMENT 3

Manufacturer of Explosives Record of Acquisition

Site Name/Location:				HGL License Number: 1-AL-089-20-4F-00632
Project Site Activity:			Supervisor's Name/Position:	
Date of Manufacture or other Acquisition	Lot Number or Manufacturer's Marks of Identification	Brand Name, Nomenclature or Description and Size-(when mixing binary materials)	Quantity Acquired	Name, Address and License or Permit Number of Distributor

HGL MR Form 15.02 (Revised Feb 2014)

Page _____ of _____.

ATTACHMENT 4

HGL HydroGeoLogic, Inc MUNITIONS RESPONSE TEAM

Daily Summary of Magazine Transactions (Magazine Data Card)

Nomenclature/Brand Name of Manufacturer:	Lot Number/Manufacturer Mark:	Hazard Class/Division:
Site Location/Name:	**GPS Coordinate:**	**HGL License Number:** 1-AL-089-20-4F-00632

Date	Quantity In	Quantity Out	Current Balance	Action/Purpose (Receipt/Issue/Inventory)	Printed Name

HGL MR Form 15.03 (Revised January 2014)

Page _____ of _____.

ATTACHMENT 5

Explosive Material Disposition Record – Bill of Lading

Date:	Site Name/Location:	Grid #/Area or GPS coordinate:	Distributee Explosive License #:
			1-AL-089-20-4F-00632

This form will be used as a Bill of Lading anytime explosives are transported in a HGL vehicle under DOT regulations and kept with the explosive driver in the vehicle until the explosives are issued, expended or returned to storage.

SECTION I. Explosive Material Issued for Demilitarization/Demolition Operations:

Lot Number/Manufacturer's Marks of Identification	Brand Name, Nomenclature or Description	Quantity	Hazard/ Class	Receipt Initials

Print Explosive Driver Name:	Explosive Driver Signature:

SECTION II. Explosive Material Expended by Detonation:

Lot Number/Manufacturer's Marks of Identification	Brand Name, Nomenclature or Description	Quantity	Hazard/ Class	Receipt Initials

SECTION III. Explosive Material Returned to Storage:

Lot Number/Manufacturer's Marks of Identification	Brand Name, Nomenclature or Description	Quantity	Hazard/ Class	Receipt Initials

Demolition Supervisor Signature:	SUXOS Signature:

HGL MR Form 15.05 (Revised Feb 2014)

ATTACHMENT 6

Munitions and Explosives of Concern Demilitarization/ Disposal by Detonation Accountability Record

Site Name:	Site Location:	Contract Number:	Delivery/Task Order No:

Anomaly No.	Grid or GPS Coordinates Location	Depth Detected (feet)	Identification/Nomenclature (include DMM, MC, MEC or UXO)	Date Located	Date of Demil/ Disposal	Method of Demil/Disposal	Comments

SUXOS review and acceptance (print name):	SUXOS signature:	Date:

HGL MR Form 15.05 (Apr 2012)

ATTACHMENT 7

HGL HydroGeoLogic, Inc MUNITIONS RESPONSE TEAM

Motor Vehicle Inspection–Hazardous Materials

Section 1 – Documentation and Instructions

1. This form applies to all vehicles which must be marked and placarded in accordance with DOT Title 49 CFR and will be retained in the cab of the vehicle with the driver operator.
2. This form will be completed in conjunction with the Vehicle Inspection Checklist and Bill of Lading forms.
3. Upon completion of explosive transportation operations this form will be retained in the project files and will be submitted to the HGL Huntsville office, attention UXO Operations Manager at the completion of field activities.

Company:	
Date of inspection:	
Time of inspection:	
Location of inspection:	
Operator's name:	
Operator's license number:	

Medical examination current: ☐ Yes ☐ No

Valid CDL with Hazardous Materials endorsement: ☐ Yes ☐ No

Route plan and map: ☐ Yes ☐ No

Hazardous Materials Compliance Handbook in vehicle: ☐ Yes ☐ No

Vehicle Inspection Checklist HGL MR Form 15.23 completed and retained in vehicle: ☐ Yes ☐ No

Bill of Lading HGL MR Form 15.05 completed and retained in vehicle: ☐ Yes ☐ No

Section 2 – Mechanical Inspection *(place "X" in the applicable box, if rejected, explain in block 3:*

	Satisfactory	Unsatisfactory		Satisfactory	Unsatisfactory
Horn operative	☐	☐	Tires, wheels and rims	☐	☐
Steering system	☐	☐	Wheel chocks set	☐	☐
Windshield/wipers	☐	☐	Tailgate and doors	☐	☐
Mirrors	☐	☐	Cargo space clear	☐	☐
Warning signals	☐	☐	Non-sparking bed liner	☐	☐
Spare fuses	☐	☐	Tarpaulin and straps	☐	☐
Electrical wiring	☐	☐	Two 10-lb fire extinguishers	☐	☐
Lights and reflectors	☐	☐	Properly placarded on all sides	☐	☐
Fuel system	☐	☐	Detonator box	☐	☐
Exhaust system	☐	☐	Type 3 day box (IME 122)	☐	☐
Brake system	☐	☐	Explosives properly segregated	☐	☐
Suspension	☐	☐	Other (explain in Block A.)	☐	☐

Inspection result *(If rejected provide reason in block 3)*: **ACCEPTED** ☐ **REJECTED** ☐

A. Remarks:

B. Inspector signature (origin):	**C.** Driver signature (origin):
D. Inspector signature (destination):	**E.** Driver signature (destination):

HGL MR Form 15.06 Jan 2014)

ATTACHMENT 8

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Report of Theft or Loss-Explosive Materials

For ATF Use Only

Date Received	Date Faxed to JSOC & Field Division	Unique Identifier
		Case Number

To Be Completed By Person Making Report

Upon discovery of any theft or loss of any of your explosive materials:
- First, contact ATF toll free at 1-800-461-8841 between 8:00 a.m. - 5:00 p.m. EST or after hours and weekends contact ATF at 1-800-800-3855 to report the theft or loss;
- Second, contact your local law enforcement office to report the theft or loss to obtain a police report; and
- Third, complete this form and attach any additional reports, sheets or invoices necessary to provide the required information, and fax the form with additional material(s) to the ATF U.S. Bomb Data Center (USBDC) at 866-927-4570 or email to USBDC@atf.gov.

1. Date	2. Type of Report *(Check one)*: ☐ Theft ☐ Loss ☐ Attempted Theft/Suspicious Activity ☐ Supplement
3. Full Name of Person Making the Report *(Last, First, Middle)*	4a. Licensee or Permittee Name
4b. Federal Explosives License or Permit Number	
5a. Office Address *(Street Address, City, State, and Zip Code)*	5b. Telephone Number
	5c. E-mail Address
6. Actual Location of Theft or Loss *(If different from item 5a)*	

7. Theft or Loss	Date	Time	8. Name of Local Law Enforcement Officer to Whom Reported
a. Discovered			9. Name and Address of Local Authority to Whom Reported
b. When Was the Magazine Last Checked			
c. Occurred *(Show approximate if exact not known)*			
d. Reported to ATF by Telephone			10. Telephone Number
e. Reported to Local Authorities			11. Police Report Number

12. Explosive Materials Lost or Stolen *(Attach invoices or additional sheets, if necessary)*

a. Manufacturer and/or Importer	b. Brand Name	c. Date Shift Code	d. Size *(Length & Diameter)*	e. Quantity *(Pounds of Explosives, Number of Dets)*	f. Type and Description *(Dynamite, Blasting Agents, Detonators, etc. Include for each type, size, MS delay or length of legwire, as applicable)*

ATF Form 5400.5
Revised July 2012

ATTACHMENT 8

13. Theft or Loss Occurred from *(Check applicable box on each row)*

a. Magazine Type:

☐ 1 ☐ 2 ☐ 2 Det. Box ☐ 3 Day Box ☐ 4 ☐ 5

☐ Outdoor ☐ Indoor

☐ Permanent ☐ Portable ☐ Mobile Truck ☐ Mobile Trailer

☐ Overnight Storage ☐ Day Storage

b. Types of Locks *(Check all that apply)*:

☐ Padlock ☐ Mortise ☐ 3-Point ☐ Puck Lock ☐ Other *(Explain)* _____

c. Location Description/Type:

☐ Licensed/Permitted Premises ☐ Remote Storage ☐ Work Site ☐ In Transit ☐ During Operations

14. Method of Entry:

☐ Door Was a Key Used? ☐ Yes ☐ No Suspected Employee-Involved Theft? ☐ Yes ☐ No

☐ Wall(s) ☐ Roof ☐ Floor/Bottom

Lock(s) Defeated? *(If yes, check additional appropriate boxes)* ☐ Yes ☐ No

☐ Lock Shackle Cut *(How?)* _____ ☐ Lock Pried, Twisted or Levered

☐ Lock Left Unlocked ☐ Lock Picked or Shimmed

☐ Keyway Drilled Out ☐ Lock Body Drilled Out or Cut

☐ Other *(Explain)* _____

Manufacturer and Model of Lock:	Location of Magazine Keys: ☐ Office ☐ Employee ☐ Other *(Address)* _____	Are All Keys Accounted For? ☐ Yes ☐ No

15. Hood Defeated? *(If yes, check all applicable)* ☐ Yes ☐ No

☐ Hood Cut ☐ Hood Removed

☐ Other *(Explain)* _____ ☐ Hood Broken

Hood Width *(Inches)* _____ Hood Length (Inches) _____

Hood Depth *(Inches)* _____ Hood Thickness (Inches) _____

16. Other Information Pertinent to the Theft, Loss or Suspicious Activity *(Any details you can provide)*

16a. Was Theft or Loss Disclosed During an ATF Inspection or Being Reported as a Result of Inspection? ☐ Yes ☐ No

16b. Additional Security Measures in Place?

☐ Alarm ☐ Security System/Service ☐ Fencing ☐ Lighting ☐ Other *(Explain)* _____

17. Signature and Title of Person Making Report	18. Date

ATF Form 5400.5
Revised July 2012

ATTACHMENT 9

EXPLOSIVE RECORD MAINTENANCE AND USE INSTRUCTIONS

RECORD	USE	ELECTRONIC RECORD	ORIGINAL RECORD
Explosive material delivery invoice – Form 15.02	Verify actual invoice receipt for accuracy and legibility.	All explosive acquisitions or transactions occurring during a work week will be submitted via email to the Huntsville office on the last work day of the week to the UXO Operations Manager, email: nfeist@hgl.com and mwhalen@hgl.com	1. Retain original record on file during field activities. 2. On completion of field activities submit to Huntsville office
Manufacturer of Explosives Record of Acquisition – Form 15.03	1. Record all On-Call delivery acquisitions. 2. Record all to on site storage delivery acquisitions. 3. Verify each item recorded on this form matches each item listed on the delivery invoice.		
Daily Summary of Magazine Transaction (Magazine Data Card) – Form 15.03	1. Record all explosive material acquisitions, receipts, issues and turn-ins on the day of occurrence. 2. Record all explosive material inventory activities.		
Explosive Material Disposition Record / Bill of Lading – Form 15.04	Record upon occurrence all explosive materials: 1. Issued for demil/demolition operations. 2. Expended by detonation. 3. Turned-in for return to storage.		
MEC Demilitarization/Disposal by Detonation Accountability Log – Form 15.05		Not required	Upon completion of field activities

Explosive Demolition Operations	SOP No.: 15.01 SOP Category: MMRP Revision No.: 2 Date: Febuary 2014

1.0 PURPOSE

This standard operating procedure (SOP) establishes the overall safe practices and procedures for conducting explosive demolition operations on HydroGeoLogic, Inc. (HGL) munitions response program (MMRP) projects sites.

2.0 SCOPE

This SOP applies to all HGL employees assigned to perform explosive demolition operation on HGL project sites. All HGL employees who are tasked with performing munitions and explosives of concern (MEC)-related activities will be qualified in accordance with the Department of Defense Explosive Safety Board (DDESB) Technical Paper (TP) 18 and the requirements specified by HGL SOP 15.00, Section 5.0. This SOP also applies to all instances when public safety may be affected by site conditions. This SOP will be used in conjunction with approved work plans and the HGL SOPs cited in Section 9.0 of this SOP.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All explosive activities will be conducted in conformance with the Explosive Safety Submission (ESS)/Explosives Site Plan (ESP) and Site Safety and Health Plan (SSHP) and HGL SOP 15.00. Procedures for packaging and disposing of all munitions waste generated during field activities will be described in the project-specific work plan and processed in accordance HGL SOP 15.00 Material Potentially Presenting an Explosive Hazard (MPPEH) Inspection and Processing.

Personnel who use this procedure must document evidence to the site manager/Senior Unexploded Ordnance Supervisor and the Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP acknowledgement form, Attachment 1. This documentation will be retained in the project file.

Any deviations from the procedures specified in this SOP will be approved by the HGL Senior UXO Operation Manager and UXO Safety Manager before implementing. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 PROCEDURES

This section provides the administrative, training, and logistical aspects for conducting explosives demolition operations on HGL MMRP project sites.

4.1 DEMOLITION TEAM PERSONNEL

All employees are required to meet the minimum requirements listed in this procedure, but may request a variance if these procedures are unsafe, or are not compatible with contract or site-specific requirements. Permission to vary from this procedure must be obtained from the Project Manager and the HGL UXO Safety Manager. All employees are encouraged to submit comments and/or recommendations to improve this procedure.

All personnel engaged in demolition operations must be thoroughly trained in explosive safety and demolition procedures, be capable of recognizing hazardous situations, and be able to take prompt corrective action. All UXO demolition team personnel must meet the minimum requirements specified by DDESB TP 18 and HGL SOP 15.00, Section 5.7.1 to perform tasks covered by this SOP. Demolition operations will not be conducted without client authorization, approved plans/SOPs, qualified and trained UXO Technicians, and proper demolition and safety equipment is available.

4.2 DEMOLITION TEAM ASSIGNMENTS AND RESPONSIBILITIES

HGL demolition operations require specific organizational roles and personnel assignments, specifically:

1. **SUXOS (Demolition Supervisor):**
   a. The SUXOS will normally perform the responsibilities of the Demolition Supervisor (Demo Supervisor), but may delegate this responsibility to a UXO Technician III level qualified individual.
   b. Responsible for planning, directing, and executing all demolition operations.
   c. When employing the services of a "certified blaster" from a licensed explosive dealer, ensure that only UXO Technicians are allowed to place donor charges next to MEC/UXO.
   d. Will maintain explosive accountability and security of all explosive materials issued for use during execution of demolition operations.
   e. Will maintain positive communications at all times with the Demolition Team and the UXOSO.
   f. Will inspect the dentonation site after each explosive detonation or any misfire and ensure no one is allowed within the MSD from the detonation site until the area is declared safe.
2. **UXOSO** will ensure:

a. All demolition operations are performed safely and in accordance with the approved site-specific plans (ESP or ESS) and this SOP.
b. Reliable primary and secondary communications are established before commencing demolition operations.
c. In collaboration with the SUXOS that all roadways and access points to the MSD area is secure and all personnel are evacuated and not allowed with the MSD from the detonation site before initiating any explosive charges.
d. The detonation site is inspected after each explosive detonation or misfire. No one will be allowed within the MSD until the area is declared safe.

3. **Demolition Team** will consist of a minimum of three personnel or as required by the approved work plan:
   a. Demo Supervisor.
   b. A UXO Technician II or above to assist the DS during demolition operations.
   c. A UXO Technican I or above.

4.3 REFERENCE DOCUMENTS

Before commencing demolition operations the SUXOS and UXOSO will read and have a good working knowledge of the following documents, as well as ensuring these approved documents and publications are on-site during all Demolition operations:

1. U.S. Army, Technical Manual 60A-1-1-31, General Information on Explosive Ordnance Disposal Procedure
2. DDESB-approved ESP or ESS
3. SSHP
4. Work Plan or Technical Management Plan

4.4 COORDINATION AND NOTIFICATIONS

A coordination meeting will be conducted by the SUXOS to establish roles and responsibilities before demolition operations begin. The meeting will address specific elements of planning and organizational responsibilities and will include, but not be limited to, the following topics:

1. Who is assigned ultimate responsibility for demolition operations
2. Demolition team assignments and responsibilities
3. Primary and secondary communications
4. On remote sites verification of reliable communications
5. Explosive handling, storage, and transportation

6. Required support services, fire, medical, security, etc.
7. Emergency procedures
8. Notification process
9. Maintaining and controlling exclusion zones:
   a. Safety guard positions
   b. Road barricades
   c. Exclusion zone clearance prior initiation of demolition shot
   d. Demolition team rally point
   e. Post operation "all clear" procedures
10. Community impact

4.4.1 Public Meeting

A public meeting will be held prior to demolition operations being conducted when Demolition operations potentially impact the local civilian community. The HGL project manager, site manager or Senior UXO Supervisor (SUXOS will conduct a briefing outlining the scheduled operation. Topics will include:

1. Daily hours of operation
2. Requirements for evacuation of occupied residences and road closures
3. Exclusion zones/MSD boundaries
4. Community impact

4.4.2 Notifications

The SUXOS will ensure the agencies responsible for emergency response are notified as far in advance as possible that disposal activities will be taking place. The notifications should address scheduling, evacuations, road closures, EZs, and any other required support. As a minimum, the following agencies should be notified and be prepared to respond, as applicable:

1. Public utility companies (electric, gas and water)
2. Paramedic/Emergency Medical Technician Squad, (as applicable)
3. Local fire department
4. Local law enforcement/police department
5. Security agency
6. Local Airport (FAA, etc)

4.4.3 Public Utility Services

When there is a potential for demolition operations to impact public utilities, the SUXOS will notify the appropriate utility company official. When situations mandate the demolition of a MEC hazard near public utilities, precautions will be taken to prevent damage or disruption of these services, either by using protective measures (engineering controls) or by relocating the MEC hazard to a safe distance when the SUXOS and UXOSO have jointly determined the MEC hazard is *acceptable- to-move*.

4.5 EXCLUSION ZONES, EVACUATIONS, AND ROAD CLOSURES

The exclusion zone for all demolition operations will be based on the munition with the greatest fragmentation distance (MGFD) as identified in the project work plan and/or ESP/ESS. Before initiating explosive demolition operations to demilitarize, destroy or dispose of MEC hazards, all personnel will be evacuated to a safe location beyond the MSD as determined by DDESB TP 16 calculation methodologies. When a single MEC item undergoes explosive demolition, the hazardous fragment distance-horizontal (HFD-H) for that munition will be observed.

Every attempt will be made to post the necessary warnings and safety controls prior to explosive operation. In some cases posters or flyers or may be suitable, however, positive site control must be maintained at all times during any explosive operation. Posters or flyers will identify the location of operations, time operations commence and cease, contact person for verifying if area is safe for passage. To ensure the highest degree of public safety is maintained barricades will be placed at residential streets and roads access points with the appropriate number of safety guards posted at key locations to prevent access to the EZ prior to conducting explosive operations.

Once demolition operations are in progress the public and other non-essential personnel will not be allowed into the EZ under any circumstances. Re-entry into the EZ will be granted only under the following conditions:

1. Essential personnel have been granted an “all-clear” by the SUXOS.
2. The UXO Safety Officer (UXOSO) has completed a post-detonation assessment of the EZ and determined the area safe to access.

4.6 TWO-PERSON RULE

The Two-Person Rule is a safety concept that requires two knowledgeable individuals to perform potentially hazardous operations. These individuals must be trained and be capable of recognizing safety hazards and improper procedures. The Two-Person Rule will apply

whenever explosives are handled or transported during demolition operations. No one will handle or assemble explosives alone.

4.7 DEMOLITION OPERATIONS BRIEF

Before beginning any explosive operations, all personnel assigned to or working with disposal teams will attend a demolition operation briefing. The purpose of the briefing will be to review MEC explosive demolition and emergency response procedures. Using attachments 1, 2, 3, 4, 5, 6, and 7 the following topics will be covered during the briefing, but are not limited to:

1. Review of the Accident Prevention Plan (APP)/SSHP
2. Review of this SOP
3. Review of demolition firing systems and components
4. Review of disposal charge placement
5. Review of explosives transportation
6. Site munitions brief
7. Type and condition of MEC
8. Emergency response equipment
9. Emergency procedures
10. Two-person rule
11. Team assignments

4.8 EQUIPMENT, MATERIAL AND VEHICLE REQUIREMENTS

The DS will be responsible for ensuring that all required equipment and materials are available. The checklists in the attachments to this procedure will be used to ensure and document equipment and material availability. As a minimum, the following will be checked prior to commencing each disposal operation:

1. Demolition equipment (Attachment 3)
2. Safety Equipment (Attachment 4)
3. Explosive vehicles (HGL SOP 15.02, Section 5.6.2)
4. Range vehicle
5. Safety vehicle(s)
6. Designated personnel accountability and assembly location/rally point

4.9 COMMUNICATIONS

Primary communications will be accomplished through the use of field handheld portable radios. The contact information for emergency services, including telephone numbers for the project personnel, is provided in the APP/SSHP. Secondary communication will be via cellular telephones, with the phone numbers for the HGL key personnel posted in the APP. The explosive demolition team SUXOS, UXOSO and DS cellular numbers will be recorded on Attachment 1.

– W A R N I N G –

Radio communication between the demolition team and SUXOS will be maintained at all times.

4.10 EXPLOSIVE VEHICLE TRANSPORTATION

Vehicles that are used to transport explosive materials will comply with the regulations specified by the Department of Transportation, Code of Federal Regulations, Title 49, Parts 171, 173 and 177 and HGL SOP 15.00, Section 5.5.

4.11 WEATHER AND ENVIRONMENTAL CONSIDERATIONS

Before beginning Demolition operations the SUXOS will obtain a local weather report. Demolition operations will not be conducted when electrical storms are within 10 miles of the site operations, when visibility restricts positive control of the exclusion zone, or when weather conditions impact safety.

4.12 EMERGENCY MEDICAL SUPPORT

The telephone number of the responding medical facility will be prominently posted at the site office. Emergency medical personnel will be notified of the location and duration of demolition operations each day. At least two UXO personnel on each demolition team will be trained in first aid and CPR. A first-aid kit, portable eyewash, and bloodborne pathogen kit will be on site at all times. The first-aid kit will contain dressings capable of treating traumatic injuries that could result from an explosion.

4.13 FIRE PREVENTION PLAN

The telephone number of the nearest fire department is posted in the work plan/APP. The fire department will be notified of the location and duration of demolition operations each day. Fire extinguishers and shovels will be on site to fight small fires. Personnel must evacuate the area if the fire approaches munitions or explosives. Do not fight grass fires in areas where there may be munitions or kick-outs.

4.14 PERSONAL PROTECTIVE EQUIPMENT

Demolition operations will normally be conducted in Level "D" personal protective equipment (PPE). This will consist of cotton, Gortex or other non-static producing clothing and foul weather gear, gloves, safety glasses and composite or steel-toed boots. The UXOSO will ensure that the proper PPE is procured, issued, and utilized by project personnel and that daily checks are performed to ensure continued availability and use.

4.15 EXPLOSIVE OPERATIONS

Only HGL UXO–qualified personnel will be allowed to conduct demolition operations on HGL munitions response project sites to demilitarize or destroy MEC/UXO using open detonation methods. The following general safety guidelines that will be followed at all times during all Demolition operations:

1. MEC items found requiring demolition that is deemed *unacceptable-to-move* by the SUXOS and UXOSO will be blown-in-place.
2. MEC items will only be deemed *acceptable-to-move* by the SUXOS and UXOSO jointly.
3. MEC items that are *acceptable-to-move* by the SUXOS and UXOSO may be moved to a single item location in within the munitions response site for destruction when approved in accordance with the ESS or ESP.
4. MPPEH/MDEH items will be perforated to facilitate 100 percent inspection of all surfaces.
5. Demolition operations will not be conducted without proper authorization.
6. This SOP will be used as guidance for demolition procedures.
7. Engineering control using sandbag mitigation will be employed to reduce blast and fragment hazards.

4.15.1 Engineering Controls

Engineering controls will be employed in accordance with the DDESB-approved ESP for this project.

4.15.2 Initiation sequence

The SUXOS or DS will ensure that the following actions are completed before initiating any demolition shot:

1. Ensure all required notifications have been made.
2. Set up EZ and post guards at the barricades.
3. Visually inspect EZ and surrounding area for unauthorized personnel.
4. Announce on the handheld/mobile radio the following demolition warnings:
    a. **Five-minute warning**. The DS will give the five-minute warning on the radio before initiation of the demolition shot(s).
    b. **One-minute warning**. The DS will give the one-minute warning on the radio, before initiation of the demolition shot(s).
5. Before initiating the demolition shot the SUXOS/DS will give three, loud "*Fire in the Hole!*" warnings and then give the "fire" command on the radio.
6. When the area has been cleared (post-blast), the SUXOS will anounce over the radio an "*all clear*".
7. The SUXOS/DS will announce on the radio that Demolition operations have ceased.

4.15.3 Initiation Systems

The following applies to the initiation systems used in explosives operations:

1. The primary firing system will use the Remote Firing Device with Nonel®.
2. The alternate primary firing system will use the Remote Firing Device with electric blasting caps.
3. The secondary system will use the Scorpion Electronic Blasting Machine with electric or Nonel® initiation.
4. In areas of high electromagnetic radiation, or a high fire index, a Nonel® system should be used.

4.15.4 Blow in Place (BIP) Operations

MEC that is discovered and jointly deemed *unacceptable-to-move* by the SUXOS and UXOSO will be blown in place (BIP). The SUXOS will notify the client when a MEC item is deemed as *unacceptable-to-move* and will be BIP. MEC items that are *acceptable-to-move* may be relocated within the site investigation area away from residences and public buildings as necessary. The following verifications must be completed before a MEC item is BIP:

1. Authorization has been granted by the client to conduct the disposal operation.
2. An appropriate EZ for the MEC encountered has been established and evacuation of the area has been confirmed.
3. When applicable, the appropriate engineering controls are in place for the reduction of the fragmentation hazard.
4. Emergency support services have been notified and are standing by in position:
5. Emergency services (when required)
6. Fire department
7. Law enforcement.
8. Every effort has been made to establish the firing point in a location where the SUXOS and the UXOSO can visually observe the entire EZ.
9. All BIP operations will be fired by positive control methods; Nonel® or direct command remote control firing device initiation to maintain positive control up to the point of detonation.

4.15.5 Phosphorus-filled Munitions

When munitions containing plasticized white phosphorus, red phosphorus or white phosphorus (WP) fillers are encountered, the following procedures will be observed in conjunction with HGL SOP 15.08 Phosphorus-filled Munitions and Residues:

1. Protective clothing, to include helmets with full-face shields, a welder's apron, and gloves will be worn when handling suspected phosphorus-filled munitions.
2. Ensure medical support personnel know they are supporting phosphorus-filled munitions demolition operations and have first-aid treatment materials on hand.
3. If an accident occurs in the field, irrigate phosphorus wounds with water, and apply saline soaked dressing. Keep dressing wet until arrival of medical personnel.
4. Ensure an ample supply of water and sand are readily available when handling suspected phosphorus-filled munitions.
5. Phosphorus-filled munitions will be counter-charged bottom centerline (CCBC) to disperse the phosphorus in the air for complete combustion.

6. Care must be taken when returning to the disposal site after detonation of phosphorus-filled muntions to ensure that all phosphorus was consumed.
7. Do not approach the area until all smoke has cleared and the SUXOS has declared the area safe.

4.15.6 MPPEH

All potential munitions-related items are considered to be MPPEH until they have undergone a 100 percent inspection by a UXO Technician II and a 100 percent re-inspection by a UXO Technician III. If an item is determined to contain high explosives (HE) or energetic material, it will be classified as MEC and then categorized as either UXO, or as DMM, or as MC as defined in Section 4.1 above. Items determined to contain HE or energetic material, or cannot be 100 percent visually inspected will be designated as material documented as an explosive hazard (MDEH) in accordance with DoD 4140.62. MDEH will be treated as Hazards Class/Division 1.1 material and until it has undergone the proper treatment process specified by the work plan and the DDESB-approved ESP/ESS. MDEH will not be commingled with any other material until it has undergone the required treatment process and a second 100 percent UXO Technician II and a 100 percent re-inspection by a UXO Technician III and met the designation requirement of MDAS.

Upon completion of the demolition shot UXO Technicians will conduct a thorough inspection of the surrounding area. All MD will be picked up and inspected to determine its designation as either MDEH or MDAS before final disposition is accomplished in accordance with the DDESB-approved ESS/ESP and HGL SOP 15.03.

5.0 SAFETY

The SUXOS and UXOSO are responsible for ensuring all demolition operations on HGL MR project sites are conducted in the safest possible manner for protection of project personnel, the public, and project equipment assets. The SUXOS and the UXOSO are responsible for ensuring Attachments 2, 4, and 5 of this SOP are briefed and acknowledged by all demolition team members before the execution of any explosive operation.

6.0 RECORDKEEPING

The SUXOS and DS will use the forms and checklists identified by this SOP and HGL SOP 15.00, Explosive Accountability and Management for all HGL demolition operations. The following checklists will be used to ensure all demolition operations personnel assignments and functions, and explosive expeditures are properly documented and recorded:

1. Disposal Operations Checklist (Attachment 2)

2. Post Demolition Opereations Checklist (Attachment 8)

6.1.1 Required Documents

In conjunction with this SOP, the following documents are required to be on site during disposal operations:

1. Approved Work Plan
2. Approved site safety and health plan
3. Approved ESP or ESS
4. Range certification (when applicable)
5. HGL SOP 15.00 Explosives Accountability and Management Program
6. HGL SOP 15.02 Explosives Storage Inspection and Security
7. HGL SOP 15.03 Material Potentially Presenting and Explosive Hazard Inspection, Management and Processing
8. HGL SOP 15.08 Phosphorus-filled Munitions and Residues

7.0 REFERENCES

Code of Federal Regulations, Tile 27, Part 555—Commerce of Explosives, 2007, Bureau of Alcohol, Tobacco, Firearms and Explosives, ATF Publication 5400.7, ATF Federal Explosives Laws and Regulations, November.

Code of Federal Regulation, Title 49 Parts 171, 173 and 177, U.S. Department of Transportation, Other Regulations Relating to Transportation.

Department of Defense Explosive Safety Board Technical Paper 18, 2004, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, December.

Department of Defense Manual 6055.9-M, 2010, DoD Ammunition and Explosives Safety Standards, February.

Department of Defense Instruction 4140.62, 2008, DoD Ammunition and Explosives Safety Standards, November.

U.S. Army, Technical Manual 60A-1-1-31, 2008, General Information on Explosive Ordnance Disposal Procedure, October.

U.S. Army Corps of Engineers, Engineer Manual 385-1-97, 2008, Explosives Safety and Health Requirements Manual, September.

U.S. Army Corps of Engineers, Engineer Regulation 385-1-95, 2007, Safety and Health Requirements Munitions and Explosives of Concern Operations, March.

HydroGeoLogic, Inc., HGL MMRP SOP 15.00, Revision 4, 2014, Explosives Accountability and Management Program, June.

HydroGeoLogic, Inc., HGL MMRP SOP 15.02, Revision 3 2014, Explosives Storage Inspection and Security, January

HydroGeoLogic, Inc., HGL MMRP SOP 15.03, Revision 3 2014, Material Potentially Presenting and Explosive Hazard Inspection, Management and Processing, January.

HydroGeoLogic, Inc., HGL MMRP SOP 15.08, 2014, Phosphorus-filled Munitions and Residues, Febuary.

8.0 ATTACHMENTS

Attachment 1	Supervisor/Workers Statements
Attachment 2	Demolition Operations Checklist
Attachment 3	Demolition Equipment Checklist
Attachment 4	Safety Equipment Checklist
Attachment 5	General Safety Precautions
Attachment 6	Explosive Systems Configuration
Attachment 7	Rothenbuhler Engineering 1670 Remote Firing Device Procedures
Attachment 8	Post Demolition Operations Checklist
Attachment 9	Three Phase Quality Control Checklist Explosive Demolition Operations (Demolition operations) (HGL SOP 15.01)

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of Naval RPM approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name	Date

ATTACHMENT 2
DEMOLITION OPERATIONS CHECKLIST

FUNCTION CHECK	DATE/TIME	INITIALS
1.0 SENIOR UXO SUPERVISOR:		
1. Assign Demolition Team: a. SUXOS: _____ b. Demolition Supervisor: _____ c. Demo Team Assistant: _____ d. Demo Team Member: _____ e. Demo Team Member: _____ f. UXOSO: _____ 1) Safety Position #1: _____ 2) Safety Position #2: _____ 3) Safety Position #3: _____ 4) Safety Position #4: _____ g. Other: _____ **2. Communications**: a. Radio call signs / cellular numbers: 1) SUXOS: _____ /_____ 2) DS: _____ /_____ 3) UXOSO: _____ /_____ 4) Safety Position-1: _____ /_____ 5) Safety Position-2: _____ /_____ 6) Safety Position-3: _____ /_____ 7) Safety Position-4: _____ /_____ **3. Brief Demolition Team**: a. Review emergency procedures. b. Discuss MEC/MC/UXO to be disposed. c. Describe Disposal procedures. **4. Inspect Range/Exclusion zone upon completion of operations.**		
2.0 DEMOLITION SUPERVISOR		
1. Verify roads are closed. 2. Verify exclusion zone boundaries in place. 3. Complete health and safety and equipment checklists. 4. Ensure command center has completed the verification checklist:		

ATTACHMENT 2 DEMOLITION OPERATIONS CHECKLIST		
FUNCTION CHECK	**DATE/TIME**	**INITIALS**
a. Responsible activity. b. Medical Facility. c. Fire Department. d. Security/Police Department. 5. Disposal Supervisor tailgate safety brief: a. Designate emergency vehicles. b. Designate emergency evacuation route. c. Review emergency response procedures. 6. Verify daily equipment inspection. 7. Verify detonators are separated from explosives. 8. Verify area has been evacuated. 9. Notify command center operations are commencing. 10. Start disposal activities. 11. UXOSO ensures detonation site insected after designated wait time. 12. Collect all metal fragments for later disposal. 13. QC check performed. 14. Stop disposal activities. 15. QA check (if required). 16. HGL notification upon completion of demolition operations: a. Notify Client: _____ b. Responsible Activity : _____ c. Medical Facility: _____ d. Fire Department: _____ e. Local Police/Security: _____ f. Public Utilitiy Company: _____ 17. Complete HGLForm 15.04 MEC/UXO Accountability Log. 18. Demobilize (when applicable) 19. Complete Post Demolitoin Operation Checklist, Attachment 8.		
Demolition supervisor signature:	**Date:**	

HGL HydroGeoLogic, Inc MUNITIONS RESPONSE TEAM	**ATTACHMENT 3** **DEMOLITION EQUIPMENT CHECKLIST**	
Equipment	**Quantity**	**Comments**
Explosive Vehicle(s)		
Personnel Vehicle(s)		
Camcorder/Digital Camera		
Handheld Radios		
Electronic Firing Device		
Radio Controlled Firing Device		
Ruler, 24-inch		
Shovel, round point, long handle		
Blasting Machine		
Duct tape		
Plastic tape		
Measuring tape, 50- or 100-meter		
Toolbox, general hand tools		
Galvanometer		
Firing Wire		
Demolition Kit		
Knife		
Magnetometer		
3.0 CHECKLIST VERIFICATION		
Disposal Supervisor Signature:		**Date:**

HGL HydroGeoLogic, Inc MUNITIONS RESPONSE TEAM	**ATTACHMENT 4** **SAFETY EQUIPMENT CHECKLIST**	
1.0 EQUIPMENT	**QUANTITY**	**COMMENTS**
Burn Blanket		
Burn Kit		
Emergency Eye Wash		
Fire Blanket		
Fire Extinguisher, 10-pound ABC		
Bloodborne Pathogen Kit		
First Aid Kit		
Leather gloves		
Goggles		
Face Shield(s)		
Welder's Gloves		
Welder's Apron(s)		
Rain Suit(s)		
Safety Vest(s)		
Stretcher		
Water, 5-gal bottle (emergency shower)		
Water, drinking – 1 liter per person		
Other:		
Other:		
2.0 CHECKLIST VERIFICATION		
Disposal Supervisor Signature:		**Date:**

ATTACHMENT 5
GENERAL SAFETY PRECAUTIONS

1. Carry blasting caps in approved containers and keep them out of direct sun. Keep the caps located at least 25 feet from other explosives until they are needed for priming.
2. Do not work with electric blasting caps or other electro-explosive devices while wearing clothing prone to producing static electricity such as nylon, silk, synthetic hair, etc.
3. Do not use explosives or accessory equipment that is obviously deteriorated or damaged. They may cause premature detonation or fail completely.
4. Always point the explosive end of blasting caps, detonators, and explosive devices away from the body during handling.
5. Use only standard blasting caps of at least the equivalent of a commercial No. 8 blasting cap.
6. Use electric blasting caps of the same manufacturer for each demolition shot involving more than one cap.
7. Do not use improvised methods for initiating blasting caps.
8. Do not bury blasting caps. Use detonating cord to transmit the explosive wave from the blasting caps, on the surface, to a buried/tamped explosive charge. Buried blasting caps are subject to unobserved pressures and movement, which could lead to premature firing or misfires.
9. Test electric-blasting caps for continuity at least 50 feet from any other explosives prior to connecting them to the firing circuit. Upon completion of testing, the lead wires will be shunted by twisting the bare ends of the wires together. The wires will remain shunted until ready to be connected to the firing circuit.
10. In the event of a misfire when disposing of explosives by detonation, do not approach the disposal site for at least 30 minutes after the expected detonation time, when firing electrically. When conducting non-electric procedures, the wait time will be at least one hour from the expected time of detonation.
11. Items with lugs, strong backs, tail-booms, base plates, etc., should be oriented away from personnel locations.
12. Consideration should be given to tamping the UXO to control fragments, if the situation warrants. Fragments will be minimized not only to protect personnel but also property, such as buildings, trees, etc.
13. Avoid inhaling the smoke, dust, or fumes of burning pyrotechnic or incendiary materials. The smoke, dust and fumes from many of these materials are irritating and/or toxic if inhaled.
14. Do not use water on incendiary fires. Water may induce a violent reaction or be completely ineffective, depending on the mixture.
15. Anticipate a high order detonation when burning pyrotechnic or incendiary-loaded MEC. Safety measures for personnel and property must be based upon this possibility.
16. Inert munitions will not be disposed of, or sold for scrap, until the internal fillers have been exposed and unconfined. Heat generated during a reclamation operation can cause the inert filler, moisture, or air to expand and burst the sealed casings. Venting or exposure may be accomplished in any way necessary to preclude rupture due to pressure from being confined. All

requirements of the UXO Procedure for the Management and Disposition of Material Potentially Presenting an Explosive Hazard (MPPEH) will be met prior to releasing any inert munitions material.

17. Maintain minimum safe distances between electromagnetic-radiating sources and electro-explosive devices (IAW EODB/TM-TO 60A-1-1-12).
18. Do not conduct blasting or Demolition operations during an electrical, dust, sand, or snowstorm severe enough to produce atmospheric static electrical charges, or when such a storm is nearby (within 10 miles). Under such conditions, all operations will be suspended or terminated, cap and lead wires shunted, and personnel removed from the demolition area. Demolition operations will also be terminated if visibility becomes less than 600 feet.
19. Loose initiating explosives: lead azide, mercury fulminate, lead styphnate, and tetracene. These explosives manifest extreme sensitivity to friction, heat, and impact. Extra precautions are required when handling these types of explosives. Keep initiating explosives in a water-wet condition at all times until ready for final preparation for detonation. Sensitivity of these explosives is greatly increased when dry.
20. Exercise extreme care when handling and preparing high explosives for detonation. They are subject to detonation by heat, shock, or friction.
21. Do not pack bomb fuze wells with explosives unless it can be positively confirmed that the fuze well does not contain any fuze components.
22. Photo flash bombs must be handled with the same care as black powder-filled munitions.
23. MEC containing phosphorus will not be detonated into the ground. Phosphorus-filled munitions will be counter-charged on the bottom centerline (CCBC) when possible.
24. A search of the detonation site, after the demolition operation, will be conducted to assure complete disposal was accomplished.
25. Do not abandon any explosives.
26. Do not leave explosives, empty cartridges, boxes, liners or other materials used in the packing of explosives lying around where children, unauthorized persons or livestock can get at them.
27. Do not allow any wood, paper or other materials used in packing explosives to be burned in a stove, fireplace, or other confined space, or be re-used for any other purpose. Such materials will be destroyed by burning at an isolated location out of doors, with no one allowed within 100 feet of the burning operation.
28. Do not fight fires involving explosive material. Evacuate all personnel to a safe location and secure the area.
29. Know and observe federal, state, and local laws/regulations that apply to the transportation, storage, and use of explosives.
30. Do not permit metal, except approved metal truck bodies, to contact explosive containers.
31. Do not transport metal, flammable, or corrosive substances with explosives.
32. Do not allow smoking, or the presence of unauthorized personnel, in vehicles transporting explosives.
33. Carefully load and unload explosives from vehicles. Never throw or drop explosives from the vehicle.

34. Assure the load is blocked and braced to prevent it from movement and displacement.

35. Do not drive vehicles containing explosives over public highways until all permits and certifications have been obtained from the state enforcement agencies.

36. All routes must be approved in writing prior to transporting explosive materials over public highways.

37. Licensed commercial carriers will conduct the shipment of explosive materials over public highways unless HGL UXO personnel have been specifically licensed and certified to make the shipment.

38. Never leave a vehicle that is loaded with explosives unattended.

39. Do not store blasting caps, detonators, or other items containing initiating explosives in the same box, container, or magazine with other explosives.

40. Store explosive materials in military or BATF-approved magazines only. Ensure the magazines used for the storage comply with quantity distance requirements, for the class of explosive material they contain. Reference documents include: Explosives Law and Regulation, BATF P 5400.7, and 49 CFR.

41. Do not store spark-producing metal/tools in an explosive magazine.

42. Do not permit smoking, matches, or any source of fire or flame within 100 feet of an explosive magazine.

43. Do not allow leaves, grass, brush, or debris to accumulate within 50 feet of an explosive magazine.

44. Do not permit the discharge of firearms within 300 feet of an explosive magazine.

45. Do not use any alkaline material such as lye, washing soda, or soap to remove TNT exudate. Alkaline materials will react with TNT to render it more sensitive.

46. Do not permit smoking, matches, or other sources of fire or flame within 100 feet of an area in which explosives are being handled.

47. Do not expose explosives or devices containing explosive to prolonged exposure to direct sun light. Such exposure can increase sensitivity and deterioration.

48. Ensure all unused explosives are returned to their proper containers and the container closed after use.

49. Do not carry explosives or explosive components in pockets or on the body.

50. Do not insert anything but time fuse or detonating cord into the open end of a blasting cap.

51. Do not strike, tamper with, or attempt to remove or investigate the contents of an electric/non-electric blasting cap, detonator, or other explosive initiating device. A detonation may occur.

52. Do not pull on the electrical lead wires of electric blasting caps, detonators, or their electro-explosive devices. A detonation may occur.

53. Do not attempt to remove an unfired or misfired primer or blasting cap from a base coupling. There is a high risk of an explosion.

54. Do not allow unauthorized or unnecessary personnel to be present when explosives are being handled.

55. Always point the explosive end of blasting caps, detonators, and other explosive devices away from the body.

56. Do not use pull rings or safety pins to lift or handle explosive devices.

ATTACHMENT 6
EXPLOSIVE SYSTEMS CONFIGURATION

1.0 REMOTE FIRING DEVICE

1. Perform system pre-operational test and set up using the Rothenbuhler Operator's Manual. Remove key from controller unit until ready to fire.
2. Place the remote near the detonation site with the antenna in the vertical position. If using electric caps the remote should be within 100 feet of the shot. Use the unit blast shield, sandbags, or natural cover to protect the remote.
3. Ensure the remote indicates a READY condition for the selected initiation method (green READY LED on steady, red ARMED LED off).
4. If using Nonel®/shocktube, connect the shock tube to the igniter tip. The tube should be wrapped around through holes in the tip's molded casing to keep it from falling out. Prime the shot and return to the safe area.
5. If using electric caps, cut off a length of firing wire that will reach between the remote and the charges (100 feet or less).
6. Conduct a continuity check of the firing wire with a galvanometer. Shunt the free ends of the wire to prevent an electric charge from building up in the firing wire.
7. Test each electric blasting cap 50 feet downwind of other explosives with a galvanometer.
8. Place blasting caps in a hole, behind a barricade, or under a sandbag before removing the shunt and testing for continuity.
9. Fully extend the leg wires and ensure the cap is pointing away from the person conducting the continuity test.
10. Secure the leg wires to prevent the cap from moving during the test.
11. Use only a special silver-chloride dry cell battery in the testing galvanometer. Other type batteries may provide sufficient voltage to fire the blasting cap.
12. Upon completion of testing, re-shunt the leg wires. The wires will remain shunted until ready to connect to the firing circuit.
13. For dual priming connect blasting caps in a parallel circuit to the extension wires.
14. Test the circuit with the galvanometer, and then connect extension wires to the remote.
15. Retrieve caps from barricade, prime shot, and return to safe area.
16. Retrieve caps from barricade, prime shot, and return to safe area.

2.0 FIRING THE REMOTE FIRING DEVICE

1. The SUXOS will verify that the exclusion zone is clear and barricades are in place.
2. The SUXOS will give a "five-minute warning" over the radio.

3. The SUXOS will give a "one-minute warning" over the radio.
4. Install the key and engage the "POWER" switch on the controller to the right until the BATTERY LED illuminates.
5. Momentarily depress the controller STATUS button. The yellow TRANSMIT LED will flash for approximately one second. At the end of this time a green READY LED will come on steady, indicating that the remote is on and in the standby mode. The steady green LED also indicates the remote is within range of the controller.
6. Push the ARM/DISARM switch to the left and hold for one second. The red ARMED LED will flash for approximately 18 seconds and then come on steady. The remote is now armed.
7. UXO Demolition Supervisor gives three loud "Fire-in-the-Hole" warnings.
8. SUXOS gives fire command on the radio.
9. SUXOS gives permission to fire the shot.
10. Lift the safety cover on the FIRE switch and push the FIRE switch forward.

3.0 PREPARATION OF THE SCORPION ELECTRONIC BLASTING MACHINE

1. Perform pre-operational check as per instructions on blasting machine.
2. Lay out firing wire or Nonel®/shocktube.
3. Conduct a continuity check of the firing wire with a galvanometer. Shunt the free ends of the wire to prevent an electric charge from building up in the firing wire.
4. Test each blasting cap with a galvanometer 50 feet away from other explosives.
5. Place blasting caps in a hole, behind a barricade, or under a sandbag before removing the shunt and testing for continuity.
6. Fully extend the leg wires and ensure the cap is pointing away from the person conducting the continuity test.
7. Secure the leg wires to prevent the cap from moving during the test.
8. Use only a special silver-chloride dry cell battery in the testing galvanometer. Other type batteries may provide sufficient voltage to fire the blasting cap.
9. Upon completion of testing, re-shunt the leg wires. The wires will remain shunted until ready to connect to the firing circuit.
10. For dual priming, connect blasting caps in a parallel circuit to the firing wire.
11. Retrieve caps from barricade, prime shot, and return to safe area.

4.0 FIRING THE SCORPION ELECTRONIC BLASTING MACHINE

1. The SUXOS will verify that the exclusion zone is clear and barricades are in place.
2. The SUXOS will give a "five-minute warning" over the radio.
3. The SUXOS will give a "one-minute warning" over the radio .

4. If firing electric check firing wire with a galvanometer.
5. Connect the firing leads to the terminal posts of the blasting machine.
6. For Nonel®/shocktube, plug in the shock tube adapter and attach Nonel®/shocktube.
7. UXO Demolition Supervisor gives three loud "Fire-in-the-Hole!" warnings.
8. SUXOS gives fire command on the radio.
9. SUXOS gives permission to fire the shot.
10. Degrees and hold CHARGE button (keep depressed throughout sequence).
11. Press DETONATE button when green ready light comes on. For non-electric shots, hold DETONATE button down for one second and release.

5.0 MISFIRE PROCEDURES FOR THE REMOTE FIRING DEVICE

1. Make three successive attempts to fire.
2. Turn off the controller and remove the key.
3. Wait 30 minutes from the last initiation attempt.
4. After the wait time has elapsed, the Demolition Supervisor and a safety observer will proceed down range to inspect the firing system.
5. If Nonel®/shocktube was used, do not remove the caps from the charge. Disconnect Nonel®/shocktube from the igniter tip on the remote. Place a new, primed explosive charge next to the misfired charge.
6. If electric caps were used, remove the old blasting caps from charge and disconnect from extension wires. Shunt cap leg wires.
7. If detonating cord was used, cut detonating cord between cap and charge, and disconnect cap from extension wires. Shunt cap leg wires.
8. Set up new firing system.

6.0 MISFIRE PROCEDURES FOR THE SCORPION ELECTRONIC BLASTING MACHINE

1. Make three successive attempts to fire.
2. If using firing wire and still unsuccessful, disconnect wires and check continuity.
3. If continuity is good, reconnect to blasting machine and make three more attempts to fire.
4. If still unsuccessful, check connections of firing wires to terminals and make three more attempts to fire.
5. Change blasting machine after third unsuccessful attempt.
6. If unsuccessful with new blasting machine, disconnect and shunt firing leads.
7. If using Nonel®/shocktube, disconnect from blasting machine.
8. Wait 30 minutes from the last initiation attempt.

9. After the wait time has elapsed, the Demolition Supervisor and a safety observer will proceed down range to inspect the firing system.
10. If electric caps were used, remove old blasting caps from charge and disconnect from firing wire. Shunt cap leg wires.
11. If detonating cord was used, cut detonating cord between cap and charge and disconnect cap from fire wire. Shunt cap leg wires.
12. If Nonel®/shocktube was used, do not remove the caps from the charge. Place a new, primed explosive charge next to the misfired charge (FM-5-250).
13. Set up new firing system.

7.0 SHOCK TUBE FIRING SYSTEMS

Shock tube is a thin plastic tube of extruded polymer with a layer of special explosive dust deposited on its interior surface. The special explosive dust propagates a detonation wave, which is normally contained within the plastic tubing. Shock tube offers the instantaneous action of electric initiation without the risk of accidental initiation of the blasting cap by radio transmitters in the area or by static electricity discharge. The shock tube medium is extremely reliable.

7.1 SHOCK TUBE SPLICING

The high reliability of shock tube blasting is due to the fact that all of the components are sealed and, unlike standard non-electric priming components, cannot be easily degraded by moisture. Cutting the shock tube makes the open end vulnerable to moisture. Care should be taken to keep moisture from the cut end of the shock tube. Use the following procedures to cut and splice shock tube.

1. Use a sharp knife or razor blade to squarely cut (90 degree angle) approximately 18 inches from a new roll or the cut-off end of a partial roll.
2. Loosely tie the two shock tube ends to be spliced together in a SQUARE KNOT. Leave at least 2 inches free at the end of each shock tube beyond the knot.
3. Pull the shock tube lightly to tighten the knot, but not so tight as to significantly deform the shock tube in the knot.
4. Use only the splicing tubes provided to make splices. Taping the two cut ends of shock tube together does not make a reliable splice.
5. Push one of the free shock tubes, to be spliced, firmly into one of the pre-cut splicing tubes at last 1/4 inch.
6. Push the other shock tube end firmly into the other end of the splicing tube at least 1/4 inch. Attempt to push the two ends up against each other or get as close as possible.
7. Secure splice with electrician's tape.
8. Each additional splice in shock tube reduces the reliability of the priming system. Minimize the number of splices in a shock tube line to as few as possible.
9. Spool out the desired length of shock tube and cut off squarely with a sharp knife or razor

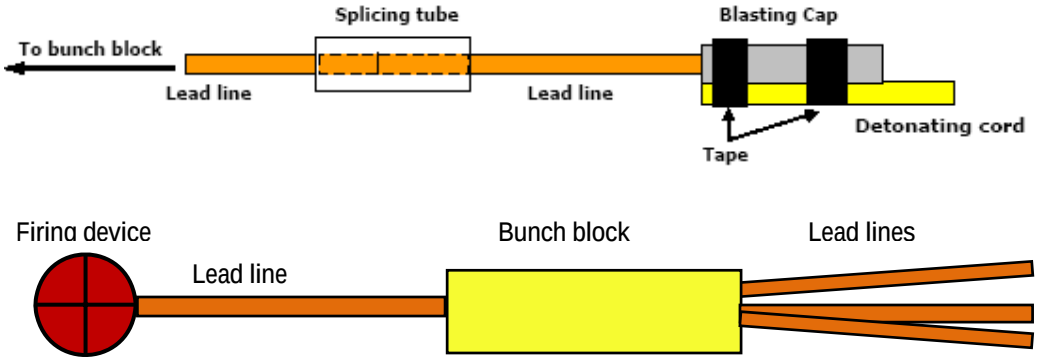
blade.

10. Secure the shock tube remaining on the spool by tying a tight overhand knot in the loose end.
11. Protect the open end of the shock tube by sealing it with the end caps provided or with electrician's tape.
12. Attach an initiator to the free end of the shock tube that is spliced into the blasting cap. If a separate blasting cap or detonating cord is used to actuate the shock tube, tie a tight overhand knot in this end

8.0 SHOCK TUBE SET-UP

1. Lay out required length of shock tube (trunk line) from demo area back to the firing point.
2. Attach an EZTL 30 bunch block (or equivalent) using the supplied splicing tube to the lead line at demo site. Secure the bunch block or immobilize with sandbags. Run additional lead line(s) from bunch block to OE (See Figure 1).
3. Attach only a maximum of six additional leads per bunch block. Use additional bunch blocks, if necessary.

FIGURE 1 – SHOCK TUBE SETUPS



9.0 DONOR EXPLOSIVES

The primary donor explosives used for MEC disposal will be the 1-pound pentolite booster, plastic explosives, jet perforators, or binary explosives.

9.1 ONE-POUND PENTOLITE BOOSTER

1. Insert 80 grain detonating cord into the detonator well. Insert all the way through and back through other hole and tie an overhand knot to secure it.
2. When using more than one booster, insert detonating cord through each of the boosters' detonator wells and secure to keep them from sliding along the detonating cord.

9.2 PLASTIC EXPLOSIVES

Set up with blasting cap(s) or detonating cord lead(s) as per EODB 60A-1-1-31. Position plastic explosives on MEC.

9.3 JET PERFORATOR

1. Use the detonating cord clip provided to secure detonating cord to the Jet Perforator.
2. Place the Jet Perforator on the MEC item using tape or other suitable methods to prevent it from moving.
3. For tamped shots, use a box or other suitable material to provide soil from getting between the perforator and MEC item.

9.4 BINARY EXPLOSIVES

Binary explosives are two-part explosives that are not classified as an explosive until mixed. These can be procured in various configurations to include plastic tube containers and pliable packs in varying sizes depending on the required application. The binary should not be mixed until ready for use. After mixing it can be primed as a cap sensitive explosive using Nonel®/shocktube, detonating cord, or electric or non-electric blasting caps. Use as any high explosive with a velocity of detonation around 20,000 feet per second.

9.5 POST-DEMOLITION PROCEDURES

1. Wait the designated wait times specified by the SOP. A minimum 5 minutes after single shots or after a series of shot that can be counted. A minimum of 30 minutes after multiple shots that could not be counted.
2. The Demolition Supervisor and one other UXO technician will return to the detonation site and check the results of the shot. If the procedure was successful the Demolition Supervisor will call in additional personnel to clean up the site. UXO personnel will conduct a visual sweep of the detonation site and the immediate area to gather fragments and explosive residue, if present.
3. Explosive residue will be collected and detonated.
4. Metal fragments will be examined to ensure complete consumption of explosive material.
5. Intact MEC items that failed to detonate will be disposed of.
6. After area is swept and cleared the Demolition Supervisor will notify the SUXOS and the “all clear’ will be given.

ATTACHMENT 7

ROTHENBUHLER ENGINEERING 1670

REMOTE FIRING DEVICE (RFD)

PROCEDURES

SAFETY WARNINGS

1) Always follow your local safety regulations. This manual and its procedures are secondary to governmental regulations, local regulations or company safety regulations and procedures. The operation procedures in this manual are only suggestions and should be checked against the above safety regulations and procedures. Company training should include the proper use of this machine and only trained personnel should use it.

2) Never rely on this equipment or any equipment totally for your safety. All mechanical and electronic equipment can fail. Always have a safety procedure that will protect you and minimize hazards of such failure.

3) High power radio transmissions can cause electric blasting caps to detonate. Keep the high powered Controller 25 or more feet (8 meters) from electric detonators.

4) The Shock Tube Initiator on the Remote Unit can develop up to 3,000 Volts. Do not touch this tip or tip jacks while arming or firing the unit.

5) Do not connect electric detonator wires or shock tube to the Remote Unit unless the green READY light is on, the red ARMED light is off, and the battery light is on steady.

6) Do not use the system if any of the units show damage to the point that failure is suspected. Thoroughly test the system prior to use.

7) Never approach the Remote Unit if it is attached to live explosives unless you have a confirmed READY status back to the Controller AND you have waited at least 2 minutes for the automatic disarm AND you have followed proper safety wait times.

8) It is MANDATORY that the Protective Cover is installed on the Charge Connector of the Remote unit at all times unless charging. There is the potential presence of voltage on some of the pins of the Charge Connector. For models produced after March 2009 (Serial Numbers 371+), the maximum current available from any pin is limited to 14.3 milliamperes.

3. PREOPERATIONAL PROCEDURES

3.1. PHYSICAL INSPECTION

3.1.1. Inspect all components for physical damage.

3.1.2. Remove the antenna dust caps and ensure the antenna jacks on the Controller Unit and Remote Unit are not damaged. Ensure they are clean and dry. Replace the antenna dust caps.

3.1.3. Ensure that the Remote and Controller Unit antennas are clean and free of damage. Ensure the electrical contacts are clean and dry.

3.1.4. Examine the shock tube igniter jacks on the left sides of the Remote Units. The jacks should be clean and dry.

3.1.5. Examine the Remote Unit's shock tube igniter tips. They should be clean and dry. If more than 200 shots have accumulated on either tip, replacement is recommended to ensure reliable shot initiation.

3.1.6. Press the two electric detonator binding posts located on the left sides of the Remote Units. Ensure they compress and return to their normal position (Dual Output Model only).

3.1.7. Ensure the key receptacles on the Controller Unit and Remote Units are clean and dry. Ensure they operate smoothly and show no signs of physical damage.

3.2. CHARGING THE BATTERIES

3.2.1. Ensure all units are turned off (The Remote Unit will not charge unless deactivated).

3.2.2. Ensure the ambient air temperature is between 32 and 86 °F (0 to 30 °C). When the ambient temperature is above 80 °F (27 °C), best results are obtained when the Remote lids are opened and air is allowed to circulate over the Remote display panels.

3.2.3. Remove the protective covers on the charge connectors. Line the key on the charger adapter plugs with the slot on the top of charge connectors mounted on each unit. Insert the plugs and turn clockwise until locked in place.

WARNING It is MANDATORY that the Protective Cover is installed on the Charge Connector of the Remote unit at all times unless charging. There is the potential presence of voltage on some of the pins of the Charge Connector. For models produced after March 2009 (Serial Numbers 371+), the maximum current available from any pin is limited to 14.3 milliamperes.

3.2.4. Insert the supplied charger adapters into suitable power outlets (100-240 VAC, 50/60 Hz).

3.2.5. As the units begin charging, the green SLOW lights will come on briefly, then the red FAST lights will blink for about 5 seconds and come on steady. The red FAST lights indicate the units are fast charging. Table 3-1 shows the charge indicator modes.

3.2.6. When charging is complete, the FAST lights will turn off, and the green SLOW lights will come on steady. Typical recharge time is 3-4 hours. For maximum battery life, avoid leaving the charger connected for more than 24 hours when possible.

Light	Blink Mode	Indicates
FAST	On steady	Fast Charging
FAST	Blinks at startup	Pre-testing
FAST	Blinks continuous	Battery Error
SLOW	On steady	Charge Complete
SLOW	Blinks continuous	Pack Temperature Range Exceeded

Table 3-1 RFD Charge Indicator Modes

3.2.7. When charging is complete, disconnect the charge adapters and reinstall the covers on the charge connectors.

WARNING It is MANDATORY that the Protective Cover is installed on the Charge Connector of the Remote unit at all times unless charging. There is the potential presence of voltage on some of the pins of the Charge Connector. For models produced after March 2009 (Serial Numbers 371+), the maximum current available from any pin is limited to 14.3 milliamperes.

3.3. BATTERY USAGE AND TESTING

3.3.1. To check the Controller's battery level, activate the unit by pressing the ON switch. The battery level will be shown as a percentage of full charge.

Figure 3-1 Controller Battery Level

Figure 3-2 Remote Battery Voltage

3.3.2. To test the Remote's battery voltage, turn the unit on and the hold the PRESS TO TEST switch for 10 seconds. A fully charged battery will stabilize with a reading of 13.5 V or more. The Remote Unit should be charged when the battery is less than 12.0 V. At 11.7 V, the yellow POWER light will flash to show the battery is too low.

3.3.3. When freshly charged, the Remote Units will run for up to 16 hours at an ambient temperature of 68 °F or 20 °C. Allow for reduced run times for hot or cold temperatures, or when the Safety Poll® mode of operation is used (Safety Poll® mode is explained in Section 5.1). Each unit can be fired approximately 100 times before recharging is required. Allow 15 minutes less run time, for each firing event.

3.3.4. When freshly charged, the Controller Unit will run in standby for up to 12 hours at an ambient temperature of 68 °F or 20°C. Allow for reduced run times for hot or cold temperatures, or when the Safety Poll® mode of operation is used (Safety Poll® mode is explained in Section 5.1).

3.3.5. The batteries will self-discharge at a rate of approximately 1% per day. This rate will increase as the temperature increases.

3.3.6. The RFD battery cells are reasonably resistant to developing a memory. For best results, allow the RFD to become mostly discharged before recharging, and allow the unit to fully charge without interruption.

3.3.7. The RFD's internal battery packs can be recharged up to 500 times before replacement is required. A decrease in run time may be noticed at the end of the battery pack's life cycle.

Return the RFD to an authorized service shop for replacement when required, or change your packs during the recommended 2-year servicing. Do not attempt field replacement.

3.3.8. Always turn the units off when not in use to conserve the battery charge.

3.3.9. The battery meter test switch can be pushed to check the battery level even if the power switch is in the off position. If the accessories bag in the lid gets excessively stuffed with tips or other items the possibility exists that the battery test button could be held down and consequently drain the battery.

3.4. TESTING THE RFD

3.4.1. This test procedure must be conducted in an area that is at least 100 feet from the nearest electric detonators or wires connected to electric detonators.

3.4.2. All RFD system components are described in detail in Section 2.

3.4.3. Ensure all units are sufficiently charged according to procedures 3.2 and 3.3.

3.4.4. Position the Controller and Remote Units at least 5 feet (1.5 meters) apart, in a position where all units can be observed while testing.

3.4.5. Install the antennas on the Remote and Controller Units.

3.4.6. On the Remotes, insert the enable keys and turn the POWER switches to the ON positions. Observe that the READY, ARMED, and POWER lights blink briefly on power up. The yellow light next to the ENABLE KEY should blink continuously to show the key is installed. The POWER light should remain on steady.

3.4.7. On the Remote Units, place the SELECT switch to the SHOCK TUBE position (Dual Output Model only). Observe the green SHOCK TUBE READY lights are on, and the red ARMED lights are out. Install a shock tube tip into the jacks located on the side of each Remote Unit.

3.4.8. On the Controller Unit, insert the Controller's key and press the ON switch. Observe the yellow POWER and KEY lights are on steady.

3.4.9. On the Controller, press the STATUS switch. After a short time the green READY lights for the Remote Units that were previously prepared for use, will come on steady to show they are disarmed and communicating two-way. The select lights will automatically be turned on for Remote Units that answered back to the Status request if the Auto Select option is enabled.

3.4.10. If Auto Select option is not enabled, on the Controller, press the SELECT switches to select the Remote Units to be tested. The yellow SELECT lights for the selected units will turn on.

3.4.11. On the Controller, press the ARM switch. The ARMED lights for the selected Remote Units will blink for up to 15 seconds and come on steady.

3.4.12. On the Remote Units, the red ARMED lights will come on steady. The system is armed.

3.4.13. On the Controller, before 2 minutes have elapsed, press the DISARM switch. All Remotes will disarm within 3 seconds.

3.4.14. Re-arm the Controller Unit and wait 2 minutes. After the 2 minutes, all Remotes will return to the disarmed state. The red ARMED lights will go out, and the green READY lights will come on steady.

3.4.15. Re-arm the Controller Unit, and before the two minutes have expired, press both FIRE switches together and hold for ½ second. You should notice that all Remote Units developed sparks at the shock tube tip electrodes. All units subsequently return to the disarmed state.

Note: 3.4.16 through 3.4.19 applies to the Dual Output Model only.

3.4.16. On the Remote Units, place the SELECT switches to the ELECTRIC DETONATOR position and observe the green ELECTRIC DETONATOR READY lights are on, and the ARMED lights are out.

3.4.17. On the Remotes, depress the two spring loaded binding posts and insert the leads of the test lamps.

3.4.18. Repeat procedures 3.4.11 through 3.4.14. The test lamps should remain extinguished through out this portion of the procedure.

3.4.19. Re-arm the Controller Unit, and before the two minutes have expired, press both FIRE switches together and hold for ½ second. You should notice that all test lamps light briefly. All units subsequently return to the disarmed state.

3.4.20. If any units did not work as described in this section, return to a service shop for repair. Never use a unit that is damaged or suspected of being damaged.

3.4.21. Turn off all units. Restore antennas, tips, and test lamps as required. The system is now operationally ready for use.

4. RFD OPERATIONAL PROCEDURES

4.1. SETTING UP THE RFD

WARNING It is MANDATORY that the Protective Cover is installed on the Charge Connector of the Remote unit at all times unless charging. There is the potential presence of voltage on some of the pins of the Charge Connector. For models produced after March 2009 (Serial Numbers 371+), the maximum current available from any pin is limited to 14.3 milliamperes."

4.1.1. Select the number of Remotes required for the operation. Ensure all units are sufficiently charged and tested according to Chapter 3.

Figure 4-1 Installing the Controller Antenna

4.1.2. Ensure the Controller Unit key is removed. Position the Controller Unit at the intended firing position and install the antenna.

4.1.3. To place the RFD in Safety Poll® mode, press and hold the STATUS switch while also pressing the ON switch (Details of Safety Poll® mode in Section 5.1).

4.1.4. Select a position for the first Remote Unit close to the blast area, but far enough to ensure the Remote is safe from direct air blasts and falling rocks.

Figure 4-2 Remote Antenna Installation

4.1.5. Install the antenna on the Remote Unit. Ensure the antenna is free of obstruction.

Figure 4-3 Activating the Remote Unit

4.1.6. Turn the POWER switch to the ON position. Observe the yellow POWER light is on and not flashing. Ensure the battery voltage is above 12.0V.

4.1.7. For underground operation, ensure the green RECEIVE light is on steady to indicate the Remote is in receiving range of the leaky feeder radio signal.

4.1.8. For surface operation, the green RECEIVE light suggests there may be an interfering

radio signal or noise present. The RECEIVE light is similar to breaking squelch on a handheld radio and does not necessarily indicate operation is degraded.

Figure 4-4 Select the Initiator

4.1.9. Place the SELECT switch to the desired initiation method (Dual Output Model only). Verify the green READY light is on, while the red ARMED light remains off.

4.1.10. If using non-electric shock tube, install the tube into the RFD Tip, and install the tip into the jacks on the left side of the Remote as described in Section 2.8.

4.1.11. If using electric detonators, install the two-wire firing cable into the spring loaded binding posts located on the left side of the Remote Unit (Dual Output Model only).

4.1.12. Install the enable key into the Remote Unit and observe the yellow light next to the ENABLE KEY begins flashing. If the Controller is in Safety Poll® mode, this light will turn on steady within 15 seconds to show that full 2-way communications are working.

4.1.13. Close the lid on the Remote for protection. Repeat Sections 4.1.4 to 4.1.13 for the remaining Remote Units to be used in the operation.

4.2. FIRING THE RFD

Figure 4-5 Activating the Controller Unit

4.2.1. Activate the Controller Unit on pressing the ON switch. Observe the yellow POWER light is on. The Controller should be recharged when the BATTERY indicator reads 20% or less.

Figure 4-6 Inserting the Controller KEY

4.2.2. When the area is clear and all shots are prepared, insert the key into the Controller Unit as shown in Figure 4-6. The yellow KEY light will turn on.

Figure 4-7 Select the Remote Units

4.2.3. Press the SELECT switches to select the Remote Units to be fired. The yellow SELECT lights will illuminate as the corresponding Remotes are selected.

Figure 4-8 Perform a STATUS check

4.2.4. Press the STATUS switch and observe the green READY lights will light for each selected Remote Unit that is operational and within range.

Figure 4-9 Observing the STATUS check results

4.2.5. Shown in Figure 4-9 are the results of our STATUS check for Unit #3. The steady green READY light indicates Unit #3 is disarmed. The steady yellow BATTERY light indicates Unit #3's battery is not low.

Figure 4-10 Arm the SELECTED Remote Units

4.2.6. Wait for the appropriate warning sirens. About 30 seconds from firing, press and hold the ARM switch for ½ second. The red ARMED lights will blink for up to 15 seconds and come on steady.

4.2.7. For systems configured in 1-way mode: If any of the ARMED lights continue to blink, those units are not within 2-way range and confirmation cannot be received. The Remote(s) may or may not fire depending on range, local interference, and the Controller radio's power setting.

4.2.8. For systems configured for 2-way only mode, units that are not within 2-way range will not be armed.

Figure 4-11 Firing the ARMED and SELECTED Remote Units

4.2.9. When ready to fire, press the two FIRE switches together at the same time and hold for ½ Second as shown in Figure 4-11. Shot initiation should be detected.

Figure 4-12 Verify the green READY Lights are on steady

4.2.10. After a short time, the green READY lights should be on steady to show that each Remote Unit has fired and is now disarmed as shown in Figure 4-12. Any lights that continue to blink indicate the Controller did not receive a confirming message and a manual STATUS check is required to ensure all units are disarmed.

Figure 4-13 Manually checking STATUS

4.2.11. To manually check status, press the STATUS switch at any time. The updated status of the SELECTED Remotes will be reported on the faceplate enunciator panel. You may alternately press DISARM and STATUS until all Remotes have reported they are confirmed READY.

Figure 4-14 Turn the Controller Unit OFF

4.2.12. With all deployed Remote Units having reported steady READY status, deactivate the Controller by pressing the OFF switch.

Figure 4-15 Remove the Controller's Key

4.2.13. Remove the Controller Unit's key.

4.2.14. Wait an additional 2 minutes, and following standard safety procedures, you may approach and retrieve the Remote Units.

4.2.15. Turn OFF the Remote Units. Remove and store the enable keys, antennas, and shock tube tips.

4.2.16. Inspect all units for physical damage. Close the lids and restore dust caps.

ATTACHMENT 8

POST DEMOLITON OPERATION CHECKLIST

I. Project Information

Site Name: _____ Date: _____

Site Location: _____ Grid Number: _____

Demolition Team Leader: _____

II. Explosive and MEC/UXO Accountability (Donor explosives)	Yes	No
(a) All unused explosive materials returned to magazine and properly stored?		
(b) Explosive Usage Record (HGL Form 15.05) completed and submitted to SUXOS?		
(c) All destroyed/demiled MPPEH, MEC and UXO accounted for and verified by SUXOS?		
(d) MEC/UXO Accountability Record (HGL Form 15.04) completed and filed?		
(e) Magazine Data Card–Daily Summary of Magazine Transaction (HGL Form 15.02) completed?		
(f) Magazine locked and secured (two-locks)?		
(g) Detonator box locked and secured (two-locks)?		
(h) Magazine fence gate locked and secured?		
(i) Magazine keys returned and properly secured?		

III. Remarks

IV. Approval (signature)

Demolition Supervisor:	Senior UXO Supervisor:

ATTACHMENT 9
Three Phase Quality Control Checklist
Demolition operations (HGL SOP 15.01)

Team:	**Location:**	**Date:**

Personnel Present:

Phase of Inspection (Circle): *PREPARATORY (P); INITIAL (I); FOLLOW-UP (F)*

CHECKLIST

Item	Reference	Inspection Point	Yes	No	N/A	Comments
1.	DDESB TP 18	All demolition team members meet the UXO-qualified personnel requirements				*(P)*
2.	Work Plans, ESP or ESS	Have all demolition team members reviewed the current work plan, ESP or ESS? *Check Dates/Record of training*.				*(P)*
3.	SOP 15.01 Sec 5.1	Do the provisions of SOP 15.01 meet procedural and safety requirements for performing demolition operations for all personnel selected to participate in the procedures meet the requirements specified in Para. 5.1?				*(P), (I), (F)*
4.	SOP 15.01 Sec 5.2	Was the **Coordination Meeting** held prior to commencing Demolition operations?				*(P)*
5.	SOP 15.01 Sec 5.4.1	Was a **Public Meeting** held prior to commencing Demolition operations?				*(P)*
6.	SOP 15.01 Sec 5.4.2	Has the SUXOS completed the mandatory notifications in advance of the conduct of Demolition operations (i.e. *Medical, Fire, Security)*				*(P), (I), (F)*
7.	SOP 15.01 Sec 5.5	Has the Explosive Safety Quantity Distance arc for the largest munition that will be detonated been used to calculate the EZ prior to the conduct of Demolition operations?				*(P), (I), (F)*
8.	SOP 15.01 Sec 5.5	Are proper visitor access and control procedures known and followed?				*(P), (I), (F)*
9.	SOP 15.01 Sec 5.5	Does the integrity of the EZ remain intact until Demolition operations are complete?				*(P), (I), (F)*
10.	SOP 15.01 Sec 5.1, 5.2	Are appropriate personnel requirements met/achieved for the proper conduct of Demolition operations?				*(P), (I), (F)*
11.	SOP 15.01 Sec 5.6	Is the two man rule concept religiously followed whenever explosives are transported or handled during explosive operations?				*(P), (I), (F)*
12.	SOP 15.01 Sec 5.7	Does a demolition procedures review occur prior to the conduct of Demolition operations in accordance with the requirements of SOP 15.01?				*(P), (I), (F)*
13.	SOP 15.01 Sec 5.8 ATT 1, ATT 2	Is all the equipment/ and materials required for Demolition operations available and checked prior to operation conduct in accordance with the provisions of SOP 15.01?				*(P), (I), (F)*
14.	TMP, SOP 15.01 Sec 5.1.2	Is a current copy of SOP 15.01, Project TMP, Explosive Safety Submission, Range Certification (when applicable) and EOD Publications (minimum TM 60A-1-1-31) available to the Team when conducting Demolition operations? *Check dates*.				*(P), (I), (F)*

15.	SOP 15.01 Sec 5.3	Have sufficient communications been established to enable team/field personnel to communicate with the Site Field Office and emergency response agencies prior to the conduct of operations?				*(P), (I), (F)*
16.	SOP 15.01 Sec 5.9	Has a backup emergency communication system been established in accordance with SOP 15.01 in the event that radios are inoperative in the EZ?				*(P), (I), (F)*
17.	SOP 15.01 Sec 5.8, 5.10, ATT 2 ATT 5	Are there sufficient range vehicles available, with appropriate safety devices installed, to transport and support Explosive Demolition Operation Personnel?				*(P), (I), (F)*
18.	SOP 15.01 Sec 5.8	Are all vehicle safety requirements of SOP 15.01 known and strictly observed?				*(P), (I), (F)*
19.	SOP 15.01 Sec 5.11	Does the SUXOS obtain a weather report prior to the conduct of Demolition operations?				*(P), (I), (F)*
20.	SOP 15.01 Sec 5.11	Are Demolition operations denied or cancelled when electrical storms are within 5 miles of the disposal site or when other severe weather conditions exist that would have a negative impact on safety?				*(P), (I), (F)*
21.	SOP 15.01 Sec 5.12	Are emergency medical support administrative, notification, training, and equipment requirements observed for Demolition operations in accordance with SOP 15.01?				*(P), (I), (F)*
22.	SOP 15.01 Sec 5.13	Are fire support administrative, notification, training, and equipment requirements observed for Demolition operations in accordance with SOP 15.01?				*(P), (I), (F)*
23.	SOP 15.01 Sec 5.14	Are the PPE items required for Demolition operations present and serviceable in accordance with SOP 15.01?				*(P), (I), (F)*
24.	SOP 15.01 Sec 5.1, 5.2	Are Demolition operations only performed by qualified UXO Personnel following the requirements specified in SOP 15.01?				*(P), (I), (F)*
25.	SOP 15.01 Sec 5.15.1	Are engineering control specifications available and employed when it becomes necessary to reduce detonation effects?				*(P), (I), (F)*
26.	SOP 15.01 Sec 5.13	Does the SUXOS or Demolition Supervisor take the appropriate actions as specified in SOP 15.01 prior to initiating a demolition shot?				*(I), (F)*
27.	SOP 15.01 Sec 5.15.2	Are explosive initiation systems chosen in accordance with SOP 15.01 provisions?				*(I), (F)*
28.	SOP 15.01 Sec 7.4	Are only Blow-in-Place (BIP) operations performed for MEC/MPPEH determined to be unsafe to move in accordance with the provisions of SOP 15.01?				*(I), (F)*
29.	SOP 15.01 Sec 7.5	Is the appropriate disposal procedures followed for munitions containing phosphorus in accordance with the provisions of SOP 15.01?				*(I), (F)*
30.	Phosphorus-filled munitions SOP 15.01 Sec 7.6	Following the performance of disposal operations does an inspection occur for MPPEH and is MPPEH inspected, collected, and certified in accordance with TMP requirements?				*(I), (F)*
31.	SOP 15.01 Sec 9.0 and ATT 8	Are Disposal Operations Checklists and Explosive Disposal Logs prepared and completed in accordance with this SOP 15.00 and SOP 15.01 Attachments 4 and 8?				*(I), (F)*

PUNCH LIST ITEMS	
No.	

Conducted by: _____ Acknowledged by: _____

Explosives Storage Inspections and Security	SOP No.: 15.02 SOP Category: MMRP Revision No.: 3 Date: January 2014

0.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide HydroGeoLogic, Inc. (HGL) employees with the basic guidelines and procedures for performing explosive storage inspections and security for magazines sited during Military Munitions Response Program (MMRP) projects. This SOP will be employed in conjunction with HGL SOP 15.00 *Explosives Accountability and Management*.

1.0 SCOPE AND APPLICATION

This procedure applies to all HGL employees who have been granted "Responsible Persons" and "Employee Possessor" status by the Bureau of Alcohol Tobacco, Firearms and Explosives (ATF) under the HGL Munitions Response Team (MRT) Type 20-Manufacturer of Explosives License and are tasked with performing explosive storage inspections, operations and security of magazines located on HGL project premises. These procedures apply to the inspection and security of all HGL explosive storage magazines during mobilization and demobilization, active site operations, and during periods when site operations are inactive, but explosives are still stored on the premises.

2.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the approved explosive safety submission (ESS) or the explosive site plan (ESP) and site safety and health plan (SSHP). Procedures for packaging and disposing of waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP Acknowledgement Form, Attachment 1. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

3.0 DEFINITIONS

Responsible Person: Responsible persons are the corporate officer and managers who have the authority to direct the management and policies as they pertain to explosive materials.

Employee Possessor: An individual who is required by law to submit their personal information to the ATF to undergo a background check for a responsible person or a employee possessor position; to restrict the availability of explosives to authorized persons only; and to reduce the risk of prohibited persons acquiring explosive materials [18 U.S.C. 843(h), 27 CFR 555.33, 555.45(c)].

4.0 PROCEDURES

Only HGL employees who are cleared by the ATF as either a Responsible Person or Employee Possessor and are listed on the HGL Explosive License–Notice of Clearance will be authorized access to explosive materials and storage magazines.

The SUXOS and the UXOQCS will be responsible for the explosive storage magazine inspections and security. The SUXOS and UXOQCS will perform all inspections with another UXO-qualified individual who should not be the same person on subsequent inspections. When the UXOQCS is not dual-hatted as the UXOSO, the UXOSO may serve as the third UXO-qualified individual.

4.1 INSPECTIONS AND TESTING

4.1.1 Project Start-up Inspections

Prior to establishing explosive magazine storage and receiving explosive materials following mobilization to a project site, a joint explosive security survey inspection will be conducted by the SUXOS and UXOQCS using the checklist provided as Attachment 2. The result of this survey will be documented using Attachment 2 and in the daily report prepared by the SUXOS.

4.1.2 Grounding Inspection and Testing

A qualified electrician will be contracted to perform grounding installation and meets the lightening protection system criteria established by National Fire Protection Association (NFPA) 780. Qualified electricians will be identified during pre operational planning.

4.1.2.1 Electrical Test

Bonding (resistance) tests will be performed in accordance with DoD 6055.09-M V2.E4.3.2, before placing explosive magazines in service and every 2 years.

4.1.2.2 Visual Inspection

A visual inspection of the explosive storage magazines, installation, and grounding will be conducted every 12 months in accordance with DoD 6055.09-M, V2.E4.3.1.

4.1.3 Weekly Inspections

Weekly inspections of the explosive magazine and munitions- and range-related debris storage areas will commence immediately upon acquisition of explosive materials following mobilization to the project site. The inspection does not have to coincide with the 7-day explosive materials inventory. The weekly inspection is necessary to determine if there has been an attempted or unauthorized entry into the magazine(s), or unauthorized removal of the magazine contents. The Explosive Storage Magazine Inspection Checklist, Attachment 3 will be used for conducting and documenting regular explosive storage inspections. Upon completion of this inspection, the checklist will be signed by the individual conducting the inspection. The SUXOS will also sign the inspection checklist upon completion of their review of this form. This report will be maintained with the project site files. This inspection includes, but is not limited to the following:

- Explosive storage magazine(s) grounding systems
- Placards and signage
- Fire hazards
- Posting of fire/chemical hazards and safety information
- Explosive compatibility
- Net Explosive Weight limits
- Explosive material container labeling and packing
- Housekeeping
- Explosive storage magazine integrity
- Fencing security
- Evidence of forced entry, sabotage, tampering or vandalism
- Vegetation
- Magazine lock and key accountability
- Abnormal odors and temperatures
- Emergency point of contact information displayed

4.1.4 Explosive Inspection and Inventories

An inventory of the explosive storage magazine containing explosive materials will be conducted every 7 days and documented in accordance with HGL SOP 15.00 *Explosive Accountability and Management*. The inventory will be performed by the SUXOS and the UXOQCS together, with another UXO-qualified individual who should not be the same person on the subsequent inspections as follows:

- Perform explosive material issue and returns from the SUXOS and UXOQCS or other designated UXO-qualified personnel.
- Confirm a current Manufacture of Explosives Record of Acquisition is maintained in the project field office.

- Confirm the Magazine Data Card—Daily Summary of Transactions is being maintained with the explosive material and a duplicate copy is being maintained in the project field office.
- Inventory, issue and receipt transactions are accurately annotated and reflect the most current transactions.
- Commercial donor explosives received and stored in the magazine are accounted for from the date of receipt to the date of destruction or to the date of transfer.

4.2 EXPLOSIVE STORAGE MAGAZINES

An appropriate number of explosive storage magazines required for the proper storage and security of explosive materials and their locations will be sited in accordance with all applicable DoD Explosive Safety Board (DDESB), ATF, federal, state and local laws and regulations. All high explosive materials will:

- Be appropriately stored in accordance with DoD Manual 6055.09-M DoD Ammunition and Explosives Safety Standards Volumes 2 and 3, ATF Publication 5400.7 ATF Federal Explosives Law and Regulations, Subpart K, and U.S. Army Corps of Engineering (USACE) Engineer Manual 385-1-97, Explosive Safety and Health Requirements Manual, Section I.2.N, and properly secured in approved ATF Type 2 outdoor portable explosive storage magazine(s); and
- Comply with the explosive quantity distances per the site-specific DDESB approved ESS or ESP.

4.3 SECURITY LOCKS

High security padlocks will be used to secure explosive materials in accordance with CFR Subpart K, §555.208, The SUXOS and UXOQCS shall maintain positive control of all keys and the explosive storage area entry gate. Accountability for all explosive magazine storage keys will be registered using the HGL Key Control Register and Inventory Log (Attachment 3).

4.4 PLACARDS AND SIGNAGE

Placards and signs will be placed on the doors of the magazines that indicate the Explosive Hazard Class and Division of the explosive materials stored in the magazine (Class 1, Division 1 for high explosives). An "*EMPTY"* placard/sign will be placed on the magazine when the magazine is empty of explosive materials and not in use. Additionally, a sign showing the HGL project personnel emergency point of contact information will be prominently displayed in an accessible location at the explosive storage area.

4.5 NOTIFICATIONS

Upon establishment of explosive storage magazines on HGL project sites the appropriate notifications will be made as required by HGL SOP 15.00 *Explosives Accountability and Management*.

4.6 FENCING PROTECTION

Appropriate fencing (physical security) protection will be installed on all site(s), in accordance with *AR 190-11, paragraph 5-3:*

- Fence Fabric will be of chain link (galvanized, aluminized or plastic coated woven steel) 2-inch square mesh 9-gauge diameter wire, including coating.

- Posts, bracing and other structure members will be located on the inside of the fence fabric. Galvanized steel or aluminized wire-ties equal in gauge to fencing will be used to secure the fence fabric to the posts or other structural members.

- The minimum height of the fence fabric will be 6 feet without an outrigger.

- The bottom of the fence fabric will extend to within 2 inches of firm ground. Surfaces will be stabilized in areas where loose sand, shifting soils, or surface waters may cause erosion and thereby assist an intruder in penetrating the fenced area. Where surface stability is not possible or is impracticable, concrete curbs, sills or other suitable type anchoring devices, extending below ground level will be provided.

- The barrier will have a minimum number of vehicular and pedestrian gates, consistent with the operational requirements. These gates will be structurally comparable to the adjacent fence. Gates will be provided with an approved lock and hinge pins and hardware will be welded or otherwise modified to prevent easy removal.

5.0 TRANSPORTATION REQUIREMENTS

Transportation of OE will comply with all Federal, state, and local regulations. Permits are not required under the Comprehensive Environmental Response, Cleanup, and Liability Act (CERCLA) for on-site or on Federal installation transportation of explosives or OE. Off-site transportation of OE will not be accomplished until coordination and approval has been received from the USACE Contracting Officer. Off-site shipment of OE will be made using commercial carriers approved to transport ammunition and explosives.

For off-site shipment:

- OE will be packaged in accordance with *49 CFR part 172 and 173*, if possible; if not possible the OE will be transported in such a manner as to not move or touch other OE items.
- Drivers will be provided with Emergency Response Information;
- Vehicles will be inspected using the Explosives Vehicle Inspection Form, and, if applicable, be properly placarded;
- Compatibility requirements will be observed;
- The load shall be well braced and, except when placed in an enclosed vehicle, covered with a fire-resistant tarpaulin.

5.1 GENERAL HIGHWAY TRANSPORTATION

In most instances, the following data is sufficient to meet the requirements for explosive transport.

5.2 COMMERCIAL MOTOR VEHICLE REQUIREMENTS *(49CFR PART 383.5)*

Commercial motor vehicle (CMV) means a motor vehicle, or a combination of motor vehicles, used in commerce to transport passengers or property if the motor vehicle
- Has a gross combination weight rating of 11,794 or more kilograms (26,001 pounds or more), inclusive with a towed unit with a gross vehicle weight rating of more than 4,536 kilograms (10,000 pounds); or
- Has a gross vehicle weight rating of 11,794 or more kilograms (266,001 pounds or more); or
- Is designed to transport 16 or more passengers, including the driver; or

Is of any size and is used in the transportation of materials found to be hazardous for the purposes of the Hazardous Materials Transportation Act, and which require the motor vehicle to
be placarded under the *Hazardous Materials Regulations (49 CFR part 172, subpart E)*.

5.3 CDL REQUIREMENTS

As long as site personnel are not using vehicles that weigh more than 26,000 pounds, and are not transporting any materials that must be placarded under the Department of Transportation(DOT) Hazardous Materials Regulations (i.e., they are only transporting 1.4 explosives), then the vehicle being used need not be classified as a CMV and the operator of the vehicle need not have a Commercial Driver's License (CDL). This is the typical situation for site personnel since they usually transport relatively small quantities of 1.4 demolition materials. However, if a CDL is required, the PM or UXOSO will ensure that the requisite license/permits are obtained.

5.4 Federal Installations/On-Site

Transportation of explosives and OE on-site and on Federal installations will comply with the following:

- Vehicles will be inspected per occurrence and will be properly placarded;
- Explosives will be transported in closed vehicles whenever possible. When using an open vehicle, explosives will be covered with a flame resistant tarpaulin (except when loading/unloading);
- Vehicle engine will not be running. Wheel chocks and brakes set when loading/unloading explosives;
- Beds of vehicles will have either a plastic bed liner, dunnage, or sandbags to protect the explosives from contact with the metal bed and fittings;
- Vehicles transporting explosives will have a first aid kit, two 10 ABC rated fire extinguishers, and communications capabilities;
- Initiating explosives, such as detonators, will remain separated from other high explosives during loading, unloading, and while on vehicles;
- Compatibility requirements will be observed;
- Operators transporting explosives will have a valid drivers license; and
- Drivers will comply with posted speed limits, but will not exceed a safe and reasonable speed for conditions. Vehicles transporting explosives off-road will not exceed 25 mph.

5.4 OFF-SITE TRANSPORTATION OF EXPLOSIVES OVER PUBLIC HIGHWAY

5.4.1 As long as only 1.4 explosives or less than 55 net explosive weight (NEW) of 1.1, 1.2, or 1.3 explosives are transported by personnel, DOT certificates of registration for individuals involved in the transportation of demolition materials are not required.

5.4.2 Explosives of compatibility Group S may be packed with explosives of all other explosive compatibility groups except A and L.

To determine the compatibility of the material typically transported by site personnel, check the Material Data Sheets presented in the appendix.

5.4.2 GENERAL PLACARDING REQUIREMENTS

Those Sites that require placards will accomplish this IAW 49 CFR 172.504. The placard requirements listed below will apply to explosives transportation, if applicable:

- "(a) Except as otherwise provided, each bulk packaging, freight container, unit load device, transport vehicle or rail car containing any quantity of a hazardous material must be placarded on each side and each end with the type of placards specified in Tables 4 and 5, in accordance with other requirements and exceptions."
- "(c) Exceptions for less than 454 kg (1,001 pounds). Except for bulk packaging and hazardous materials subject to § 172.505, when hazardous materials covered by Table 5 of this section are transported by highway or rail, placards are not required on:
  (1) A transport vehicle or freight container which contains less than 454 kg (1,001 lbs.) aggregate gross weight of hazardous materials covered by Table 5 of paragraph (e) of this section or;
  (2) A rail car loaded with transport vehicles or freight containers, none of which is required to be placarded."

The exceptions provided in paragraph (c) provided above do not prohibit the display of placards in the manner prescribed in this subpart, if not otherwise prohibited (see § 172.502), on transport vehicles for freight containers, which are not required to be placarded.

5.4.3 DOCUMENTATION

Any time explosives are being transported this chapter to include the completed copies of documents described below will be in the vehicle. Any deviation from the planned route will be coordinated with the UXOSO.

- Instructions for Motor Vehicle owners (Emergency Response Information) -
  Only those items, which are being transported, will be entered in the form with the applicable qty/units and weight columns completed. It is imperative that the NEW limitations of 55 lbs. not be exceeded. All required data will be entered on the front and the Guide 50 block should be checked on the back of the form.

- Explosives Purchase/Receipt/Authorization List
  The form will be completed ensuring the pertinent data for all those transporting explosives is included on the form. As with the other required forms, this one will be part of the transport paperwork. Only the route shown will be used unless there is an

emergency or the route is blocked.

• Explosives Vehicle Inspection Form -
The form is to be completed prior to placing any explosives in the vehicle and will accompany the shipment.

• BATF Permit/License.
A copy of the current BATF license will accompany the vehicle and be readily available.

6.0 QUALITY CONTROL

The HGL UXO Operations Manager is responsible for ensuring that this SOP is reviewed annually for completeness and accuracy, and that appropriate safety measures are addressed. The HGL UXO Safety Manager is responsible for the maintenance, management and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety Manager.

Project Managers and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this, it will be brought to the attention of the responsible supervisor for corrective action.

6.1 TRAINING REQUIREMENTS

All personnel assigned the responsibility for explosive storage magazine and security will receive training on the requirements of this SOP. The training will be conducted by the SUXOS or their designee. This training will be documented using the HGL Training Attendance Log and in the SUXOS daily report.

7.0 SAFETY

If an explosive safety situation is encountered during any phase of work the SUXOS and UXOSO, and the project manager will be immediately notified. The following explosive safety precautions and protocols will be followed:

- Never open a metal container inside or within 50 feet of the explosive storage magazine or explosives.
- Open all containers of explosives with non-sparking tools, except metal slitters, which may be used on fiberboard containers.

- Do not permit matches, lighters or any other spark-producing devices inside or in the proximity of an explosive storage area, explosive storage magazine or potential explosive site (PES).
- No smoking is allowed within 50 feet of the explosive storage area or a PES.
- Ensure cleanliness of magazines. Magazines will be kept clean, dry and free of trash at all times. Magazine floors will be swept regularly. All cleaning gear used to maintain cleanliness will be non-sparking.
- Clean floors stained with leakage from explosive materials according to the explosive manufactures instructions.
- Keep the area within 25 feet in all direction surrounding the explosive storage magazines clear of rubbish, brush, high grass and trees. Live trees greater than 10 feet tall do not need to be moved.
- Do not allow flammable and volatile materials within 50 feet from the explosive storage area.
- Observe the two-person rule at all times during inventory, inspection, issue, turn-in and transportation of explosives.

8.0 RECORDS

8.1 GROUNDING INSPECTIONS

Explosive storage magazines grounding test certification documentation will be provided by the certifying individual to the HGL Site Manager/SUXOS upon completion of the test. The documentation will include a statement that the explosive storage magazine(s) complies with the requirements of NFPA 780 before storing explosive materials in the magazine(s). The SUXOS will maintain the original inspection report in the project files and the UXOQCS will send an electronic copy to the HGL MMRP Office, Huntsville, Alabama, UXO Safety Manager.

8.2 SECURITY INSPECTIONS

Original copies of all inspection records will be maintained on-site by the SUXOS, and will be available for inspection by authorized HGL designees and agencies. An electronic copy of this inspection will be submitted by the UXOQCS to the UXO Operations Manager. Upon completion of project field operations all original inspection and explosive transaction records will be sent to the HGL MMRP Office, Huntsville, Alabama, Attention UXO Operations Manager for archiving throughout the life of HGL's explosive license.

8.3 DOCUMENTATION

Documentation generated as a result of this procedure will be collected and maintained utilizing the following forms:

Attachment 1 SOP Acknowledgement Form
Attachment 2 Explosive Storage and Security Survey Checklist
Attachment 3 Explosive Storage Magazine Inspection Checklist
Attachment 4 Key Control Register and Inventory Log

In the event of that a nonconformance is identified during an inspection, a detailed description of the nonconformance will be provided with recommendations for addressing the nonconformance. All inspections will be recorded using the Explosive Storage Area Inspection Checklist, Attachment 3.

Attachment 1

STANDARD OPERATING PROCEDURE ACKNOWLEDGEMENT

I have read, understand and agree to abide by the provisions as detailed in this standard operating procedure (SOP) prepared by HGL. By signing below, I certify that I have had the opportunity to read and ask questions about this SOP, and that I understand the procedures, equipment and restrictions, and agree to abide by them. Failure to comply with this SOP may lead to disciplinary action and/or my dismissal from the work site and termination of employment.

Prior to the commencement of any work task associated with this SOP, the SUXSO or UXOQCS assigned to the project will discuss additional procedures to be implemented, or any other site-specific conditions that may arise. All on-site personnel of HydroGeoLogic, Inc. must sign this Acknowledgment Form before performing the task covered by these SOPs.

Print Name	**Signature**	**Date**

Attachment 2

Explosive Storage and Security Survey Checklist

Project Site (name, city and state):				
Inspection conducted by/position:	**Signature**			**Date**
UXOQCS or UXOSO:	**Signature**			**Date**
Reviewed by SUXOS:	**Signature**			**Date**

1. Publications	YES	NO	NA	COMMENTS
a. ATF Federal Explosive Law & Regulations, ATF P 5400.7, Nov 2007 (27 CFR Part 555)	☐	☐	☐	
b. HGL SOP 15.00 Explosive Accountability & Management	☐	☐	☐	
c. HGL SOP 15.02 Explosive Storage, Inspection & Security	☐	☐	☐	
2. Explosive Storage	**YES**	**NO**	**NA**	**COMMENTS**
a. Proper explosive storage magazines, Type 2 conforming to BATF standard	☐	☐	☐	
b. Placards. Each magazine properly placarded with DOT Haz Class/Division symbol	☐	☐	☐	
c. Explosive compatibility groups. Separated into the appropriate Haz Class/Division	☐	☐	☐	
d. Physical Security survey conducted and documented	☐	☐	☐	
e. Locks met BATF standards	☐	☐	☐	
f. Key control system established and functional	☐	☐	☐	
g. Lightening Protection.	☐	☐	☐	
1) Magazine constructed of minimum 3/16 inch metal	☐	☐	☐	
2) Magazine grounded	☐	☐	☐	
3) Magazine located 6.5 feet from nearest fence	☐	☐	☐	
4) BRAC, IRP, FUDS and active installation standards met	☐	☐	☐	
h. Fire Protection. Minimum size/type fire extinguisher located within 30 feet of storage magazine	☐	☐	☐	
1) Proper fire division symbol at entrance to storage site	☐	☐	☐	
5) Fire fighting control plan established & posted	☐	☐	☐	
6) Area surrounding magazine free of rubbish, brush, dry grass, trees for a minimum of 25 foot.	☐	☐	☐	
i. Magazine location site meets IBD/PTR distances	☐	☐	☐	
j. Commercial explosives being stored in DoD facilities require DoD HC/SCG approval	☐	☐	☐	
k. Adequate earth cover used to meet IBD & PTR distances	☐	☐	☐	

MR Form 15.31 (June 2011)

Attachment 2

Explosive Storage and Security Survey Checklist

3. Explosive Accountability & Management	YES	NO	NA	COMMENTS
a. Explosive accountability and management responsibilities and organization established	☐	☐	☐	
b. Explosive material purchase/receipt signature authority on-hand	☐	☐	☐	
c. Accountability records & tracking established	☐	☐	☐	
d. MEC final disposition accountability tracking records established	☐	☐	☐	
e. Lost, missing and stolen procedures in place	☐	☐	☐	
f. Disaster preparedness plan in place	☐	☐	☐	
g. Receipt procedures accounting for each item of explosives properly documented on-site	☐	☐	☐	
h. Individuals authorized to receive issue and transport Identified and granted explosive access by the BATF FELC.	☐	☐	☐	
4. Explosive Transportation	**YES**	**NO**	**NA**	**COMMENTS**
a. Hazardous waste manifest on-hand and maintained	☐	☐	☐	
b. Explosive Transport Vehicle	☐	☐	☐	
1) Vehicle inspection checklist on hand	☐	☐	☐	
2) Proper DOT placards, lettering, and/numbering on hand	☐	☐	☐	
3) Operators licensed (CDL/HazMat endorsement)	☐	☐	☐	
4) First aid kit on board vehicle	☐	☐	☐	
5) Minimum of two methods of communications	☐	☐	☐	
6) Blasting caps box on hand	☐	☐	☐	
7) Day box on hand	☐	☐	☐	

MR Form 15.31 (June 2011)

Attachment 3

Explosive Storage Magazine Inspection Checklist

Site (name, city and state):		
Inspection by:	**Signature:**	**Date:**
Reviewed by Senior UXO Supervisor:	**Signature:**	**Date:**

INSPECTION ITEM	Yes	No	Discrepancies must be explained in this column
1. Are explosive storage magazines grounding systems in place, and properly grounded and bonded?	☐	☐	
2. Are the proper hazard class/division and fire symbols placards posted and in good condition?	☐	☐	
3. Are any fire hazards (flammable/volatile materials) visible within 50 feet of the magazine?	☐	☐	
4. Are no-smoking signs posted?	☐	☐	
5. Are there any unusual odors present?	☐	☐	
6. Are Net Explosive Weigh limits exceeded?	☐	☐	
7. Are detonators segregated from high explosives and stored properly?	☐	☐	
8. Are ventilation ports clear?	☐	☐	
9. Are explosive material containers properly packed, marked and stowed in the magazine?	☐	☐	
10. Are all magazines clean and dry, and good housekeeping being followed and maintained?	☐	☐	
11. Are containers properly stowed away from the magazine walls?	☐	☐	
12. Are magazines and fence gates in good repair, locked and secured?	☐	☐	
13. Are there any indications of vandalism/tampering with the magazines, fence or locks?	☐	☐	
14. Is the area around the magazine cleared of vegetation not less than 25feet in all directions?	☐	☐	
15. Are all magazines locks and key accounted for and recorded on the Key Control Register and Inventory?	☐	☐	
16. Is the emergency point of contact information prominently displayed in an accessible location?	☐	☐	
17. Upon completion of this inspection send an electronic copy of this report to the HGL MRT Albuquerque, UXO Safety Manager.	☐	☐	

HGL MR Form 15.09 (Dec 2010)

Attachment 4

Key Control Register and Inventory Log

SITE NAME/LOCATION:	PERIOD COVERED: FROM: TO:

KEY CONTROL NUMBER(S)
(Enter serial number or other identifying number from key)

1.	13.	25.	37.
2.	14.	26.	38.
3.	15.	27.	39.
4.	16.	28.	40.
5.	17.	29.	41.
6.	18.	30.	42.
7.	19.	31.	43.
8.	20.	32.	44.
9.	21.	33.	45.
10.	22.	34.	46.
11.	23.	35.	47.
12.	24.	36.	48.

KEY ISSUE AND TURN IN

KEY NUMBER	ISSUED (Date/Time)	ISSUE BY (Printed Name/Signature)	ISSUED TO (Printed Name/Signature)	TURNED IN (Date/Time)	RECEIVED BY (Printed Name/Signature)

HGL MR Form 15.26 (Sep 10)

Material Potentially Presenting an Explosive Hazard Inspection and Management	SOP No.: 15.03 SOP Category: MMRP Revision No.: 03 Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide HydroGeoLogic, Inc. (HGL) employees with procedures for material potentially presenting an explosive hazard (MPPEH) inspection, management, safety, security and chain of custody (CoC) certification during munitions response activities.

2.0 SCOPE AND APPLICATION

This SOP applies to all HGL employees involved in the inspection and management process for certifying MPPEH as either material documented safe (MDAS) or as material documented as an explosive hazard (MDEH) before transfer within or release from U.S. Department of Defense (DoD) control. All HGL employees who are tasked with performing these procedures will be qualified in accordance with the Department of Defense Safety Board (DDESB) Technical Paper 18 and Department of Defense Instruction (DoDI) 4140.62.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site or project specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Explosive Safety Submission/Explosives Site Plan and Site Safety and Health Plan (SSHP). Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must document evidence to the Senior Unexploded Ordnance Supervisor and the Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP acknowledgment form, Attachment 1. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager (PM) and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS

Exclusion Zone (EZ): A safety zone established around a MEC work area. Only project personnel and authorized, escorted visitors are allowed within the EZ. Examples of EZs are safety zones around MEC intrusive activities and safety zones where MEC is intentionally detonated.

Fuze: (1) A device with explosive components designed to initiate a train of fire or detonation in a munition. (2) A nonexplosive device designed to initiate an explosion a munition. Devices that initiate the detonation sequence in munitions. Fuzes are typically associated with munitions (for example, mortars, and bombs), but they are occasionally found separately. They may contain a charge large enough to cause injury. Magnetic and proximity fuzes are the most sensitive and, depending on other factors (for example, fuze location and arming), greatly influence the likelihood of detonation.

Minimum Separation Distance (MSD): The minimum safe distance for nonessential personnel to be present during unexploded ordnance (UXO) operations. Site specific MSD information can be found in the ESS or ESP.

Material Documented as Safe: MPPEH that has been assessed and documented as not presenting and explosive hazard and for which the CoC has been established and maintained. This material is no longer considered MPPEH.

Material Documented as an Explosive Hazard: (Formerly referred to as material documented as hazardous, or MDAH). MPPEH that cannot be documented as MDAS, that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present, and for which the CoC has been established and maintained. This material is no longer considered to be MPPEH. (The MDEH characterization addresses only the explosives safety status of the material.)

Material Potentially Presenting an Explosive Hazard: Material potentially containing explosives or munitions (for example, munitions containers and packaging material; munitions debris (MD) remaining after munitions use, demilitarization, or disposal; and range-related debris) (RRD); or material potentially containing a high enough concentration of explosives that the material presents and explosive hazard.

Military Munitions: 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 DoD, 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 chemical 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, except that the term does include 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. 2710(e)(3)(A)).

Military Munitions Response Program (MMRP): The MMRP addresses the potential explosives safety, health, and environmental issues caused by past DoD munitions related activities. MMRP is a relatively new (2002) element of the Secretary of Defense's Defense Environmental Restoration Program. The program addresses the potential explosives safety hazards presented by MEC, which includes UXO, discarded military munitions (DMM), and munitions constituent concentrations high enough to pose an explosive hazard and potential environmental contamination.

Munitions and Explosives of Concern (MEC): This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (1) UXO, as defined in 10 U.S.C. 101(e)(5)(A) through (C); (2) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (3) Munitions constituents (such as TNT and RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munitions Debris (MD): Remnants of munitions (for example, fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal. Inert munitions-related material recovered during an MEC removal.

Range-Related Debris: Debris, other than munitions debris, collected from operational ranges or from former ranges (for example, targets such as tanks, vehicles or other man-made structures).

Transferred Within or Released from DoD control: A receiver has acknowledgment of MDEH or MDAS material by signed documentation (DD Form, 1348–1A "Issue Release/Receipt Document," or an equivalent document) and has taken physical custody of the MDEH or MDAS from the DoD.

Unexploded Ordnance (UXO): Military munitions that have been primed, fuzed, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material; and remain unexploded either by malfunction, design, or any other cause. For the purpose of this project, the definition of UXO is limited to items larger than 50-caliber.

UXO-Qualified Personnel: Personnel who meet the training requirements for UXO Technician and Personnel and have performed successfully in military Explosives Ordnance Disposal (EOD) positions or are qualified to perform in the following service contract act contractor positions: UXO Technician II, UXO Technician III, and UXO Safety Officer (UXOSO), UXO Quality Control Specialist (UXOQCS), and Senior UXO Supervisor (SUXOS).

5.0 PROCEDURES

5.1 MANAGERS AND SUPERVISORS

PMs and field supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, discrepancies will immediately be brought to the attention of the responsible supervisor for corrective action.

The SUXOS or senior UXO-qualified individual assigned is responsible for ensuring that all MPPEH activities are conducted in accordance with DoD 6055.09-M, Volume 7, *DoD Ammunition and Explosives Safety Standards: Criteria for Unexploded Ordnance, Munitions Response, Waste Military Munitions, and Material Potentially Presenting an Explosive Hazard,* DoDI 4140.62 Material Potentially Presenting and Explosive Hazard, U.S. Army Corps of Engineers (USACE) Engineer Manual (EM) 1110-1-4009, *Military Munitions Response Actions* and EM 385-1-97 *Explosives Safety and Health Requirements Manual* and all other references shown in Section 8.0 of this SOP.

HGL employees assigned by the field level UXO Technicians will comply with these procedures for processing MPPEH for final disposition. Only UXO-qualified personnel are authorized to perform MPPEH processing.

5.2 UXO TECHNICIAN RESPONSIBILITIES AND PROCEDURES

The objective of the following procedures is to ensure that an inspection of the exterior and interior surfaces of all recovered MPPEH is safely conducted to ensure these items do not present and explosive hazard.

1. Unexploded Ordnance Sweep Personnel (UXOSP) will only mark suspected items and will not be allowed to perform any assessment of a suspect item to determine its status.
2. UXO Technician I can tentatively identify a located item as MPPEH confirmation by a UXO Technician II or III.
3. UXO Technician II will:
    a. Perform a 100 percent inspection of each item as it is recovered and determine the following:
        (1) Is the item a UXO, a DMM, munitions debris, or range-related debris?
        (2) Does the item contain explosives hazards or other dangerous fillers?
        (3) Does the item require detonation?
        (4) Does the item require demilitarization or venting to expose dangerous fillers?

(5) Does the item require removal of batteries, mercury seals, or switches; the draining of engine fluids, illuminating dials and other visible liquid hazardous, toxic, or radiological waste (HTRW) materials?

b. Segregate material items requiring demilitarization or venting procedures from those items ready for certification.

c. Process any items found to contain explosives hazards or other dangerous fillers in accordance with applicable procedures.

4. UXO Technician III will:

a. Perform a 100 percent reinspection of all recovered items to determine if free of explosives hazards or other dangerous fillers and engine fluids, illuminating dials, and other visible liquid HTRW materials.

b. Supervise detonation of items found to contain explosive hazards or other dangerous fillers and venting/demil procedures.

c. Supervise the consolidation of MPPEH for containerization and sealing. MD and RRD will be segregated.

5. UXO Quality Control Specialist (UXOQCS) will:

a. Conduct daily audits of the procedures used by UXO teams and individuals for processing MPPEH.

b. Perform and document random sampling (by pieces, volume or area) of all MPPEH collected from the various teams to ensure no items with explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials are identified as munitions debris or range-related debris as required for completion of DD Form 1348–1A–Issue Release/Receipt Document, Attachment 2.

6. UXO Site Safety Officer (UXOSO) will:

a. Ensure the specific procedures and responsibilities for processing MPPEH for certification as munitions debris or range-related debris specified in the work plan are being followed.

b. Ensure all procedures for processing MPPEH are being performed safely and consistent with applicable regulations.

7. SUXOS will:

– N O T E –

When a SUXOS is not assigned to a project site where MPPEH is being processed, the UXOSO will be responsible for performing the procedures outlined this section.

a. Be responsible for ensuring work and Quality Control (QC) Plans specify the procedures and responsibilities for processing MPPEH for final disposition as munitions debris or range-related debris.

b. Ensure a Requisition and Turn-in Document DD Form 1348–1A is completed for all munitions debris and range-related debris to be transferred for final disposition.

c. Perform random checks to satisfy that the munitions debris and range-related debris is free from explosive hazards necessary to complete the DD Form 1348–1A.

d. Certify all munitions debris and range-related debris as free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials.

e. Be responsible for ensuring that inspected debris is secured in a closed, labeled, and sealed container and documented as follows:

(1) The container will be closed and clearly labeled on the outside with the following information: The first container will be labeled with a unique identification that will start with either USACE or other applicable DoD component/Installation Name/HGL's Name/0001/Seal's unique identification and continue sequentially.

(2) The container will be closed in such a manner that a seal must be broken to open the container. A seal will bear the same unique identification number as the container or the container will be clearly marked with the seal's identification if different from the container.

(3) A documented description of the container will be provided by HGL with the following information for each container: contents, weight of container, location where munitions or range-related debris was obtained, name of contractor, names of certifying and verifying individuals, unique container identification,; and seal identification, if required. HGL, in a separate section of the final report, also will provide these documents.

f. Establish a secure location for collection, processing and storage of DMM, MPPEH, MD and RRD until transferred off site.

g. Use the MPPEH, Munitions Debris and Range Debris Processing and Storage Area Inspection Checklist, Attachment 2 to ensure:

(1) Exclusion zones are maintained during MPPEH inspection and processing activities.

(2) Adequate warning signs and boundary markers are in place during MPPEH inspection and processing activities.

(3) Storage containers, drums, pallets, and tarpaulins are in good repair.

(4) Storage containers and drums are properly labeled and legible.

(5) Uninspected material is properly segregated from inspected material to prevent comingling.

(6) Storage containers or drums in active use are locked to prevent uninspected material from being comingled with inspected material until seals are installed.

(7) Demilitarized items are secured.

5.3 MPPEH CERTIFICATION AND VERIFICATION:

MPPEH procedures will be in accordance with DoDI 4140.62 and EM 1110-1-4009. All MPPEH will be assessed and its explosive safety status determined and documented before transfer within the DoD or release from DoD control. Before release to the public, MPPEH will be documented by authorized and technically qualified personnel as Material Documented as Safe after a 100 percent inspection and an independent 100 percent reinspection to determine that it is safe from an explosive perspective. The following certification and verification procedures will be followed for material suspected or determined as MPPEH:

1. The SUXOS will certify that the debris is free of explosives hazards.
2. The USACE Ordnance and Explosive Safety Specialist (OESS) or similarly trained individual will verify that the debris is free of explosive hazards. When an USACE OESS is not assigned, a similarly trained UXO-qualified person will perform this step.
3. DD Form 1348–1A Issue Release/Receipt Document will be used as the certification/verification documentation. The DD Form 1348–1A must clearly show the names of the SUXOS and the USACE OESS or similarly trained UXO-qualified individual and will be completed with the following information (refer to example shown in Enclosure 3):

a. Block 5: Document date

b. Block 17: Basic material content (Type of metal, such as steel or mixed);

c. Block 20: Total weight;

d. Blocks 24, 25, 26, and 27:

- SUXOS and OESS, or UXOQCS if OESS is not present;
- Company name;
- SUXOS and OESS signatures or the UXOQCS if OESS is not present;
- HGL Huntsville office addresses and telephone number;
- HGL unique identification number for each container;
- Container seal number;
- Origin of where munitions debris or range-related debris was obtained, site name, city and state.
- The following certification/verification will be entered on each DD Form 1348–1A (refer to Attachment 3) for MD or RRD transferred within or release from DoD control and will be signed by the SUXOS and the USACE OESS if present or a similarly trained UXO-qualified individual if the OESS is not on site/assigned. This statement will be used on any ranges where range related-debris is be processed along with MD:

"This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, are free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials."

- The following certification/verification will be entered on each DD Form 1348–1A (refer to example, Attachment 3) for turnover of MD and will be signed by the SUXOS and the USACE OESS if present or a similarly trained individual if the OESS is not on site on properties where only munitions debris is being processed:

"This certifies and verifies that the material listed has been 100 percent inspected and to the best of our knowledge and belief, are inert and/or free of explosives or related materials."

e. Upon receipt of the material identified on the DD Form 1348–1A, the PM and the SUXOS are responsible for ensuring the following blocks are completed by the qualified recycler:

- Block 10: Quantity of material receive;

- Block 22: Signature; and
- Block 23: Date.

5.4 MAINTAINING CHAIN OF CUSTODY AND FINAL DISPOSITION

HGL, in coordination with the appropriate DoD agency, will arrange for maintaining the CoC and final disposition of the certified and verified materials. The certified and verified material will only be released to qualified recycler that will:

1. Provide certification on company letterhead stating the following:

   "Upon receiving the unopened labeled containers each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreed with the provided documentation that the sealed containers contained no explosive hazards when received. The contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content."

2. Send notification and supporting documentation to the sealed container-generating contractor documenting the sealed containers have been smelted and are now only identifiable by their basic content.
3. This document will be incorporated into the final report as documentation for supporting the final disposition of munitions debris and range-related debris. If the CoC is broken, the affected MPPEH must undergo a second 100 percent inspection, then 100 percent reinspection, and be documented to verify its explosives safety status (identified as either munitions debris or range-related debris).
4. MDAS is no longer considered MPPEH as long as the CoC remains intact. A legible copy of inspection, reinspection, and documentation must accompany the material through final disposition and be maintained for a period of 3 years thereafter. This documentation will be maintained as directed in Section 7.0 of this SOP.
5. MDAS being transferred within or released from DoD control will be documented on the form Inert, Demilitarization/Destruction and CoC Certification for Nonhazardous Ammunition, Explosives and other Dangerous Articles (AEDA) and Range Scrap, which is presented as Attachment 5.
6. The PM will contact the receiving agent/recycler to obtain MDAS final demilitarization certification documentation.

5.5 MDAS MANAGEMENT

All MDAS will be disposed of at a qualified recycler where it will be processed through a smelter, shredder, or furnace prior to resale or release in accordance with EM 1110-1-4009, Section 14-3. If it is discovered during the material transfer and shipping process that a seal has been broken and the CoC of the material cannot be verified, the material in question will be subject to reinspection following the established MPPEH process. The MDAS recycler subcontractor will prepare the documentation verifying the demilitarization and final disposition of the material. Copies of all MDAS certification and CoC documentation will be provided to HGL; refer to examples provided as Attachments 3, 4 and 5.

5.6 MDEH MANAGEMENT

The following procedures must be accomplished before MDEH is released:

1. Ensure that MDEH is only transferred or released to those entities that:
    a. Have the licenses and permits required to receive, manage, or process the materials.
    b. Have technical experts about the known or suspected explosive hazards associated with the MDEH.
    c. Are qualified to receive, manage, and process MDEH in accordance with DoDI 4140.62.
    d. Have personnel who are:
        (1) Experienced in managing and processing hazardous materials equivalent to the MDEH.
        (2) Trained and experienced in the identifying and safe handling of used and unused military and/or any potential explosive hazards that may be associated with the specific MPPEH.
2. The receiver must be advised of all of the potential hazards associated with the MPPEH and agree to receive and process the material in accordance with with DoD Instruction 4140.62.
3. All MPPEH shipments over public transportation routes must comply with DoD guidance that implements hazardous material transportation regulations.
4. Ensure that CoC and accountability records are maintained through final disposition of MPPEH. A legible copy of inspection, reinspection, and documentation must accompany MPPEH through final disposition and be maintained for a period of 3 years thereafter and in accordance with Section 7.0 of this SOP.

5.7 INSPECTION

An inspection of the MPPEH processing and MD/RRD storage area containers will be conducted weekly by the UXOQCS and a periodic spot-check by the SUXOS to ensure the security, integrity, and good housekeeping of the storage area is maintained. This inspection will be documented in the project Daily Quality Control Report (DQCR). Attachment 2 will be used to conduct and record this inspection.

– N O T E –

It is paramount that these inspections enforce all safeguarding and security control measures required for preventing potential comingling of processed material and ensuring the integrity of this process is properly maintained.

5.8 PROJECT STARTUP AND ROUTINE INSPECTIONS

Before establishing the MPPEH processing, munitions- and range-related debris storage areas, a joint inspection will be conducted by the UXOQCS and UXOSO. The results of the inspection, identification of any discrepancies, and their disposition will be documented in the project DQCR.

5.8.1 Weekly Inspections

After mobilizing to the site, weekly inspections will held once materials are collected at the site. The weekly inspection is necessary to determine if there has been an attempted or unauthorized entry into the container, or unauthorized removal of the contents. The MPPEH Processing and Munitions Debris and Range Debris Storage Area Inspection Checklist (Attachment 2) will be used for conducting and documenting weekly storage area inspections. Upon completion of this inspection, the checklist will be signed by the individual conducting the inspection. The SUXOS also will sign the inspection checklist upon completion of their review of this form. This report will be maintained with the project site office files and annotated in the daily and weekly production and quality control reports. This inspection includes addressing the following:

1. Are exclusion zones properly maintained?
2. Are adequate hazard warning signs and boundary markers in place?
3. Are storage containers and drum pallet in fair condition?
4. Are containers properly labeled and labels intact?
5. Are containers seal and locked?
6. Are uninspected items segregated from inspected items?

7. Are demilitarized items secured?
8. Are any materials missing, evidence of tamping or unauthorized entry?

6.0 QUALITY CONTROL

The HGL Senior UXO Operation Manager is responsible for ensuring this SOP is reviewed annually for completeness, accuracy, and safety. The HGL UXO Safety Manager is responsible for the maintenance, management and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety Manager.

PMs and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this, it will be brought to the attention of the responsible supervisor for corrective action. When there is the potential to encounter MEC during HTRW-related activities a UXO Team must be assigned to provide anomaly avoidance support.

All personnel involved in the MPPEH inspection process and management are responsible for ensuring all safeguards and security control measures are carefully followed to prevent comingling of processed material. Whenever there is any suspicion that comingling has occurred, the SUXOS and the UXOQCS will be notified immediately, and the suspect material will be reinspected and processed in accordance with this SOP.

6.1 TRAINING

All UXO-qualified personnel will be trained in the recognition and safe handling of used and unused military munitions and specific types of MPPEH in accordance with DoDI 4140.62, Material Potentially Presenting an Explosive Hazard and shall be qualified in accordance with DDESB Technical Paper 18.

7.0 RECORDS

All project personnel are responsible for documenting in detail all reports, logs, and certification and inspection forms based on their assigned level of technical responsibility. The following forms listed in Section 9.0 will be used for documenting the MPPEH inspection, certification, storage, and transfer and release of material process.

7.1 TRANSFER, RELEASE AND CHAIN OF CUSTODY DOCUMENTS

Before the transfer within DoD or release from DoD, all accessed and certified materials will be documented as follows:

1. The SUXOS will prepare two original copies of:
   (a) DD Form 1348–1A Issue Release/Receipt Document, refer to the two examples provided as Attachment 3.
   (b) Inert, Demilitarization/Destruction CoC Certification for Nonhazardous AEDA and Range Residue Scrap.
   (c) Ensure the SUXOS, OESS and qualified recycler signatures are obtained in all appropriate blocks on all documents as shown on the Attachments 3, 4. and 5.
2. Distribute copies of the DD Form 1348–1A Issue Release/Receipt Document and Inert, Demilitarization/Destruction CoC Certification for Nonhazardous AEDA and Range and Range Residue Scrap as follows:
   (a) ***Copy 1:*** Issued to the receiver (for example, transporter, demilitarization facility or recycler).
   (b) ***Copy 2*:**
      - The original will be mailed to the HGL Huntsville office repository, attention: UXO Safety Manager for retention.
      - This copy will be scanned as a pdf and submitted electronically to the subcontracted qualified recycler manager and the HGL UXO Safety Manager.
3. The PM and SUXOS will coordinate together:
   (a) Notifying the receiver agent/qualified recycler in advance of any pickups and shipments to their facility.
   (b) Forwarding advanced electronic copies of all completed CoC and DD Form 1348–1A documents to the receiving agent/recycler.
   (c) Follow up with the receiving agent/recycler to obtain final (signed) destruction certification documents.
   (d) Ensure either hard or electronic copies of the final demilitarization certification documents are forwarded to the HGL Huntsville office, attention UXO Safety Manager.

– NOTE –

It is the responsibility of the project manager to coordinate with the UXO Safety Manager to ensure final closeout of all material demilitarization/destruction certification records.

8.0 REFERENCES

HydroGeoLogic, Inc., 2010. Safety and Health Manual, Section 15, Munitions and Explosives of Concern.

U.S. Army Corps of Engineers (USACE), 2008. Engineer Manual 385-1-97 Explosives Safety and Health Requirements, September.

USACE, 2007. Engineer Manual 1110-1-4009, Military Munitions Response Actions, June.

U.S. Code of Federal Regulations (CFR), Title 27, Part 55, Commerce in Explosives.

CFR, Title 29, Part 1910, Occupational Safety and Health Standards.

CFR, Title 29, Part 1926, Occupational Safety and Health Standards.

CFR, Title 40, Parts 260-299, Protection of the Environment.

CFR, Title 49, Parts 100-199, Transportation.

U.S. Department of Defense (DoD) 4145.26-M, 2008. Contractor's Safety Requirements for Ammunition and Explosives, March.

DoD Explosive Safety Board Technical Paper 18, 2004. Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, December.

DoD Manual 6055.09-M, Volume 7, 2010. DoD Ammunition and Explosives Safety Standards: Criteria for Unexploded Ordnance, Munitions Response, Waste Military Munitions, and Material Potentially Presenting an Explosive Hazard, August.

DoD Manual 4160.28-M-1, 2011 Defense Demilitarization Manual, June.

DoD Instruction 4140.62, 2008. Material Potentially Presenting an Explosive Hazard, November.

9.0 ATTACHMENTS

Attachment 1 Acknowledgment Form

Attachment 2 Sample Certificate of Destruction and Blanket Certificate of Destruction letters

Attachment 3	DD Form 1348–1A Issue Release/Receipt Document (MD and RRD release of transfer) and DD Form 1348–1A Issue Release/Receipt Document (MD release only)
Attachment 4	Inert, Demilitarization/Destruction and CoC Certification for Nonhazardous AEDA and Range Residue Scrap, HGL MR Form 15.07
Attachment 5	Material Potentially Presenting and Explosive Hazard, Munitions Debris and Range Debris Processing and Storage Area Inspection Checklist, HGL MR Form 15.28

ATTACHMENT 2

STANDARD OPERATING PROCEDURE ACKNOWLEDGMENT

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of Naval RPM approval before implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Printed Name	Company	Signature	Date

ATTACHMENT 2

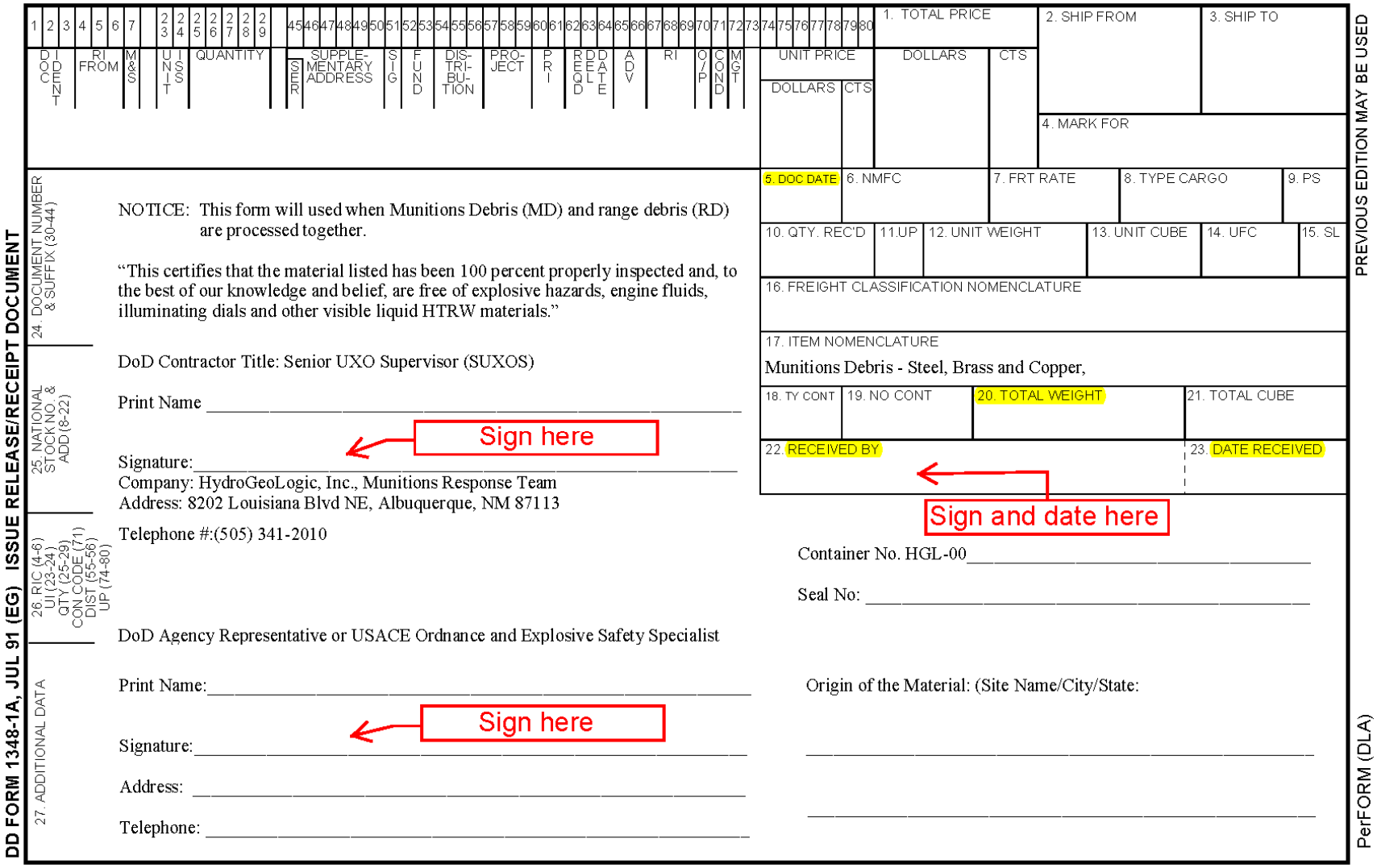
Material Potentially Presenting an Explosive Hazard, Munitions and Range Debris Processing and Storage Area Inspection Checklist

Site (name, city and state):		
Inspection conducted by:	**Signature:**	**Date:**
Reviewed by Senior UXO Supervisor:	**Signature:**	**Date:**

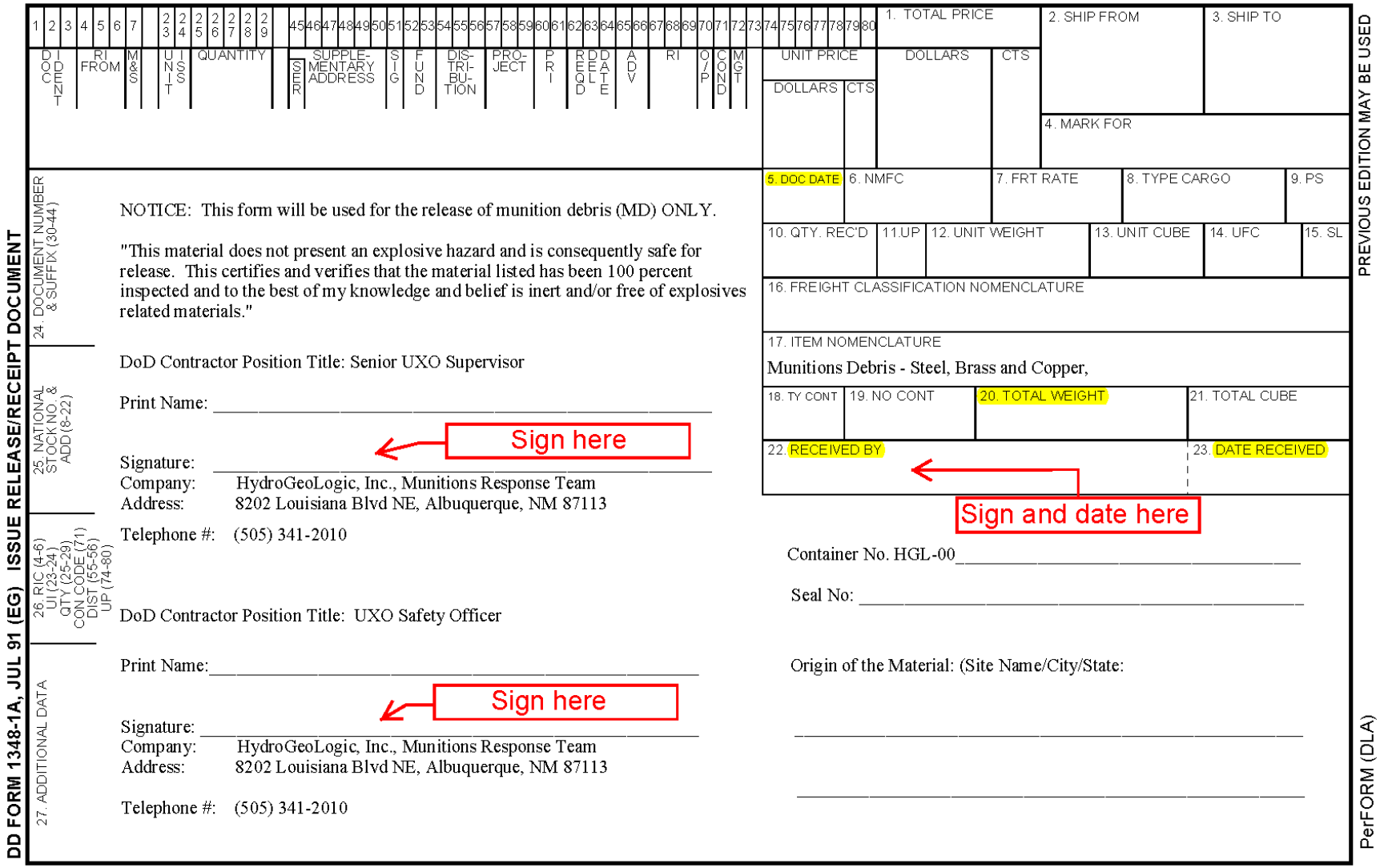
I. INSPECTION ITEM			
A. MPPEH and MD Storage Areas	**YES**	**NO**	**Explain Discrepancies**
1. Are exclusion zones maintained during processing?	☐	☐	
2. Are adequate warning signs and boundary markers in place?	☐	☐	
3. Are containers/drums in fair condition?	☐	☐	
4. Are drum pallets in fair condition?	☐	☐	
5. Are containers properly labeled and labels intact?	☐	☐	
6. Are un-inspected items segregated from inspected items to prevent comingling?	☐	☐	
7. Are containers sealed or locked?	☐	☐	
8. Are MDEH items properly segregated and secure?	☐	☐	
9. Are demilitarization items secure?	☐	☐	
10. Is the plastic tarpaulin intact?	☐	☐	
B. RD Storage Area	**YES**	**NO**	**Explain Discrepancies**
1. Are there any pieces or parts of targets missing?	☐	☐	
2. Is there evidence of any disturbance to the pile?	☐	☐	

HGL MR Form 15.28 (Dec 2010)

ATTACHMENT 3



ATTACHMENT 3 (continued)



ATTACHMENT 4

SAMPLE

CERTIFICATE OF DESTRUCTION

To: Mr./Mrs. _____,
Project Manager,
HydroGeoLogic, Inc.
(Applicable HGL office address)

From: Mr./Mrs. Debris,
President/Owner
American EOD Services, Inc.
1206 East Park Avenue
Anaconda, MT 59711-0878

Re: Demilitarization and Recycling of Material Documented as Safe (MDAS) for the Remedial Investigation at Munitions Response Site ANAD-001-R-01, Recoiless Rifle Range, Anniston Army Depot, AL, U.S. Army Corp of Engineer Contract Number W912DY-10-D-0023, Delivery Order Number 002

Upon receiving the unopened labeled containers each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreeing with the provided documentation that the sealed containers contained no explosive hazards when received. The contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

I hereby certify that the material received/shipped from Anniston Army Depot, AL was demilitarized by means of shredding and smelting by the Bonetti Explosives, LLC, Columbus, TX and were only identifiable by their basic contents; furthermore, recycling was accomplished by smelting. The material was recycled by smelting into new steel products by at Lone Star Foundries, Inc., Austin, TX an are only identifiable by their basic content.

This certifcation is made in accordance with and subject to penalties of law under the United States Code, Title 18, Section 1001, Crimes and Criminal Procedures.

SIGNATURE: _____

NAME: _____

DATE: _____

TITLE: President/Owner

AGENCY: American EOD Services, Inc.

ATTACHMENT 4 (continued)

SAMPLE

BLANKET END USE CERTIFICATION

ANNISTON ARMY DEPOT, AL
REMEDIAL INVESTIGATION AT MUNITIONS RESPONSE SITE ANAD-001-R-01,
RECOILESS RIFLE RANGE,
U.S. ARMY CORP OF ENGINEER CONTRACT NUMBER W912DY-10-D-0023,
DELIVERY ORDER NUMBER 002

It is hereby certify that Bonetti Explosives, LLC, Columbus, TX will comply with all applicable federal, state and local ordinances, and regulations with respect to the care, handling, storage, shipment, resale, export, and other use of the material hereby purchased or received, and that he/she as a user in said materials is capable of complying with all appplicable federal, state and local laws. It is further certified that the material will be recycled into new steel and products by means of smelting within the continental United States of America and that the material will only be identifiable by its basic content. This certification is made in accordance with and subject to the penalties of the United States Code, Title 18, Section 1001, Crimes and Criminal Procedures.

SIGNATURE: SIGN HERE _____

NAME: _____

DATE: _____

TITLE: _____

AGENCY: American EOD Services, Inc.

ATTACHMENT 5

Section I – Generator Release

Inert, Demilitarization/Destruction Certification Chain of Custody (CoC) for Non-Hazardous Munitions and Range-related Debris

1a. Project location and contract number:

1b. Generator name and mailing address:

HydroGeoLogic, Inc. Munitions Response Team
8202 Louisiana Blvd NE Albuquerque, NM 87107-2105

Telephone number:

(505) 341-2010 or (505) 348-3362

1c. Project site name and location:

Telephone number:

1d. Container Number:	**1e.** Unique Seal Identification Number:	**1f.** Gross weight (lbs):	**1g.** Net weight (lbs):	**1h.** Tare weight (lbs):

1i. Material description:	**1j.** Material type:	**1k.** Units (weight/volume):

1l. Inert certification:

"I certify and verify that the ammunition, explosives and other dangerous article (AEDA) residue, range residue and/or explosive contaminated property listed have been 100 percent inspected and to the best of my knowledge and belief is free of AEDA and other dangerous articles."

1m. Generator Inspector/Certifier—Unexploded Ordnance Quality Control Specialist:

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

1n. Generator Inspector/Certifier—Site Senior Unexploded Ordnance Supervisor or Site UXO Supervisor:

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

1o. Generator Release—I am the Project Site Supervisor and acknowledge release of this material:

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

Section II –Transporter

2a. Transporter company name and mailing address:	Telephone Number:	Dispatcher Name:

2b. Transporter Receipt—I acknowledge receipt of this material and have verified that each container is sealed and intact:

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

2c. Transporter Release— I acknowledge release of this material:

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

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Page 1 of 3

Section III – Qualified Receiver

3b. Qualified Receiver Storage Manager Receipt Acknowledgement:

I acknowledge receipt of the unopened labeled container(s) listed herein each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and agreeing with all the provided supporting documentation, I sign for having received the provided documentation that the sealed containers contained no explosive hazards when received.

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

3c. Demilitarization/Destruction Processor Acknowledgement:

I acknowledge receipt of this material and certify and verify that each item or items listed herein were demilitarized and/or destroyed so as to no longer resemble AEDA beyond the requirement listed in DoD 4160.21-M-1 and is only identifiable by its basic content.

Print or type name: SIGN HERE	Signature:	Month/Day/Year:

3e. Qualified Receiver Manager Demilitarization/Destruction Certification:

I acknowledge this material has undergone demilitarization/destruction in accordance with DoD 4160.21-M-1and Engineer Manual 1110-1-4009 and that the contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

Print or type name: SIGN HERE	Signature	Month/Day/Year:

4a. Special Instructions:

1. The SUXOS will produce the required number of the original CoC certification copies for distribution in accordance with HGL MMRP SOP 15.03.
2. The *Transporter* will be provided *1 original CoC certification copy* and complete Section II, blocks 2a. through 2.c.with signature.
3. The *Transporter* will turn over *this CoC certification copy* to the Qualified Recycler Manager upon delivery.
4. The *Qualified Recycler Manager* upon receipt of the material will verify and certify the CoC certification document information is complete and accurate by completing Section III. 3a.through 3e. with signatures.
5. The *Qualified Recycler Manager* after completing the demilitarization/destruction of the material listed on this CoC certification document will provide the Generator with a signed company letterhead stating:

   "Upon receiving the unopened labeled containers each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreeing with the provided documentation that the sealed containers contained no explosive hazards when received. The contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content".
6. The *Qualified Recycler Manager* will complete the attached DD FORM 1348–Issue Release/Transfer Document, blocks 22 and 23 and return this form along with this CoC certification document and Certificate of Destruction letter to the Generator address shown in block 1b.

4b. Discrepancies.

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ATTACHMENT 5 (continued)

Section I – Generator Release (Continued)		**1.d.** Container Numbers:	**1.e.** Unique Seal Identification No:	**1.f.** Gross weight (lbs):	**1.g.** Net weight (lbs):	**1.h.** Tare weight (lbs):
	1.					
	2.					
	3.					
	4.					
	5.					
	6.					
	7.					
	8.					
	9.					
	10.					
	11.					
	12.					
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	20.					
	21.					
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	23.					
	24.					
	25.					
	26.					
	27.					

HGL MR Form 15.07 (Revised Jun 2012)

Page 3 of 3

Analog Detection and Anomaly Removal (Mag-and-Dig) Operations	SOP No.: 15.04 SOP Category: MMRP Revision No.: 2 Date: July 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard safe practices for analog detection and anomaly removal, referred hereon as "mag-and-dig" operations during munitions response (MR) projects conducted by HydroGeoLogic, Inc. (HGL) personnel.

2.0 SCOPE AND APPLICATIONS

This SOP applies to all HGL employees who are involved in mag-and-dig operations while conducting MEC surface and subsurface anomaly detection, investigation and removal. All HGL employees who are tasked with performing these procedures will be qualified in accordance with the Department of Defense Safety Board (DDESB) Technical Paper 18.

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the project-specific Accident Prevention Plan APP and Site Health and Safety Plan. Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP acknowledgement form, Attachment 1. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and the Military Munitions Response Program Manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

3.0 DEFINITIONS

Exclusion Zone (EZ): A zone in which unauthorized personnel are not allowed to be present during MEC clearance or disposal activities.

Fuzes: Devices that initiate the detonation sequence in munitions. Fuzes are typically associated with munitions (for example,, mortars and bombs), but they are occasionally found separately. They may contain a charge large enough to cause injury. Magnetic and proximity fuzes are the most sensitive and, depending on other factors (for example, fuze location and arming), greatly influence the likelihood of detonations. When separated from the munitions, a fuze may not look like an explosive munitions item. The terms fuse and fuze mean different

things. For this SOP, a fuze is a mechanical or electrical device with explosive or non-explosive components designed to initiate a train of fire or detonation in ordnance (for example, hand grenade). A fuse is a cord of readily combustible material that can be lit at one end to carry a flame along the length of the fuse to detonate an explosive at the other end (for example, firecracker).

Munitions and Explosives of Concern (MEC): Specific categories of military munitions that may pose unique explosive risks, including: UXO, as defined in 10 U.S.C. §101(e)(5); discarded military munitions (DMM), as defined in 10 U.S.C. §2710(e)(2); or munitions constituents (for example, TNT, RDX), as defined in 10 U.S.C. §2710(e)(3), present in high enough concentrations to pose an explosive hazard.

MEC Operations: Defined as MEC identification; access procedures such as excavation, either by hand or using heavy equipment; handling of UXO, explosives or explosive items; or disposal, including movement, transportation, and final disposal of MEC.

Minimum Separation Distance (MSD): The minimum safe distance for non-essential personnel to be present during MEC operations. Generally speaking, the maximum horizontal fragmentation distance is to be used for all UXO items as the MSD for all non-essential personnel for both intentional and unintentional detonations.

Unexploded Ordnance (UXO): As defined by 10 U.S.C. §101(e)(5)(A) through (C), UXO includes military munitions that: (a) have been primed, fuzed, 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; and (c) remain unexploded whether by malfunction, design, or any other cause A more detailed description of the term UXO is provided in P.L. 106-65, section 3031 (c)(5)(A).

4.0 PROCEDURES

HGL employees performing the activities addressed by this SOP are responsible for meeting the requirements detailed herein. HGL employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

4.1 SENIOR UXO SUPERVISOR

The Senior UXO Supervisor (SUXOS) has ultimate responsibility for ensuring all mag-and-dig operations are performed in accordance with this SOP and the project work plan.

4.2 UXO TEAM LEADER

The UXO Team Leader will direct all intrusive team Mag-and-dig clearance during field operations.

4.3 ANALOG DETECTION AND ANOMALY REMOVAL

On MR sites where mag-and-dig operations are in progress, all non-UXO-qualified personnel will be under the direct supervision of UXO-qualified personnel. Non-UXO trained personnel will not be allowed in the exclusion zone (EZ) during mag-and-dig operations except as authorized by approved planning documents. If access is required by non-essential personnel, all mag-and-dig operations will stop while they are in the EZ. During operations, HGL personnel will adhere to the APP/SSHP and the following general safety practices:

- Operations will be conducted only during daylight hours;
- Access to operating areas will be limited to only those personnel necessary to accomplish the specific operation;
- UXO will only be handled by qualified UXO Technicians;
- During MEC clearance operations the minimum separation distance (MSD) between the UXO team(s) and non-essential personnel operations is the fragmentation distance of the munitions with the maximum generated fragmentation distance (MGFD), as stated in the Work Plan and either the site explosive safety plan/submission. Personnel remaining on-site will be limited to those personnel needed to safely and efficiently prepare the item/s for destruction.);
- As a general rule, all fuzed munitions of explosive concern (MEC) will be detonated in the original position found. This is the safest method to effect final disposition of munitions if deemed unmovable.
- MEC operations will not be conducted until all applicable plans for the site in question are prepared and approved. These plans will be based upon the concept of limiting exposure to the minimum number of personnel, for the minimum amount of time, to the minimum amount of MEC consistent with safe and efficient operations.
- Prior to any action being performed on an ordnance item, all fuzing will be definitively identified. This identification will consist of fuze type by function and the physical state/condition (armed or unarmed) of the fuze, i.e., burned, broken, parts exposed/ sheared, etc.
- Projectiles containing base-detonating fuzes are to be considered armed if the round is fired.
- Arming wires and pop-out pins on unarmed fuzes should be secured prior to moving MEC items.
- Do not depress plungers, turn vanes, or rotate spindles, levers, setting rings, or other external fittings on MEC items. Such actions may arm or activate the items.
- Non-UXO technicians will receive initial ordnance recognition and safety training before commencing operations;

- All personnel will attend the Daily Safety Briefing before entering the operating area;
- Anyone can stop operations if an unsafe act or situation is observed;
- Safety violations and/or unsafe acts/practices will be immediately reported to the UXO Safety Officer (UXOSO);
- Failure to comply with safety rules/procedures may result in termination of employment.

4.4 SITE LAYOUT PROCEDURES

Site layout and search grids will be established using Global Positioning System (GPS), licensed surveyor, or compass and measuring tape. If applicable, survey crews will be escorted in the field by a UXO Technician II or above who will provide MEC anomaly avoidance including checking the intended survey stake locations with a magnetometer before driving stakes into the ground. This will prevent driving stakes into buried MEC hazards.

When mag-and-dig operations are performed along transects to aid in site characterization the coordinates for the endpoints and intermediate "waypoints" along each transect are provided to the field team by the HGL GIS department. The distance between the intermediate waypoints varies from 50-500 feet depending upon site conditions. The field team will upload the coordinate information for each transect into the GPS and use the coordinates to navigate along thetransect while performing mag-and-dig operations.

4.5 MAG-AND-DIG PROCEDURES

1. Mag-and-dig operations are particularly effective in areas where vegetation and terrain limit the use of larger digital systems. Also, mag-and-dig approaches should be used when there is insufficient difference between MEC items at the site and other metallic fragments and debris such that digital discrimination is ineffective or cost prohibitive.
2. Each grid will be subdivided into individual search lanes approximately four to five feet wide. Teams will use two 100-foot tapes laid out parallel to each other: one tape will be laid out from the northwest grid stake to the northeast grid stake, and the second tape will be laid out between the southwest grid stake and the southeast grid stake. After the 100-foot tapes are in position, lengths of rope will be spaced at four- to five-foot intervals perpendicular to and overlapping the tapes. When laying out partial grids, a combination of both 100-foot tapes and rope will be laid out to connect all three of the partial grid stakes. The same procedures will be used for search lane spacing. Each lane will be surveyed using a ferrous-only or all-metals handheld magnetometer.
3. Begin the operation at one end of each lane and move forward toward the opposing base line. During the forward movement the technician moves the magnetometer back

and forth from one side of the lane to the other. Both forward movement and the swing of the magnetometer are conducted at a pace that ensures the entire lane is searched and that the instrument is able to appropriately respond to subsurface anomalies.

4. Whenever a subsurface anomaly or metallic surface object is encountered, the UXO Technician will immediately halt and investigate the anomaly. Throughout this operation, the team leader will closely monitor individual performance of each team member to ensure these procedures are being performed correctly.
5. Mag-and-dig operations along transects occur in a similar manner to those operations that occur in grids. As the technician(s) progress along each transect at a consistent pace they halt and investigate audible "hits". The location of each "hit" is recorded in the GPS with a unique identifier along with the characteristics and depth of the item(s) identified at the location, or the information for each intrusive location is documented on a hardcopy sheet. The actual path travelled along the transect, coordinates and unique ID for each intrusive location, and the characteristics and depth for each item(s) identified are uploaded to the project database and GIS system.

4.6 SURFACE MEC

Upon encountering a surface MEC item, the item will be identified by a minimum of one UXO Technician II and one UXO Technician III and marked in accordance with the approved work plan for future disposition

4.7 SUBSURFACE ANOMALIES EXCAVATION PROCEDURES

Subsurface anomalies will be investigated by UXO-qualified personnel as they are identified during the sweep. All identified anomalies within the grid will be intrusively investigated manually by an UXO Technician. Excavations for individual anomalies will be conducted using a ferrous-only or all-metals handheld magnetometer to assist the team in determining the location and orientation of the target item. Personnel excavating an anomaly shall initially use a trowel or shovel to remove no more than a 6-inch layer of soil at the location of the anomaly. A visual and electronic search of the excavation shall then be made. This process shall be repeated, removing soil in 6-inch lifts until the audible signal from the magnetometer indicates that the object is close to the surface. Once this determination has been made, soil will be removed by hand until the source of the anomaly is located.

5.0 EQUIPMENT

Equipment for mag-and-dig operations will be provided by HGL, subcontractors, and vendors offering equipment for lease or purchase. All equipment, regardless of the source, will be inspected and its functionality checked to ensure operational readiness. Any equipment found

to be damaged or defective will be tagged as "unserviceable" and returned to the source for repair or 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 manufacturers' equipment manual. Equipment required for daily use shall be calibrated twice daily (start and finish). This system of checks ensures that the on-site equipment is functioning properly. If an equipment function 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.

5.1 EARTHMOVING EQUIPMENT

Earthmoving equipment (EMM) may be used to excavate large anomalies (for example, pits) or those deeper than 2 feet if required (for example, to confirm the anomaly is not a MEC). Any decision to use EMM to excavate these anomalies will be made by the SUXOS. Excavation will proceed slowly to ensure that the item is not broached by the EMM. If the excavated material is considered to be a MEC, it shall be uncovered sufficiently by hand to obtain a positive identification of the item. If the item is identified as MEC, a determination will subsequently be made as to whether it is or is not fuzed.

While excavating using EMM, a UXO technician will be assigned to observe the process and stationed in a position that is out of the reach of the excavation equipment but affords a view of the excavation site. This observer will ensure that the next lift is visually free of UXO. The excavated soils/spoils will be placed onto the ground within a screening area that has been surface swept and the boundaries recorded. The soil spoils will be spread across the screening area using the excavator bucket. The excavated material will be screened for range related debris, munitions debris, and MEC items. UXO Technicians will recover all pieces of munitions debris or range related debris and any MEC items. All DMM, MPPEH, MEC will be inspected, processed, stored and disposed of in accordance with HGL SOP 15.03 MPPEH Inspection, Management and Processing. After screening, the soil spoils will be stockpiled to the side of the screening area pending final disposition.

5.2 GEOPHYSICAL INVESTIGATION EQUIPMENT

The use of geophysical investigation equipment (magnetometer) will depend on the local area of the sweep and the intended work to be conducted in that area. For the purpose of mag-and-dig operations, the following geophysical investigation equipment is authorized for use:

- Flux-gate magnetometers:
    - Schonstedt GA 52-CX
    - Schonstedt GA 72-CD

- Forester FEREX 4.032
- Ebinger MAGEX 120 LW
- Vallon EL 1302D1 or 1303D
- Chicago Steel Tape (magna-trak 102)

- Frequency-Domain Electromagnetic Induction Metal Detectors:
  - White's All Metals Detector
  - Fisher 1266X
  - Garrett
  - Geophex GEM3
  - Foerster Minex
  - Minelabs Explorer II
- Additional equipment items that may be required for marking hazards are:
  - Spooled polypropylene line for marking sweep lanes
  - Non-metallic shaft pin flags
  - Brightly colored surveyors tape
  - High visibility biodegradable spray paint

5.3 EQUIPMENT FUNCTION CHECKS

Daily equipment function checks will be performed on all geophysical instruments. The checks will consist of using the instrument in a designated function check area to verify response to known target anomalies. Upon completion of the function check the geophysical instrument type, serial number and results will be recorded using the Equipment/Instrument Calibration/Maintenance Log, Attachment 2. This function check will include the following steps:

1. Turn instrument on;
2. Set gain level;
3. Set gain control; and
4. Perform field test using test pit/strip.

6.0 SAFETY

Before entering a munitions site to perform mag-and-dig operations, the UXO Team Leader must conduct a daily tailgate safety meeting covering emergency procedures, operations, MEC and all other hazards associated with the work site.

6.1 MEC SAFETY

If MEC is encountered during any phase of work the HGL Project Manager, Site Supervisor, Site Safety Officer and UXOSO, as applicable, will be immediately notified. In general, the following MEC safety precautions and protocols are:

- Remain alert at all times for MEC and related scrap or MPPEH hazards.
- The cardinal principle to be observed during construction activities involving ordnance, explosives, ammunition, severe fire hazards, or toxic materials is to limit the exposure to a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- Always assume MEC hazards contain a live charge until determined otherwise.
- Death or injury can occur from MEC and explosive related accidents.
- The age or condition of a MEC hazard does not decrease the 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 agent 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, move or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification.
- DO NOT touch, pickup up, kick or move anything that is unfamiliar or unknown.
- DO NOT roll an unknown item over or scrape the item to identify markings.
- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, leave the site immediately and seek shelter.
- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards.
- DO NOT walk across an area that the ground surface cannot be seen that has not been cleared of MEC hazards by the UXO Technician.
- DO NOT rely on color codes for positive identification of ordnance items nor their contents.
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes.
- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.

- DO NOT be misled by markings on the MEC item stating "practice bomb," "dummy," or "inert." Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly.
- The location of any ordnance item found will be clearly marked so it can be easily located and avoided.
- Follow the procedures of the WP and SSHP; and upon locating any MEC hazards immediately notify the UXO Technician so appropriate measures can be taken.

– W A R N I N G –

Removing or taking any munitions, explosive or unexploded ordnance or munitions related debris from the site by any employee is strictly prohibited.

7.0 QUALITY CONTROL

The HGL Senior UXO Operation Manager is responsible for ensuring this SOP is reviewed annually for completeness, accuracy and safety. The HGL UXO Safety Manager is responsible for the maintenance, management and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety and Quality Manager.

Project Managers and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, it will be brought to the attention of the responsible supervisor for corrective action.

The specific quality metrics for the mag-and-dig application will be presented in the Project Work Plan.

8.0 RECORDS

Project participants are responsible for documenting information in sufficient detail to provide objective documentation that the requirements of this SOP have been met. Such documentation shall be retained with the project record files. Documentation generated as a result of this procedure is collected and maintained utilizing the following forms:

- SOP Acknowledgement Statements, Attachment 1; and
- Equipment/Instrument Calibration/Maintenance Log.

9.0 REFERENCES

Department of Defense Explosive Safety Board Technical Paper 18, 2004, Minimum Qualification for UXO Technicians and Personnel, December;

HydroGeoLogic, Inc., Standard Operating Procedure, 2014 15.03 Material Potentially Presenting an Explosive Hazard Inspection, Management and Processing, February.

HydroGeoLogic, Inc., 2011, Safety and Health Manual, Section 15—Munitions and Explosives of Concern, June.

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of client approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name	Date

ATTACHMENT 2

Equipment/Instrument Calibration/Maintenance Log

Project Name and Location (City and State):						Contract No:
Team Number:		Instrument Description/Type:				Equipment/Instrument Serial Number:
Date	Calibration Standard (example, IVS)	Test results (check box)		Conducted (check box)		Name of Individual	Comments or Observations
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Anomaly and Munitions and Explosives of Concern Subsurface Clearance

SOP No.: 15.05
SOP Category: MMRP
Revision No.: 1
Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish standard safe practices for performing anomaly and munitions and explosives of concern (MEC) subsurface clearance operations during munitions response projects conducted by HydroGeoLogic, Inc. (HGL) unexploded ordnance-qualified (UXO) personnel.

2.0 SCOPE AND APPLICATIONS

This SOP applies to all HGL employees involved in anomaly and MEC subsurface clearance operations. All HGL employees who are tasked with performing MEC-related activities will be qualified in accordance with the Department of Defense Explosive Safety Board (DDESB) Technical Paper (TP) 18.

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the project-specific Accident Prevention Plan (APP) and Site Health and Safety Plan (SSHP). Procedures for packaging and disposing of all waste generated during field activities will be described in the project-specific work plan.

Personnel who use this procedure must provide documented evidence to the Senior UXO Supervisor (SUXOS) and UXO Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP Acknowledgement Form, Attachment 1. This documentation will be retained in the project file.

Any deviations from specified requirements or procedures will be justified to and authorized by the project manager and the Military Munitions Response Program Manager and discussed in the approved project plans. Deviations from requirements or procedures will be sufficiently documented to re-create the modified process.

2.1 DEFINITIONS

Essential Personnel: Essential Personnel are defined as DoD and contractor project personnel necessary for the safe and efficient completion of field operations conducted in an exclusion zone (EZ). Examples are: contractor work team members including the UXO Safety Officer (UXOSO), UXOQCS, SUXOS, and a U.S. Army Corps of Engineers Ordnance (USACE) and Ordnance and Explosives Safety Specialist, and geophysical equipment operators.

Exclusion Zone: A zone in which unauthorized personnel are not allowed to be present during MEC clearance or disposal activities.

Intentional Detonations: The greater of the K328 overpressure distance based on the total NEW of the demolition hot, or the maximum fragment range - horizontal distance (MFR-H), will be used, as identified in DDESB TP 16. These distances may be reduced using DDESB-approved engineering controls.

Minimum Separation Distance (MSD): The minimum safe distance for non-essential personnel to be present during MEC operations. Generally speaking, the maximum horizontal fragmentation distance is to be used for all UXO items as the MSD for all non-essential personnel for both intentional and unintentional detonations.

Team Separation Distance: Project teams have been determined to be essential personnel to the project execution, they will maintain the minimum team separation distance (TSD), normally the K-40 distance of the munition with greatest fragmentation distance (MGFD) for the munitions response site (MRS) where the work is taking place from other teams working in the area, this includes the UXO teams.

3.0 PROCEDURES

HGL employees performing the activities addressed by this SOP are responsible for meeting the requirements detailed herein. HGL employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

3.1 SENIOR UXO SUPERVISOR

The SUXOS has ultimate responsibility for ensuring all subsurface clearance operations are performed in accordance with this SOP, the work plan and APP/SSHP.

3.2 UXO TEAM LEADER

The UXO team leader will direct all subsurface clearance operations.

3.3 NOTIFICATIONS

In accordance with 29 CFR 1926.651(b)(2), utility companies or property owners will be contacted during regular local business hours; advised of the proposed work; and asked to establish the location of the utility underground installations prior to the start of any excavations. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

3.4 SITE LAYOUT PROCEDURES

Site layout and search grids will be established using global positioning system (GPS), licensed professional land surveyor, or compass and measuring tape. If applicable, survey crews will be escorted in the field by a UXO Technician II or above who will provide MEC anomaly avoidance

including checking the intended survey stake locations with a magnetometer before driving stakes into the ground. This will prevent driving stakes into buried MEC hazards.

3.5 DIGITAL GEOPHYSICAL SURVEY REACQUISITION

Reacquisition personnel will reacquire and mark anomalies (for example, pin flag) to be excavated. The UXO intrusive team leader will be provided with data containing the coordinates and a grid map of the targeted geophysical anomalies to be investigated that day.

The UXO intrusive team will use the pin flags left by the reacquisition team to reacquire anomalies. A geophysical instrument (identified by the project work plan) will then be used to pinpoint the anomaly. The area of the target anomaly will be searched using a geophysical instrument to determine the exact location of any anomalies in proximity to the interpreted target coordinates. According to the site specific work plan, a specified radius around coordinate location will be searched in order to locate the anomaly. Once an anomaly is sufficiently cleared with the geophysical instrument, the appropriate geophysical detection equipment will be used to verify the millivolt (mV) reading is below the minimum threshold established by the Geophysical Verification Strip/Instrument Verification Strip.

3.6 INTRUSIVE INVESTIGATION PROCEDURES

UXO teams will deploy to the area(s) as directed by the SUXOS for intrusive, subsurface investigations. The following actions will take place during the subsurface investigation:

1. Each anomaly will be excavated from the side of anomaly location and evaluated by carefully removing all debris to expose anomaly features.
2. Once clearly visible, a UXO Technician II and UXO Technician III (team leader) will determine the items condition and classification. The SUXOS will be notified immediately if item is determined to be MEC.
3. All MPPEH will be further classified as either munitions documented as an explosive hazard (MDEH) or munitions documented as safe (MDAS):
    a. Once MPPEH is classified as MDEH, it can be further classified as UXO, DMM or munition constituent (MC) (this is MC that is both an explosive and is present in sufficient concentrations to present an explosive hazard).
    b. MDAS is classified as either MC (this is MC that is not an explosive [for example lea, beryllium, and cadmium] or an explosive, but not present in sufficient concentrations to present an explosive hazard.), range-related debris (RD), munitions debris (MD) or cultural debris (CD).
4. Once classified, anomalies will be removed, collected/stored (as required) pending final disposition.

a. If a recovered anomaly is classified as MEC, the SUXOS/UXOSO will then make the determination of whether the item is safe to move.

b. If the item can be safely moved, the item will be removed and relocated pending further disposition (consolidated destruction or destruction in grid depending on guidance of the WP.)

c. If the item cannot be safely moved, it *will* be blown-in-place (BIP). No MEC designated as BIP will be moved for any reason. If needed, protective works will be used to decrease the possibility of damage to personnel or property.

d. If the anomaly is classified as MD, CD or RD, it will be collected with items of same classification and stored for further inspection.

5. Characterization data for all items and MEC will be recorded in accordance with the work plan and the UXO team leader field log as required by HGL SOP 15.23 UXO Field Logbook Procedures.
6. The SUXOS will account for MEC items using the grid maps provided by the team leaders and MEC accountability logs/spreadsheets.
7. All MEC, MC, MD, and RD will be disposed of in accordance with the approved procedures in the project work plan.
8. All appropriate documentation for data collection and MEC discovery will be completed and filed/saved in applicable project folders.

3.7 EARTH-MOVING MACHINERY INTRUSIVE INVESTIGATION PROCEDURES

All earth-moving machinery operations will be conduct in accordance with HGL SOP 15.15, *EMM Operations* and this SOP.

1. Start all excavations from the side of the anomaly. Carefully dig until the location of the anomaly is found. Excavation operations, whether by hand or using earth-moving machinery (EMM), will employ a step-down or offset access method. Under no circumstances will any EMM excavation be made directly over suspected military munitions.
2. Clear debris/dirt from the anomaly only enough to permit identification and to apply necessary MEC procedures. When the excavated hole is of sufficient size, the team will utilize geophysical instruments and dig tools to pinpoint and unearth the anomaly.
3. The hole will be backfilled, following quality control verification, and the condition preventing investigation (e.g., water in the hole) will be recorded in the field either digitally or manually on the MEC Investigation Field Log (Attachment 5) as an abandoned dig.

3.8 DATA COLLECTION AND RECORDING

Three types of data will be collected during MEC subsurface clearance activities: MEC, photographic, and location coordinates.

3.8.1 MEC Anomaly Data Collection

MEC anomaly data includes all descriptive data regarding the nature and condition of MEC items as listed on the MEC Investigation Log. All observations and measurements collected during the subsurface investigation will be recorded in the field either digitally, manually, or both, on the MEC Investigation Field Log. When digitally recorded in the field, subsurface clearance investigation observations and measurements will be recorded into an electronic version of the MEC Investigation Field Log on a portable personal computer/hand-held device by the UXO team leader. When recorded manually in the field, the subsurface clearance investigation observations and measurements will be hand entered on hard copies of the MEC Investigation Field Log by the team leader.

The upper portion of the accountability log will be completed by the UXO team leader in the field. The lower portion of the log will be prepared by the SUXOS based upon reference materials providing detailed information on MEC characteristics, such as fuze type, filler, and filler weight.

The UXO team leader will record all data on the MEC Investigation Field Log at the time MEC item is discovered. The UXO team leader will submit the MEC Investigation Field Logs to the SUXOS at the end of each day. The SUXOS will provide a copy to the Data Manager who will enter the data into the database (if the Data Manager position is being used on the project, otherwise, the SUXOS will track MEC information in a spreadsheet). The SUXOS will identify and correct errors in the forms and explain the errors to the team leader to avoid making the same mistakes again.

3.8.2 Photographic Data Collection

Digital photographs will be taken of all MEC items found during subsurface clearance investigation activities. Team leaders will log photo data in their logbooks. The date, time, and subject of each photograph will be recorded at the time the photograph is taken. The digital camera data and copies of the photo logs will be given daily to the SUXOS for entry into tracking spreadsheet. All digital photos will be downloaded and saved daily. Digital photos will be uploaded to the project files on-line on a weekly basis and will serve as a backup.

3.8.3 Location Coordinate Data

The location coordinates of MEC items will be recorded in accordance with the work plan. Location coordinates will be provided in the same format by all teams as required by the statement of work, or other applicable directives. Data will be downloaded from the GPS units to the project laptop computer at the end of each work day.

All electronic and manual data, including MEC Investigation Field Logs, digital photographs, and checklists, will be turned over to the specified manager/technician at the end of each working day without exception. It is critical that data not be lost or compromised through loss or improper handling. Data must be entered into the database and quality checked as soon as possible.

4.0 EQUIPMENT

4.1 GENERAL EQUIPMENT

Equipment for subsurface clearance operations will be provided by HGL, subcontractors, and vendors offering equipment for lease or purchase. All equipment, regardless of the source, will be inspected and its functionality checked to ensure operational readiness. Any equipment found to be damaged or defective will be tagged as "unserviceable" and returned to the source for repair or 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 manufacturers' equipment manual. Equipment required for daily use shall be calibrated twice daily (before operations begin and when all operations are finished). This system ensures that the on-site equipment is functioning properly. If an equipment function 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.

4.2 EARTHMOVING EQUIPMENT

EMM may be used to excavate large anomalies (for example, pits) or those deeper than two feet if required (for example, to confirm the anomaly is not a MEC). Any decision to use EMM to excavate these anomalies will be made by the SUXOS. Excavation will proceed slowly to ensure that the item is not broached by the EMM. If the excavated material is considered to be a MEC, it shall be uncovered sufficiently by hand to obtain a positive identification of the item. If the item is identified as MEC, a determination will subsequently be made as to whether it is or is not fuzed.

While excavating using EMM, a UXO technician will be assigned to observe the process and stationed in a position that is out of the reach of the excavation equipment but affords a view of the excavation site. This observer will ensure that the next lift is visually free of UXO. The excavated soils/spoils will be placed onto the ground within a screening area that has been surface swept and the boundaries recorded. The soil spoils will be spread across the screening area using the excavator bucket. The excavated material will be screened for range related debris, munitions debris, and MEC items. UXO Technicians will recover all pieces of munitions debris or range related debris and any MEC items. All DMM, MPPEH, MEC will be inspected, processed, stored and disposed of in accordance with HGL SOP 15.03 MPPEH Inspection and Processing. After screening, the soil spoils will be stockpiled to the side of the screening area pending final disposition.

4.3 GEOPHYSICAL INVESTIGATION EQUIPMENT

The use of geophysical investigation equipment (magnetometer) will depend on the local area of the sweep and the intended work to be conducted in that area. For the purpose of subsurface clearance operations, the following geophysical investigation equipment is authorized for use:

- Flux-gate magnetometers:
    - Schonstedt GA 52-CX
    - Schonstedt GA 72-CD
    - Forester FEREX 4.032
    - Ebinger MAGEX 120 LW
    - Vallon EL 1302D1 or 1303D
    - Chicago Steel Tape (magna-trak 102)
- Frequency-Domain Electromagnetic Induction Metal Detectors:
    - White's All Metals Detector
    - Fisher 1266X
    - Garrett
    - Geophex GEM3
    - Foerster Minex
    - Minelabs Explorer II
- Additional equipment items that may be required for marking hazards are:
    - Spooled polypropylene line for marking sweep lanes
    - Non-metallic shaft pin flags
    - Brightly colored surveyors tape
    - High visibility biodegradable spray paint

4.4 EQUIPMENT FUNCTION CHECKS

Daily equipment function checks will be performed on all geophysical instruments. These checks will consist of using the instrument in a designated function check area to verify response to known target anomalies. Upon completion of the function check the geophysical instrument type, serial number and results will be recorded using the Equipment/Instrument Calibration/Maintenance-HGL MR Form 15.16, Attachment 2. This function check will include the following steps:

1. Turn instrument on;
2. Set gain level;
3. Set gain control; and
4. Perform field test using test pit/strip.

– N O T E –

Use the Whites factory program, EEPROM (Electrical, Erasable, Programmable, Read Only Memory) HI-PRO for calibration and testing if available. This program works best to establish the initial "find" noise, which is very loud when pulling and holding the trigger (pinpoint mode) when the search-head is precisely over the target. This program is preferred over the standard UXO process.

5.0 SAFETY

Before entering a munitions site to perform subsurface clearance operations, the UXO team leader must conduct a daily tailgate safety meeting covering various emergency procedures, operations, MEC and all other hazards associated with the work site, using the Tailgate Safety Meeting Log.

5.1 MEC SAFETY PRECAUTIONS

If MEC is encountered during any phase of work the SUXOS and UXOSO will be immediately notified. In general, the following MEC safety precautions and protocols are:

- Remain alert at all times for MEC and related scrap or MPPEH hazards;
- It is most important to limit the exposure to a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation during construction activities involving ordnance, explosives, ammunition, severe fire hazards, or toxic materials;

- personnel will always assume MEC hazards contain a live charge until determined otherwise;
- Remember, death or injury can occur from MEC and explosive related accidents;
- The age or condition of a MEC hazard does not decrease the 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 agent 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 in its original state;
- DO NOT touch, move or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification;
- DO NOT touch, pickup up, kick or move anything that is unfamiliar or unknown;
- DO NOT roll an unknown item over or scrape the item to identify markings;
- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, leave the site immediately and seek shelter;
- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards;
- DO NOT walk across an area that the ground surface cannot be seen that has not been cleared of MEC hazards by the UXO Technician;
- DO NOT rely on color codes for positive identification of ordnance items nor their contents;
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes;
- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site;
- DO NOT be misled by markings on the MEC item stating "practice," "dummy," or "inert." Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly;
- Clearly mark the location of any ordnance item found so it can be easily located and avoided in the future; and
- Follow the procedures of the WP and SSHP; and upon locating any MEC hazards immediately notify the UXO Technician so appropriate measures can be taken.

– W A R N I N G –

Removing or taking any munitions, explosive or unexploded ordnance or munitions related debris from the site by any employee is strictly prohibited.

5.2 OTHER HAZARDS

Hazards that may be present during the anomaly and MEC subsurface clearance operations may include sharp metal, industrial chemicals, and other hazards as described below:

- *Cultural Debris*: Debris, other than munitions debris, that is located during the clearance will be documented in the logbook maintained by the UXO team leader. Cultural Debris will be processed in accordance with site specific requirements.
- *Chemicals*: Locating industrial-type chemicals is a possibility during MEC clearance activities. If any evidence of chemical contamination is detected, all activities will cease, and the SUXOS will notify the Project Manager using established notification procedures. Any phosphorous munitions or residue encountered will be handled in accordance with HGL SOP 15.08, *Phosphorous Filled Munitions Safe Practices*. Work will not continue in the area where the chemical was discovered until the SUXOS and UXOSO evaluate the situation and confer with the Project Manager and HGL's Corporate Health and Safety Director (CHSD), and all agree it is safe to proceed.
- *Other Hazards*: If sealed drums, contaminated soils, or other suspect conditions that indicate a potential health or safety hazard are encountered during the subsurface clearance, work efforts will stop, and the proper notification procedures will be followed. Work will not continue in the area where the hazard was discovered until the SUXOS and UXOSO evaluate the situation and confer with the project manager, and HGL's CHSD and all agree it is safe to proceed.

5.3 EXCLUSION ZONES AND MINIMUM SEPARATION DISTANCES

5.3.1 EXCLUSION ZONES

On munitions response to MEC projects, it is the responsibility of the UXOSO to establish the EZ for each MRS. During intrusive excavation operations only essential project personnel may be within the EZ.

EZ's will be established and marked with clearly identifiable markers, such as traffic cones, sandwich boards, signs, etc. The signs will be placed at the entrance to the EZ or at accesses leading to the EZ. The EZ will remain intact until clearance operations are complete. If a MEC, larger than the identified MGFD, is encountered, proper notifications will be made and an EZ appropriate for that munition will be used. The EZ distance can be reduced by implementing engineering controls, such as use of sand bags and open front barricades.

5.3.1.1 Essential Personnel

Only project personnel necessary for the safe and efficient completion of the field operations will be allowed in an EZ. Tasks which are not necessary to the operation will be prohibited within the immediate area of the hazard. Multiple UXO teams performing tasks required to execute the project may be in the same EZ while MEC operations are being performed if the specified TSD is maintained. Team locations must be closely coordinated with the UXOSO. Personnel will not be allowed to work in the EZ without the following:

- Briefing on the use of the buddy system;
- personnel protective equipment (PPE) requirements in accordance with the SSHP;
- medical authorization;
- applicable training and certifications;
- understanding of the SSHP; and
- approval of SUXOS.

5.3.2 MINIMUM SEPARATION DISTANCE

MSDs will be established for all MEC operations involving intrusive excavation, access and identification of MEC, MEC recovery, and MEC destruction. During these operations, all non-essential personnel will be moved beyond the EZ/MSD for the MEC item(s) being detonated in accordance with the DDESB TP 16, Fragmentation Database.

5.3.2.1 Unintentional Detonations

All non-essential personnel will be evacuated from within the EZ/MSD during intrusive operations in areas with known or suspected MEC. The MSD for unintentional detonations is the MGFD hazardous fragmentation distance (HFD): no more than one fragment per 600 square feet as calculated by the DDESB TP 16 Fragmentation Data Review Form.

5.3.2.2 Intentional Detonations

All personnel will be evacuated from within the MSD during intentional detonation of MEC items. The MSD for intentional detonations is the maximum fragment fragmentation distance, horizontal per the DDESB TP 16 Fragmentation Data Review Form, the Buried Explosive Module and the Generic Equations Calculators as applicable to the munition(s) being detonated and its donor explosives when calculated.

6.0 MEC DISPOSITON

All MEC will undergo final disposition in accordance with the project work plan and the DDESB-approved ESP/ESS. Specific procedures for the demilitarization or destruction of MEC are detailed in HGL SOP 15.01 Explosive Demolition Operations.

6.1 MPPEH PROCESSING

All MPPEH will be processed in accordance with the project work plan, the DDESB-approved ESP/ESS and HGL SOP 15.03 MPPEH Inspection, Management and Processing.

6.2 MEC DISPOSAL

All MEC disposal procedures will be conducted in accordance with the project specific work plan, the DDESB-approved ESP/ESS and HGL SOP 15.01 *Explosive Demolition Operations*.

7.0 QUALITY CONTROL

The HGL Senior UXO Operation Manager is responsible for ensuring this SOP is reviewed annually for completeness, accuracy and safety. The HGL UXO Safety Manager is responsible for the maintenance, management and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP will be directed to the UXO Safety and Quality Manager.

The project manager, SUXOS and UXOQCS are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, it will be brought to the attention of the UXOSO for corrective action.

7.1 ANOMALY RESOLUTION

After a grid, or other area, has been geophysically mapped, multiple "anomalies" may have been located. For projects using analog geophysical surveys, anomalies will be marked and excavated as each subsurface anomaly is detected in accordance with HGL SOP 15.04, *Analog Detection and Anomaly Removal (Mag-and-Dig) Operations*. For projects where digital geophysical methods are used, the geophysicist will pick and evaluate anomalies with the help of analytical software. In each instance, UXO-qualified personnel will excavate the anomalies in order to determine if the anomaly represents MEC, or some other feature. Once a grid or area has been cleared of all anomalies, the UXOQCS will check 10% (or more or less depending on the requirements of the WP) of the total anomalies to ensure the subsurface investigation was completed satisfactorily.

8.0 RECORDS

Project participants are responsible for documenting information in sufficient detail to meet the requirements of this SOP. Such documentation shall be retained with the project record files. Documentation generated as a result of this procedure will be collected and maintained utilizing the following forms listed in Section 10.

9.0 REFERENCES

Code of Federal Regulations, Title 29, Part 1926 Subpart P, Safety and Health Regulations for Construction.

Department of Defense Explosive Safety Board, Technical Paper 16, 2009, Methodologies for Calculating Primary Fragment Characteristics, April.

Department of Defense Explosive Safety Board Technical Paper 18, 2004, Minimum Qualification for UXO Technicians and Personnel, December;

U.S. Army Corps of Engineers, 2008, Engineering Manual 385-1-97, Explosive Safety and Health Requirements, September.

HydroGeoLogic, Inc., Standard Operating Procedure 15.01, 2014, Explosive Demolition Operations, February.

HydroGeoLogic, Inc., Standard Operating Procedure 15.03, 2014, Material Potentially Presenting and Explosive Hazard Inspection, Management and Processing, February.

HydroGeoLogic, Inc., Standard Operating Procedure 15.04, 2014, Analog Detection and Anomaly Removal (Mag-and-Dig) Operations, February.

HydroGeoLogic, Inc., Standard Operating Procedure 15.23, 2012, Munitions Project Field Logbook Procedures, June.

HydroGeoLogic, Inc., 2010. Safety and Health Manual, Section 15–Munitions and Explosives of Concern.

10.0 ATTACHMENTS

Attachment 1 Supervisor and Workers Statement

Attachment 2 Equipment/Instrument Calibration/Maintenance Log

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of client approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure the process is stopped until the hazards have been eliminated.

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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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name	Date

ATTACHMENT 2

Equipment/Instrument Calibration/Maintenance Log

Project Location (Name, City and State):			Contract No:
Team Number:	Instrument Description/Type:		Equipment/Instrument Serial Number:

Date	Calibration Standard (example, Test Pit)	Test results (check box) Pass	Fail	Name of Individual	Comments or Observations
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HGL MR Form 15.16 (Oct 2007)

Phosphorous-filled Munitions and Residue	SOP No.: 15.08 SOP Category: MMRP Revision No.: 1 Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish safe practices and procedures for the disposition of phosphorous-filled munitions and residues during munitions response (MR) projects conducted by HydroGeoLogic, Inc. (HGL) personnel.

2.0 SCOPE AND APPLICATION

This SOP applies to all HGL employees who are involved in the disposition of phosphorous-filled munitions and residues during munitions and explosives of concern (MEC) investigations or removal actions. All HGL employees who are tasked with performing these procedures will be qualified in accordance with the Department of Defense Safety Board Technical Paper 18.

Personnel who use this procedure must provide documented evidence to the Senior Unexploded Ordnance Supervisor (SUXOS) and Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP acknowledgement, Attachment 1. This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from these requirements will be sufficiently documented to re-create the modified process.

3.0 DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

Exclusion Zone (EZ): A safety zone established around a MEC work area. Only project personnel and authorized, escorted visitors are allowed within the EZ. Examples of EZs are safety zones around MEC intrusive activities and safety zones where MEC is intentionally detonated.

Phosphorous-filled Munitions and Residue: Any munition item that is determined to contain, or is suspected to contain phosphorous material. Also, any area, whether it be near a munition item or not, that is suspected to be the remains of phosphorous material.

Plasticised white phosphorous: Has the same characteristics as white phosphorous (WP) but adds a plastisizer which is designed to stick to targets. Plasticised white phosphorous (PWP), is a thick, rubber paste at room temperature with a yellow-brown or tan color. It does not break into small pieces and thus burns more slowly, thereby lessening the pillaring effect. PWP does not react with water.

Red Phosphorous: Red phosphorus (RP) may be formed by heating WP to 250° C (482° F) or by exposing WP to sunlight. RP use in munitions is designed to produce white smoke to indicate

munitions impact. This smoke is produced when the RP is exposed to and reacts with moisture in the air. The RP composition produces smoke which is highly caustic to moist tissues of the nose and throat. Breathing of this smoke must be guarded against.

White phosphorous: WP is a screening smoke that burns on contact with air and can be used as an incendiary. WP is a yellow solid at ordinary temperatures. It is the white form of phosphorus which spontaneously reacts with air to form a dense cloud of phosphorous pentoxide. Heat generated by its burning causes "pillaring." The tendency of WP to break into very small pieces that burn rapidly, together with its low melting point that sometimes causes melting in storage, led to mixing WP with synthetic rubber. WP does not react with water.

Unexploded Ordnance (UXO): Military munitions that have been primed, fuzed, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material; and remain unexploded either by malfunction, design, or any other cause. For the purpose of this SOP, the definition of UXO is limited to items larger than 50-caliber.

UXO-Qualified Personnel: Personnel who meet the training requirements for UXO Technician and Personnel and have performed successfully in military Explosives Ordnance Disposal (EOD) positions or are qualified to perform in the following service contract act contractor positions: UXO Technician I, UXO Technician II, UXO Technician III, and UXO Safety Officer (UXOSO), UXOQCS, and SUXOS.

3.2 ABBREVIATIONS

EZ	Exclusion Zone
HGL	HydroGeoLogic, Inc.
MEC	Munitions and Explosives of Concern
PPE	Personnel Protective Equipment
PWP	Plastisized White Phosphorous
RP	Red Phosphorous
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
SUXOS	Senior Unexploded Ordnance Supervisor
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
WP	White Phosphorous

4.0 PROCEDURES

HGL employees performing the activities addressed by this SOP are responsible for meeting the requirements detailed herein. HGL employees conducting technical review of task performance are also responsible for following appropriate portions of this SOP.

4.1 SENIOR UXO SUPERVISOR

The SUXOS has ultimate responsibility for ensuring all operations involving phosphorous-filled munitions and residue are performed in accordance with this SOP, the work plan, APP and SSHP.

4.2 UNEXPLODED ORDNANCE SAFETY OFFICER

1. The HGL UXOSO is responsible for ensuring increased safety awareness and procedures are emphasized to all UXO personnel who are involved in MEC operations where phosphorous munitions and residues are suspected. The UXOSO will ensure that UXO personnel are adequately trained in accordance with this SOP on the specific hazards and emergency procedures associated with phosphorous munitions. In accordance with the site specific APP/SSHP, the UXOSO will reinforce the following safety items:
    - Determining evacuation routes;
    - The "buddy" system (two-person rule);
    - Work zones and EZ;
    - Personnel protection requirements; and
    - Phosphorous safety and handling procedures.
2. The UXOSO will ensure the agencies responsible for emergency response are notified of ongoing MEC operations and the possibility of encountering munitions containing phosphorous hazards. The notifications should address the need for potential fire support when dealing with brush/grass fires and first aid medical care. At a minimum, the following agencies should be notified and be prepared to respond, as applicable:
    - Paramedic/Emergency Medical Technician
    - Local Fire Department

4.3 UXO TEAM LEADER

The UXO Team Leader is responsible for safety of all team members involved in MEC investigation and clearance activities on munitions project sites. The UXO Team Leader will

ensure all team personnel able to recognize phosphorous-filled munitions, residue and all associated hazards.

4.4 TRAINING

Before beginning field operations on MEC sites potentially contaminated with phosphorous munitions, the UXOSO will conduct safety training on personnel roles, responsibilities and procedures. The training will address how to properly identify phosphorus munitions, specific handling procedures, and first aid treatment. Common types of phosphorus-filled munitions found during MR projects are shown in Attachment 2. The following topics will be covered during the training:

- Review of the SSHP
- Review of this SOP
- Two-person-rule
- Personal Protective Equipment (PPE) requirements
- Equipment requirements
- First aid and treatment
- Emergency actions and communications
- Proper handling and disposal procedures
- Phophorous safety and handling
- Disposal procedures

4.5 PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

Project-specific PPE requirements are addressed in the SSHP, however, the UXO team leader is responsible for ensuring the additional PPE listed below is readily available and worn by UXO personnel when handling phosphorous munitions:

- Leather welders gloves
- Welder's apron
- Helmet with full-face shield

4.6 EQUIPMENT REQUIREMENTS

The following is a list of the minimum equipment required to be readily available to UXO teams performing MEC operations on sites known to have phosphourous munitions or residue. The SUXOS and UXOSO will evaluate the site conditions to ensure that the proper equipment is identifed and provided to the UXO team prior to commencing operations.

For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator.

– WARNING –

Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

- First aid kit
- Burn kit
- Water, 5 gallon container
- Shovels
- 5-gallon bucket
- Sand (e.g., Sandbags or 5 gallon bucket filled with sand) mix with water to cover exposed phosphorus

4.7 FIRST AID TREATMENT

First aid treatment is divided into two categories, self–aid and general first aid as described below:

4.7.1 Self–Aid

Self–aid comprises those aid measures which the individual can apply in helping himself or herself. Incandescent particles of phosphorous may produce extensive burns. The burns usually are multiple, deep, and variable in size. Prompt first aid treatment is mandatory to prevent serious injury.

1. If burning particles strike and stick to clothing, remove the contaminated clothing quickly before the phosphorous burns through to the skin.
2. If burning particles strike the skin, smother the flame with water, wet cloth, or wet sand. Keep the phosphorous particle(s) covered with wet material to exclude air until the particles can be removed. WP and PWP will continue to burn unless deprived of oxygen.

3. If the eyes become contaminated, flush the eyes immediately with water. Tilt the head to one side, pull the eyelids apart with the fingers and pour water slowly into the eye so that it will run off the side of the face to avoid the spreading of the contamination.
4. Report injuries and seek medical attention immediately.
5. Since phosphorous will ignite spontaneously and continue to burn when exposed to air, oxygen must be excluded until the phosphorus is removed from the wound.

4.7.2 General First Aid

General first aid emergency actions will be undertaken to restore or to maintain vital body functions in an incident or accident. The procedures for general first aid are as follows:

4.7.2.1 Personal Decontamination

Perform personal decontamination if physically able to do so. If the person is incapacitated, decontamination must be done by a second person as soon as possible. If phosphorous particles are burning flesh:

- Immediately plunge the affected portions of the body under water to stop phosphourous from burning.
- If particles are in the victim's face or eyes apply a continuous, gentle stream of water to the afflicted area or apply wet compresses until medical help is available.

4.7.2.2 Treament for Embedded Phosphorous

Phosphorous particles that become embedded in a perons flesh will be treated as follows:

1. Apply the dressing white side down and directly over the wound.
2. Wrap the tails so that the dressing is covered and both sides of the dressing are sealed.
3. Tie the tails into a non-slip knot over the outer edge of the dressing, not over the wound.
4. Check to make sure that the dressing is applied lightly over the burn but firmly enough to prevent slipping.
5. Keep bandages moistened but do not remove the bandages in order to avoid causing the phosphorus particles to re-ignite.
6. Follow standard first aid protocol for patient treatment and monitoring until patient receives proper medical care.
7. Monitor and treat for shock if needed.
8. Immediately transfer patient to a medical treatment facility.

Phosphorous-filled Munitions and Residue	SOP No.: 15.08 SOP Category: MMRP Revision No.: 1 Date: February 2014

4.8 SAFETY

The following are the minimum safety precautions that will be observed by all on-site personnel while conducting MEC operations involving phosphourous munitions and residues.

1. DO NOT inhale the smoke or fumes of burning phosphorous materials. The fumes and dust from these materials are irritating and toxic if inhaled. Wear a protective mask where extensive fumes may be encountered.
2. DO NOT permit red phosphorus to come in contact with oxidizing agents (chlorates, perchlorates, etc.). Such mixtures can form very sensitive explosive compounds.
3. Isolate and decontaminate, as necessary, items or equipment which have been associated with burning red phosphorus under water. Such items may be contaminated with phosphorus residue which may re-ignite spontaneously as they dry out.
4. Submerge a damaged, partially consumed, or functioned pyrotechnic device containing unconsumed red phosphorus residue in water, or cover it with mud, wet sand or earth, or foam as quickly as possible if necessary to handle or transport.
5. Protect the eyes with No. 6 shade welder's goggles, or equivalent, if visual exposure to burning pyrotechnic materials is probable Such burning materials can cause serious eye injury unless the eyes are properly protected.
6. Assume that phosphorous munitions with explosive burstors are present until an investigation by the SUXOS and UXOSO jointly proves otherwise. Use protective equipment and have first aid items available and ready for use.
7. Check expended pyrotechnic devices carefully for red phosphorus residue, and decontaminate if necessary. Due to incomplete combustion, red and white phosphorus may be present and re-ignite spontaneously.
8. Identify and treat a known or suspected phosphorous munitions in accordance with the requirements of its fuzing and the item's overall condition. The items fuzing may be armed, of an especially hazardous type, or be in an otherwise hazardous condition.
9. DO NOT crush or break crusted phosphorus residue which may be present after red phosphorus has been burned. This residue is sensitive and may ignite if subjected to friction or if the crust is broken.
10. DO NOT approach smoking phosphorous munitions or residues unless absolutely necessary. Burning phosphorus munitions may detonate the burstor or disperse the incendiary compounds at any time
11. Submerge a smoking (leaking) phosphorous munitions in water or cover it with mud, wet sand or earth, or foam as quickly and gently as possible if necessary to handle or transport.

12. Personnel will have gloves (cotton, leather, or asbestos), a face shield, and flame-retardant clothing available when working with suspected leaking phosphorous munitions. The protective mask should be worn when personnel are exposed to phosphorous smoke.
13. Use sand to smother phosphorous fires. Be aware that water may induce a violent reaction or may be completely ineffective, depending on the compound's mixture.
14. Bury incendiary-loaded munitions in sand when transporting them. This will smother any fire which could start until other corrective action can be taken.
15. Anticipate a high-order detonation when burning pyrotechnic- or incendiary-loaded ordnance. Safety measures for personnel and property must be based on this possibility.
16. Dispose of pyrotechnic- and/or incendiary-loaded munitions by burning or detonation. The exact method to be used will vary depending on the particular item to be destroyed.
17. Do not approach a phosphorous, pyrotechnic or incendiary munitions burn area for 30 minutes after the cessation of burning. Unconsumed explosive components may still be present after burning apparently ceases.
18. When performing demolition operations on a white phosphrous munition, extra care will be used to limit fire hazards. The area (up to 200 ft and beyond) around the item should be cleared of vegetation and a fire department shall wet down the area with water or foam. Fire department will remain on standby in the safe area to respond with the UXOSO if needed. The five minute wait time shall be waived in case of fire inside demoliton exclusion zone.

4.9 PHOSPHOROUS HANDLING

The UXO team leader is responsible for ensuring that all team members follow proper handling and disposal procedures of phosphourous munitions and residues. The follow procedures will be observed during MEC operations that involve the potential for encountering these materials:

1. Damaged fuzed phosphorous munitions will not be moved unless an evaluation has been conducted by the SUXOS and UXOSO jointly, and determined as *acceptable–to–move*, for example, placement in wet sand of water until final disposition.

2. Phosphorous munitions and residues will be handled in a manner to avoid damage that could cause leaks or explosure to air.

– C A U T I O N –

1. *Phosphourous munitions fillers, WP and PWP will ignite spontaneously upon contact with air.*
2. *When performing soil excavations, for example frag pits containing we soil, take caution to ensure spoils are cleared of phosphorus residues to prevent ignition as soil drys and potentially igniting surrounding vegetation.*

3. Damaged phosphorous munitions or residues must be immediately immersed in water or wet sand and isolated pending final disposal.
4. Phosphorus vapors and fires are controlled by complete immersion of a leaking munition in a container of water. However, the phosphorous may reignite when removed from water.
5. Ensure medical support personnel know they are supporting Phosphorus munitions demolition operations and have first-aid treatment materials on hand.
6. If an accident occurs in the field, irrigate Phosphorus wounds with water and apply saline soaked dressing. Keep dressing wet until arrival of medical personnel.
7. Ensure an ample supply of water and sand are readily available when handling suspected Phosphorus-filled munitions.

Additonal precautions and requirements can also be found in:

- DArmy Phamplet 385–63 *Range Safety*
- DA Phamplet 385-64, *Arms, Ammunition and Explosives Safety Standards*
- HGL SOP 15.01 *Explosive and Demolition Operations*, Sections 5.15.5 and 6.0
- HGL SOP 15.03 *Material Potentially Presenting and Explosive Hazard Inspection, Management and Processing*
- U.S. Army Corps of Engineers (USACE) Engineer Manual 385-1-97 *Explosives Safety and Health Requirements Manual*
- USACE Engineer Regulation 385-1-95 *Safety and Health Requirements Munitions and Explosives of Concern Operations*

4.10 PHOSPHORUS DISPOSAL

All explosive demolition operations involving the dispoal of phosphorous munitons or residues will conduted in accourdance with this SOP and HGL SOP 15.01 *Explosive Demolition Operations*, Section 5.15.5, Department of Defense Instruction 4140.62, and HGL SOP 15.03 *Material Potential Presenting an Explosive Hazard Inspection, Management and Processing* be followed during all phosphorous disposition activities.

– W A R N I N G S –

1. *Avoid skin contact with smoke, fumes, dust, and vapors of detonations and MEC residue.*
2. *Phosphorus munitions will be counter-charged bottom centerlineto disperse the phosphorus in the air for complete combustion.*
3. *Care must be taken when returning to the disposal site after detonation of Phosphorus muntions to ensure that all Phosphorus was consumed.*
4. *Do not approach the area until all smoke has cleared and the SUXOS has declared the area safe.*

5.0 REFERENCES

Department of Army Phamplet 385-63, 2012, Range Safety, January.

Department of Army Phamplet 385-64, 2011, Arms, Ammunition and Explosives Safety Standards, May.

Deparment of Defense Explosive Safety Board Technical Paper 18, 2004, Minimum Qualifications for Unexploded Ordnance Technicians and Personnel, December.

Department of Defense Instruction 4140.62, 2008, DoD Ammunition and Explosives Safety Standards, November.

HydroGeoLogic, Inc., HGL SOP 15.01, 2014, Explosive and Demolition Operations, February.

HydroGeoLogic, Inc., HGL SOP 15.03, 2014, Material Potentially Presenting and Explosive Hazard Inspection, Management and Processing, February.

U.S. Army Corps of Engineers, Engineer Manual 385-1-97, 2008, Explosives Safety and Health Requirements Manual, September.

U.S. Army Corps of Engineers, Engineer Regulation 385-1-95, 2007, Safety and Health Requirements Munitions and Explosives of Concern Operations, March.

6.0 ATTACHMENTS

Attachment 1 Supervisor/Workers Statements

Attachment 2 Phosphorus Munitions Identification

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of Naval RPM approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name

ATTACHMENT 1

Page 1-1

ATTACHMENT 2

COMMON TYPES OF PHOSPHORUS MUNITIONS

PROJECTILE BASE PLATE COMPARISON (Does not 100% ID munitions type)	
Nomenclature: **M1 105mm HE Projectile**	
Description: **HE projectiles typically have a welded base plate**	
Nomenclature: **M105 155mm WP Projectile**	
Description: **WP projectiles baseplates typically are non-welded**	
Nomenclature: **M60 Series 105mm WP Projectile**	
Description: **Non-welded WP baseplate**	

ATTACHMENT 2

WHITE PHOSPHORUS PROJECTILES	
Nomenclature: **M1 105mm HE projectile** **Description:** **Projectile with crusted WP**	
Nomenclature: **Mk 30 5-inch WP projectile** **Description:** **Contains 168 WP filled steel tubes 0.5 inch in diameter and 2.86 inches long.**	
WHITE PHOSPHORUS MORTARS	
Nomenclature: **M2 4.2-inch WP mortar** **Description:** **Some obsolete M2-series cartridges substituted** **WP filler**	

ATTACHMENT 2

Nomenclature: **M375 81mm WP mortar**	
Description: **The projectile is painted light green with one yellow band and light red markings**	
Nomenclature: **M375 81mm WP mortar**	
Description: **12-gram RDX burster, 1.6-pound WP filler, 8-gram double-base ignition cartridge**	
Nomenclature: **M302A1 60mm WP mortar**	
Description: **The mortar has a 11-gram burster and 340-grams of WP filler**	

ATTACHMENT 2

2.75-INCH WHITE PHOSPHORUS ROCKET	
Nomenclature: **2.75-inch rocket WP cups**	
Description: **WP Cups in several field conditions, "Crusted"**	
Nomenclature: **275-inch rocket WP cups**	
Description: **Crust broken, WP exposed to air auto-ignition**	
Nomenclature: **2.75-inch WP rocket**	
Description: **Rocket with burning WP**	

ATTACHMENT 2

WHITE PHOSPHORUS GRENADES	
Nomenclature: **M34 WP grenade** **Description:** **Used for ignaling, screening, and incendiary purposes. Thrown by hand or launched from a rifle.**	
Nomenclature: **M15 WP grendade** **Description:** **This grenade is painted grey with one yellow band and yellow markings.**	
Nomenclature: **M15 WP grendade** **Description:** **The WP filler burns for about 60 seconds at a temperature of 5,000 degrees Fahrenheit**	

Vegetation Removal Operations on Munitions Response Sites	SOP No.: 15.10 SOP Category: MMMR Revision No.: 1 Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide HydroGeoLogic, Inc. (HGL) employees with the procedures to safely conduct vegetation removal operations on a munitions response site (MRS). This SOP will be used in conjunction with HGL SOP 15.12 *Munitions and Explosives of Concern (MEC) Anomaly Avoidance Support* (HGL, 2013).

2.0 SCOPE AND APPLICATION

This SOP applies to HGL employees who are involved in vegetation removal activities being accomplished by manual or mechanized removal, controlled burning, or defoliation. All HGL employees tasked with performing MEC anomaly avoidance support during vegetation removal activities will be UXO-qualified in accordance with the U.S. Department of Defense Safety Board (DDESB) Technical Paper 18. This SOP does not apply to projects involving chemical agents or chemical warfare materiel.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration (OSHA) standards and requirements. Refer to the project site-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the approved project Work Plan, Accident Prevention Plan (APP), Site Safety and Health Plan (SSHP), and when applicable the DDESB-approved Explosive Safety Submission or Explosive Site Plan. Procedures for packaging and disposing of waste generated during field activities will be described in the project-specific Work Plan.

Personnel who use this procedure must provide documented evidence to the Senior Unexploded Ordnance (UXO) Supervisor (SUXOS) and UXO Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP Acknowledgment, Attachment 1. This documentation will be retained by the UXOQCS in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS

Anomaly Avoidance: Techniques employed on property known or suspected to contain MEC, other munitions that may have experienced abnormal environments (for example, discarded military munitions [DMM]), munitions constituents in high enough concentrations to pose an explosive hazard to allow entry to the area for the performance of required operations. *Military Munitions*: All ammunition products and components produced for or used by the armed forces for national defense and security. Includes: confined gaseous, liquid, and solid propellants;

explosives; pyrotechnics; riot control agents; smokes and incendiaries, including bulk explosives; rockets; guided and ballistic missiles; bombs; warheads; mortar rounds; artillery ammunitions; small arms ammunition; grenades; mines; torpedoes; depth charges; cluster munitions and dispensers; demolition charges; and devices and components thereof.

Minimum Separation Distance: The minimum separation distance (MSD) is the safe distance for nonessential personnel to be present during UXO operations. Generally speaking, the maximum horizontal fragmentation distance is to be used for all UXO items as the MSD for all nonessential personnel for both intentional and unintentional detonations.

Munitions and Explosives of Concern: Specific categories of military munitions that may pose unique explosive risks, including: UXO, as defined in 10 U.S. code (U.S.C.) Section 101(e)(5); DMM, as defined in 10 U.S.C. Section 2710(e)(2); or munitions constituents (such as, TNT, RDX), as defined in 10 U.S.C. Section 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munition with the Greatest Fragmentation Distance: Munition with the greatest fragment distance (MGFD) that is reasonably expected (based on research or characterization) to be encountered in any particular area.

Unexploded Ordnance: UXO as defined by 10 U.S.C. Section 101(e)(5)(A) through (C). UXO includes military munitions that: (1) have been primed, fuzed, armed, or otherwise prepared for action; (2) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and (3) remain unexploded whether by malfunction, design, or any other cause.

5.0 PROCEDURES

5.1 PERSONNEL CERTIFICATIONS AND QUALIFICAITONS

All HGL employees and subcontractor personnel will meet the training certification and qualification requirements specified by the project APP/SSHP. In addition to meeting the conditions listed in the APP/SSHP, the following certifications are required for all HGL personnel or subcontractors performing vegetation removal activities:

- Drivers license,
- Operators certification for earth-moving mechanical equipment operations, and
- UXO Technician Level II or above for providing MEC anomaly avoidance support.

5.2 TRAINING

Before commencing any vegetation removal operations, training will be provided to all employees and supervisors on the hazards and safety precautions associated with the vegetation

removal methods being used. In addition to receiving training on this SOP, training also will include the following:

- Initial site specific hazards and indoctrination;
- MEC awareness and recognition;
- Instruction in initial use, operation, and maintenance of vegetation removal manual tools, as well as machines and vehicles in accordance with manufacturer's directions, and acknowledgment of warnings and precautions for that equipment;
- Recognition of safety and health hazards associated with the employee's specific work tasks, including the use of measures and work practices to prevent or control those hazards.
- Recognition, prevention, and control of other safety and health hazards in the vegetation removal.
- Procedures, practices and requirements of the employer's work site.
- The requirements of the OSHA logging industry standards, when applicable.

Each employee is required to be trained and work under the close watch of a designated supervisor or team leader until the employee demonstrates the ability to safely perform his or her duties independently.

5.3 MEC ANOMALY AVOIDANCE

When non-UXO personnel are used to conduct vegetation removal activities on a suspected or known munitions site, a minimum of one UXO Technician II is required for anomaly avoidance duties for each vegetation removal team. MEC anomaly avoidance procedures will be used and followed in accordance with HGL SOP 15.12, *MEC Anomaly Avoidance Support*.

5.4 VEGETATION REMOVAL AREA PLANNING AND PREPARATION

The following methods and procedures will be observed to ensure safe and expedient vegetation removal within an MRS. Vegetation removal planning must account for the possibility of vegetation growing back before MEC clearance operations commence:

- A UXO Technician II or above will clearly mark the boundaries of the vegetation removal area in advance of survey teams installing grid markers/stakes.
- A UXO Technician II or above will provide MEC anomaly avoidance to the survey team during grid marker/stake installation. Installation of boundary marker stakes will facilitate expedient and safe vegetation removal.
- Vegetation removal teams will attempt to cut vegetation by following natural terrain contours and patterns of vegetation rather than artificial boundaries within the site.

- Vegetation removal teams will avoid displacing or damaging the wooden lathes/stakes installed by the survey team to mark grid and work site boundaries.

Selection of an appropriate vegetation removal approach will be based on several site-specific factors, including the following:

- The type of munitions and fuzing suspected to be encountered;
- The probability levels for encountering MEC;
- Type and density of vegetative cover;
- Site topography, terrain and soil conditions, and drainage patterns;
- The required level of environmental and natural resource protection identified;
- Site location operational and access restrictions, for example, active military ranges; and
- Client requirements.

5.4.1 Determining Vegetation Removal Methods

The following factors should be considered when determining vegetation removal methods:

- Terrain and topography limitations:
  - For manual methods, limitations of operator performance and the speed of the operation may be reduced in areas of rugged and mountainous terrain.
  - For mechanical methods, topography may limit site accessibility and equipment performance, thus increasing the time to complete the operation.
  - If a controlled burn method is used, then topography may not have a significant effect on the cost.
- Vegetation density; and
- Defoliation.

5.4.2 Mechanical Vegetation Removal

Mechanized vegetation removal operations have several advantages in that they are usually more expedient; reduce personnel exposure, thereby reducing the likelihood of injuries; and may reduce project costs compared to manual methods. The following factors must be considered when selecting mechanized equipment for vegetation removal:

- Type of munitions and fuzing suspected to be encountered; and
- Probability levels for encountering MEC based on concentrations.

5.4.3 Manual Vegetation Removal

Manual vegetation removal methods may be used when there is limited or low density vegetation. This method requires vegetation removal teams to be properly outfitted with the appropriate types of equipment necessary for the safe performance of vegetation removal operations (refer to Section 6.0).

When using manual tools, employees will be properly trained on their use and outfitted with the appropriate personal protective equipment (PPE), for example protective glasses, chaps, composite boots and gloves as specified by the SSHP activity hazard analysis.

5.4.4 Controlled Burn

Controlled burns may be used to thin dense brush or undergrowth or clear areas of vegetation to make operations safer for personnel conducting MEC removal operations.

– W A R N I N G –

Controlled burning of vegetation on ranges is not an approved method to clear MEC hazards.

When planning controlled burns, it is essential to coordinate with the client regarding local regulations, restrictions, and support requirements.

Controlled burns will only be conducted when authorized and approved by the appropriate agency per the project work plan.

When controlled burn methods are used on a project site, all personnel will remain beyond the MSD for the MGFD until the UXOSO and SUXOS jointly deem the area is safe to enter following the burn.

6.0 EQUIPMENT

Equipment requirements for each project will be specified in the approved Work Plan, but may be modified based on site conditions as follows:

- The SUXOS or the UXOSO will ensure that all equipment/instruments used by site personnel are working properly and that the functionality of vegetation removal equipment is verified and documented on a daily basis in the team's field logbook.
- Each UXO team leader/escort will ensure the team's safety equipment is inspected before commencing work each day and will verify that required equipment is available and operational.
- Whenever any machinery or equipment is found to be unsafe, or whenever a deficiency that affects the safe operation of equipment is observed, the equipment will immediately

be taken out of service, properly tagged, and its use prohibited until unsafe conditions have been corrected.

- All equipment, function checks, maintenance, and calibration will be properly recorded in the team leader's logbook and using HGL Form 15.16 *Equipment Maintenance Log*, Attachment 2.

6.1 GENERAL EQUIPMENT

The following is a list of equipment typically is used to perform vegetation removal activities. Current site conditions will dictate which equipment will be needed:

- Chainsaws,
- Weed cutters/trimmers,
- Mechanized shredder,
- Wood chipper,
- Brush hog,
- Hand saws,
- Shovels,
- Machetes, and
- Axes.

6.2 CHAINSAWS

6.2.1 Chainsaw Operations

Each chainsaw used on site will be equipped with a functional chain brake and a protective device that minimizes chainsaw kickback. Chainsaw kickback devices will not be removed or otherwise disabled. Each chainsaw:

- Will be equipped with a continuous pressure throttle control system that will stop the chain when pressure on the throttle is released, if gasoline or fuel-powered;
- Will be operated and adjusted in accordance with the manufacturer's instructions;
- WILL NOT be fueled within 50 feet from any open flame or other source of ignition
- WILL NOT be started within 20 feet from the fueling area;
- WILL NOT be filled to the brim in order to leave room for fuel expansion. Portable containers and gas tanks should never be more than 3/4 full;
- WILL NOT be fueled if the engine is hot (allow the engine to cool for 10 minutes before refueling);

- Will be started on the ground or where the saw is firmly supported (this step may include the use of plywood or other protective measures to ensure the chain does not contact the ground. Drop starting a chainsaw is prohibited);
- Will be started with the chain brake engaged;
- Will be controlled with two hands during saw operations (exceptions to this policy include the minimal time needed to adjust the throttle or reach for and activate the kill switch);
- Will be used by personnel who have ensured their footing is stable before starting to cut (the chainsaw shall not be used in a position or at a distance that could cause the operator to become off balance, to have insecure footing, or to relinquish a firm grip on the saw);
- WILL NOT be used to cut directly overhead; the manufacturer's recommendations for chainsaw use will be followed at all times;
- Will be carried in a manner that will prevent operator contact with the chainsaw bar or chain;
- Will be either immediately shut off and placed on the ground, or the throttle initially released and the saw carried out of the area (but no more than 50 feet) until the saw can be turned off and set down safely, before felling starts; and
- Will be shut down whenever a saw is carried farther than 50 feet or when terrain conditions, such as obstructed ground, slippery surfaces, or dense underbrush, could cause the operator to stumble, slip, or fall.

6.2.1.1 Chainsaw "Kickback"

Kickback occurs when the teeth on the chain catch on something as they rotate around the tip of the blade. The teeth may have enough force to cause the blade to kick back violently toward the operator. There are several situations that are prone to cause kickbacks:

- When the nose of the blade strikes another object,
- Starting a bore cut improperly, and
- When the blade nose or tip catches the bottom or side of a saw cut during reinsertion.

The best defense against kickback is to keep the tip guard on the chainsaw. Keeping a firm hold on the saw and using a saw that has a chain-brake or kickback guard can maintain some kickback control.

Since dull teeth are more likely to cause kickback, ensure that the saw teeth are sharp. Never cut above shoulder height, otherwise the saw will be difficult to control and there will be a high potential for kickback toward the head and face.

6.2.1.2 Chainsaw Pinching

Chainsaw operators should always be watchful for blade pinching situations and plan accordingly. The base of the blade should be used to cut branches rather than the tip of the blade, and a high chain speed should be used when reinserting the blade in a cut or removing it from a cut.

6.2.2 Chainsaw Inspection and Maintenance

The following elements should be checked on a regular basis, but no less than before starting work and at the end of the work day:

- Controls: ensure proper function;
- Chains: ensure proper adjustment;
- Mufflers: ensure they are in place and operational;
- Chain brakes and nose shielding devices: ensure they are in place and operational;
- Cutting edges: ensure they are properly shaped and sharp; and
- Ensure all other safety devices are in place and function properly.

If chainsaw is in need of repair, it will be taken out of service, properly tagged, repaired, and reinspected before use.

6.3 BRUSH CUTTER PROCEDURES

6.3.1 Brush Cutter Safety and Operation

Individuals conducting brush cutting and removal with fuel-powered brush cutters will be spaced at least 50 feet apart while the brush cutters are in use. This restriction assumes that the operators are wearing proper PPE. Personnel who are not operating fuel-powered brush cutters will maintain a separation of at least 100 feet from the brush cutting operators. Greater distances than those listed above may be required if specified by the manufacturer in the manufacturer's operating manual or other applicable documents.

Gas-powered brush cutters/trimmers will be used in accordance with the manufacturer's recommendations as specified in the manufacturer's operating manual. All brush cutters/trimmers will be equipped with a kill switch and all personnel will be familiar with the procedure for using the equipment controls and the kill switch. Additionally, field personnel who will be using brush cutters and trimmers will:

- Be trained in the operation, inspection, and maintenance of issued equipment;
- Read the manufacturer's operating manual prior to operation;
- Wear the prescribed PPE:

  - Nylon Line – shin guard leg protection, foot protection with high traction soles and ankle protection, leather gloves, safety glasses or goggles, hard hat with mesh face shield and ear muffs, and hearing protection; and
  - Metal Cutting Blades – prescribed PPE for chainsaw operations.
- Never allow untrained personnel to operate the cutter or trimmer.
- Make sure the muffler is in good condition (in dry weather, use a fire-safe muffler);
- Ensure that shields and other guards are in place and working properly (DO NOT remove or disable guards or other safety devices);
- Use proper fuel mixture with the manufacturer's recommended two-stroke oil mixed to the manufacturer's recommendations;
- Check the cutting blades prior to each use for cracks, missing teeth, and overall condition (replace bent, warped, damaged, or dull blade);
- NOT overfill the fuel tank and allow fuel to leak onto muffler or hot engine;
- NOT fuel if the engine is hot (allow the engine to cool for 10 minutes before refueling);
- Maintain a distance of at least 50 feet between operators to avoid injury from thrown objects;
- Stop operations immediately if approached;
- Start the cutter/trimmer on the ground or where the unit is firmly supported in an open area;
- Control equipment with both hands during operations (exceptions to this policy include the minimal time needed to adjust the throttle or reach for and activate the kill switch);
- Ensure feet are firmly planted and footing is stable;
- Keep the trimmer head below waist level;
- Always stand on the proper side of the trimmer while cutting (on a curved shaft trimmer, the line head rotation is clockwise (cut on the left side); on a straight shaft trimmer, the line head rotation is counterclockwise (cut on the right side);
- Bring the engine to operating speed before starting vegetation cutting;
- NOT operate engine faster than needed to effectively cut the vegetation;
- NOT allow the engine to return to idle speed when not cutting;
- Always turn off the engine and disconnect the spark plug, if accessible, before attempting to unclog or adjust the trimmer;
- Avoid placing hands near the blade (use a stick or similar item to remove any vegetation clogging the unit);
- Stop the engine before putting the cutter/trimmer down; and
- Secure the cutter to prevent fuel spills and damage during transport.

6.3.2 Brush Cutter Inspection and Maintenance

At a minimum, brush cutter inspection will include the following:

- Inspect the brush cutter periodically for potential hazards, such as loose belts and missing or damaged guards.
- Examine for accumulations of grass, leaves, or excessive grease to reduce fire hazard.
- Conduct routine maintenance and inspections in accordance with the manufacturer's operating manual.
- If brush cutter/trimmer is in need of repair, the cutter/trimmer will be tagged as out of service, properly repaired, and reinspected prior use.

6.4 MECHANIZED SHREDDER PROCEDURES

The mechanized shredder is a large, excavator-mounted, rotary vegetation and tree shredder. This attachment is very heavy and requires extreme care when being operated, especially in an area with the possibility of encountering MEC. Mechanized shredder operations are typically performed by a subcontractor; however, UXO technicians must be alert and aware of the hazards involved during this operation.

6.4.1 Mechanized Shredder Operation

All excavator and shredder operations will be conducted in accordance with the manufacturer's instructions and safety precautions. Additionally, excavator and shredder operators WILL:

- Be trained in the operation, inspection, and maintenance of shredder;
- Ensure equipment is inspected prior to use each day;
- Stay seated while machine is running;
- Know how to shut down equipment in an emergency;
- Always maintain eye contact with the equipment machinery while it is in operation;
- Be aware of personnel entering the work area;
- Ensure a 500-foot exclusion area is established (mandatory when operating in a MEC contaminated area and a 200-foot exclusion zone area is mandatory when operating in a non-MEC area);
- Shut down the machine when a person enters the work area and inform the individual of the danger (DO NOT restart the machine until all persons have cleared the exclusion area);
- Have radio communications at all times when operating in a MEC-contaminated area (loss of communications will trigger an immediate work stoppage until communications can be restored);

- NOT enter any area until UXO personnel have performed UXO avoidance procedures for the area and declared it safe for vegetation clearance;
- NOT allow riders or passengers on the outside of the machine or inside the driver's compartment of the machine;
- Keep the shredder and boom a safe distance from obstructions, buildings, and power lines;
- Never allow the shredder to come within 6 inches of the ground at any time;
- Only lift cutter drum as high as needed (operation of cutter wheel more than 1 foot above ground is extremely dangerous);
- Use extreme care when on uneven or rough terrain; when on hillsides or steep inclines, only track up and down slopes; on steep inclines DO NOT operate over side of tracks;
- Stay away from cliffs, overhangs, and uneven ground;
- Lower boom to ground to slow or stop slide if machine starts to slide on sloped terrain;
- NOT operate shredder more than 45 degrees out of flat (engine damage **will** occur);
- Keep machine under control and use common sense in operations;
- Position throttle to idle and run at idle for 5 minutes prior to shutdown;
- Turn shredder ignition to OFF position, lower carrier to ground, and disengage excavator controls when shutting down operations; and
- Wear ear plugs or ear muffs required for shedder operations and other high noise activities deemed necessary by the site safety and health officer.

6.4.2 Shredder Inspection and Maintenance

The shredder shall be inspected and maintained in accordance with the manufacturer's instructions, and will be inspected at least once before use each day. At no time will the shredder be operated if the required controls and guards are not in place and fully functional. Conduct the following inspections and maintenance procedures before and after daily use:

- Follow normal startup and shutdown procedures.
- Check all machine systems (fuel, air, water, oil, and hydraulics)
- Make sure machine is free of debris and flammable fluids.
- Make sure all bolts, covers, and safety equipment are secure.
- Check cutter drum for damaged teeth, blocks, or holders.
- Grease machine every 2 hours (or as required by manufacturer's operating manual).
- Check air filter; typically, it will have an air filter box with an air filter restriction indicator. It is located inside the engine compartment on the side of the filter housing.

When the filter indicator is red, the filter should be changed (see manufacturer's operating manual).

- If shredder is in need of repair, it will be removed from service, properly tagged, repaired, and reinspected before use.

6.5 WOOD CHIPPER PROCEDURES

Wood chipper operations are normally be performed by a subcontractor; however, UXO technicians must be alert and aware of the hazards involved during this operation.

6.5.1 Wood Chipper Operations

During wood chipping operations, it is necessary to provide a safe work environment and to comply with the appropriate safeguarding of machinery standards. Along with any manufacturer-specific safety precautions or procedures, the operator will ensure the following:

- Chipper access covers or doors are not opened until the drum or disc is at a complete stop;
- Feed chute and discharge chute are guarded to prevent contact with the disc, knives, or blower blades;
- Chipper is shut down when an employee performs any servicing or maintenance;
- Chippers mounted on a trailer are properly chocked to prevent rolling or sliding;
- Operators are properly trained and supervised when operating machinery;
- Loose items or clothing that may get caught or snag on chipper are removed;
- Chipper is fed from the side position away from the front of the in-feed chute and once the in-feed rollers catch the wood, the operator will then move away from the feed line of the chipper;
- The butt end of branches are fed into the chipper in-feed rollers first;
- At no time will personnel be permitted to climb onto or stand on the in-feed chute of the chipper, nor will anyone sit or ride on the in-feed chute of the chipper;
- Adequate warning signs are posted as a constant reminder to operators of the potential hazards associated with the machine;
- The in-feed rollers are completely stopped before correcting an action or cleaning up small pieces of wood or leaves on the machine; and
- All guarding and emergency control mechanisms are maintained in place and operational at all times when the machine is running.

6.5.2 Wood Chipper Inspection

The wood chipper shall be inspected and maintained in accordance with the manufacturer's instructions with at least one inspection prior to use each day. At no time will the chipper be operated if the required controls and guards are not in place. If chipper is in need of repair the chipper will be removed from service, properly tagged, repaired, and reinspected before use.

6.6 BRUSH HOG PROCEDURES

Brush hog operations may be performed by either a subcontractor or UXO technicians; however, when this operation is being performed by a subcontractor, UXO technicians must be alert and aware of the hazards involved during this type of operation.

6.6.1 Brush Hog Operations

Brush hogs (a tractor with mower deck attachment) can be an effective, efficient, and safe method of clearing vegetation. Current OSHA regulations state in part: "At the time of initial assignment and at least annually thereafter, the employer shall instruct every employee in the safe operation and servicing of all equipment with which the employee is, or will be involved."

In addition to the design and configuration of equipment, hazard control and accident prevention depend on the awareness, concern, prudence, and proper training of personnel in the operation, transport, maintenance, and storage of equipment. Lack of attention to safety can result in accident, personal injury, reduction of efficiency, and—worst of all—loss of life. Watch for safety hazards and correct deficiencies promptly. Use the following precautions as a general guide to safe operations when using brush hogs. Personnel should read equipment-specific manufacturer's operating manuals and review the safety precautions often until they know the equipment limitations. Each operator will take the following steps:

- All guards must be kept in place while when the machine is in operation.
- Permit no riders on equipment.
- Stop engine, disconnect the power source, and wait for all machine movement to stop before servicing, adjusting, cleaning, or unclogging the equipment. The exception to this policy is when the machinery must be kept running for proper servicing or maintenance. In this case, the employer shall instruct employees on all steps and procedures necessary to safely service or maintain the equipment.
- Make sure all personnel are clear of machinery before starting the engine, engaging power, or operating the machine.
- Read the operator's manual (failure to read the operator's manual is considered a misuse of this equipment).
- Become familiar with all of the machine's controls and the caution, warning, and danger decals affixed to the machine before attempting to start or operate.

- Make a walk-around inspection to check for obvious defects, such as loose mounting bolts and damaged components before starting or operating the machine (any deficiencies will be corrected before starting).
- Use a piece of cardboard or wood rather than hands to search for hydraulic leaks. Hydraulic oil escaping under pressure can penetrate the skin. If hydraulic oil is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
- Lower implement to ground – stop tractor engine, apply parking brake, and allow blades to completely stop before leaving the tractor.
- Keep hands and feet away from blades.
- Do NOT operate the equipment near any area where people may be present unless all sides of the unit are enclosed by permanent bands, safety chains or other factory-approved safety shields that are in good repair.
- Establish the safe personnel working distance (depending on the size and type of brush hog, the ejection hazard can be upwards of several hundred feet).
- Securely fasten seat belt and ensure the tractor has a roll-over protection system (ROPS).
- Where possible, avoid operating the tractor near ditches, embankments, and holes.
- Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces.
- Stay off slopes that are too steep for safe operation.
- Be careful of, at row ends, crossing onto roads, and going around trees.
- Hitch up only to the drawbar and hitch points recommended by manufacturer.
- Set brakes securely, lower attachments, and use park lock if available when tractor is stopped.
- Wear PPE such as, but not limited to, protection for eyes, ears, feet, hands, and head when operating or repairing the equipment,
- DO NOT wear loose clothing or jewelry that may catch on equipment moving parts,
- When performing adjustments or maintenance on the cutter, first lower the cutter to the ground or block it securely at a workable height,
- Never stand between tractor and cutter while tractor is being backed to the cutter hitch.
- Reduce speed when transporting cutter to avoid bouncing and momentary loss of steering,
- Use tractor flashing warning lights, day or night, when transporting cutter on road or highways unless prohibited by law,
- Stand clear of wing(s) when raising or lowering.

6.6.2 Brush Hog Inspection and Maintenance

The brush hog shall be inspected and maintained in accordance with the manufacturer's instructions with at least one inspection before use each day. These inspections will be recorded

using HGL Form 15.24 *Heavy Equipment Safety Inspection Checklist*. The following are the minimal guidelines for inspection and maintenance:

- Grease and lubricate prior to each use and at required intervals (see manufacture's operating manual).
- Ensure driveline shields are in place and in good repair to minimize entanglement injuries to persons by rotating drivelines.
- Ensure deflector shields (chains, bands, and similar items) are in good repair to minimize injuries to persons by the discharge of high-speed thrown objects.
- Inspect blades for wear (replace if necessary).
- Check blade bolts for tightness.
- Check blades and spindles to be sure that no foreign objects, such as wire or steel strapping bands, are wrapped around them.
- Inspect hydraulic lines and fittings for wear or leaks (repair or replace if needed).
- Inspect wheel(s) for wear, damage, or foreign objects (repair or replace if necessary).
- Check tractor tire air pressure (refer to manufacturer's operating manual).
- During operation, listen for abnormal sounds that might indicate loose parts, worn bearings, or other damage.
- After each use:
    - Clean all debris from machine especially underside of deck and affixed safety decals.
    - Inspect cutter for worn or damaged components (repair or replace if necessary).

6.7 TREE FELLING PROCEDURES

Tree felling procedures performed by HGL employees will normally be limited to trees with a 4-inch or less diameter; trees with a greater diameter will normally be performed by a professional tree-cutting service subcontractor.

According to OSHA, "More people are killed while felling trees than during any other logging activity." Safety must be of utmost concern when approaching a tree to cut. Cutting trees with a chainsaw is particularly hard on the eyes and ears. Always wear a safety helmet, face shield hearing protection, and safety-toed boots; nonslip gloves also are recommended. OSHA Regulation (29 CFR 1910.266) requires that employed chainsaw operators wear the following:

- Head protection;
- Hearing protection (combination head and ear protection may be used);
- Eye and face protection;
- Protective chaps or pants; and

- Protective footwear.

6.7.1 Tree Felling Safety and Operation

6.7.1.1 Personnel Separation Distance

Work areas shall be designated so trees cannot fall into an adjacent occupied work area. If multiple felling personnel are working adjacent to each other, the distance between the occupied work areas shall be at least two tree lengths of the trees being felled. The distance between adjacent occupied work areas shall reflect the degree of slope, the density of the growth, the height of the trees, the soil structure, and other hazards reasonably anticipated at that work site.

6.7.1.2 Overhead Hazards

Tree felling operations near overhead electric lines shall be done in accordance with the requirements of Title 29 of the Code of Federal Regulations (CFR), Section 1910.333(c)(3). The site safety officer shall notify the power company immediately if a felled tree makes contact with any power line. Each employee shall remain clear of the area until the power company advises that there are no electrical hazards.

6.7.2 Tree Felling Operation

The general requirements listed below shall be followed during all tree-felling operations.

- Trees shall not be felled in a manner that may create a hazard for an employee, such as but not limited to, striking a rope, cable, power line, or machine.
- The immediate supervisor shall be consulted when unfamiliar or unusually hazardous conditions necessitate a supervisor's approval before cutting is commenced.
- If one operator is felling a tree, personnel shall maintain a safe distance from the tree being felled.
- Each tree posing a danger shall be felled or removed using mechanical or other techniques that minimize employee exposure before work is commenced in the area of the danger tree. Lodged trees and snags are considered to be particularly dangerous. If not removed, the tree shall be flagged and avoided; no work shall be conducted within two tree lengths of the flagged tree unless the SSHO indicates that a shorter distance will not create a hazard for an employee.
- Each tree shall be carefully checked for signs of loose bark, broken branches and limbs, or other damage before the tree is felled or removed.
- Accessible loose bark and other damage that may create a hazard for an employee shall be removed or held in place before felling or removing the tree.

- Felling on any slope where rolling or sliding of trees or logs is reasonably foreseeable shall be done uphill from, or on the same level as, previously felled trees.
- Using one tree to fell another (domino felling) is prohibited, unless by using this method the hazards are reduced to the feller based on felling the other single tree by itself imposes a greater risk; and the SSHO has evaluated this condition and granted approval to use this method.

6.7.3 Manual Felling

Before each tree is felled, conditions shall be evaluated by the feller and precautions taken to not create a hazard for the feller or other site personnel. Conditions to be evaluated include, but are not limited to, snow and ice accumulation, the wind, the lean of tree, dead limbs, and the location of other trees. During manual tree felling, the chainsaw operator will take the following steps:

- Be certain of footing before starting to cut (the chainsaw shall not be used in a position or at a distance that could cause the operator to become off balance, to have insecure footing, or to relinquish a firm grip on the saw).
- Clear away brush or other potential obstacles that might interfere with cutting the tree or using the retreat path.
- Plan and clear a retreat path. The retreat path shall extend diagonally away from the expected felling line at an angle of approximately 45 degrees. After the back cut has been made, the feller shall immediately shut down the saw, place the saw on the ground, and move a safe distance away from the tree on the retreat path.
- Start the face cut with a 45-degree notch on the side that the tree fall will be directed toward (cut the bottom of the notch first, about one third of the way through the diameter). The second cut is made at a 90-degree angle that will meet the depth of the first cut. The back cut (felling cut) should be made from the opposite side, about 2 inches higher than the floor of the notch. DO NOT cut all the way through, but leave a hinge that will keep the tree from kicking back and upward as it falls. The hinge will be about 1/8 to 1/6 of the diameter where you are cutting but it may vary depending on when the tree starts to fall.
- Use two wedges to start the fall and influence its direction if a tree happens to be so well balanced that it does not fall after a felling cut has been made (always use two wedges and a sledge that has a face 1/3 larger than the face of the wedge).
- Always remove the chainsaw when wedges are being driven into the cut (strike the wedge carefully since a careless blow may cause the wedge to pop out of the cut and allow the tree to fall backward, on you).

- Never use an axe as the wedge or driver (the head of the ax may shatter and you could be injured by flying pieces of metal. If cutting must be continued, insert the chainsaw into the cut very carefully since the conditions are extremely dangerous).
- Ensure no employee other than the feller is closer than two trees lengths when the stress is released when a spring pole or other tree under stress is cut.

6.7.4 Limbing and Trunk Sizing

Limbing and trunk sizing (bucking) can create significant hazards for the chainsaw operator and others in the area as a result of tree movement that may result when the limbs are removed or the trunk is cut into manageable pieces. To minimize the hazards, the procedures outlined below will be followed during limbing and bucking operations.

- Limbing and bucking on any slope where rolling or sliding of trees or logs is reasonably foreseeable shall be done on the uphill side of each tree or log.
- Before bucking or limbing wind-thrown trees, precautions shall be taken to prevent the root wad, butt, or logs from striking personnel. These precautions include, but are not limited to, chocking or moving the tree to a stable position.
- An examination will be conducted to ensure the fallen tree is stable and will not move as the limbs are removed. The situation will be examined at every limb to be removed to ensure that the limb will not bind against the saw.
- The chainsaw operator will cut on the opposite side of the tree trunk whenever possible, thereby keeping the trunk between the operator and the saw.
- The chainsaw operator shall never stand on the downhill side when removing limbs and all personnel in the area will keep in mind that the tree trunk may roll as limbs are removed.
- Personnel should always watch for limbs that may spring out when they are cut because of the released tension, as these limbs can cause injury.
- Larger limbs may require more than one cut to be removed safely. The cuts should be planned so that the blade will not be bound. Stored energy in the limb or trunk can cause a cut to pinch the blade and immobilize the saw. Wedges can be used as previously mentioned, and the operator should plan an escape route when removing large limbs since they may roll when they become free of the tree trunk.
- When cutting large limbs and the trunk of the tree into convenient lengths, ensure the trunk is supported along its entire length and will not roll.
- To cut a large limb or trunk, cut downward from the top of the trunk (over buck) about one-third of the diameter and then roll it over to make final cuts (under buck).
- Wedges can be used to keep the cut open if the log or limb cannot be rolled over. Again, wedges must be driven with care so as not to come in contact with the chainsaw.

7.0 SAFETY

7.1 ENVIRONMENTAL CONDITIONS

All vegetation and tree removal work will cease and each employee shall move to a place of safety when environmental conditions create a hazard for the employee in the performance of the job. Potentially dangerous conditions include, but are not limited to, electrical storms, strong winds that may affect the fall of a tree, heavy rain or snow, extreme cold, dense fog, fires, mudslides, and darkness.

7.2 MUNITIONS AND EXPLOSIVES OF CONCERN SAFETY

There are no "safe" methods for dealing with MEC, merely procedures and process controls that are designed to reduce potential hazards. Maximum safety in conducting any MEC operations can be achieved through adherence to applicable safety precautions, a planned approach, intensive supervision, and MEC safety oversight. UXO qualified personnel will conduct a site safety briefing before commencing operational activities each workday.

Operations within areas suspected of containing MEC must be conducted in a manner that exposes a minimum number of people to the smallest quantity of explosives for the shortest period of time, consistent with a safe and efficient operation. General safety considerations applicable to personnel, both essential and nonessential, at project sites where MEC may be encountered include the following:

- DO NOT become complacent by reason of familiarity with MEC or the reported probability level of MEC.
- DO NOT conduct explosive or potentially explosive operations during inclement weather.
- Avoid contact with MEC
- Conduct MEC-related operations during daylight hours only.
- Wash hands and face after working and before eating.
- Observe the "buddy system" at all times.

7.3 PERSONAL PROTECTIVE EQUIPMENT

HGL shall provide and ensure the wearing of the following PPE for chainsaw operators: (The PPE is provided at no cost to the employee.)

- Leg protection: constructed with cut-resistant material, such as ballistic nylon; the leg protection shall cover the full length of the thigh to the top of the boot on each leg to protect against contact with a moving chainsaw.

- Foot protection: such as heavy-duty logging boots that are waterproof or water repellent, and that cover and provide support to the ankle; each employee who operates a chainsaw shall wear foot protection that is constructed with cut-resistant material that will protect the employee against contact with a running chainsaw (safety toe);
- Safety glasses or goggles;
- Hearing protection (as required);
- Leather gloves;
- Hardhat meeting American National Standards Institute (ANSI) Z89 with hearing protection and mesh face shield (as required);
- High-visibility safety vest meeting ANSI Class 2 or 3 (as required);
- Leg chaps (constructed with cut-resistant material, such as ballistic nylon, that covers the full length of the thigh to the top of the boot on each leg (as required);
- Snake guards (as required); and
- Dust masks.

7.4 CHEMICAL SAFETY EQUIPMENT (AS REQUIRED)

- Fuel spill kit;
- Drip pan (fuel spill protection);
- Fire extinguisher; and
- First aid kit.

8.0 QUALITY CONTROL

The HGL UXO Safety Manager is responsible for the maintenance, management, and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety Manager.

Project managers and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this, it will be brought to the attention of the responsible supervisor for corrective action.

9.0 RECORDS

The records listed in Section 11.0 will be completed and maintained with the project site records and are subject to audit.

10.0 REFERENCES

Code of Federal Regulations, Title 29, Section 1910.266, Logging.

Code of Federal Regulations, Title 29, Section 1910.333(c)(3), Selection and Use of Work Practices.

HydroGeoLogic, Inc., 2014. Standard Operation Procedure 15.12, MEC Anomaly Avoidance Support, February.

11.0 ATTACHMENTS

Attachment 1	SOP Acknowledgment Form
Attachment 2	HGL MR Form 15.16 *Equipment/Instrument Calibration/Maintenance Log*
Attachment 3	HGL MR Form 15.24 *Heavy Equipment Safety Inspection Checklist*

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of Naval RPM approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name

ATTACHMENT 2

Equipment/Instrument Calibration/Maintenance Log

Project Location (Name, City and State):				Contract No:
Team Number:		Instrument Description/Type:		Equipment/Instrument Serial Number:

Date	Calibration Standard (example, Test Pit)	Test results (check box) Pass	Test results (check box) Fail	Name of Individual	Comments or Observations
		☐	☐		
		☐	☐		
		☐	☐		
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ATTACHMENT 3

Heavy Equipment Safety Inspection Checklist

Contract No.:	**Date:**	**Time:**	**Log Number:**
Site Name & Location:			
SUXOS:	**SSHO:**		
Odometer Reading:	**Hour Meter Reading:**	**Fuel Level:**	
Make/Description: _____ **Model:** _____ **Serial No.:** _____			

Place a ✓mark in the "In Order" column to indicate that the item is present and in working condition. If absent or deficient describe the discrepancy and the corrective action taken in the "Discrepancy/Comments" box. If item does not apply to equipment being inspected, enter "NA". All listed items must have a response.

Item	In Order	Discrepancies/Comments
Service Brakes		
Emergency Brakes		
Parking Brake		
Brake Lights		
Back-up Alarms		
Horn		
Tires		
Spare Tire and Tire Changing Equip.		
Steering		
Seat Belt		
Operating Control		
First Aid Kit, Burn Blanket, Eye Wash		
Emergency Numbers/Hospital Map		
Fire Extinguisher		
Head and Tail Lights		
Mirrors		
Windshield		
Windshield Wipers and Washers		
Coupling Devices		
Guards for Moving Parts		
Brake – Hydraulic		
Brake Fluid		
Hydraulic Oil		
Engine Oil and Coolant		
ROPS		
Falling Object Protection System		
Other		
Other		
Other		

Inspection conducted by: _____ _____
Name Printed Signature

Deficiencies corrected by: _____ Date: _____

HGL MR Form 15.24 (Sep 2005)

Munitions and Explosives of Concern Anomaly Avoidance Support	SOP No.: 15.12 SOP Category: MMRP Revision No.: 03 Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the procedures for performing munitions and explosives of concern (MEC) anomaly avoidance support during field operations on environmental projects where there is a potential for encountering MEC hazards.

2.0 SCOPE AND APPLICATIONS

This MEC SOP discusses surface and subsurface anomaly avoidance procedures and techniques to be used while conducting hazardous, toxic, radioactive waste (HTRW)-related activities during investigative, design, and remedial actions. These procedures were developed using the U.S. Department of Defense (DoD) Manual 6055.09-M DoD *Ammunition and Explosive Safety Standard*, DoD Explosive Safety Board (DDESB) Technical Paper 18 *Minimum Qualifications for UXO Technicians and Personnel,* U.S. Army Corps of Engineers (USACE) EM 385-1-97 *Explosives Safety and Health Manual*, USACE ER 385-1-92 *Safety and Occupational Health Requirements for HTRW Activities* and USACE ER 385-1-95 *Safety and Health Requirements for MEC Operations*. These procedures will be performed and adhered to by all HGL and subcontractor personnel during HTRW field activities. HGL and its subcontractors will work closely together to ensure a safe working environment and to ensure the equipment, supplies, and other resources needed to provide MEC anomaly avoidance support are present on site.

No intrusive work will be allowed during investigative phases where physical contact is NOT planned or intended; for example, during Preliminary Assessments/Site Inspections (PA/SI). Intrusive work also will not occur when a determination is made that the probability of encountering MEC is moderate to high; specifically, current or previous land use leads to a determination that MEC was employed or disposed of in the parcel of concern, such as open burn and open detonation areas, impact areas, maneuver areas, and similar locations. Intrusive anomaly investigation and/or MEC removal is not authorized unless stated in the current Performance Work Statement (PWS) or Scope of Work (SOW). If a MEC removal action is authorized at a later date, the policies and procedures for a MEC removal action will be contained in a separate MEC Removal Action Work Plan (WP) and when in support of HTRW remedial action phase (construction) the HGL SOP 15.13 MEC Construction Support will be implemented.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the Site Health and Safety Plan.

Personnel who use this procedure must provide documented evidence to the Site Manager, Project Manager, or Senior Unexploded Ordnance Supervisor (SUXOS) that they have read and understand this procedure by completing the SOP acknowledgment (Attachment 1). This documentation will be retained in the project file.

Any deviations from specified requirements will be justified to and authorized by the project manager and/or the relevant program manager and discussed in the approved project plans. Deviations from requirements will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS AND ABBREVIATONS

4.1 DEFINITIONS

Anomaly Avoidance: These are techniques employed on property known to contain or suspected of containing MEC or other munitions, regardless of configuration, in high enough concentrations to pose an explosive hazard, or munitions that contain chemical agent (CA). Examples of munitions include discharged military munitions (DMM) and munitions constituents (MC). The avoidance techniques focus on avoiding contact with potential surface or subsurface explosives or CA hazards, which will then allow entry into the area for the performance of the required operations. Anomaly avoidance techniques are implemented to avoid any potential surface MEC or MPPEH and any subsurface anomalies. Anomaly avoidance techniques are primarily implemented during Hazardous, Toxic, and Radioactive Waste (HTRW) project activities; for example, in support of soil sampling or well installation activities where the specific site of the activity can be moved to another location.

Hazardous, Toxic, and Radioactive Waste Activities (HTRW): HTRW activities include those activities undertaken for the U.S. Environmental Protection Agency's (EPA) Superfund program, the Defense Environmental Restoration Program (DERP), including Formerly Used Defense Sites (FUDS), and Installation Restoration Program (IRP) sites at active DoD facilities, HTRW actions associated with Civil Works projects, and any other mission or non-mission work performed for others at HTRW sites. For the purposes of MEC support, HTRW actions during the investigative/design phase of a HTRW project on a site with known UXO or unknown fillers requires anomaly avoidance procedures. HTRW activities during the remedial action phase (construction) of a HTRW project on a site with known or UXO with unknown fillers may require either standby support or subsurface removal.

Material Potentially Presenting an Explosives Hazard (MPPEH): Material potentially containing explosives or munitions; for example, munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or final disposition; and range-related debris). Also includes material potentially containing a high enough concentration of explosives that the material presents and explosive hazard.

Military Munitions: 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 DoD, 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 chemical 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, except that the term does include 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. 2710(e)(3)(A)).

Munitions and Explosives of Concern (MEC): This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (1) UXO, as defined in 10 U.S.C. 101(e)(5)(A) through (C); (2) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (3) Munitions constituents (such as, TNT or RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munitions Constituents (MC): 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).

Munitions Debris: Remnants of munitions remaining after munitions use, demilitarization, or final disposition. Examples of munitions remnants include fragments, penetrators, projectiles, shell casings, links, and fins. Also includes inert munitions-related material recovered during an MEC removal.

Recovered Chemical Warfare Materiel (RCWM): Non-stockpile CWM that was previously discarded, buried, or fired and discovered either unexpectedly or during planned environmental restoration operations.

Unexploded Ordnance (UXO): Military munitions that have been primed, fuzed, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material; and remain unexploded either by malfunction, design, or any other cause. For the purpose of this project, the definition of UXO is limited to items larger than 50-caliber.

UXO-Qualified Personnel: Personnel who meet the training requirements for UXO Technician and Personnel and have performed successfully in military EOD positions or are qualified to perform in the following service contract act contractor positions: UXO Technician II, UXO Technician

III, and UXO Safety Officer (UXOSO), UXO Quality Control Specialist (UXOQCS), and SUXOS. Refer to DDESB TP 18 for detailed information for approved contract titles and qualifications.

4.2 ABBREVIATIONS

EPA	U.S. Environmental Protection Agency
DDESB	Department of Defense Explosive Safety Board
DoD	U.S. Department of Defense
DPT	direct push technology
FSP	Field Sampling Plan
FUDS	Formerly Used Defense Site
GPS	global positioning system
HTRW	hazardous, toxic and radiological waste
IDW	investigated derived waste
IRP	Installation Restoration Program
MC	munitions constituents
MEC	Munitions and Explosives of Concern
PPE	personal protective equipment
SSHP	Site Safety and Health Plan
SOP	standard operating procedure
SSO	site safety officer
SUXSO	Senior Unexploded Ordnance Supervisor
USACE	U.S. Army Corps of Engineers
UXO	Unexploded Ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
WP	work plan

5.0 PROCEDURES

5.1 UXO TEAM

The senior UXO-qualified person will serve as the UXO Team Leader and has ultimate responsibility for ensuring all MEC anomaly avoidance support activities are performed in accordance with this SOP, the WP and/or the SSHP. The UXO Team Leader will direct all MEC anomaly avoidance support during field operations.

STEP ONE–The UXO Team will:

A. Review any archival information available on the area where MEC anomaly avoidance is required in an effort to determine the probable of types of MEC that may be encountered and identify specific hazards and precautions.

B. Provide MEC recognition, location, and safety function for the prime contractor during construction support and HTRW activities.

C. Conduct MEC safety briefing for all site personnel and visitors.

D. Conduct a surface access survey to locate all surface and near-surface anomalies.

E. The UXO Technician on the point position will conduct the initial surface sweep.

F. Establish and delineate surface MEC or subsurface anomaly-free ingress/egress lanes and work areas.

G. Reporting of all MEC encountered to the appropriate authority, and coordinate final disposition as directed by the Project Manager.

H. Work closely with the USACE personnel on all MEC-related matters.

I. Document all MEC discoveries following these procedures.

J. Coordinating and reporting MEC discoveries to the appropriate authority.

STEP TWO–Non UXO-qualified personnel responsibilities include:

A. Be trained to recognize the potential hazards imposed by MEC, which are fire, fragmentation, and blast overpressure.

B. Remain with the UXO Technician all times unless otherwise cleared to proceed on your own.

C. Follow the instructions given by the UXO Technician in the event of an accident.

D. Notify the UXO Technician immediately if witnessing something suspicious.

E. Exercise caution when walking on site and following UXO Technician directions.

F. Use the buddy-system at all times on the work site.

5.2 ANOMALY AVOIDANCE

A. Anomaly avoidance procedures will be used during HTRW-related field investigation activities whenever there is a potential for encountering MEC. These activities include, but are not limited to:

1. Ensuring site access and conducting MEC avoidance survey;
2. Performing clearing and grubbing;
3. Completing land surveying and mapping;

4. Conducting PA/SI on Formerly Used Defense (FUDS) and Base Realignment and Closure (BRAC) Sites;
5. Performing geophysical surveying; and
6. Conducting environmental and natural resource assessments:
   (a) surface soil sampling,
   (b) subsurface soil sampling,
   (c) boring and drilling,
   (d) ground water monitoring, and
   (e) test pits and trenches excavations.

B. The purpose of MEC anomaly avoidance is to keep away from any potential surface and subsurface MEC hazards during these activities. For anomaly avoidance on an HTRW site with potential MEC, HGL will provide an UXO Team consisting of a minimum of two personnel, one of whom must be a UXO Technician II or above.

5.2.1 Site Access and MEC Avoidance Surveying

In HTRW areas with known or suspected MEC the UXO Team will:

STEP ONE:

A. Use geophysical instrumentation capable of detecting the smallest known or anticipated MEC to locate anomalies just below the surface that may be encountered through erosion from rain or continual foot or vehicular traffic.

B. Conduct a geophysical instrument-assisted surface access survey and/or a subsurface survey for anomalies before any activities, such as site visits, field investigations or PA/SI, commence, including footpath and/or vehicular traffic routes.

C. Ensure the access route both approaching and leaving is at least twice as wide as the widest vehicle that will use the route. The route shall be clearly marked with flagging or stakes for future entry control.

D. Make certain non-UXO qualified HTRW field personnel are escorted by UXO-qualified personnel at all times in areas where there is any potential for encountering MEC hazards until the UXO Team has completed the access surveys and the clear areas are visibly marked.

E. Ensure non-UXO-qualified personnel follow behind the UXO Technician.

F. Take appropriate steps if MEC hazards are detected; specifically, the UXO Technician will halt the escorted personnel in place, select a course around the hazard, and instruct escorted personnel to follow behind.

G. Make certain no personnel are allowed outside the surveyed and cleared areas.

STEP TWO:

A. Complete an access survey of an area around the proposed investigation site that is large enough to support all planned operations.

B. Determine that the size of the surveyed area is appropriate for the project and takes into account factors such as, maneuverability of required equipment (drill rigs, excavation equipment, and similar items), parking of support vehicles, and establishment of decontamination stations.

C. Ensure that the surveyed area, at a minimum, has a dimension in all directions equal to twice the length of the longest vehicle or piece of equipment to be brought on site and is clearly delineated with flagging or stakes.

STEP THREE:

A. Mark any anomalies or surface MEC hazards encountered with flagging and relocate the investigation area to avoid contact with the hazards.

B. Clearly mark the boundaries of the surveyed area using survey flagging or pin flags.

C. Establish a system of flagging colors that will distinguish anomalies, surface MEC, and route boundaries from each other as well as from any utility markings used at the site.

D. Attempt to identify the hazard and will inform the appropriate project management personnel. Under no circumstances will the team disturb the hazard in anyway.

E. Coordinate with the proper authorities for the final disposition of all MEC hazards. Coordination will include the HGL PM and stakeholders addressed the project WP.

5.2.2 Clearing and Grubbing

Initial clearing and grubbing operations may be required for specific projects before HTRW field activities. The objective of clearing and grubbing is to allow for unhindered access by the HTRW field teams. In areas with potential MEC hazards, the UXO Team must:

STEP ONE:

A. Conduct an access survey of the routes to and from the proposed clearing and grubbing area. The UXO Team will conduct a geophysical instrument-assisted survey for the entire area to be grubbed. When this step has been accomplished, the clearing and grubbing operation may commence.

B. Ensure Qualified UXO Technicians accompany grubbing teams at all times.

C. Exercise caution when using mechanical grubbing equipment. Specifically, the lowest part of the cutting deck of the grubbing equipment must remain at least 6 inches above

ground level to ensure that any possible surface MEC hazard that may have been missed during the surface sweep is not contacted by the cutting blades of the equipment.

STEP TWO:

A. Stop all clearing and grubbing operations if a potential MEC hazard is encountered. The clearing and grubbing team will immediately notify the accompanying UXO Technician. No further action shall be taken until the UXO Technician has made all notifications and the appropriate safety concerns are addressed, in accordance with the SSHP.

B. Avoid disturbing identified MEC hazards. The UXO Team Leader is responsible as directed by the Project Manager for all coordination with the proper authorities for the final disposition of all MEC hazards. After final disposition of the MEC hazard has been coordinated, clearing and grubbing operations may continue.

5.2.3 Land Surveying and Mapping

During land surveying activities in areas with potential MEC, the survey team will have a minimum of one UXO Technician II or above assigned to perform MEC anomaly avoidance. The UXO Technician will:

A. Conduct an access survey of the routes to and from the proposed survey site as well as an area around the site, as described in Section 5.2.1.

B. Visually survey the surface of each proposed survey point for any indication of MEC or MEC-related contamination.

C. Use a Schonstedt GA-52Cx magnetometer (or equivalent) to assess the presence or absence of buried metallic anomalies at the locations where survey points/stakes will be installed. If magnetometer responses indicate a buried metallic anomaly, no survey point/stake will be installed at that specific location. An alternate location will be selected.

D. Use GPS for location surveying in areas with suspected non-conventional MEC may exist, for example, micro-gravel mines. Additionally, no intrusive survey markers will be used, only traffic cones and paint will be used to mark locations.

5.2.4 Geophysical Surveying

Geophysical survey methods will consist of several progressive procedures to ensure the safe collection of reliable quality data that can be used to relocate and investigate any anomalies detected. When an area has been identified and selected for geophysical surveying, UXO sweep personnel will:

STEP ONE:

A. Conduct a geophysical instrument-assisted surface clearance of the area to aid in locating surface metal that may be obscured by vegetation.

B. Manage the surface clearance using a search system based on transects. To accomplish this surface clearance, UXO sweep personnel will line up side by side, forming a sweep line, and walk each geophysical survey area in an orderly manner.

C. When appropriate, divide the geophysical survey area into grids. An automated line-marking system or physical lines will be used to ensure complete coverage within each geophysical survey area or grid.

D. Use the geophysical instrument-aided surface clearance to determine the presence or absence of surface MEC and provide increased safety to site personnel.

E. Remove surface debris during the surface clearance process support subsequent geophysical mapping. Non-MEC metallic debris, which may interfere with the subsurface geophysical survey, will be removed from the surface of the work area, to the maximum extent possible, and consolidated for later disposition.

STEP TWO:

A. Stop all geophysical survey operations if the geophysical mapping team a potential MEC item is encountered by the geophysical mapping team, all geophysical survey operations will cease.

B. Immediately notify the UXO Team Leader when MEC items are encountered.

C. Do not disturb potential MEC items.

D. Cease activities until the UXO Team Leader has made all notifications and the appropriate safety concerns are addressed, in accordance with the SSHP. The UXO Team Leader is responsible as directed by the Project Manager for all coordination with the proper authorities for the final disposition of all MEC hazards.

5.2.5 Sampling and Drilling

5.2.5.1 Surface Soil Sampling

The following paragraphs describe anomaly avoidance procedures for surface soil sampling (between 0 and 12 inches below ground surface [bgs]) in areas with potential MEC. Soil sampling at depths greater than 12 inches bgs will follow the procedures in Section 5.2.5.4 of this plan. The UXO Team will:

STEP ONE:

A. Conduct a surface access survey of the routes to and from the proposed investigation site as well as an area around the investigation site, as described in Section 5.2.1.

B. Visually survey the surface of each proposed surface soil sampling site for any indication of MEC or MEC-related contamination.

C. Conduct a survey of the proposed sample locations using hand-held geophysical instruments.

STEP TWO:

A. Select an alternate location to collect surface soil samples if anomalies are detected at a proposed sampling location or too many anomalies are detected in a general area of interest.

B. Prominently mark any anomalies detected with survey flagging or non-metallic pin flags for avoidance during HTRW sampling activities.

5.2.5.2 Subsurface Soil Sampling and Monitoring Well Installation

The following paragraphs describe anomaly avoidance procedures for subsurface soil sampling and monitoring well installations in an area with potential MEC. Subsurface soil sampling is defined as the collection of samples below a nominal depth of approximately 12 inches with a split-spoon, Shelby tube, direct push sampler, or bucket auger (that is, hand auger) soil sampler using drilling techniques. Drilling techniques also will be used to drill larger diameter soil borings (for example, 4- to 8-inch outer diameter) and install groundwater monitoring wells for HTRW investigations. The UXO Team will:

STEP ONE:

A. Conduct a surface access survey of the routes to and from the proposed investigation site as well as an area around the investigation site, as described in Section 5.2.1.

B. Complete a hand-held, geophysical instrument-assisted, subsurface survey of the proposed drill-hole location(s).

STEP TWO:

A. Select a new borehole location if an anomaly is detected.

B. Prominently mark any anomalies detected with survey flagging or non-metallic pin flags for avoidance.

C. Incrementally complete the downhole geophysical survey to undisturbed soil depth If the subsurface sampling depth is greater than the geophysical instrumentation (for example, handheld geophysical instrument) detection capabilities. This process is outlined below.

5.2.5.3 Underground Utilities

Utility clearance and/or excavation permits, if required, must be obtained before beginning any incremental subsurface geophysical survey activities by the UXO Team. The UXO Team Leader is responsible for:

STEP ONE:

A. Verifying that all necessary excavation permits are on-site prior to commencing operations.

B. Ensuring that the appropriate agencies or companies have marked the location of all subsurface utilities in the investigation areas prior to commencing intrusive work.

C. Using high-visibility paint, pin flags, or other appropriate means to visually delineate their approximate subsurface routing. The color shall not conflict with the colors used in MEC avoidance activities.

STEP TWO:

A. Attempting to verify the location of subsurface utilities if their presence is suspected in an excavation area.

B. Understanding that not all utility lines will be detectable with geophysical instrument equipment. Not all utility lines are constructed of ferrous material.

C. Recognizing that utility clearance procedures and contact numbers are listed in the Field Sampling Plan (FSP).

5.2.5.4 Pilot Hole and Incremental Geophysical Survey for Conventional MEC Avoidance

For intrusive sampling (that is, subsurface sampling and well drilling) in areas with incremental suspected conventional (metallic) MEC, pilot holes and geophysical surveying will be completed. When an access survey has been completed, the team will install a pilot hole to undisturbed soil depth at each proposed drill-hole location. During pilot hole installation, the team will:

STEP ONE:

A. Have non-essential personnel withdraw from the immediate area while the UXO team is completing their geophysical survey.

B. Use manual or mechanical means to install the pilot hole.

C. Employ a geophysical instrument configured for down-hole utilization during installation of the pilot hole to inspect for anomalies every 2 feet or unless otherwise specified by the WP or SSHP.

STEP TWO:

A. Backfill the pilot hole if an anomaly is detected. Backfilling will be conducted in accordance with project-specific procedures, and HTRW sampling personnel will select a new drill-hole location.

B. Prominently mark any anomalies detected on the surface with survey flagging or pin flags for avoidance.

STEP THREE:

A. Advance the pilot hole when no anomalies are detected. Advance to the maximum reach of the auger or to the maximum depth of the proposed drill hole, whichever is less.

B. Inspect the pilot hole upon reaching the final depth. Provide a total clearance depth equal to the pilot hole depth plus 2 feet.

C. Bring the drill rig on site if no anomalies are detected. Operate the rig to the total depth of the proposed drill hole.

STEP FOUR:

A. Advance in 2-foot increments beyond the clearance depth of the pilot hole with the drill rig when the pilot hole does not reach the proposed boring depth; for example, the proposed depth of the drill hole is more than the maximum depth of the auger or the team cannot penetrate the soils using the auger.

B. Have UXO personnel screen for anomalies at the end of each 2-foot increment. As necessary with loose soils, a polyvinyl chloride (PVC) pipe (minimum 3 inches inner diameter) may be inserted to keep the hole open and to allow for incremental geophysical instrument screening.

C. Cease incremental screening once the drilling has extended to depths greater than the maximum estimated depth of MEC presence (as described in the WP), based on the maximum depth of fill materials and maximum depth of MEC penetration.

D. Backfill holes in accordance with project-specific procedures.

5.2.5.5 Test Pits for Non-Conventional MEC Avoidance

For intrusive sampling (subsurface and well drilling) in areas with suspected non-conventional MEC (for example, non-metallic micro-gravel mines), MEC avoidance and location clearance activities will also include test pits. The test pits will:

STEP ONE:

Be dug by armored or remote-controlled equipment for each intrusive sampling location.

STEP TWO:

The procedure for test pit non-conventional MEC avoidance will be as follows:

1. Conduct a geophysical instrument-assisted subsurface survey of the proposed boring location to identify metallic anomalies. If an anomaly is detected, a new location will be selected.
2. Withdraw all non-essential personnel to a distance not less than the MGFD established for the site.
3. Use an armored or remote-controlled excavator to excavate a small area around the proposed soil boring down to 2 feet. UXO Technicians will inspect the excavation and excavated soil for non-conventional MEC. This process will continue at 2-foot intervals until undisturbed soil is reached or until depths determined in the project WP.
4. Mobilize HTRW sampling personnel and equipment to the site after excavation operations have ceased and begin intrusive soil sampling.

5.2.5.6 Soil Sampling with Direct Push Technology

The following paragraphs describe anomaly avoidance procedures for soil sampling and use of direct push technology (DPT) in areas with potential MEC. Soil sampling with DPT typically involves manual or mechanical penetration at the desired location, followed by withdrawal and collection of a soil sample. The UXO Team will:

1. Conduct a surface access survey of the routes to and from the proposed investigation site as well as an area around the investigation site, as described in Section 5.2.1.
2. Ensure soil sampling and DPT installations follow the same anomaly-avoidance procedures as described previously for subsurface soil sampling and monitoring well installations; specifically, incremental down-hole geophysical survey for metallic anomalies and remote-dig test pits for non-conventional MEC. However, the actual sampling and geophysical instrument screening will occur through the DPT borehole. Following collection of the soil samples, the sampling location will be backfilled in accordance with project-specific procedures.

5.2.6 Test Pit and Trench Excavating

Test pits and trench excavations may be used to identify and characterize large subsurface HTRW areas of concern. The following paragraphs describe MEC anomaly avoidance procedures for test pit and trench excavations on a HTRW site with potential MEC. The UXO Team will:

STEP ONE:

A. Conduct a surface access survey of the routes to and from the proposed investigation site as well as an area around the investigation site, as described in Section 5.2.1.

B. Complete a subsurface geophysical survey of the proposed excavation locations.

STEP TWO:

A. Coordinate with HTRW sampling personnel to select a new excavation location if an anomaly is detected

B. Prominently mark anomalies with survey flagging or pin flags for avoidance.

C. Perform an incremental geophysical survey as outlined by STEPS THREE, FOUR and FIVE below if proposed excavation depths are greater than the geophysical instrumentation detection capabilities.

5.2.6.1 Test Pits and Trenches MEC Avoidance

STEP THREE:

A. Begin excavation in 2-foot increments after an access survey has been completed. During excavation, personnel not directly involved in the excavation activities should withdraw to a distance of not less than the fragmentation distance of the MGFD established for the site.

B. Screen for anomalies at the end of each 2-foot increment. If an anomaly is detected, HTRW sampling personnel will modify the excavation locations to avoid the anomaly.

C. Prominently mark detected anomalies with survey flagging or pin flags for avoidance.

STEP FOUR:

A. Cease operations if a potential MEC hazard is uncovered in an excavation. The UXO Team will attempt to identify the hazard.

B. Address appropriate safety concerns in accordance the SSHP and WP.

C. Resume excavations after final disposition of the MEC hazard has been completed.

STEP FIVE:

A. Use an armored or remote-controlled excavator for test pits and trenches in areas with suspected non-conventional MEC, for example, non-metallic micro-gravel mines.

B. Visually inspect 100 percent of the material excavated, as well as the excavation, for non-conventional MEC.

5.2.6.2 Waste and/or Other Materials Encountered

In the event potentially hazardous waste, debris, or drums are encountered during test pit or trenching operations, excavation activities will cease. The HTRW SSO will:

A. Assess the situation and may direct a change to the personal protective equipment (PPE) for site workers.

B. Notify the appropriate personnel in accordance with the WP or SSHP.

C. Handle wastes in accordance with the Investigation-Derived Waste (IDW) Management, Transportation, and Disposal Plan (IDW Plan).

5.2.7 Groundwater Monitoring

Groundwater monitoring activities include measuring groundwater elevations, measuring free product thickness, and collecting analytical samples. Unless a path is clearly marked, HTRW sampling personnel must be escorted by UXO-qualified personnel when conducting groundwater monitoring/aquifer characterization activities in areas with potential MEC.

5.2.8 Preliminary Assessment and Site Inspection

Whenever HGL employees conduct PA/SI work on in areas where MEC may be encountered UXO-qualified personnel will provide anomaly avoidance measures to prevent non-UXO-qualified personnel from coming into contact with an MEC hazard.

5.3 MUNITIONS AND EXPLOSIVES OF CONCERN

5.3.1 MEC ENCOUNTERED

If MEC/UXO is encountered, the UXO Technician on point will direct the team to stop, point out the hazard and mark the hazard with a high-visibility pin flag, paint, or surveyors tape. The UXO Technician discovering the MEC hazard will inform the UXO Team Leader who then will notify the Site Supervisor of the hazard and its location. The UXO Team Leader shall:

A. Attempt to identify the MEC hazard via markings and other external features such as shape, size, and external fittings.

B. Record the MEC hazard item(s) location, record GPS coordinates if possible.

C. Take a digital photograph of the hazard.

D. Notify the Site Supervisor and all other authorities of the MEC hazard(s) and collect the necessary data. After these steps are taken, the team may proceed with their activities.

5.3.2 DISPOSITION

The disposition of MEC hazards will be implemented as specified by the applicable site WP, SSHP or when applicable the Memorandum of Agreement (MOA). The senior UXO-qualified person has the responsibility for coordinating with the proper authorities for the final disposition of all MEC hazard(s) discoveries. Specific procedures for reporting MEC discoveries during a PA/SI are covered by USACE Military Munitions Center of Expertise (MM CX) Interim Guidance Document 06-05.

6.0 QUALITY CONTROL

The HGL Senior UXO Operation Manager is responsible for ensuring this SOP is reviewed annually for completeness, accuracy, and safety. The HGL UXO Safety Manager is responsible for the maintenance, management, and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to HGL's UXO Safety Manager.

Project Managers and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, they will be brought to the attention of the responsible supervisor for corrective action. Anytime there is a potential for encountering MEC during HTRW-related activities, a UXO Team will be assigned to provide anomaly avoidance support.

6.1 AUTHORITY

The senior UXO-qualified person on site has final on-site authority on all munitions and MEC procedures and safety issues. This individual will have direct reporting and communications responsibility with and as directed by the HGL Project Manager with all responsible authorities.

6.2 CERTIFICATIONS

HGL will provide UXO-qualified personnel who meet the certification levels specified by DDESB Technical Paper 18 and USACE EM 385-1-97. The UXO Team will:

A. Consist of a minimum of two personnel for anomaly avoidance, one of whom must be a UXO Technician II or above.

B. Be on-call during all investigative/design HTRW activities where there is a potential for encountering MEC.

C. Conduct access surveying activities:

   1. The second person can be a designated UXO Sweep Person (DDESB TP 18).

   2. UXO Sweep Personnel are required to have undergone site specific training on the potential hazards present.

D. Assess the need for additional UXO-qualified personnel. Staffing is dependent on project-specific and task-specific conditions and requirements, certificates of training and medical monitoring guidelines, and as specified in the Site Safety and Health Plan (SSHP).

6.3 EQUIPMENT

Project equipment for MEC anomaly avoidance and construction support will come from HGL sources, subcontractors, and local vendors offering equipment for lease or purchase. All equipment, regardless of source, will be inspected and function checked 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 usage shall be calibrated twice daily (start and finish). This system of checks ensures that the equipment on site is functioning properly. If an equipment function 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.

6.3.1 Geophysical Equipment

A. The use of geophysical sweep equipment (magnetometers) will depend on site conditions and the intended work to be conducted in that area. If the area is to be investigated only on foot, it may suffice to conduct only a detector-aided visual search of the area. If vehicular traffic is expected, the site will require a geophysical sweep for shallow subsurface anomalies. For the purpose of anomaly avoidance, the following geophysical equipment will be used:

   1. For a geophysical sweep of an area, either the Schonstedt GA-52Cx or GA-72Cd or the Subsurface ML-1 or ML-1M will be utilized. These units can be expected to detect subsurface ferrous anomalies to a depth of 4 feet.

   2. Additionally, the White's Spectrum XLT all-metals detector may be used. This unit can be expected to detect subsurface ferrous and non-ferrous anomalies to a depth of 18 to 24 inches.

   3. For down-hole surveillance, the Subsurface BHG-1, Schonstedt MG 220/230, MAGEX 120 LW or the MK26 Forrester will be used. The down-hole geophysical instrument used will depend on the diameter of the borehole. If direct push technology (DPT) is used, then the MAGEX 120 LW, Subsurface BHG-1 or Schonstedt MG 220/230 will be used. The MK 26 will not fit inside the typical direct push borehole (for example, 1 to 1.5 inches outer diameter).

B. Additional equipment items that may be required for marking hazards are as follows:

1. Pin flags (as required)
2. Brightly colored surveyors tape (as required)
3. High visibility, biodegradable spray paint (as required)

6.3.2 Equipment Function Checks

A daily equipment function check will be performed on all geophysical instruments and global positioning systems (GPS). The check will consist of using the geophysical instrument in the demarcated function check area and verifying its response on a known designated target anomaly. A record of the geophysical equipment/serial number function check will be noted in the logbook or logged using an instrument maintenance and calibration log following each functionality test describing the performance results.

6.4 TRAINING

As part of the anomaly avoidance support process, the senior UXO-qualified person or UXOSO, as assigned, will perform project-specific training for all on-site personnel assigned to these activities. The purpose of this training is to ensure that all on-site personnel fully understand the operational procedures and methods to be used, including individual duties and responsibilities and all safety and environmental concerns during investigation and excavation activities. Any personnel arriving at the site after this initial training session will have to complete the training before being allowed to work. On-site training will include the following topics:

A. Field equipment operation, including safety precautions and safety equipment, field inspection of equipment, and maintenance procedures that will be used.

B. Procedures, guidelines, and requirements in relevant sections of the WP and the SSHP, as they relate to the task being performed.

C. Site- and task-specific hazards, including physical, biological and chemical hazards.

D. Specific ordnance materials (for example, MEC, MC, explosive soil) potentially found on-site and hazards awareness.

E. Public relations, including interactions with press and public.

F. Environmental concerns and sensitivities, including endangered/threatened species and historical, archaeological, and cultural resources on site.

G. Emergency procedures and contact information.

7.0 SAFETY

If MEC is encountered during any phase of work the HGL Project Manager, and when assigned the Site Safety Officer or UXOSO will be immediately notified. In general, the following MEC safety precautions and protocols will be followed:

- Always remain alert at all times for MEC, UXO and related scrap or MPPEH hazards.
- Observe this cardinal principle when work may involve ordnance, explosives, ammunition, severe fire hazards, or toxic materials: limit the exposure to a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- Always assume MEC hazards contain a live charge until determined otherwise.
- Recognize that death or injury can occur from MEC/UXO and explosive related accidents.
- Understand that the age or condition of a MEC hazard does not decrease the 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 agent 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, move or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification.
- DO NOT touch, pick up, kick, or move anything that is unfamiliar or unknown.
- DO NOT roll the item over or scrape the item to identify markings.
- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, leave the site immediately and seek shelter.
- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards.
- DO NOT walk across an area that the ground surface cannot be seen that has not been cleared of MEC hazards by the UXO Technician.
- DO NOT rely on color codes for positive identification of ordnance items nor their contents.
- DO NOT drive vehicles into a suspected MEC area until anomaly avoidance techniques have been implemented.
- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.
- DO Not be misled by markings on the MEC item stating “practice bomb,” “dummy,” or “inert.” Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly.

- The location of any ordnance item found anomaly avoidance activities will be clearly marked so it can be easily located and avoided.
- Follow the procedures of the WP and SSHP; and upon locating any MEC hazards immediately notify the UXO Technician so appropriate measures can be taken.

— WARNING —

REMOVING OR TAKING ANY MUNITIONS, EXPLOSIVE OR UNEXPLODED ORNANCE OR MUNITIONS-RELATED DEBRIS FROM THE SITE BY ANY EMPLOYEE IS STRICTLY PROHIBITED,

7.1 DAILY TAILGATE SAFETY MEETING

Before entering an area requiring MEC anomaly avoidance, the UXO Team Leader must conduct a safety brief covering emergency procedures, operations, MEC hazards, and anomaly avoidance procedures.

8.0 RECORDS

Documentation generated as a result of this procedure is collected and maintained using the following forms:

- SOP Acknowledgment (Attachment 1)
- HGL MEC Form 15.01 MEC Investigation Field Log (Attachment 2)
- HGL MEC Form 15.16 Instrument Maintenance and Calibration Log (Attachment 3)
- HGL MEC Form 15.19 Daily Tailgate Meeting Log (Attachment 4)

All forms also are available on the HGL SharePoint Website.

9.0 REFERENCES

USACE, 2006. Memorandum, Procedures for PA/SI Teams that Encounter UXO While Gathering Non-UXO Field Data, Military Munitions Center of Expertise (MM CX) Interim Guidance Document 06-05, March.

USACE, 2007a. Engineer Regulation 385-1-92 Safety and Occupational Health Requirements for Hazardous, Toxic and Radioactive Waste (HTRW) Activities, May.

USACE, 2007b. Engineer Regulation 385-1-95 Safety and Health Requirements for Munitions and Explosives of Concern (MEC) Operations, March.

USACE, 2008. Engineer Manual 385-1-97 Explosives Safety and Health Requirements, September.

USACE, 2013. Errata Sheet No. 6, Explosives Safety and Health Requirements EM 385-1-97, April.

U.S. Department of Defense (DoD) Explosive Safety Board (DDESB) Technical Paper (TP) 18, 2004. Minimum Qualification for UXO Technicians and Personnel, December.

DoD Manual 6055-09-M, 2010. DoD Ammunitions and Explosives Safety Standards, August.

ATTACHMENT 1

STANDARD OPERATING PROCEDURE ACKNOWLEDGMENT

I have read, understand and agree to abide by the provisions as detailed in this standard operating procedure (SOP) prepared by HGL. By signing below, I certify that I have had the opportunity to read and ask questions about this SOP, and that I understand the procedures, equipment, and restrictions and agree to abide by them. Failure to comply with this SOP may lead to disciplinary action and/or my dismissal from the work site and termination of employment.

Before beginning any work task associated with these SOPs, the Senior Unexploded Ordnance Supervisor (SUXOS) or Senior Unexploded Ordnance Technician assigned to the project will discuss additional procedures to be implemented, or any other site-specific conditions that may arise.

Print Name	Signature	Date

ATTACHMENT 2

HGL HydroGeoLogic, Inc MUNITIONS RESPONSE TEAM

Munitions and Explosives of Concern Investigation Field Log

UXO Technician:		**Team:**		**Date:**	
Anomaly ID No.					
Actual Anomaly Coordinates *(Latitude= Longitude=Y)*		**X:**		**Y:**	
Object Depth (from center of mass):	Inches				
Object length:	Inches				
Object Diameter/Thickness:	Inches				
Object Weight (Estimated):	Lbs.				
Slope of terrain (Check one box):	☐ <10°	☐ 10° to 30°	☐ >30		
Vegetation cover (Check one box):	☐ Clear	☐ Tundra	☐ Swamp		
Soil type (Check one box):	☐ Sand	☐ Clay	☐ Rock		
Inclination:	☐ 0°	☐ 45°	☐ 90°	☐ 135°	☐ 180°
Orientation:	N-S	NW-SE	E-W	SW-NE	
Item Description/Justification/Comments:					

Anomaly type categories (Check Appropriate Box)					
☐ MEC	☐ Abandoned	☐ Scrap	☐ Practice Ordnance	☐ Inert Ordnance	☐ Metal Waste
☐ Other	☐ No Find	☐ No Dig	☐ Rust Layer	☐ Dig Abandoned	☐ Target >4 ft

Was photo taken?	☐ Yes ☐ No	**File Name:**	
Ordnance Positive Identification (If Known, Record Below and record fuze condition and disposition):			
Quantity:	Ordnance Mark/Mod:	Nose Fuze Mark/Mod:	Tail Fuze Mark/Mod:
Ordnance Filler:	☐ Explosive ☐ Propellant ☐ Pyrotechnic ☐ Other	**N.E.W.**	

Ordnance Category:			
☐ Bomb	☐ Guided Missile	☐ Mortars	☐ Pyrotechnics and Flares
☐ Cluster/Dispenser	☐ Land Mine	☐ Projectiles	☐ Small Arms
☐ Grenade	☐ Misc. Explosive Device	☐ Rockets	☐ Underwater Ordnance

Fuzing Types:				
☐ All-ways Acting	☐ Base Detonating	☐ Influence	☐ Electric	☐ Impact
☐ Mechanical Time	☐ Mechanical long delay	☐ MT Super-quick	☐ Piezoelectric	☐ Point Detonating (PD)
☐ Point-initiating, Base-detonating	☐ Powder Train Time Fuze (PTTF)		☐ Pressure	☐ Proximity (VT)

HGL MR Form 15.01 (Jul 2007)

1 of 2

Munitions and Explosives of Concern Investigation Field Log

Status of MEC:	☐ Armed	☐ Unarmed		
Physical Condition of MEC:	☐ Broken Open	☐ Soil Staining	☐ Filler Visible	☐ Soil Sample Taken
MEC/MPPEH Disposition:				
Disposition: (Clarify Under Remarks)	☐ Transport	☐ Leave In Place	☐ Other	Date:
Notifications To EOD By:	Signature:			Date
Transported By:	Signature:			Date:
Transferred To:	Signature:			Date:
Storage Location:				
Destroyed By:	Signature			Date:
Remarks:				
SUXOS/UXO Team Leader Signature:		EOD Personnel Signature (when applicable):		

Abandoned—MEC that was disposed of by abandonment; may have been fuzed or armed, but was not employed.
Inert—Same physical features as an ordnance item but does not and never did contain energetic material.
MEC—Military munitions that may pose unique explosives safety risks, Unexploded ordnance (UXO), Discarded military munitions (DMM), Munitions constituents (e.g., TNT, RDX); present in high enough concentrations to pose an explosive hazard.
MPPEH—Material potentially containing explosives or munitions (e.g., munitions containers and packaging material; munitions documented as an explosive hazard (MDEH) or material document as safe (MDAS) remaining after munitions use, demilitarization, or disposal; and range-related debris) or material potentially containing a high enough concentration of explosives such that the material presents an explosive hazard.
MDEH–Material documented as an explosive hazard that contains an energetic material.
MDAS—Material documented as safe that does not contain an energetic material.

HGL MR Form 15.01 (Jul 2007)

ATTACHMENT 3

Equipment/Instrument Calibration/Maintenance Log

Project Location (Name, City and State):			Contract No:
Team Number:	Instrument Description/Type:		Equipment/Instrument Serial Number:

Date	Calibration Standard (example, Test Pit)	Test results (check box) Pass	Test results (check box) Fail	Name of Individual	Comments or Observations
		☐	☐		
		☐	☐		
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HGL MR Form 15.16 (Oct 2007)

Page _____ of _____.

ATTACHMENT 4

HydroGeoLogic, Inc
MUNITIONS RESPONSE TEAM

Tailgate Safety Meeting Log

Date:	**Time:**	**Team No:**
Site Name/Location:		**Grid No:**

1. SAFETY TOPICS DISCUSSED:

- ☐ Site Description
- ☐ Site Controls
- ☐ Personal Protective Equipment
- ☐ Emergency Procedures / Equipment
- ☐ Site Evacuation
- ☐ Physical/Biological Hazards
- ☐ Heat or Cold Stress
- ☐ Communication/Radio Procedure
- ☐ Environmental Concerns/Hazards
- ☐ Emergency Procedures/Route
- ☐ First Aid Procedures
- ☐ Injury Reporting
- ☐ Safe Work Practices
- ☐ Other:
- ☐ Other:
- ☐ Other:

2. TASK OPERATION AND REMARKS:

_____

_____

3. ATTENDEES:

	Print Name	**Signature**	**Company**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			

Meeting Conducted by:	**Signature:**

HGL MR Form 15.19 (Nov 2007)

Off-Highway Vehicle Operation	SOP No.: 15.14 SOP Category: MMRP Revision No.: 1 Date: February 2014

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide HGL employees the basic guidance and procedures for the safe operation of off-highway vehicles (OHV) used to transport project personnel and recovered munitions in conjunction with military munitions response program (MMRP) operations.

2.0 SCOPE AND APPLICATIONS

This SOP applies to all OHV operations conducted in support of HGL MMRP activities. These procedures were developed following the guidelines established by United States Army Corps of Engineers (USACE) Engineering Manual (EM) 385-1-1.

3.0 GENERAL REQUIREMENTS

All work will be performed in a manner that is consistent with Occupational Safety and Health Administration established standards and requirements. Refer to the site- or project-specific health and safety plan for project related health and safety requirements. All field activities will be conducted in conformance with the Site Health and Safety Plan.

Personnel who use this procedure must document evidence to the site manager/Senior Unexploded Ordnance Supervisor and the Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP Acknowledgement, Attachment 1. This documentation will be retained in the project file.

Significant deviations from the requirements of this SOP will be authorized by the project manager and/or the relevant program manager. Changes by the responsible party to approved project plans will be sufficiently documented to re-create the modified process.

4.0 DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

Competent OHV Trainer: An individual designated by HGL MRT Safety Manager to have shown an adequate level of knowledge and proficiency in the operation of a particular OHV. This person will have satisfied all the requirements stipulated in this SOP.

OHV: The term off-highway vehicle (OHV) is used to describe all-terrain vehicles (ATV) and off-road vehicles (ORV).

ATV: Class 1 ATVs are motorized flotation-tired vehicles with at least three but no more than six low pressure tires that have an engine displacement of less than 960 cubic centimeters and

total dry weight of less than 1000 pounds. Class 2 ATVs are motorized flotation-tired vehicles with at least three, but no more than six, low pressure tires that have an engine displacement of less than 960 cubic centimeters and total dry weight of 1,000 to 1,800 pounds. Dry weight is normally the weight of the vehicle without fluids.

ORV: ORVs are motorized recreational vehicles capable of cross-country travel on natural terrain.

4.2 ABBREVIATIONS

ATV	all-terrain vehicle
EM	Engineering Manual
MEC	munitions and explosives of concern
MRT	Munitions Response Team
OHV	off-highway vehicle
ORV	off-road vehicle
PM	project manager
PPE	personal protective equipment
QC	quality control
SOP	standard operating procedure
USACE	United States Army Corps of Engineers
UXOQCS	Unexploded Ordnance Quality Control Specialist

5.0 PROCEDURES

5.1 MANAGERS AND SUPERVISORS

The project manager (PM) will provide the necessary management support and allocate sufficient project resources to permit project personnel to operate OHVs in a safe manner. The project Site Supervisor is responsible for implementation of the OHV safety, training, and operations procedures in the field.

5.2 SITE SAFETY AND HEALTH OFFICER

The Site Safety and Health Officer will ensure that the requirements of these procedures are implemented in the field.

5.3 OFF-HIGHWAY VEHICLE OPERATOR

The OHV operator is responsible for the safe operation of the vehicle as well as the safety of any passengers. All OHVs utilized by HGL will comply with the requirements outlined in USACE EM 185-1-1, and all applicable state laws and regulations.

5.4 PRE-OPERATIONAL CHECKS

1. Before operating the OHV, the vehicle will be thoroughly inspected using Attachment 3, Vehicle Inspection Checklist, HGL Form 15.23.
2. All discrepancies will be annotated on the checklist and corrected prior to vehicle operation.
3. If discrepancies are found the inspector will inform the supervisor so discrepancies can be remedied promptly.
4. If the vehicle is inoperable or could be damaged, the inspector will secure the vehicle in a fashion as to prevent its operation. The checklist annotating the problem will be left secured in the vehicle.

5.5 OPERATIONAL CHECKS

1. Don appropriate PPE as required.
2. Mount OHV and fasten the seatbelt.
3. Ensure parking brake is engaged.
4. Start engine (a cold engine may require the use of choke for starting) and listen for unusual sounds.
5. Verify engine is making adequate oil pressure.

CAUTION – To prevent engine damage, NEVER use starting fluid to start the engine unless specifically called for in vehicle owner's manual

6. Allow engine to completely warm up before getting underway.
7. As you begin to move out, listen for any unusual noise coming from drive train.
8. Test brakes and steering for proper operation.

5.6 CARE AND MAINTENANCE

1. Check fluids daily or before each use. If any fluids are low or contaminated, replace only with fluids recommended by owners operating manual.
2. Ensure vehicles are fueled at the end of each day's operations.
3. Note vehicle operation discrepancies and report them to a supervisor.

6.0 TRAINING/CERTIFICATION REQUIREMENTS

All OHV operators and passengers will be trained on the requirements of this SOP. Each OHV operator will be thoroughly familiar with all aspects of and will be trained in the practical use of the vehicle. HGL personnel who operate OHVs will first demonstrate to the Competent OHV Trainer their competence during the training course.

Attachment 2, OHV Training Course Lesson Guide and Attachment 3, OHV Qualification will be used for classroom and practical training and evaluation. Training will at a minimum, consist of negotiating steep terrain, safe backing, turning, braking, proper loading and load securing, basic troubleshooting, performing pre- and post- operation inspections, and use of required personal protective equipment.

7.0 SAFETY

7.1 SAFE DRIVING

- Accelerate slowly to prevent loss of traction. Terrain should dictate speed but the operator should never exceed manufacture's recommendations.
- If the brakes are used to control forward speed, apply them gently to prevent sliding.

WARNING – Never accelerate or brake suddenly while driving. This could cause the vehicle to roll over causing serious injury or death.

- Do not operate the vehicle on a slope greater than 30 degrees or the maximum recommended by the manufacturer. Terrain conditions may lessen this value.
- When driving uphill or downhill, try to pick a path that will keep the vehicle perpendicular to the slope and minimize the possibility of sliding sideways or rolling over.
- When negotiating slopes, keep the vehicle in the lowest gear to maximize power and prevent the brakes from overheating. If at all possible, do not operate vehicle on a side slope or when the orientation of the vehicle could become parallel to the slope of the terrain. In the event that side slopes cannot be avoided, limit slope to 20 degrees.
- Passengers will only ride in designated seating with seatbelts fastened. All occupants will ride with arms and legs inside the vehicle at all times.
- It may be prudent for passengers to dismount when negotiating rough or steep terrain.

WARNING – Never overload an OHV. Loads will change the vehicle's center of gravity and could adversely affect the vehicle's handling and performance. All equipment and loads will be secured to prevent damaged to vehicle or injury to occupants.

7.2 SAFETY EQUIPMENT

All OHVs will undergo a proper safety inspection by the operator prior to operation using Attachment 4 and be properly equipped with the following safety equipment:

- **Hearing Protection.** When operating OHVs for extended periods of time it is recommended that hearing protection be worn.
- **Fire Extinguishers.** Each OHV will carry at least one Type B-I or B-II fire extinguisher approved by Underwriters Laboratories (UL). Each fire extinguisher will be inspected at least once weekly to ensure that it is sufficiently charged and that the nozzle is free and clear. Discharged or defective fire extinguishers will be recharged or replaced immediately.

- **Inclinometers.** Each ATV/Utility Vehicle will be equipped with an inclinometer to enable the operator to accurately access the slope of terrain in degrees. The ATV/Utility Vehicle will not be operated on side slopes greater than 20 degrees or inclines/declines greater than 30 degrees.

- **Load Capacity.** The maximum load of the OIHV will not exceed manufacturer's recommendations, for example the ARGO is 1,150 lbs and the Polaris is 1,500 lbs. When loading OHVs, the heavy items will be placed low in the vehicle so that the stability of the vehicle will remain within safe operating limits. All light equipment will be secured within the racks provided on the vehicles front, rear, or top as applicable. It is always advisable to keep the center of gravity as low as possible when operating in mountainous terrain.

- **Tool Kit.** OHVs will be equipped with basic tools for emergency repairs. The tool kit will consist of but not be limited to the following: Allen wrench set, flat screwdriver, hammer, pliers, and pin for removing track pin, lug wrench, portable air compressor, and low pressure air gage.

- **Wind Shield.** OHVs should be equipped with wind shields to protect HGL personnel from debris, dust, etc. If OHVs are not equipped with wind shields, eye protection will be worn while operating the vehicle.

- **Audible Back Up Alarm.** All OHVs will have an audible back up alarm. In the event that an OHV was not equipped with an alarm from the factory, an air horn may be used as a substitute. Ground guides should be utilized at all times, when possible.

8.0 QUALITY CONTROL

The HGL Senior UXO Operations Manager is responsible for ensuring this SOP is reviewed annually for completeness, accuracy and safety. The HGL UXO Safety manager is responsible for the maintenance, management, and annual review of this SOP for procedural, quality control, and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety Manager.

Project manager and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, it will be brought to the attention of the responsible supervisor immediately for corrective action.

8.1 THREE PHASE INSPECTION CHECLIST

The Unexploded Ordnance Quality Control Specialist (UXOQCS) is responsible for ensuring that the quality control (QC) and safety measures instituted by this SOP are met during the initial, preparatory and final phases OHV training and operations. The UXOQCS will use the Three Phase Inspection Checklist, Attachment 5 to evaluate OHV operations performance and safety.

9.0 RECORDS

All personnel operating OHVs are responsible for documenting records and inspections associated with this SOP. Training records will be maintained along with all other training documentation conducted on-site. The following forms will be utilized for documenting training, operations and QC on HGL projects requiring the use OHVs.

- Standard Operating Procedure Acknowledgement Form, Attachment 1
- OHV Training Course Guide, Attachment 2
- OHV Qualification Card, Attachment 3
- Vehicle Checklist, Attachment 4

8.0 REFERENCES

US Army Corps of Engineers, 2008 Engineer Manual 385-1-1 Safety and Health Requirements Manual, Chapter 18, I.

10.0 ATTACHMENTS

Attachment 1	Standard Operating Procedure Acknowledgement Form
Attachment 2	OHV Training Course Guide
Attachment 3	OHV Qualification Card
Attachment 4	Vehicle Safety Inspection Checklist, HGL MR Form 15.23
Attachment 5	Three Phase Inspection Checklist

Attachment 1

STANDARD OPERATING PROCEDURE ACKNOWLEDGEMENT

I have read, understand and agree to abide by the provisions as detailed in this standard operating procedure (SOP) prepared by HGL. By signing below, I certify that I have had the opportunity to read and ask questions about this SOP, and that I understand the procedures, equipment and restrictions, and agree to abide by them. Failure to comply with this SOP may lead to disciplinary action and/or my dismissal from the work site and termination of employment.

Prior to the commencement of any work task associated with these SOPs, the Senior Unexploded Ordnance Supervisor (SUXOS) or Senior Unexploded Ordnance Technician assigned to the project will discuss additional procedures to be implemented, or any other site-specific conditions that may arise. All on-site personnel of HydroGeoLogic, Inc. must sign this Acknowledgment Form before performing the task covered by these SOPs.

Printed Name	Company	Signature	Date

Attachment 2

OHV TRAINING COURSE LESSON GUIDE

A. OHV

1. The OHV can be configured several different ways:
    a. With tracks
    b. With tires
    c. A combination of the two

2. Configuration is determined by a careful recon of the area of operation prior to starting work.
    a. Though the ARGO OHV is an amphibious vehicle, we do not operate them as such.
    b. The top of the vehicle provides a large sail area for the wind and makes the vehicle top heavy as well.
    c. When crossing through water make sure the wheels of the vehicle maintain contact with the ground.

3. Though the OHV is capable of operating in various off-road terrain conditions, it has its limitations, which will be discussed in detail later on.

CAUTION – If the vehicle floats, it will go wherever the wind takes it! AVOID AND STAY OUT OF PONDS AND LAKES!

4. As you gain experience operating the OHV you will find it will take you most anywhere you need to go, for example:
    a. The ARGO Avenger is equipped with a liquid-cooled, 674cc, 25-horsepower, V-twin engine. The Polaris is equipped with a 700cc liquid-cooled 40 hp engine.
    b. The ARGO and Polaris gearbox has two forward speeds, reverse, and neutral.
    c. The gear should be selected that best suits the terrain and load to be carried.
    d. If the vehicle is equipped with tracks, low gear is normally the best choice.

5. To steer the ARGO, the brake is applied to the wheels on the side you want to steer toward, hence the name "skid-steer." The Polaris steering box operates the same as a car. The ARGO brakes are dual piston calipers over 9-inch rotors. The Polaris has 4 wheel hydraulic disc brakes. The following operating procedures apply to the ARGO ONLY:

a. The skid-steer brake mechanism is the weak-link in the system and must be kept lubricated and adjusted properly.
b. If the idler chain brakes, the effected side will lose steering and braking power.
a. Tension on the drive chains is kept constant by chain tensioners that help to prevent sprocket damage.
b. Tensioners should be replaced when they can no longer take up the slack in the chain.

6. OHVs equipped with enclosed cab.
    a. If the vehicle is equipped with an enclosed cab of any sort, make sure there is plenty of ventilation to avoid exposure to exhaust gases and particulates.
        1) Gasoline engine exhaust contains high levels of carbon monoxide, an odorless, colorless, toxic gas that will cause injury or death.
        2) Inspect the engine exhaust for damage and disrepair.
        3) Listen for a change in exhaust or engine noise that may indicate a leak in the exhaust system.

CAUTION -- If an exhaust leak is suspected, place the vehicle out of service and report it to the craft supervisor.

B. DRIVING THE OHV

1. PRE-OPERATIONAL CHECKS:
    a. Before operating the OHV it should be thoroughly checked out as to its condition and an inspection sheet filled out.
        1) See Attachment 4, Vehicle Safety Inspection Checklist of this SOP.
        2) All discrepancies should be noted on the Vehicle Safety Inspection Checklist and corrected prior to operating the vehicle.
        3) Inform the craft supervisor of any problems with the vehicle so that repairs can be made promptly.
        4) If the craft supervisor is not available leave the check sheet on the seat with a description of the problem written in the comments or on the back and they will get to it as soon as possible.

2. OPERATIONAL CHECKS:
    a. Get in the vehicle and have everyone buckle up.
    b. Start the engine and listen for any unusual sounds.
    c. A cold engine may require the use of the choke for starting.
    d. Allow the engine to warm up before getting underway.
    e. As you begin to move out, listen again for any unusual noise coming from the gearbox or drive train.
    f. Check your gages and inclinometer for proper operation.
    g. Test the brakes and steering for proper operation.

3. OPERATING THE OHV IN REMOTE AREAS:
    a. When traveling in remote areas ensure you have the required safety equipment with you in the OHV.
    b. Follow safe driving techniques when traveling in remote areas.
    c. When driving up hills, always attempt to approach the hill head on to minimize the possibility of sliding sideways or rolling over.
        1) Accelerate slowly to prevent loss of traction.

CAUTION – Never accelerate or brake suddenly while driving up or down a hill. Sudden acceleration or braking can cause the vehicle to roll over, causing serious injury or death.

2) When traction is lost, the vehicle may slide sideways or backwards.
3) Apply the brakes gently and evenly to stop the slide.
4) Attempt to avoid steep hills and inclines.
5) When a steep hill or inclines can't be avoided, be prepared to shift occupant weight forward, or have occupant get out of the vehicle to decrease the possibility of rolling over.
6) Do not operate the OHV on side slopes greater than 20 degrees or inclines/declines greater than 30 degrees.
7) Due to terrain conditions you may wish to lower the limit to a lesser value.

CAUTION – When driving downhill attempt to approach the hill head on to minimize the possibility of sliding sideways or rolling over.

8) Shift the gearbox into low and keep the speed of the engine up just enough to keep the clutch engaged. This allows the engine to brake the vehicle and keeps the brakes from overheating.
9) If the brakes need to be used to control forward speed, apply them gently so as not to break traction.

4. OPERATING ON A SIDE SLOPE:
    a. If at all possible, **DO NOT** drive the OHV on a side slope.
    b. In the event a side slope cannot be avoided, choose a path that limits operation to 20 degrees or less. Side slope operation greatly increases the risk of rolling the vehicle.
    c. Operation of vehicles on a side slope requires constant use of the brakes for steering correction as the vehicle tends to head downhill.
    d. This may cause brake overheating or fade.

C. CARE AND MAINTENANCE OF THE ATV/OHV

1. ENGINE OIL INFORMATION:
    a. Check the engine oil each day before operating the engine.
    b. To check the oil during an operating period, shut the engine off and allow the oil time to drain into the sump.
    c. Do not overfill the sump.

2. GEARBOX OIL INFORMATION:
    a. Check the gearbox oil each day before operating the vehicle.
    b. Clean the area around the dipstick before removing.
    c. Do not overfill the gearbox.
    d. Overfilling may cause oil to be forced out the breather hole, which could contaminate the brake pads and lead to brake failure.

3. BRAKE FLUID LEVEL:
    a. Check the brake fluid level each day before operating the vehicle. The fluid level must be above the top of the sight glass mounted in the side of the master cylinder reservoir.
    b. If the brake fluid is below this level, thoroughly clean the master cylinder cover and surrounding area.
    c. Remove the two screws; lift off the cover and the gasket.
    d. Add only fresh clean DOT 5 fluid.
    e. Replace the cover on each master cylinder, making sure the rubber gaskets are properly seated before tightening the cover screws.

CAUTION – Do not mix DOT 3 and DOT 5 fluid. They are not compatible. DOT 5 is recommended by the manufacturer for both OHVs.

4. BRAKE COOLING SYSTEM:
    a. Eight-wheel ARGO vehicles with hydraulic brakes have a 12-volt fan forcing cool air from outside the engine compartment onto the brake components to protect the system from overheating.
    b. Overheating can damage the brake components and gearbox seals.
    c. Make sure the brake cooling fan is operating when the vehicle is being driven.
    d. The fan can be heard as soon as the ignition key is turned to the "on" position.

D. CARRYING PASSENGERS AND ATV/OHV

1. Keep OHV as low as possible and evenly distributed.

2. Use extreme caution when negotiating inclines with a load in the vehicle.
    a. Heavy loads and high loads decrease the stability of the vehicle and may cause it to roll.
    b. Keep the weight of the load near the floor of the vehicle. This will lower the center of gravity and help keep the vehicle stable.
    c. The maximum load is 1,150 pounds for the ARGO Avenger and 1,500 pounds for the Polaris.
    d. Secure the load to prevent shifting of the weight while driving.

3. When carrying passengers, ensure they wear their seatbelts and keep their arms and legs in the OHV.
    a. It may be advisable to have passengers get out of the vehicle when rough or steep terrain is encountered.
    b. These vehicles are not known for their comfort in rough terrain.
    c. Limit the number of personnel in the OHV to the driver and three passengers. No passengers are allowed on a Class I ATV.

E. POST OPERATION CHECKS

1. When securing the OHV check the following:
    a. Check the fuel level.
    b. If the fuel level is low, report condition to the site supervisor for refueling as directed.
    c. Remove tools and personal gear.
    d. Close the doors and fasten the snaps.
    e. Always chock the wheels, even if parked on level ground.

2. Plan for the next day's operation. Follow the 6-Ps, *Proper Prior Planning Prevents Poor Performance*:
    a. Inform the site supervisor when OHV requires relocation to the next work site/area.
    b. Vehicles equipped with tracks will not be driven on public roads.
    c. If you have any problems, let the site supervisor know so correct actions can be taken as necessary or have another OHV delivered to the work area.

Attachment 3

OHV QUALIFICATION CARD

Name: _____

Instructor: _____ Date: _____

QUALIFICATION	INITIALS
1. Classroom instruction completed.	_____
2. Pre-operation checks.	_____
3. Test drive.	_____
4. Driving on a 30-degree incline.	_____
5. Driving on a 30-degree decline.	_____
6. Driving on a 20-degree right side slope.	_____
7. Driving on a 20-degree left side slope.	_____
8. Driving and parking on uneven terrain.	_____
9. Backing and ground guide procedures	_____
10. Securing the loading and weight distribution.	_____
11. Post-operations OHV inspections.	_____
12. On the job training.	_____

I certify that the individual named above has met the training requirements specified by this SOP of the safe operation of the OHVs required for use on this project:

SSHO: _____ Date: _____
Signature

SUXOS: _____ Date: _____

Signature

Attachment 4

Vehicle Safety Inspection Checklist

Inspection date:	**Site name/location:**
Site Supervisor:	**Vehicle** (make and license plate number):
Mileage:	**Owner** (contractor/HGL/rental):

1. DOCUMENTATION:	Pass	Fail	5. BRAKES:	Pass	Fail
Registration and License Plate			Hand/Emergency		
Insurance			Service		
Emergency Route Map & Phone #s					
2. TIRES:	**Pass**	**Fail**	**6. BELTS:**	**Pass**	**Fail**
Pressure			Proper tension		
Condition			Condition		
3. EQUIPMENT:	**Pass**	**Fail**	**7. GENERAL:**	**Pass**	**Fail**
Fire extinguishers			Windshield		
First Aid/CPR/Burn Kits			Windshield Wipers		
Emergency Route Directions/Map			Windows (Condition/Operation)		
Vehicle Registration/Rental Contract			Seat Belts		
HGL Insurance Coverage Card			Steering		
Eyewash Kits			Horn		
Spare Tire			Gas Cap		
Tire Changing Equipment			Mirrors		
Tie downs ✱☐			Door/Window Handles/Latches		
Chocks ✱☐			Cleanliness		
Placards ✱☐			Exhaust System ✱☐		
4. FLUID LEVELS:	**Pass**	**Fail**	**8. LIGHTS:**	**Pass**	**Fail**
Oil			Headlights (high & low)		
Coolant			Brake Lights		
Brake			Parking		
Steering			Back-up		
Transmission			Turn Signals		
Windshield Wiper			Emergency Flashers		
Fluid Leaks			Interior Lights		
Last Oil Change (mileage):					

Notes:
1. To be used weekly for all vehicles EXCEPT explosive carriers that must be inspected prior to each explosives transport.
2. Items marked with an ✱ are required for explosive carriers and must be inspected prior to each use per HGL MRT SOP 15-0.
3. All forms with failures must note the deficiencies and forward a copy of this form within two working days to the Safety Officer.

Description of deficiencies:		
Corrective Actions to be taken:		
Inspection conducted by: (Printed name/signature)		
Deficiencies corrected by: (Printed name/signature)		

HGL MR Form 15.23 (Sep 2005)

Attachment 5

THREE PHASE INSPECTION CHECKLIST OFF-HIGHWAY VEHICLE OPERATION			
Team:	**Location:**		**Date:**
Personnel present print names:			

Phase of Inspection (insert "X" in the approbox):		PREPARATORY (P)		INITIAL (I);		FOLLOW-UP (F)

Step	Reference	Inspection Point	Yes	No	N/A	Inspection Phase Requirement
1.	Work plan	Is a current copy of SOP 15.14 available for Supervisor/Operator review before OHV operations?				P
2.	SOP 15.14, Sections 3.0, 5.0 6.0, 7.0 and Attachment 1	Has the Project Manager, Site Supervisor, Site Safety and Health Officer, OHV operators/ passengers reviewed and understand their individual responsibilities by completing the SOP acknowledgment?				P/ I/F
3.	SOP 15.14, Section 6.0 and Attachment 2 & 3	Have all OHV operators/passengers received the appropriate classroom and practical training?				P/ I/F
4.	SOP 15.14, Section 5.2 & 7.0	Are SSHO personnel available to perform operational and safety oversight of OHV operations?				P/ I/F
5.	SOP 15.14, Section 5.1 & 6.0	Does the Site Supervisor have a current training record on file for all OHV operators/passengers?				P/ I/F
6.	SOP 15.14 Section 5.0, 7.2 & Attachment 4	Are safety devices and equipment required for OHV operation available and utilized?				P/ I/F
7.	SOP 15.14 Section 4.4.1	Do OHV operators/passengers wear hearing protection for periods of prolonged vehicle operation?				P/ I/F
8.	SOP 15.14 Section 7.2 and Attachment 4	Are OHVs equipped with an approved and properly mounted fire extinguisher?				P/ I/F

9.	SOP 15.14 Section 4.4.2	Are OHV fire extinguishers inspected at least once each week to ensure that they are sufficiently charged and that the nozzle is free and clear?				I/F
10.	SOP 15.14 Attachment 2	Is each OHV equipped with an inclinometer and proper working order?				I/F
11.	SOP 15.14 Section 7.1 and Attachment 2	Is each OHV operated on side slopes less than 20 degrees or inclines/declines less than 30 degrees?				I/F
12.	SOP 15.14 Section 7.1 and Attachment 2	Are OHV loads limited restricted to the safe working loads established by the OHV manufacturer and are loads properly placed low and securely in the vehicle so that the stability of the vehicle will remain within safe operating limits?				I/F
13.	SOP 15.14 Section 4.6	Are all OHVs equipped with basic tools for emergency repairs to include a hex wrench set, flat screwdriver, hammer, pliers, and a pin for removing the track pin, lug wrench, portable air compressor, and low pressure air gauge?				P/ I/F
14.	SOP 15.14 Section 4.7	Does the OHV operator utilize Attachment 3, Vehicle Checklist to conduct pre and post inspections for operational serviceability?				I/F

Punch list Items (assigned by number):	
1.	
2.	
3.	
4.	
5.	
6.	
7.	

Inspection by (print name):	**Inspection by (print name):**
Acknowledged by (print name):	**Acknowledged by (print name):**

Manual Excavation of Anomalies Suspected as Material Potentially Presenting an Explosive Hazard (MPPEH)	SOP No.: 15.15 SOP Category: MMRP Revision No.: Date: May 2013

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide guidance for HydroGeoLogic, Inc. (HGL) employees performing manual excavation operations of anomalies by hand or using earth moving machinery (EMM) on munitions response sites (MRS).

2.0 SCOPE

This SOP applies to all HGL employees involved in manual excavation of anomalies suspected as material potentially presenting an explosive hazard (MPPEH). All work will be performed in a manner that is consistent with Occupational Safety and Health Administration (OSHA) standards and requirements. Refer to the project or site-specific health and safety plan for relevant health and safety requirements. All activities will be conducted in conformance with the approved explosive safety submission (ESS), explosive site plan (ESP), Work Plan, Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP) as required.

Personnel who use these procedures must provide documented evidence to the Senior Unexploded Ordnance (UXO) Supervisor (SUXOS) and UXO Control Specialist (UXOQCS) that they have read and understand this procedure by completing the SOP Acknowledgement Form, Attachment 1.

3.0 DEFINITIONS

Competent Person: OSHA defines a competent person in 29 Code of Federal Regulations (CFR) 1926.32(f), as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

Material Potentially Presenting an Explosive Hazard: MPPEH is material potentially containing explosives or munitions (for example, munitions containers and packaging material; munitions debris [MD] remaining after use, demilitarization, or disposal; and range-related debris [RD]); or material potentially containing a high enough concentration of explosives such that the material presents and explosive hazard.

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

Munitions and Explosives of Concern: Munitions and explosives of concern (MEC) is a term, which distinguishes specific categories of military munitions that may pose unique explosive safety risks: (A) UXO, as defined in 10 U.S.C. §101(e)(5); (B) discarded military munitions

as defined in 10 U.S.C. §2710(e)(2); or (C) munitions constituents (for example, TNT, RDX), as defined in 10 U.S.C. §2710(e)(3), which are present in high enough concentrations to pose an explosive hazard.

Unexploded Ordnance: UXO as defined by 10 U.S.C. §101(e)(5)(A) through (C), and 40CFR 266.201; includes military munitions that: (A) have been primed, fuzed, 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; and (C) remain unexploded either by malfunction, design, or any other cause.

4.0 PROCEDURES

Designated equipment operators, safety observers, and team leaders shall familiarize themselves with this SOP and review periodically to remain current on manual excavation operations. HGL employees performing the activities addressed by this SOP are responsible for meeting the requirements detailed herein. Equipment specific manuals and publications will be adhered to and a copy kept in the vehicle for all EMM that may be leased, purchased, or otherwise employed on HGL project sites.

Anomaly excavations on MRSs are typically to depths less than 4 feet, however when excavations are greater than 4-foot or create a "confined space" condition which employees are required to enter, the SUXOS will coordinate with UXO Safety Officer (UXOSO) to ensure that appropriate safety protection systems are applied in accordance with Title 29 Code of Federal Regulations (CFR) 1926.650. Whenever there is a cave-in potential excavations must be evaluated by a "competent person," The competent person will be present on-site to inspect the excavation condition and approve protective systems before employees are permitted to enter the excavation site. Excavations over 5 foot deep where employees have to enter are required to have protective systems in place such as a trench boxes, benching or sloping the sides, or a shoring system built in accordance with the tables in the 29 CFR 1926.650 standard. Confined space entry procedures and air monitoring must be conducted in trenches deeper than 4 feet if workers will be entering and if there is reason to believe that toxic vapor concentrations can accumulate in the excavation.

4.1 UXO TEAM

The size and composition of UXO teams conducting excavation operations will depend on site conditions and the scope of work. The minimum make-up of teams will consist of following positions:

4.1.1 UXOSO

The UXOSO has the overall responsibility for ensuring all excavation operations involving manual excavations of anomalies on MRSs are conducted safely and in accordance with this SOP and *U.S. Army Corps of Engineers, Engineer Manual 385-1-97* and the approved project work plan.

4.1.2 UXO Team Leader

A UXO Technician III will be assigned as the team leader and will be responsible for directing all personnel involved in excavation operations. The team leader WILL NOT allow any employees to enter any excavation where there is a cave-in potential without the approval of a competent person.

4.1.3 EMM Operator

The EMM operator may be either a UXO Technician or a non UXO-qualified person. When using non UXO-qualified personnel as EMM operators, the operator will be directly supervised by a UXO Technician III or above.

4.1.4 Ground Guide

The ground guide will be UXO-qualified. Team members working as ground guides during excavation operations will be qualified through on-the-job training (OJT) and will perform such tasks as geophysical instrument checks, manual excavations, and checks of the excavation for MPPEH items. Ground guide responsibilities include:

- Marking the EMM safety zones;
- Stopping workers from entering the safety zone while EMM is in operation; and
- Maintaining positive communications with the EMM operator and team leader for example, hand signals or radio communications.

4.2 MANUAL EXCAVATION OPERATIONS

All manual excavations of anomalies suspected as MPPEH will be conducted offset to the side of the suspected MPPEH item or anomaly being investigated. Under no circumstances will any excavation be made directly over MPPEH (MEC/UXO).

– W A R N I N G S –

1. *Only UXO-qualified members on the UXO team may conduct manual excavation operations.*
2. *Under no circumstances will any excavation be made directly over suspected MEC.*
3. *If, during an excavation, MPPEH is discovered, all operations will cease, all machinery will be placed in stand-by mode, non-essential personnel will evacuate beyond the MSD and the item will be investigated by UXO-qualified personnel to determine type of hazard.*
4. *Non UXO-qualified operators must evacuate beyond the pre-designated minimum safe distance (MSD) until recalled by the UXO team leader.*

1. Excavation operations, whether by hand or EMM will employ a step-down or offset access method.
2. Start all excavations from the side of the anomaly.
3. Carefully dig from the side employing a step-down or offset access method until identification of the anomaly is made.
4. Clear debris/soil from the subsurface anomaly only enough to permit identification of the anomaly and to apply the necessary MEC safety procedures.
5. Move with slow, deliberate motions; avoid abrupt moves.
6. Avoid impacting, jarring, or striking suspected MEC.
7. Do not subject suspected MEC to shock, rough handling, heat, or any other force.
8. EMM will uncover no more than six inches of earth per dig;
9. EMM WILL NOT be used to excavate closer than 12 inches from suspected MPPEH. When a manual excavation closes within approximately 12 inches of an anomaly, manual excavation methods must be used to complete the excavation.
10. If 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.). If this effort fails, the excavation will cease. The hole will be backfilled following verification by the SUXOS and UXOQCS.
11. When personnel will be in or around an excavation, a competent person shall inspect the excavation, the adjacent areas, and protective systems daily, as needed throughout the work shifts, and after every rainstorm or other hazard increasing occurrence.

4.3 EMM PROCEDEURES

4.3.1 Function-check

The SUXOS, or senior UXO Technician on site, will ensure that all EMM is function-checked and working properly before starting daily operations. The operator will be responsible for completing the daily equipment checks and recording the results on HGL MR Form 15.24, *Equipment Safety Inspection Log*, Attachment 2. The completed inspection form will be turned to the SUXOS daily. The function

Brakes, hydraulic lines, light signals, backup alarms, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be checked daily and maintained in good working order throughout the duration of its use. If an equipment function check indicates that any piece of EMM equipment is not operating correctly and field repair cannot immediately be accomplished, the operator will report the condition immediately to the appropriate supervisor, and the piece of equipment will be placed in an unusable status until it has been repaired or replaced.

This system of checks ensures that the on-site equipment is safe and functioning properly.

The following procedures apply when EMM are in operation, this includes moving, repositioning, and using the front and rear attachments:

- EMM WILL NOT be operated without a spotter;
- Before starting an excavation:
    - The EMM footprint and safety zone will be cleared of MPPEH by an UXO Technician II or above using a visual and instrument-aided survey
    - A safety arc will be etched in the ground with the front or rear boom, fully extended with the ends of the arc marked with safety cones.
    - On a hard surface, the safety arc will be marked on the ground, with bright spray paint or by the placement of traffic cones.
- Workers WILL NOT be allowed to enter the safety arc until the EMM is placed in stand-by mode as follows:
    - Swing the boom fully to one side.
    - Lower the bucket to the ground.
    - Place engine in idle speed.
    - Hold his hands clear of the controls or in the "Hands Up" position to indicate to the spotter that the driver has no intention of moving the machine.
- EMM needing to be moved adjacent to an excavation or approach the edge, and the operator does not have a clear and direct view of the edge, will institute a warning system, such as barricades, stop logs, or arm and hand signals from the safety observer.

4.3.2 MEC Anomaly Avoidance

When non UXO-qualified personnel operate EMM, a UXO Technician II or above will provide MEC anomaly avoidance ground guides duties.

5.0 PERSONAL PROTECTIVE EQUIPMENT

All UXO team members will be trained for the use of, medically qualified for, and physically able to wear the prescribed PPE. At a minimum, Level-D PPE will be worn at all times (for example, boots, gloves, protective glasses or goggles, shirt and pants) unless the UXOSO determines otherwise. The following equipment will typically be used to perform manual excavation and EMM operations:

- Leather gloves;
- Safety glasses or goggles;
- Boots with high traction soles and ankle protection (safety toe equipped, as required);
- Hardhat – American National Standards Institute (ANSI) Z89 (as required);
- High visibility safety vest – ANSI Class 2 (as required);
- Hearing protection – Level of hearing protection will be determined through a noise survey (sound level meter) for any EMM brought on site. Until the survey is completed and the degree of attenuation determined, personnel working near the EMM will wear appropriate hearing protection; and

- Dust filtering face pieces (as required).

6.0 SAFETY

Before entering a MRS to perform excavation operations, the UXO team leader will conduct a daily tailgate safety meeting covering various emergency procedures, safety operations, MEC that might be encountered, and all other hazards associated with the work site.

6.1 EMM

EMM will be properly equipped with the following safety devices:

- Roll-Over Protection Structure (ROPS);
- Audible Back-up Warning System;
- One dry chemical or CO2 fire extinguisher with a minimum rating of 5-B:C for each bulldozer, scraper, dragline, crane, motor grader, front-end loader, mechanical shovel, backhoe, and other similar equipment. ;
- Operator's Manual and Lubrication Order; and
- Radio or cell phone for communications with team leader.

6.1.1 EMM Hazards

The hazards associated with EMM involve moving parts and exposure to possible pinch points. Safe operating procedures for each type of equipment or activity must be reviewed and followed. Safety protection, including equipment guards, which must not be removed, shall be provided to mitigate this problem. Site personnel operating or working within close proximity to EMM will wear hard hats, eye protection, steel-toed boots, and hearing protection (as necessary). All personnel who operate equipment must use any safety devices, such as seat belts during equipment operation. All operators will follow these EMM operating rules:

- Only personnel trained in the operation of EMM are permitted to operate such equipment;
- Personnel may only operate equipment for which they have received training and certification. Trainees may operate EMM, but only under competent supervision;
- The operators of EMM will complete a daily inspection form; and
- When the manufacturer's instructions or recommendations are more stringent than the requirements of this SOP, the manufacturer's instructions or recommendations shall be followed.
- All EMM will have an audible back up alarm. Any EMM that arrives on site will be inspected to insure that the alarm is functioning properly. If at any time the alarm malfunctions, the EMM will be taken out of service and repaired.

- EMM will be provided with necessary safety equipment including seat belts, roll-over protection, emergency shut-off during roll-over, backup warning lights, and audible alarms as applicable.
- Blades and buckets will be lowered to the ground and parking brakes will be set before shutting off any EMM.
- Special consideration must be given to the proper function of tires, horns, lights, batteries, controllers, lift systems (including forks, chains, cable and limit switches), brakes, and steering mechanisms.
- All EMM will be operated at an authorized safe speed, consistent with conditions, at a safe distance from other vehicles, and will be under positive control at all times.
- No riders other than the driver are permitted on EMM at any point.
- When EMM is left unattended, loads must be lowered, controls neutralized, power shut off, and brakes set. Wheels should be chocked if the equipment is parked on an incline.
- Backhoe support struts (downriggers) will be equipped with cleated pads for use in soft sandy soil rather than rubber pads (for hard surfaces).
- When working near EMM, field personnel will maintain sight contact with the operator. Field personnel will not work within the swing radius of the equipment while the equipment is operating. The swing radius will be defined with traffic cones, barrier tape, or other suitable means, such as inscribing the radius on the soil surface using the backhoe bucket.
- Personnel will not cross the demarcated line without first establishing eye contact with the operator. The operator will cease vehicle operations and remove his hands and feet from the controls and/or turn the equipment off, before allowing personnel access to the area within the swing radius. Operations will resume only after all personnel have left the area within the swing radius.
- Operator and assigned personnel may use hand signals during intrusive operations. Hand signals should follow the guidelines in EM 385-1-1and will be discussed prior to commencing operations.
- The use of headphones for entertainment purposes, AM/FM radio and digital music players while operating equipment is prohibited.

6.2 MEC HAZARDS AND PRECAUTIONS

All personnel will receive a daily site safety briefing from the UXOSO or designated representative. UXO-qualified personnel will conduct a daily tailgate safety briefing prior to commencing operational activities each workday.

Operations within areas suspected of containing MPPEH must be conducted in a manner that exposes a minimum number of people to the smallest quantity of explosives for the shortest period

of time, consistent with a safe and efficient operation. If MPPEH is encountered during any phase of work the SUXOS and UXOSO will be immediately notified. In general, the following MEC safety precautions and protocols include:

- Do not conduct explosive or potentially explosive operations during inclement weather.
- Avoid contact with MEC except during approved MEC removal conducted during surface clearance activities
- Conduct MEC-related operations during daylight hours only.
- Note chemical hazards. Be aware of the potential presence of CWM on munitions response sites. If suspect CWM is encountered during operations, all work shall cease, and the site will be evacuated and secured.
  - Symptoms of CWM exposure could be anything from burning eyes, choking, skin irritation, nausea, vomiting, unconsciousness or death.
  - Other chemical hazards such as petroleum products and industrial chemicals might be encountered. Report strange smells and liquids.
- Remain alert at all times for MEC and related scrap or MPPEH hazards.
- Assume MEC hazards contain a live charge until determined otherwise.
- Understand death or injury can occur from MEC and explosive related accidents.
- Be aware that the age or condition of a MEC hazard does not decrease the 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 agent 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, move or jar any ordnance items regardless of the markings or apparent condition. Under no circumstances will any MEC be handled during avoidance activities or moved in an attempt to make a positive identification.
- DO NOT touch, pickup up, kick or move anything that is unfamiliar or unknown.
- DO NOT roll an unknown item over or scrape the item to identify markings.
- DO NOT approach or enter a munitions site if an electrical storm is occurring or approaching. If a storm approaches during site operations, cease operations and seek shelter.
- DO NOT transmit radios or cellular phones in the vicinity of suspect MEC hazards.
- DO NOT walk across an area that the ground surface cannot be seen that has not been cleared of MEC hazards by the UXO Technician.
- DO NOT rely on color codes for positive identification of ordnance items nor their contents.
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes.

- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.
- DO NOT be misled by markings on the MEC item stating "practice bomb," "dummy," or "inert." Practice ordnance can have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly.
- Mark all MEC discoveries so they can be easily located and avoided.

– W A R N I N G –

Removing or taking any munitions, explosives, unexploded ordnance or munitions-related debris from the site by any employee is strictly prohibited.

6.3 MINIMUM SEPERATION DISTANCES

All excavation operations will adhere to the MSD as described in the site specific work plan and DDESB Fragmentation Database, and when applicable the DDESB-approved ESS/ESP. MSDs can be reduced if approved engineering controls are applied.

6.4 UNDERGROUND UTILITIES

Utility companies will be contacted prior to the start of an actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the excavation may proceed, provided HGL does so with caution, and provided detection equipment or other acceptable means to locate utility installations are utilized. While the excavation is opened, and underground utilities exposed, they shall be protected, supported or removed as necessary to safeguard workers.

When required, HGL will obtain a "Dig Permit" (excavation permit) from installation Civil Engineers or other authority having jurisdiction prior the initiation of any excavation work.

6.5 EXPOSURE TO VEHICLE TRAFFIC

Employees exposed to vehicular traffic will be provided with and will wear warning vests or other suitable garments with a highly visible (reflective) material. Traffic direction paddles or saw horse type barricades may also be required to halt or redirect vehicular traffic around the excavation site.

If vehicular traffic consists of non-essential personnel (i.e., public roads) the project manager will coordinate the excavation operations with the appropriate authorities.

6.6 EXPOSURE TO FALLING LOADS

Workers are required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling material. EMM booms or buckets will not be swung over the

heads of personnel in the work area. If movement of machinery is necessary, ensure all personnel are out of the path of the machinery before movement. Hardhats will be worn when there is an overhead hazard. Guide lines may be used to insure for safe movement of loads.

6.7 LOOSE ROCK OR SOIL

Workers will be protected from falling or rolling into excavated sites or being exposed to materials that could pose a hazard. All equipment or materials will be placed at least 2 feet from the edge of excavations, or will be separated from sites by the use of retaining devices that are sufficient to prevent the equipment or material from falling or rolling into the excavation. Scaling the excavation face to remove loose rock or soil and the installation of protective barriers at intervals on the face to stop or contain falling material may be used when appropriate.

6.8 CAVE IN

Excavations will be protected from cave-ins by adequate protective systems (sloping and benching or shielding and support). Excavations greater than 5 feet in depth will require sloping, shoring or shielding unless the excavation is in stable rock as determined by a competent person. Sufficient stairs, ramps, or ladders shall be provided when personnel are required to enter excavations over 4-foot deep. Ladders should be placed no greater than a 10-foot travel distance.

6.9 CONFINED SPACE

If entry into an excavation may expose personnel to confined space/atmospheric dangers and there is a risk of excavated wall collapse, personnel will follow confined-space entry procedures (29 CFR 1926.21). Regardless of depth, a competent person must assess the excavation prior to each entry. Workers will not be allowed to enter an unstable excavation.

6.10 PERIMETER PROTECTION

Protection shall be provided to prevent people, vehicles, and equipment from falling into excavations (for example, barriers and warning tape) if excavations are not clearly visible. Excavations will be backfilled as soon as possible.

7.0 TRAINING

Before commencing any EMM operations all employees will receive site indoctrination training regarding the site-specific hazards and safety precautions as required by the project APP/SSHP. Specific site hazard training will include:

- MEC awareness and recognition;
- Anomaly avoidance procedures for non UXO-qualified EMM operators;

- Initial use, operation and maintenance of EMM in accordance with manufacturer's operating and maintenance instructions, along with warnings and precautions for that equipment;
- Recognition of safety and health hazards associated with the employee's specific work tasks, including the use of measures and work practices to prevent or control those hazards; and
- Recognition, prevention and control of other safety and health hazards in EMM operations.
- Roll-over protection structure (ROPS) and certificate on file at site (unless equipment is not designed to accommodate ROPS. ROPS may be removed from certain types of equipment when the work cannot be performed with the ROPS in place or when ROPS removal is justified and delineated in an approved Activity Hazard Analysis (AHA).
- Back-up warning system
- Each bulldozer, scraper, dragline, crane, motor grader, front-end loader, mechanical shovel, backhoe, and other similar equipment shall be equipped with at least one dry chemical or carbon dioxide (CO_2) fire extinguisher with a minimum rating of 5-B:C.
- Review of the Operator's manual and lubrication order
- Communications between EMM operators, SUXOS, UXOSO and other field team leaders (, for example, radios or cell phones, etc.)
- Review of *Construction/Excavations* – OSHA Regulation 29 CFR 1926, Subpart P, Appendix A and *Soil Classification;* and 29 CFR 1926.652, Subpart P, Appendix F, *Requirements for Protective Systems*;
- Proper shoring and sloping techniques;
- Soil classification and evaluation at the excavation site (as required); and
- Responsibilities of a Competent Person.

7.1 COMPETENT PERSON

HGL's Corporate Health and Safety Director will oversee Competent Person training. This training will include:

- OSHA 29 CFR 1926.21(b)(2), *Safety Training and Education,* which states: "The employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury."
- Review of OSHA Regulation for Safety and Health Requirement for Construction/Excavations, 29CFR1926, Subpart P, Appendix A and 29CFR1926.652, Subpart P, Appendix F;
- Proper Shoring and Sloping Techniques;
- Soil classification and evaluation at the excavation site, Attachment 3; and

- Responsibilities of a Competent Person.

7.1.1 EMM Operator

EMM operators will be qualified through documented formal training, equivalent previous employment experience, or OJT. Personnel will receive appropriate training, be on the OSHA medical surveillance program, and have personal protective equipment (PPE) required by the safety plan, contract specifications, OSHA Standards, and other applicable regulations. In addition the mandatory training qualification requirement specified in the project APP/SHHP the EMM operator will possess the following certifications:

- Driver's license;
- EMM operator certificate; and
- Familiarization training and OJT with the EMM before starting excavation operations.

7.2 GROUND GUIDE

The ground guide will be UXO-qualified and trained in accordance with DDESB TP 18 and qualified through on-the-job training (OJT).

7.3 UXO PERSONNEL

UXO-qualified personnel will meet qualification requirements specified by DDESB TP 18.

8.0 QUALITY CONTROL

The HGL UXO Safety Manager is responsible for the maintenance, management and annual review of this SOP for procedural, quality control and safety issues. All questions, comments or recommendations regarding this SOP should be directed to the UXO Safety and Quality Manager.

Project Managers and supervisors are responsible for ensuring all site personnel read, understand, and follow this SOP. If any discrepancies are found with procedural steps or safety issues pertaining to this SOP, it will be brought to the attention of the responsible supervisor for corrective action.

9.0 RECORDS

Training qualification and certification documentation will be kept on file at the project site. Project participants are responsible for documenting information in sufficient detail to provide objective documentation that the requirements of this SOP have been met. Such documentation shall be retained with the project record files. Documentation generated as a result of this procedure will be collected and maintained utilizing the following forms:

- SOP Acknowledgement Log, Attachment 1;
- HGL MR Form 15.24, *Equipment Safety Inspection Log,* Attachment 2; and

- Soil Classifications for excavation operations, Attachment 3.

10.0 REFERENCES

Code of Federal Regulations, Title 29, Part 1926, Subpart C, *General Safety and Health Provisions;* Subpart P, *Safety and Health Requirements for Construction;*, Subpart P, Appendix A, *Soil Classification;* Part 1926.652, Subpart P, Appendix F, *Requirements for Protective Systems*; Part 1926.21, *Safety Training and Educatio*n

U.S. Army Corp of Engineers, Engineer Manual 385-1-1, 2008, *Safety and Health Requirements Manual*, September

U.S. Army Corps of Engineers, Engineer Manual 385-1-97, 2008, *Explosives Safety and Health Requirements Manual*, September

HydroGeoLogic, Inc., Standard Operation Procedure 15.05, 2014, *Anomaly and MEC Subsurface Clearance*, February

ATTACHMENT 1

SUPERVISOR'S STATEMENT

I have read and understand this SOP. To the best of my knowledge, the activities 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 Design Change Notice (DCN) by the HGL project team and receipt of client approval prior to implementation. If unexpected safety, health, or environmental hazards are found, I will make sure 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 perform in accordance with the SOP, I will stop the process and notify my immediate supervisor.

Worker's Name	Date	Supervisor's Name	Date

ATTACHMENT 2

EQUIPMENT SAFETY INSPECTION CHECKLIST

Date:	Time:	SSHO:	SUXOS:
Site Name/Location (city and state):			Contract Number:
Equipment Make/Description		Model	Serial Number:

Place a "X" mark in the appropriate column to indicate that the item passed or failed inspection. If an item failed inspection describe the discrepancy and the corrective action taken in the "Discrepancy/Comments" column. If item does not apply to equipment being inspected, enter "NA". All listed items must have a response.

Item	Pass	Fail	Discrepancies/Comments
Service brakes			
Emergency brakes			
Parking brake			
Brake lights			
Back-up alarm/warning signal			
Horn			
Tires			
Spare tire			
Spear tire changing equipment			
Steering			
Seat belt			
Operating controls			
Communications			
Fire extinguisher			
Head and tail Lights			
Mirrors			
Windshield			
Windshield Wipers and Washers			
Coupling Devices			
Guards for Moving Parts			
Outriggers/stabilizers			
Brake – hydraulic			
Brake Fluid			
Hydraulic Fluid Levels			
Engine Oil			
Engine coolant			
ROPS			
Falling Object Protection System			

Inspection conducted by (print name):	Signature:
Discrepancies corrected by:	**Date:**

HGL MEC Form 15.24 (Sep 2005)

ATTACHMENT 3

SOIL TYPES

The following soil types may be encountered in the course of excavating soil. Knowledge of soil characteristics of the soil types is beneficial to understanding the hazards associated with each.

Cemented Soil: Soil in which a chemical agent such as calcium carbonate, holds the particles together whereas a hand-size sample cannot be crushed into powder, or individual soil particles by finger pressure.

Cohesive Soil: A fine grained soil (clay) or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical side slopes and is "plastic" when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry Soil: A soil that does not exhibit visible signs of moisture content.

Fissured Soil: A soil material that has a tendency to break along definite planes of fracture with little resistance or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular Soil: Means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered System: Means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist Soil: Means a condition in which a soil looks and feels damp. Moist cohesive soils can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic Soil: Means a property of a soil, which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated Soil: Means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

SOIL CLASSIFICATION

If personnel are to enter the excavation, the soils of the excavation must be classified to determine the design of the appropriate protective system. Each soil and rock deposit at an excavation site must be classified by a competent person, as either stable rock, Type A, Type B, or Type C soil.

The soil classification results must be made based on the results of at least one visual test (for example, tension cracks or signs that the soil has been previously disturbed) and one manual test (e.g., use of pocket penetrometer or shear-vane to measure unconfined compression strength). The definitions of the various soil classifications are presented below.

ATTACHMENT 3

Stable Rock: Is natural solid mineral matter that can be excavated with vertical sides and will remain intact while exposed.

Type A Soils: Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kilopascals [kPa]) or greater. Examples of Type A cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. A soil cannot be classified as Type A if it is fissured; subject to vibration from traffic, pile driving, or similar effects; has previously been disturbed, is part of a sloped, layered system where the layers dip into the excavation on a slope of 4 horizontal to 1 vertical (4H:1V) or greater; or has seeping water.

Type B Soils: Cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of other Type B soils are: angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; and layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).

Type C Soils: Cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include: granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.

Maximum Allowable Slopes

Soil or Rock Type	**Maximum Allowable Slopes (H:V) for Excavations less than 20 feet in depth**
Stable Rock	Vertical (90 degrees)
Type A	¾ : 1 (53 degrees)
Type B	1 : 1 (45 degrees)
Type C	1 ½ : 1 (34 degrees)

Exception: Simple slope excavations, which are open 24 hours, or less (short term) and 12 feet or less in depth, shall have a maximum allowable slope of ½:1.

Note:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

Trimble® GeoXH™ Global Positioning System (GPS) Digital Data Collection

SOP No.: 15.17
SOP Category: MMRP
Revision No.:
Date: December 2011

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish and properly maintain a digital data collection filing system and digital data transfer procedures using Trimble® Global Positoning System (GPS) Pathfinder Office® software and the Trimble® GeoXH™ GPS handheld device with Trimble® TerraSync™ software on HydroGeoLogic, Inc. (HGL) projects.

2.0 SCOPE AND APPLICATIONS

This SOP applies to all HGL employees who are assigned the responsibility for uploading, downloading, and file management of digital data using the Trimble® GeoXH™ GPS handheld, which from hereon is refered to as the "GPS".

Personnel who use this procedure must provide documented evidence to the Senior Unexploded Ordnance Supervisor (SUXOS) and the Unexploded Ordnance Quality Control Specialist (UXOQCS) that they have read and understand this procedure by completing SOP Acknowledgement, Attachment 1. This documentation will be retained in the project file.

3.0 DEFINITIONS AND ABBREVIATIONS

3.1 DEFINITIONS

Trimble® GeoXH™ GPS: A GPS made by Trimble for high accuracy and data collection. This unit provides real-time subfoot accuracy and allows the user to enter feature specifice information.

Data Dictionary: Allows the GPS operator to record attributes at each position location.

Coordinate System: A reference system used to measure horizontal and vertical distances on a map.

Position Dilution of Position (PDOP): The PDOP is a measurement of possible position error that is related to geometeric quality. In general, the farther apart satelites being used, the lower the PDOP and the greater the accuracy of the fix. Adequate to good accuracy of the PDOP is indicated by values below 20.

3.2 ABBREVIATIONS

FTP	file transferr protocol
GIS	geographic information system
GPS	global positioning system
HGL	HydroGeoLogic, Inc.
PC	personal computoer
PDOP	position dilution of position

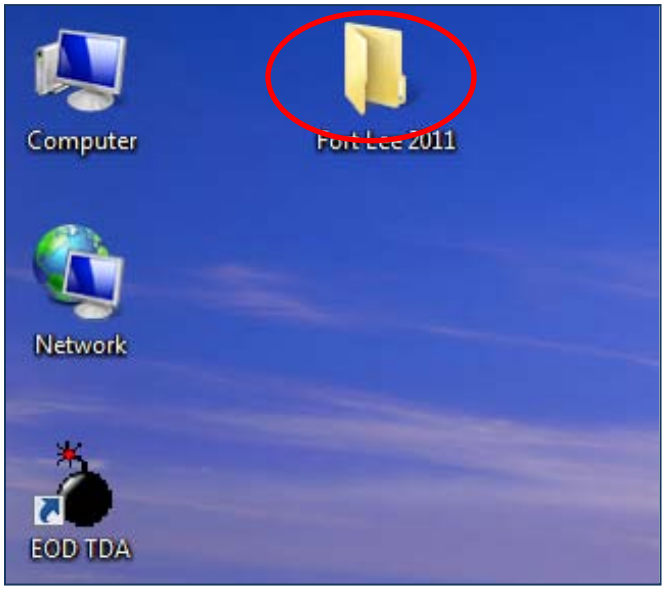
SOP	standard operating procedures
SUXOS	Senior Unexploded Ordnance Supervisor
UXOQCS	Unexploded Ordnance Quality Control Specialist

4.0 PROCEDURES

The following procedures outlines the process for establishing and properly maintaining a digital data collection filing system and digital data transfer procedure using a laptop or personal computer (PC).

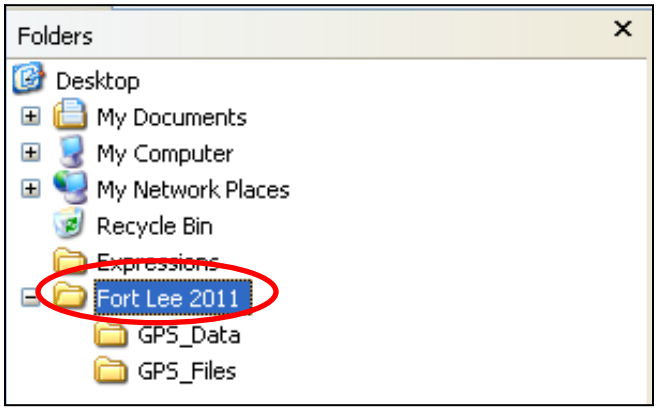
4.1 ESTABLISHING THE PRIMARY PROJECT

Establish the primary project data folder by creating a folder on the computer's desktop, titled with the site name and year, for example "Fort Lee 2011".



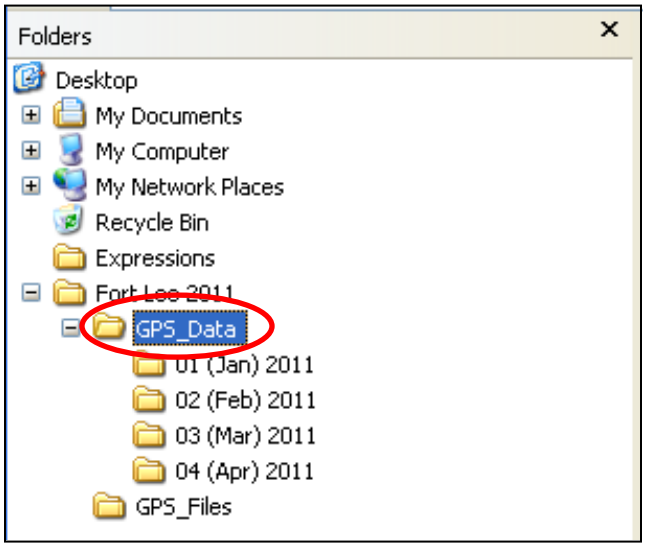
4.2 ESTABLISHING THE PROJECT DATA FOLDERS

Within the primary project data folder, create two folders one titled "GPS_Data" and the other titled "GPS_Files". The "GPS_Data" folder will be used for downloading the GPS field data collected that day. The "GPS_Files" folder will contain files that will be uploaded to the GPS, such as background maps, site maps, shapefiles, data dictionaries, and waypoint files.



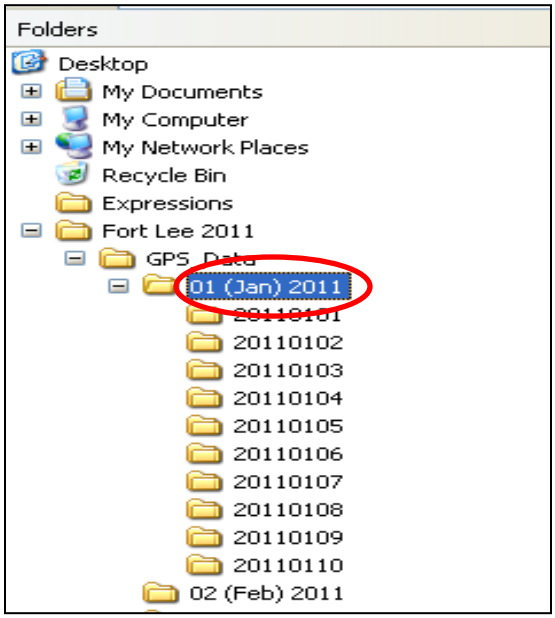
4.3 ESTABLISHING THE PROJECT GPS MONTHLY FOLDERS

Within the "GPS_Data" folder, create monthly subfolders labeled by month and year, for example "01 Jan 2011", for the entire period the project will be active.



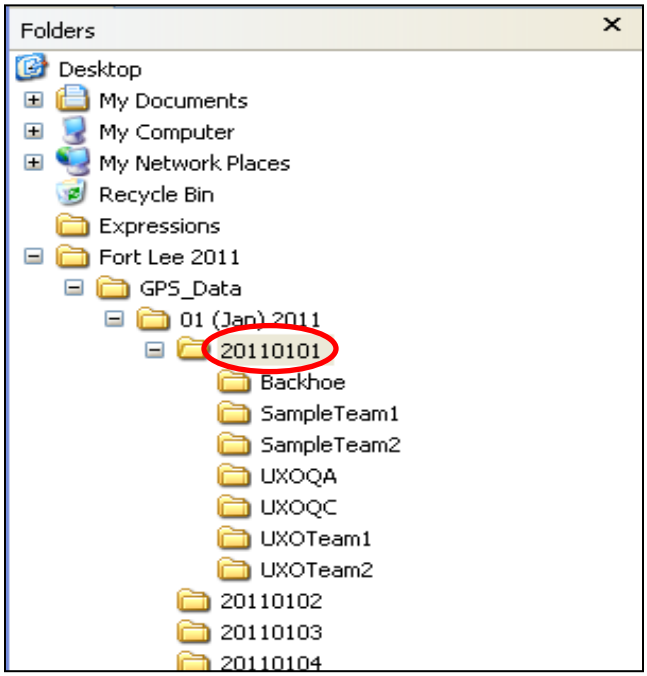
4.4 ESTABLISHING THE PROJECT GPS DAILY FOLDERS

Within the "Monthly" folders, create individual folders for each workday of each month the project will be active. The format for the individual workday folders must be YYYYMMDD.



4.5 ESTABLISHING FIELD ACTIVITY FOLDERS

In the individual workday folders, create new individual folders for each of the MEC/Intrusive teams, UXOQCS, sampling team, backhoe team (when required), and any other field teams that will be collecting data using the GPS.



4.6 TRANSFERING FILES BETWEEN THE GPS AND COMPUTER

To transfer data files between the Windows® powered computers and GPS, the appropriate versions of Trimble® GPS Pathfinder® Office software and either Microsoft ActiveSync or Windows® Mobile Device Center must be installed on the laptop or PC. When using Windows XP or 2000 operating systems, ensure the appropriate version of Microsoft ActiveSync is installed. When using Windows Vista, a connectivity driver for Windows Mobile-based devices is included with your operating system. Prior to using the GPS in the field, the GPS' must be loaded with site maps, shapefiles, data dictionaries, and if required, waypoint files. The HGL project GIS Specialist will preload the GPS or post GPS files to the HGL Sharepoint Private FTP site. These files will be downloaded from the Private FTP and saved to the "GPS_Files" folder.

4.6.1 To Turn GPS On

Turn the GPS on by pressing the green "power key" button, see Attachment 2.

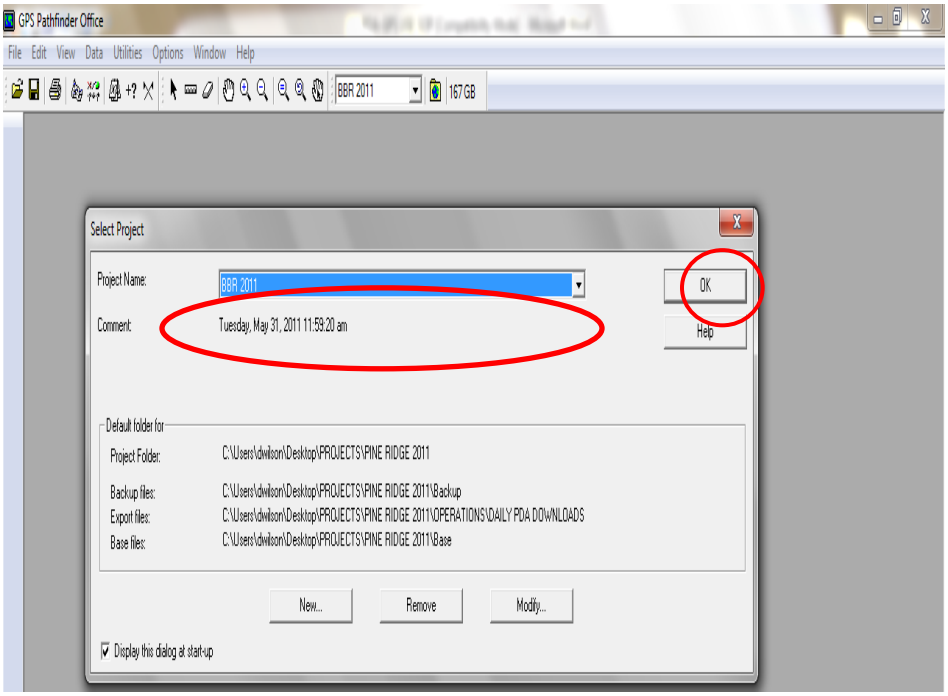
5.6.2 To Connect to the GPS

Insert the GPS in the charging cradle and open the GPS Pathfinder Office software. Depending on your operating system, either the Microsoft® ActiveSync (Windows XP or 2000) or Windows Mobile Device Center (Vista or Windows 7) window will open. After a short time the "Not Connected" message will change to "Connected".

4.7 UPLOADING BACKGROUND FILES TO THE GPS

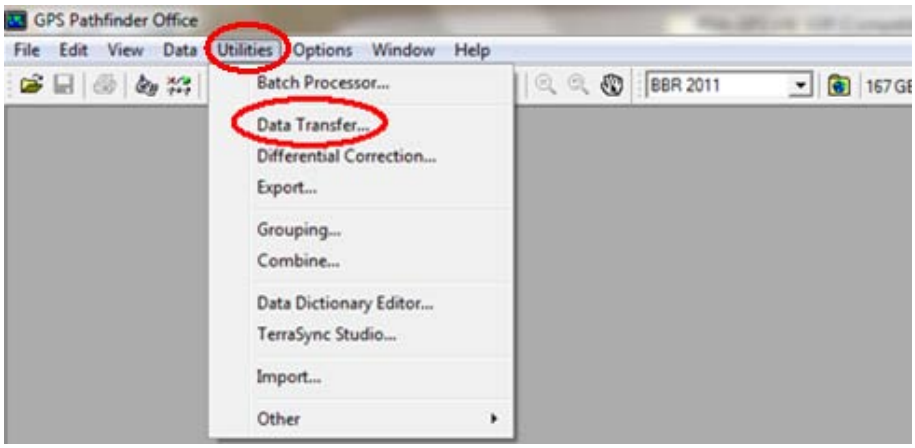
4.7.1 To Select a Project

Open GPS Pathfinder Office and select the project from the "Project Name" dropdown menu. The following window will display. Click "OK" to close the window.



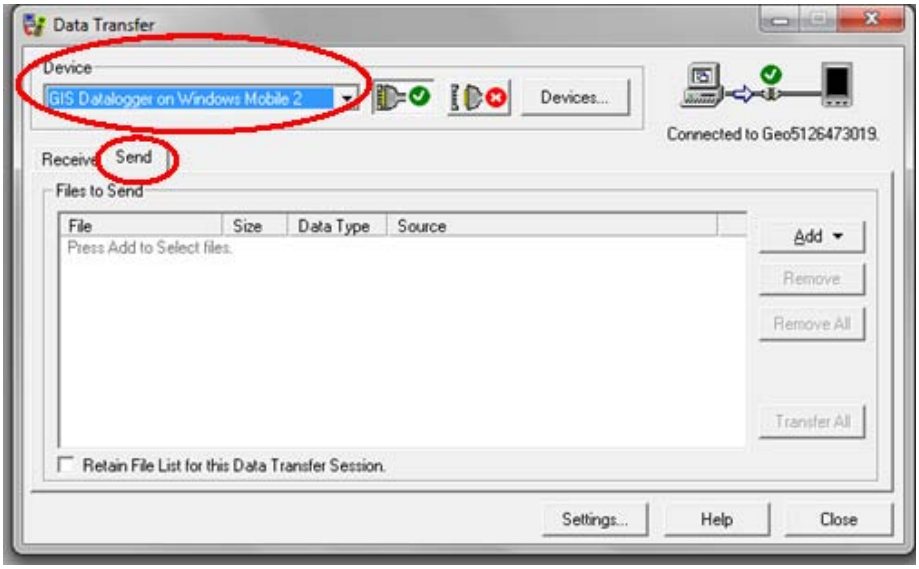
4.7.2 To Transfer Data

On the menu bar click on "Utilities", then on the dropdown menu select "Data Transfer".



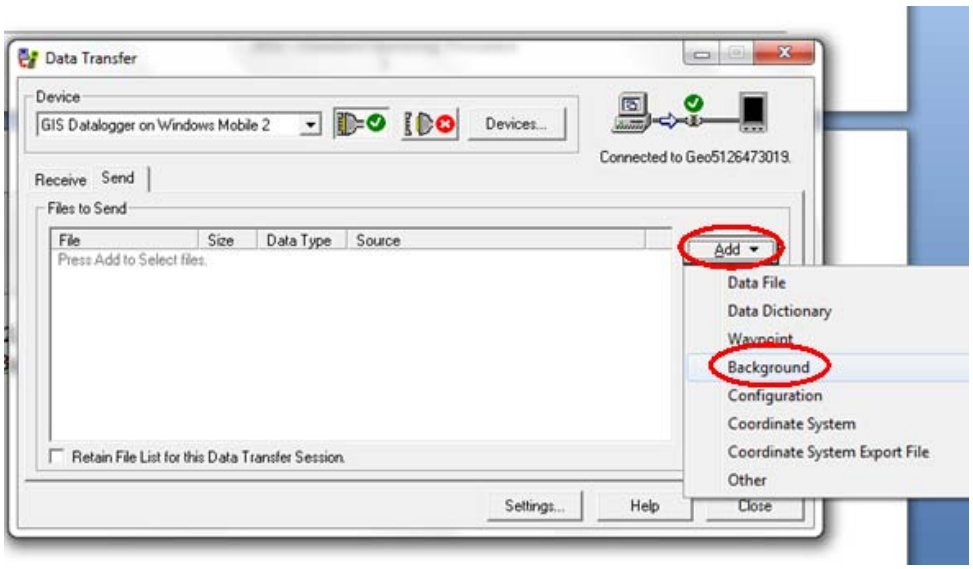
4.7.3 To Send Transferred Data

Once the "Data Transfer" window displays, select from the dropdown menu "Device", choose "GPS Datalogger", then click on the "Send" tab.



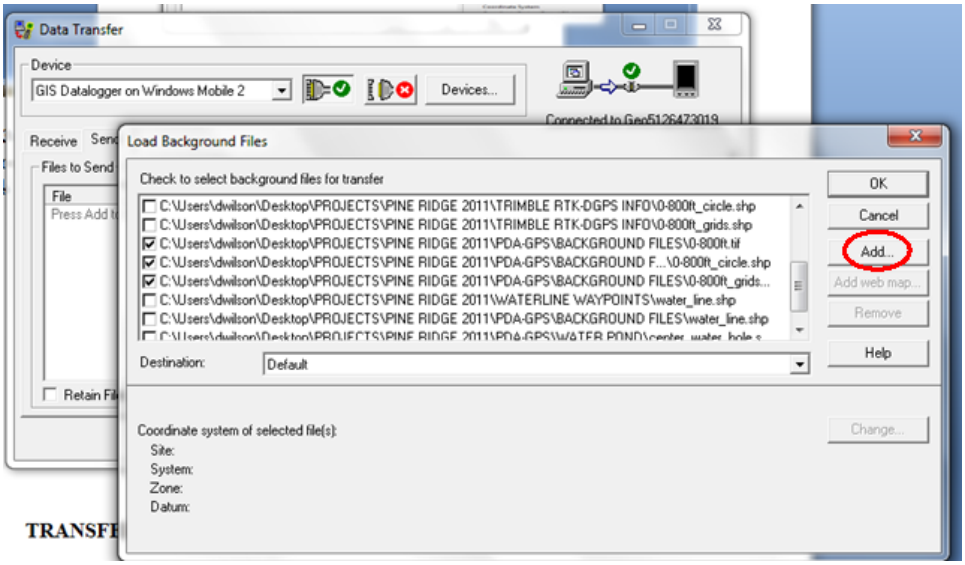
4.7.4 To Select Background Files

Click on the "Add" tab and from the dropdown menu select "Background". Background files will have the extension of .TIFF or .shp.



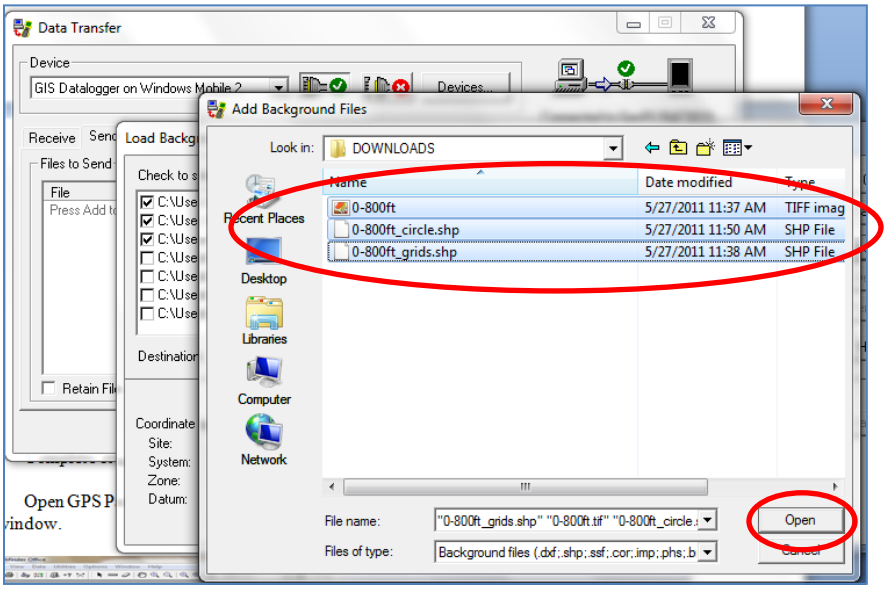
4.7.5 To Load Background Files

The "Load Background Files" screen will display. Select the appropriate boxes to the left, a checkmark should display on the background files to be loaded. If the desired background files do not display on the list, select the "Add" button.



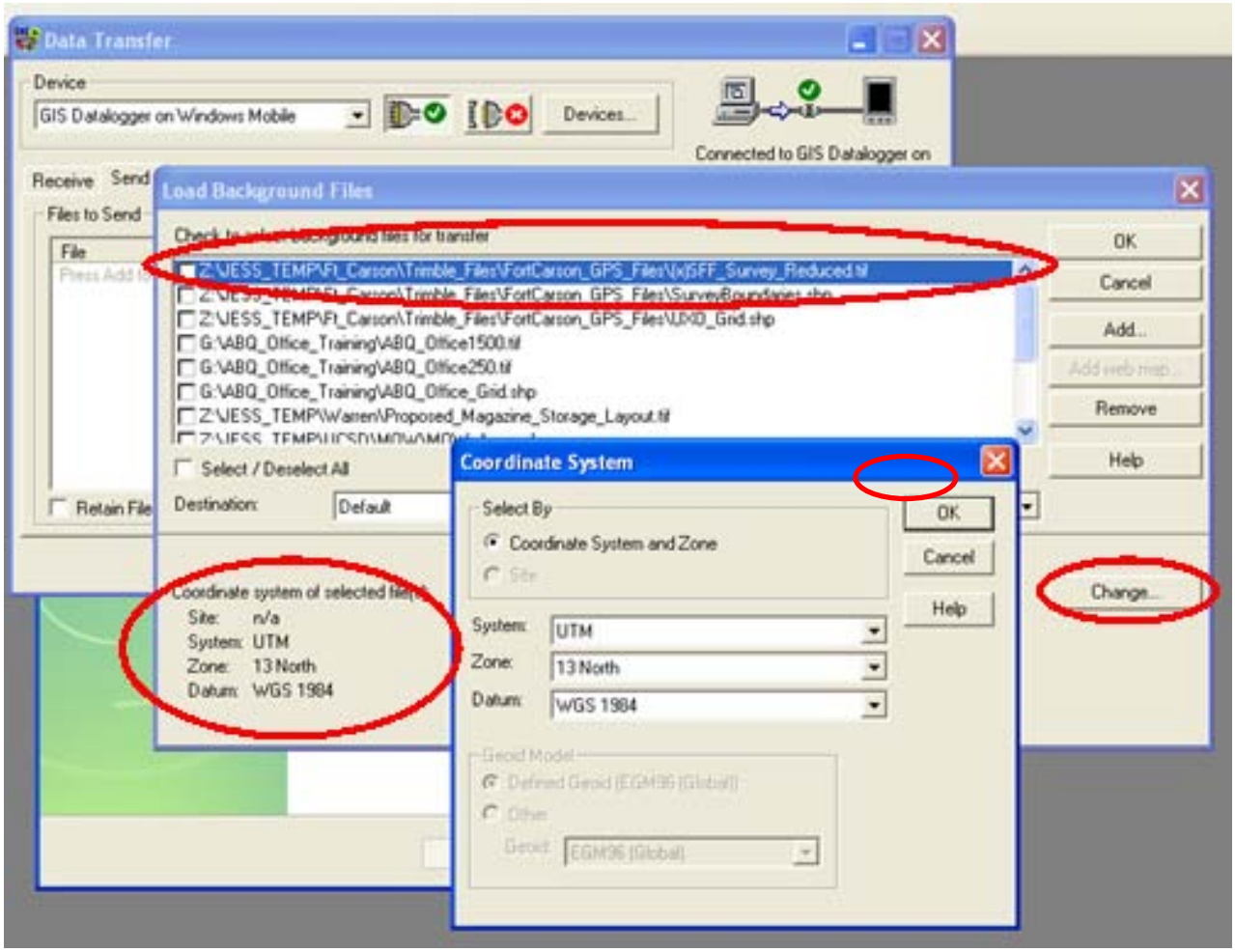
4.7.6 To Select Background Files

Navigate to the "GPS_Files" folder and select the desired background files to add, then click the "Open" button.



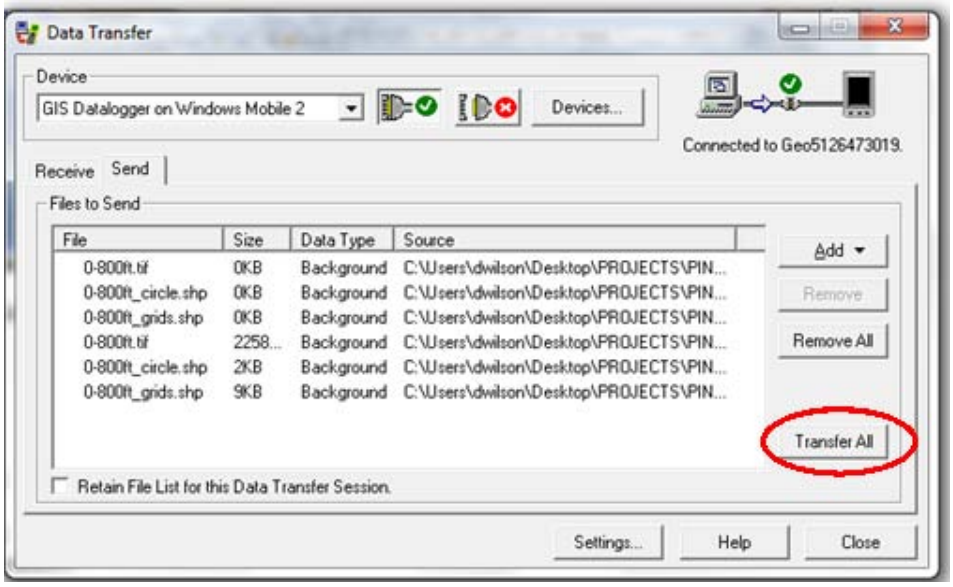
4.7.7 To Select a Coordinate System

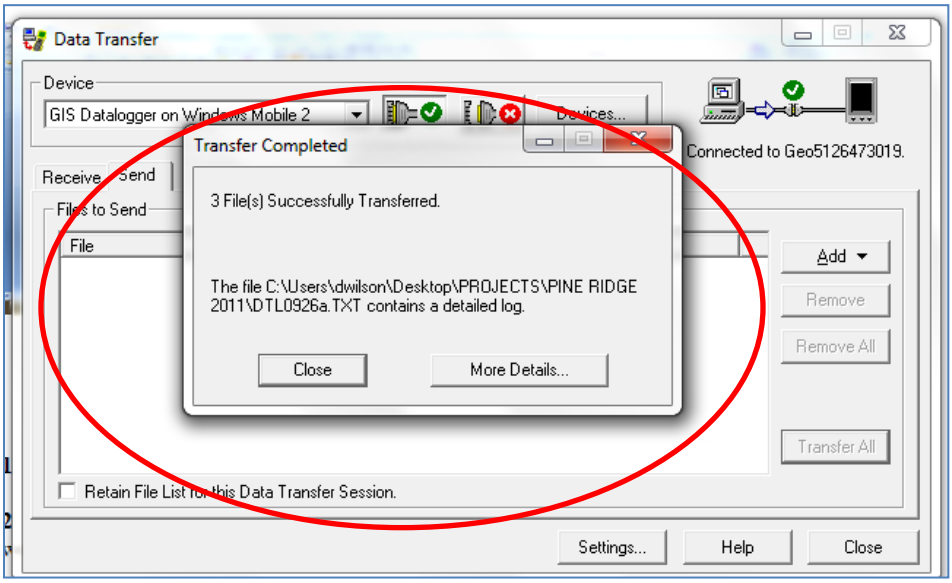
Each project will have a designated coordinate system. Set the coordinate system for each background file by selecting and clicking on the appropriate filepath. When the filepath has been selected it will be highlighted in blue. The coordinate system of the selected background file will be displayed at the bottom of the "Load Background Files" screen. To change or set the coordinate system values of a background file, select the filepath, then click the "Change" button on the right. After all the background file coordinate systems have been checked and set, select "OK" from the "Load Background Files" screen.



4.7.8 To Transfer Background Files

The "Data Transfer" window will display listing all the background files that will be transferred to the GPS. Click the "Transfer All" button. A "Transfer Completed" window will display when all background files have been successfully transferred to the GPS.





4.8 UPLOADING THE DATA DICTIONARY AND WAYPOINT FILES TO THE GPS

To upload the data dictionary and/or waypoint files, use the same procedures shown in steps 5.7.1 through 5.7.6. When step 5.7.4 is completed select either "Data Dictionary" or "Waypoint".

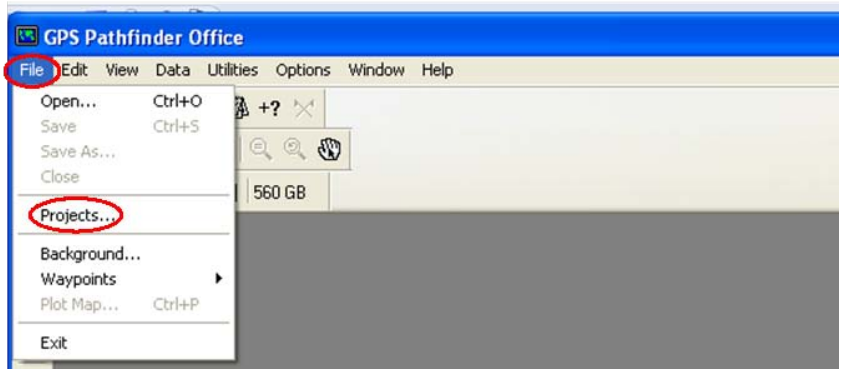
4.9 DOWNLOADING DATA FROM THE GPS TO THE COMPUTER

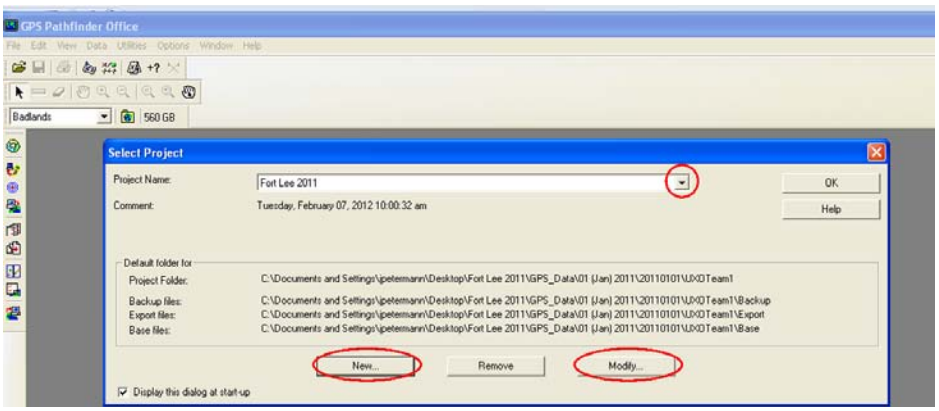
4.9.1 To Upload Background Files to the GPS

Complete step 5.7 above.

4.9.2 To Select a Project

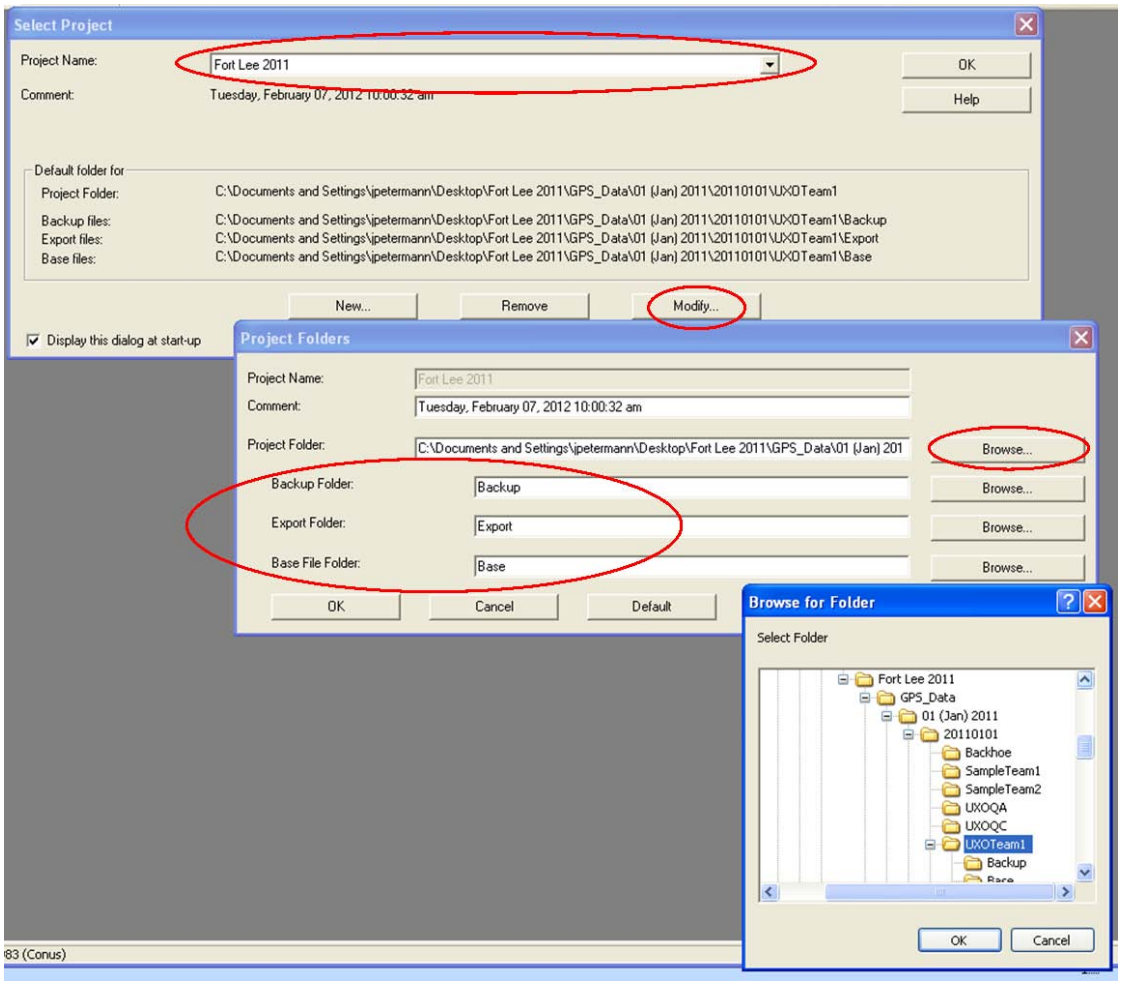
Open the GPS Pathfinder Office software. You will be prompted to the "Select Project" screen. From this screen a new project can be entered or modifed. If the "Select Project" screen does not display, from the top menu bar select "File", then from the dropdown menu select "Projects". To select an existing project, on the "Select Project" screen select from the choices in the "Project Name" menu. To enter a new project name, on the "Select Project" screen, select "New". To modify an existing project, on the "Select Project" screen, select "Modify".





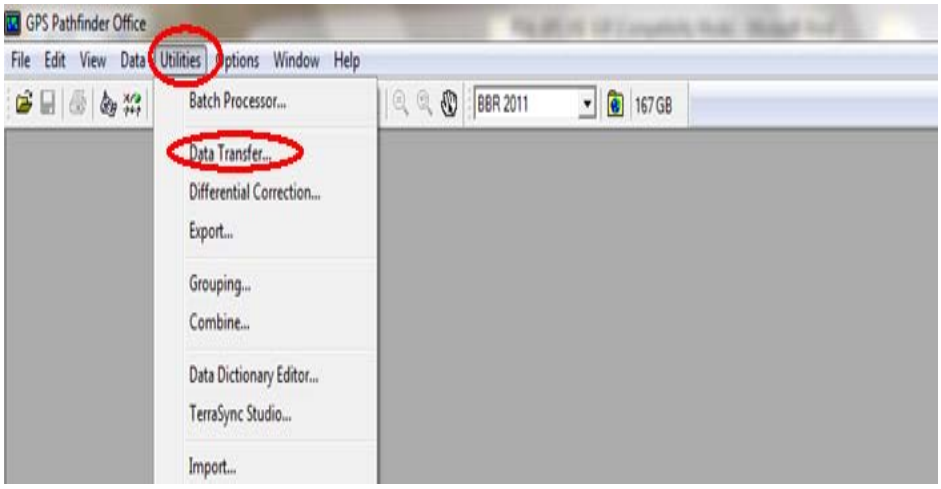
4.9.3 To Modify the Default Folder

The "Default" folder for the project will need to be modified for each GPS unit so that the data on the GPS is stored in the correct folder on the laptop or PC. Ensure the correct project is in the "Project Name" window. Select "Modify" on the "Select Project" screen. From the "Project Folder" screen, select "Browse", navigate to the applicable Team folder, then on the "Backup Folder" line, type "Backup"; on the "Export Folder" line, type "Export"; on the "Base File Folder" type "Base", select "OK". If prompted with a message "folder already exists", select "OK".



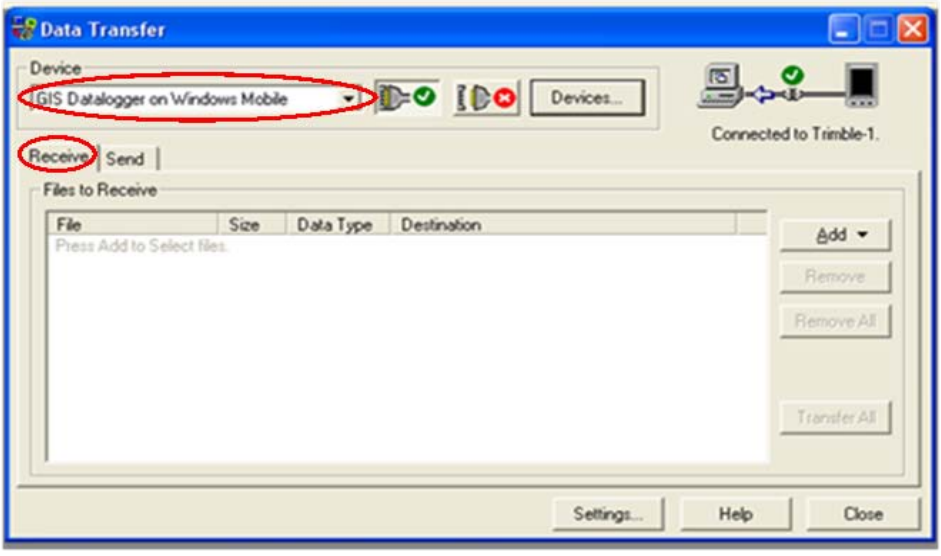
4.9.4 5.9.4 To Transfer Data

On the menu bar, click on “Utilities”, then select “Data Transfer”.



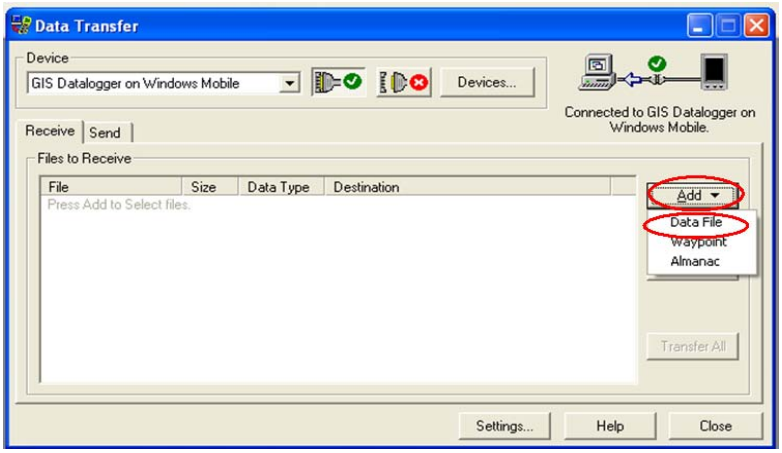
4.9.5 To Receive Data

In the window below “Device” “GPS Datalogger…” displays, click the “Receive” tab.



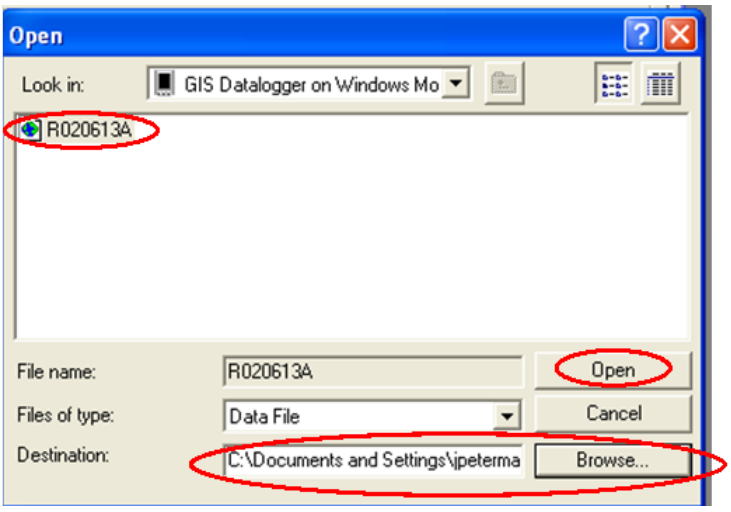
4.9.6 Select Files to Receive

In the "Files to Receive" window, select "Add", for the dropdown menu select "Data File"; the data files from the GPS will be listed in the "Files to Receive" window. Files that have not been transferred will be highlighted in blue.



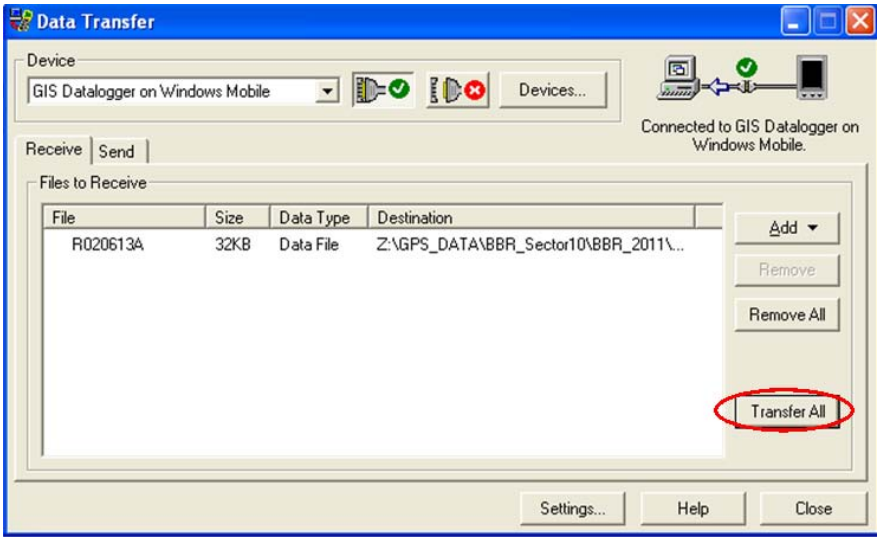
4.9.7 Select Files to Transfer

From the "Open" screen, select the GPS data files that need to be transferred to the laptop or PC. Double check to ensure the "Destination" line, has the correct "Field Activity" folder established during paragraph 5.1. Double click the "Open" button; the collected data files will be displayed in the Data Transfer window, paragraph 5.9.8.



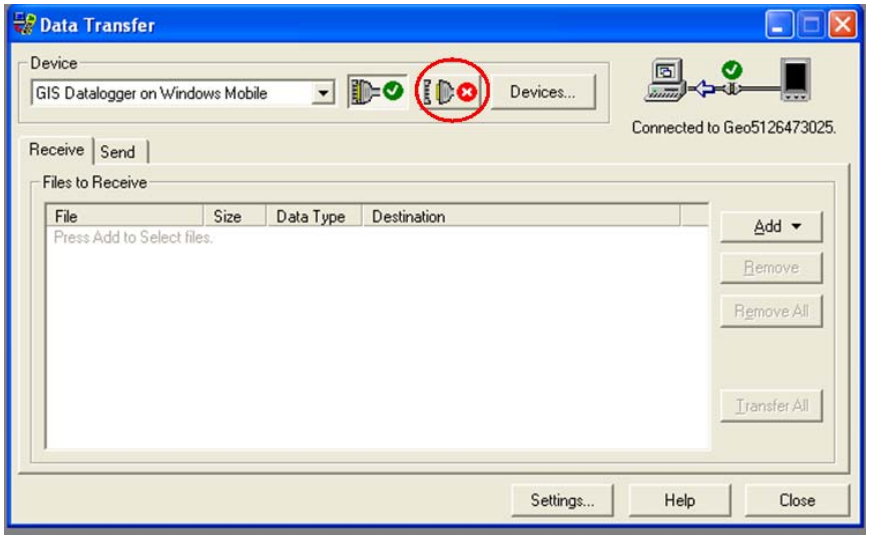
4.9.8 To Transfer Files

All files being transferred to the laptor or PC will be displayed in the "Data Transfer" screen. Select the "Transfer All" button. A "Transfer Complete" window will display with the number of files successfully transferred. Click the "Close" button if the number of files transferred is correct.



4.9.9 To Disconnect from the GPS

To disconnect the GPS, from the screen below, select the "Disconnect" radio button. Remove the GPS from of the cradle.

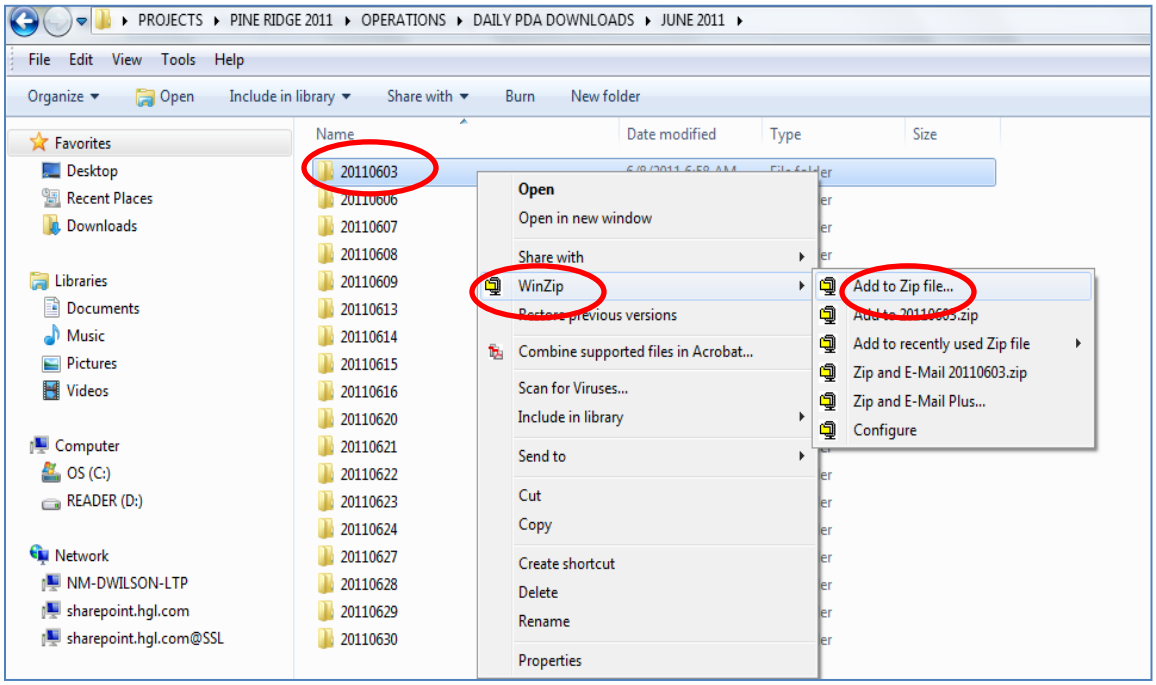


4.9.10 To Complete all GPS Units

Complete steps 5.9.3 to 5.9.9 above for all GPSs used for collecting and recording field data during the workday.

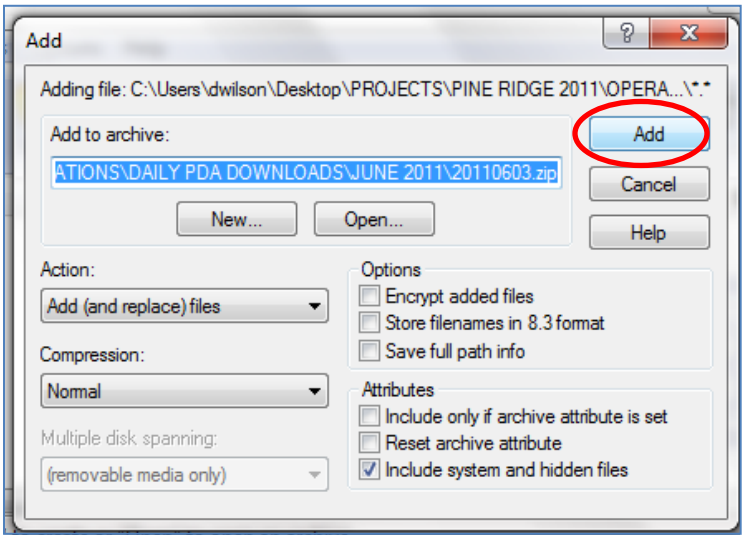
4.9.11 To Zip the Files

From the "Daily File Folder" menu, select the applicable file, then select "WinZip", then select "Add to Zip File".



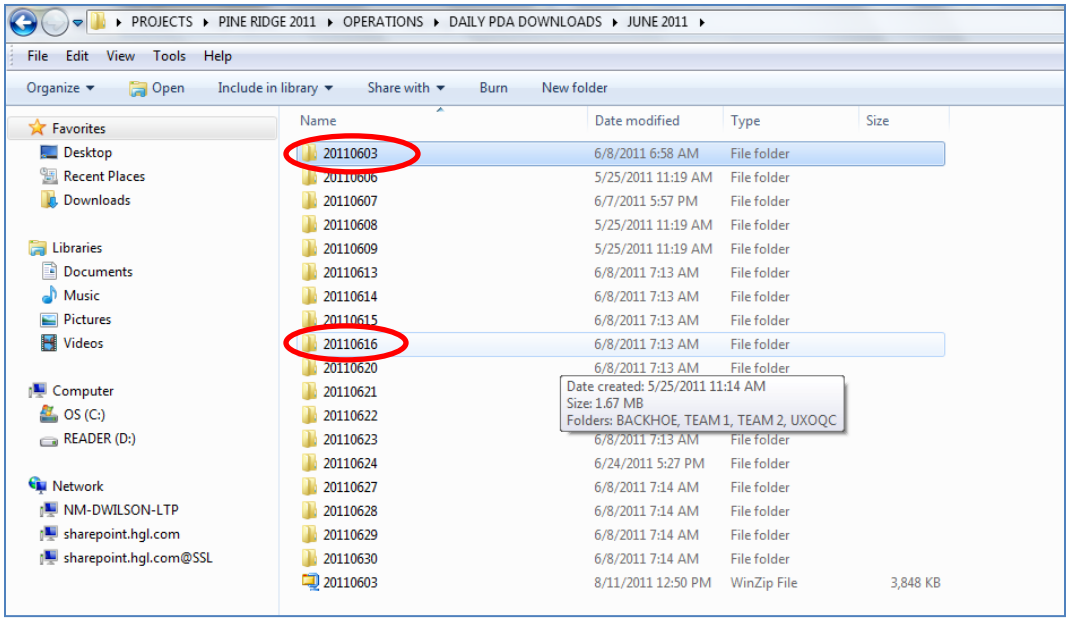
4.9.12 To Add Files

From the "Add" screen, select "Add" button when the "WinZip" window displays.



4.9.13 View Zipped Folder

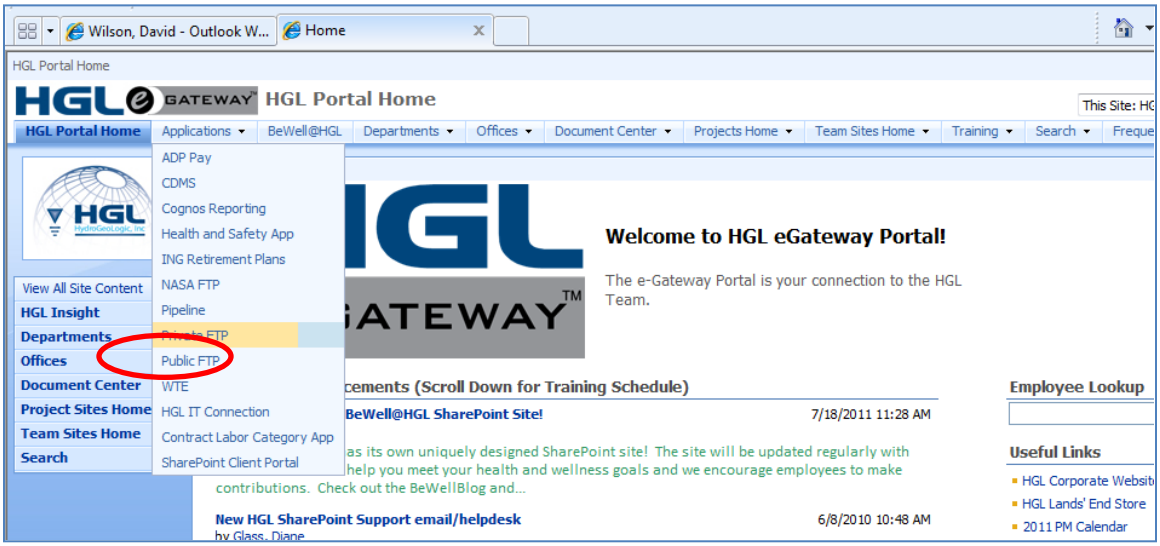
A "Zipped" copy of the daily file folder will be placed at the bottom of the monthly file folder.



4.10 UPLOADING DATA TO THE HGL SHAREPOINT PRIVATE FTP SITE

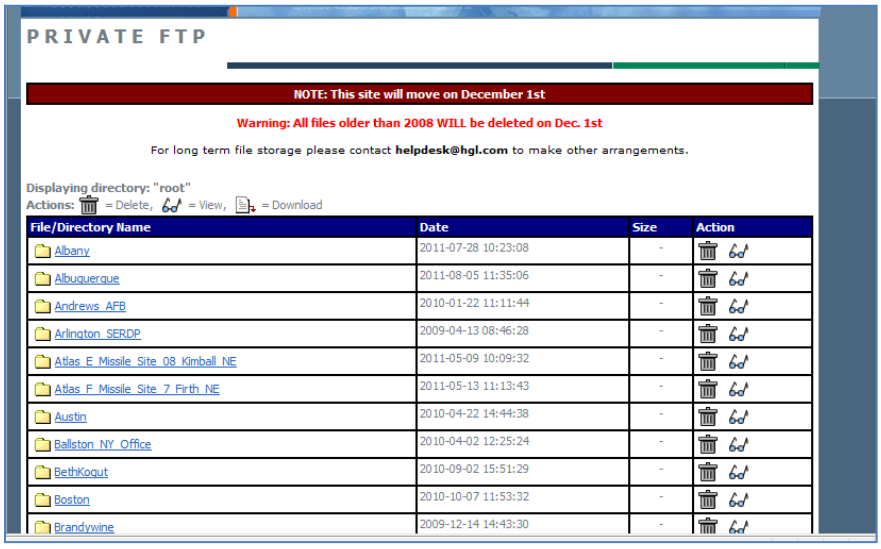
4.10.1 To Locate the Private FTP Site

On the HGL SharePoint website, navigate to the "Applications" tab, from the dropdown menu, select "Private FTP".



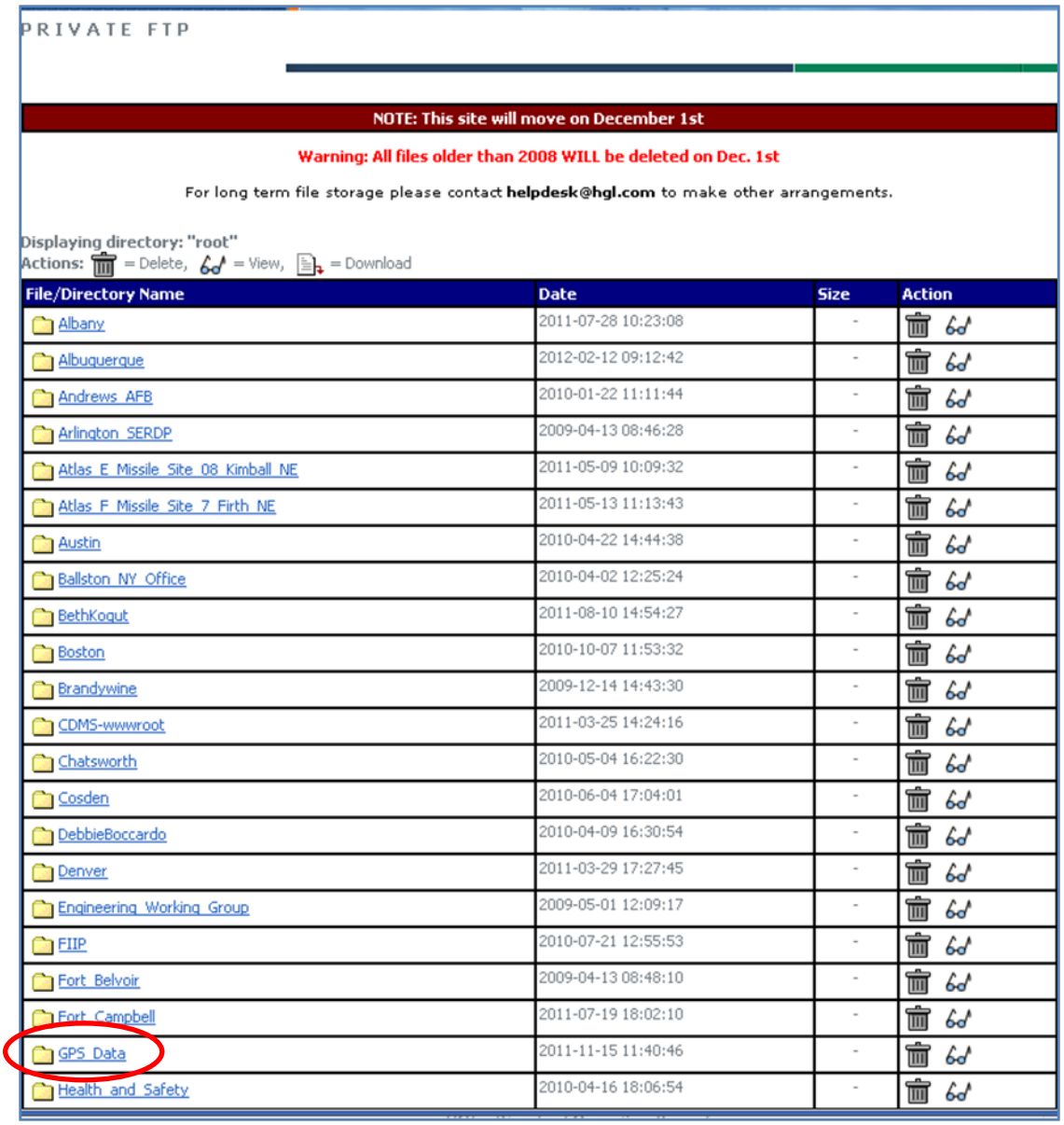
4.10.2 Enter ID and Password

Click on "Private FTP", then on the access screen enter your user name and password to access the site. The following screen will then display:



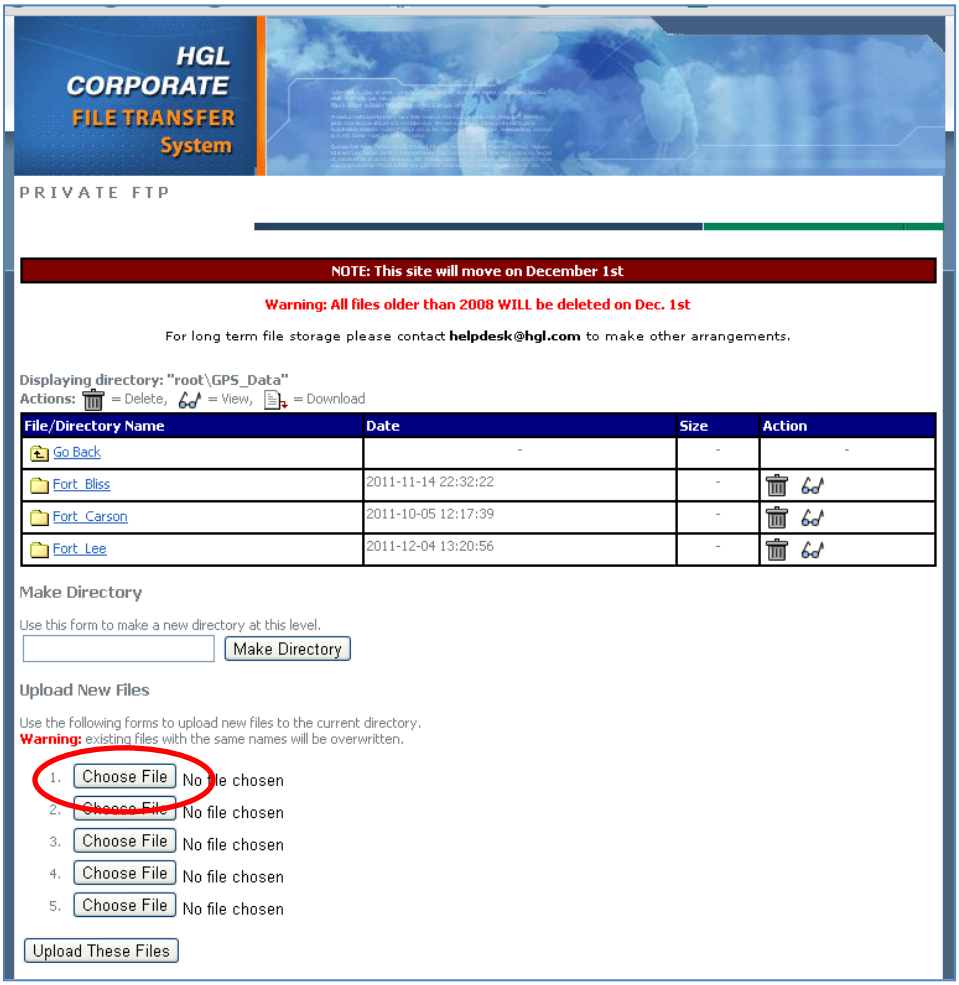
4.10.3 To Locate the Directory

On the "File/Directory Name " screen, locate and click on the "GPS_Data" file/directory.



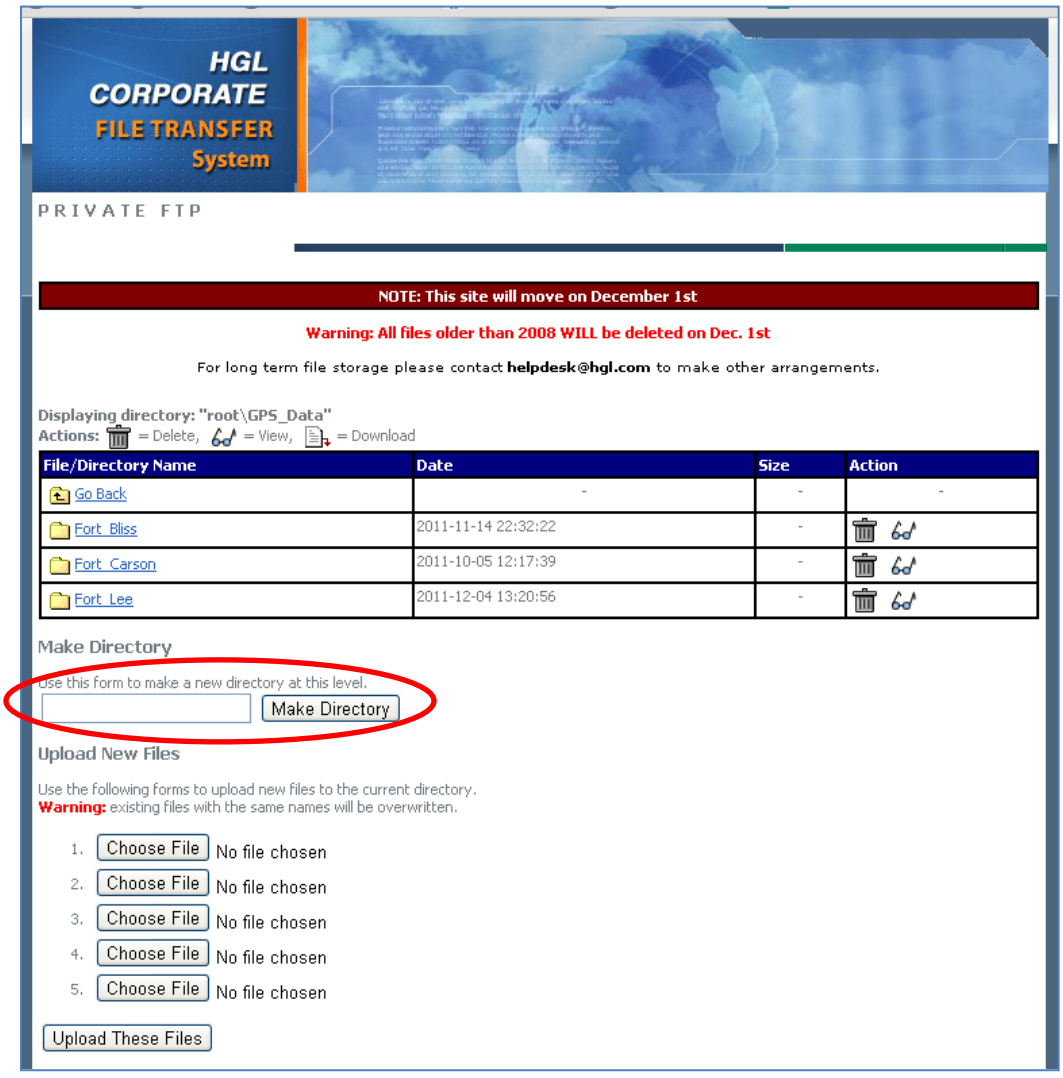
4.10.4 To Select the Directory

Within the "GPS_Data" file/directory, locate and click on your project file/directory. Individual folder/directories for all active projects are listed in alpha numeric order. All digital GIS data transfer(s) for the project will be listed in the project file/directory.



4.10.5 To Create a Directory

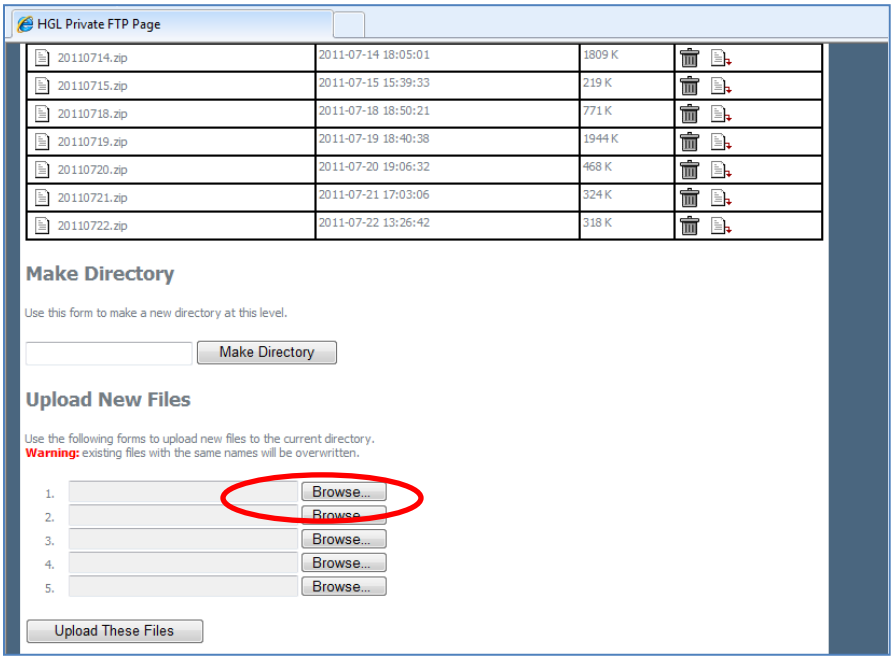
If a project is not listed in the "GPS Data" file/directory, scroll down to the "Make Directory" section and establish a folder for your project.



4.11 INSERTING AND UPLOADING THE FILES TO THE PRIVATE FTP SITE

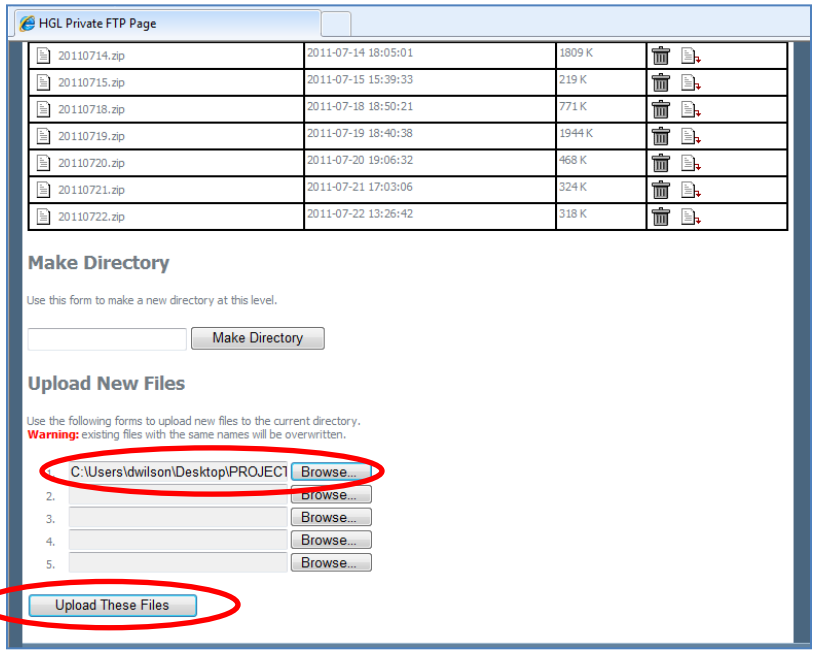
4.11.1 To Locate Files

Open the project file/directory and scroll down to the bottom of the page and click on the first line, then choose the "Browse" button.



4.11.2 To Insert a Zip File

Navigate to the project's GPS_ Data folder on your laptop or PC and insert the daily data file "zipped" in paragraph 5.3.12 above to be uploaded. Once all data files have been inserted, click on "Upload These Files" button on the very bottom of the page.



5.0 REFERENCES

All HGL SOPs and forms required for MMRP project field activities are available at: https://sharepoint.hgl.com/docs/Munitions%20Response/Forms/AllItems.aspx

ATTACHMENT 1

STANDARD OPERATING PROCEDURE ACKNOWLEDGEMENT

I have read, understand and agree to abide by the provisions as detailed in this SOP prepared by HGL. By signing below, I certify that I have had the opportunity to read and ask questions about this SOP, and that I understand the procedures, equipment and restrictions, and agree to abide by them. Failure to comply with this SOP may lead to disciplinary action and/or my dismissal from the work site and termination of employment.

Prior to the commencement of any work task associated with these SOPs, the SUXOS or Senior Unexploded Ordnance Technician assigned to the project will discuss additional procedures to be implemented, or any other site-specific conditions that may arise. All on-site personnel of HydroGeoLogic, Inc. must sign this Acknowledgment Form before performing the task covered by these SOPs.

Printed Name	Company	Signature	Date

ATTACHMENT 2

Trimble® GeoXH™

APPENDIX J

EXPLOSIVES SITE PLAN

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DEPARTMENT OF THEARMY
US ARMY DEFENSE AMMUNITION CENTER
1 C TREE ROAD
MCALESTER OK 74501-9053

JMAC-EST 12 May 2015

MEMORANDUM FOR Military Munitions Center of Expertise, (CEHNC-EMM/Mr. Zange/Mr. Barker), P.O. Box 1600, Huntsville, AL 35807-4301.

SUBJECT: Army and DDESB Approval, Explosives Site Plan (ESP), Former Conway Bombing and Gunnery Range, MRS-R01, Range II, MRS-R02, Range III, MRS-R03, Range IV; and MRS-R09 Machine Gun/Rifle Range, Horry County, SC

1. References:

a. Memorandum, Explosives Site Plan (ESP), Former Conway Bombing and Gunnery Range, MRS-R01, Range II, MRS-R02, Range III, MRS-R03, Range IV; and MRS-R09 Machine Gun/Rifle Range, Horry County, SC, January 2015.

b. DoD 6055.09-M, Ammunition and Explosives Safety Standards, date varies by Volume, Administratively Reissued 4 August 2010.

c. Memorandum, DDESB-PE, dated 4 May 2015, Subject: DDESB Approval of Explosives Site Plan, Remedial Investigation/Feasibility Study of Former Conway Bombing and Gunnery Range, Horry County, SC. (Encl).

2. The subject Explosives Site Plan, transmitted by reference 1.a, has been reviewed in accordance with reference 1.b. This memorandum with the enclose reference 1.c provides US Army Technical Center for Explosives Safety (USATCES) and Department of Defense Explosives Safety Board (DDESB) final approval. This approval supersede previous submissions for the Former Conway Bombing and Gunnery Range Munitions Response Sites.

3. Any changes that increase risk or hazard will require additional approval; an Amendment to this Explosives Site Plan must be submitted to USATCES and DDESB for review and approval. This approval and all other stipulation and requirements will be made part of the administrative record for the site.

JAMC-EST
SUBJECT: Army and DDESB Approval, Explosives Site Plan (ESP), Former Conway Bombing and Gunnery Range, MRS-R01, Range II, MRS-R02, Range III, MRS-R03, Range IV; and MRS-R09 Machine Gun/Rifle Range, Horry County, SC

4. Point of contact for this submission is the undersigned, email: usarmy.mcalester.usamc.list.dac-est-siteplan@mail.mil

PAUL A. CUMMINS
Chief, Risk Management Division,
US Army Technical Center for Explosives Safety

CF(w/Encl):
Office of the Director of Army Safety (Mr. Patton), Building 1456, 9351 Hall Road, Fort Belvoir, VA. 22060-5860

Office of the Deputy Assistant Secretary of the Army for Environment, Safety, and Occupational Health, Special Assistant for Munitions, DASA-DESOH (Mr. King), 110 Army Pentagon, Washington, DC 20310-0110

DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD
4800 MARK CENTER DRIVE, SUITE 16E12
ALEXANDRIA, VIRGINIA 22350-3606

MAY 04 2015

DDESB-PE

MEMORANDUM FOR DIRECTOR, U.S. ARMY DEFENSE AMMUNITION CENTER
ATTENTION: JMAC-EST

SUBJECT: DDESB Approval of Explosives Site Plan, Remedial Investigation/Feasibility Study of Former Conway Bombing and Gunnery Range, Horry County, SC

References: (a) DAC JMAC-EST Memorandum of 10 April 2015, Subject: Request DDESB Approval, Explosives Site Plan (ESP), Former Conway Bombing and Gunnery Range, MRS-R01, Range II, MRS-R02, Range III, MRS-R03, Range IV; and MRS-R09 Machine Gun/Rifle Range, Horry County, SC, January 2015.

(b) DoD 6055.09-M, DoD Ammunition and Explosives Safety Standards, date varies by volume

(c) DDESB-PE Memorandum of 27 October 2009, Subject: DDESB Approval of Explosives Site Plan (ESP), Munitions and Explosives of Concern, Military Munitions Response Program (MMRP) Remedial Investigation/ Feasibility Study (RI/FS) for Conway Bombing and Gunnery Range, Horry County, SC

(d) DDESB TP-15, Approved Protective Construction, Revision 3, May 2010

(e) DDESB-PD Memorandum of 22 May 2014, Subject: Revision of DDESB Approval for Use of Sandbags for Mitigation of Fragmentation and Blast Effects Resulting from the Intentional Detonation of Munitions

The Department of Defense Explosives Safety Board (DDESB) Staff has reviewed the subject explosives site plan (ESP) forwarded by reference (a) against the requirements of reference (b). Based on the information provided, approval is granted for removal and treatment of material potentially presenting an explosive hazard (MPPEH) and munitions and explosives of concern (MEC) at Former Conway Bombing and Gunnery Range (BGR), Horry County, SC. This approval is based on the following:

a. The efforts addressed in this ESP involve manual unintentional detonation operations (to include mechanized unintentional detonation operations employing anomaly avoidance) and intentional detonations supporting munitions response actions within Munitions Response Site (MRS)-R01, Range II; MRS-R02, Range III; MRS-03, Range IV; and MRS-09, Machine Gun/Rifle Range (MG/RR).

b. The DDESB acknowledges, as noted in reference (a), that munitions response actions have occurred at MRS-R01, MRS-R02, and MRS-R03 with DDESB approval. Consequently, this ESP serves to zero-base all previous actions and the DDESB waives the requirement to submit after action reports for DDESB-approved ESP, reference (c), and considers those actions closed.

c. The Former Conway BGR is currently owned by private and public groups. The developed portions are used for recreational (golf courses), residential, and commercial purposes. The undeveloped portions are used primarily for hunting and timber foresting. The future land use is projected to remain similar to the current usage with additional residential development planned.

d. The results of this ESP will be used to prepare an explosives safety submission per reference (a).

e. The attached Table lists the munition with the greatest fragmentation distance (MGFD) for the four MRSs; the team separation distance (TSD); the minimum separation distance (MSD) for unintentional detonations for nonessential personnel; and the MSD for intentional single in-grid detonations for all personnel.

f. Collection points and consolidated shots are authorized provided the Army ensures usage of reference (d), paragraph C6.2.7.5.

g. The use of sandbags and earth tamping is authorized as an engineering control for intentional detonations involving the MEC identified in reference (a) provided the Army ensures usage per reference (d), paragraph C6.2.7.5.

h. The use of double sandbags is authorized as an engineering control for intentional detonations involving the MEC identified in reference (a) provided the Army ensures usage per reference (e).

i. One BATF Type II aboveground magazine is approved to store demolition materials up to 100 pounds net explosive weight of hazard division (HD) 1.1 and mission essential quantities of HD 1.4. The applicable inhabited building distance is 658 feet (ft) and the public traffic route distance is 395 ft.

j. Demolition materials, per reference (a), may be delivered as needed.

k. Prior to initiation and through completion of on-site explosives operations, all nonessential personnel will be evacuated and prevented from entering any area/facility encumbered by the MSD required for the operation being conducted, or explosives operations will be suspended if nonessential personnel enter the MSD.

l. MPPEH will be inspected and classified as material documented as safe prior to release to the public.

If changes occur during or after completion of this effort that could increase explosive hazards to site workers or the public due to the presence of military munitions at the site, an amendment to this ESP must be submitted to DDESB for review and approval.

The point of contact for this action is Ms. Kristene Bigej, (571) 372-6705, DSN 372-6705, E-mail address: kristene.a.bigej.civ@mail.mil.

Attachment
As stated

THIERRY L. CHIAPELLO
Executive Director

TABLE

MRS/MRA	MGFD	TSD[1] (ft)	MSD[2] (ft) unintentional detonation	MSD[3] (ft) intentional detonation
MRS-R01, Range II	100-pound M38A2 Practice Bomb	44	44[4]	357[4]
MRS-R02, Range III & MRS-R09, MG/RR	250-pound M57 (TNT filled) Bomb	202	536	2,513
MRS-R03, Range IV	20-pound M41 (Composition B filled) Frag Bomb	59	67	1,707

[1] For essential personnel for manual and mechanized operations employing anomaly avoidance based on K40 of MGFD
[2] For nonessential personnel for manual and mechanized operations with anomaly avoidance based on the HFD of the MGFD
[3] For all personnel for intentional single in-grid detonations based on the MFD of the MGFD
[4] Non-fragmenting item, use K40 and K328 vice HFD and MFD

Attachment

EXPLOSIVES SITE PLAN

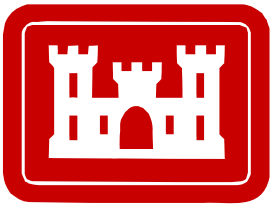
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

FORMER CONWAY BOMBING AND GUNNERY RANGE: MRS-R01, Range II; MRS-R02, Range III; MRS-R03, Range IV; and MRS-R09, Machine Gun/Rifle Range

HORRY COUNTY, SOUTH CAROLINA
PROJECT W912DY-10-D-0023
DELIVERY ORDER 0018

FEBRUARY 2015

Prepared For



U.S. Army Corps of Engineering and Support Center, Huntsville
4820 University Square
Huntsville, AL 35816-1822

Prepared By

HydroGeoLogic, Inc.
1107 Sunset Hills Road, Suite 400
Reston, Virginia 20190

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EXPLOSIVES SITE PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA

1.0 SITE

a. Name: Former Conway Bombing and Gunnery Range

b. State: South Carolina

2.0 ANTICIPATED START DATE

October 2015

3.0 PURPOSE

a. This Explosives Site Plan (ESP) is being submitted to support munitions response services during the Remedial Investigation (RI)/Feasibility Study (FS) at four muntions response sites (MRSs) at the Former Conway Bombing and Gunnery Range (BGR): MRS-R01, Range II; MRS-R02, Range III; MRS-R03, Range IV; and MRS-R09, Machine Gun (MG)/Rifle Range (RR).

b. This ESP will supercede the "*Explosives Site Plan, Former Conway Bombing and Gunnery Range Ordnance and Explosive (OE) Response Action for Remedial Investigation/Feasibility Study (RI/FS) Horry County, South Carolina"*, which was approved by the Department of Defense Explosives Safety Board (DDESB) on 29 October 2009.

c. The RI/FS is being performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. The RI/FS is being conducted to collect the information needed to design the required munitions response and to prepare, as appropriate, an Explosive Safety Submission for the selected response.

d. This ESP clarifies that unexploded ordnance (UXO) personnel, qualified in accordance with DDESB Technical Paper (TP) 18, *Minimum Qualifications for UXO Technicians and Personnel*, will perform all munitions and explosives of concern (MEC) activities at the site.

4.0 SITE BACKGROUND AND CURRENT CONDITIONS

This ESP addresses four MRSs within the Former Conway BGR. Each MRS has a historical MRS boundary, as illustrated in Figure 1. However, based on the findings of recent site investigations and project delivery team consensus, the historic MRS boundary will not be sufficient to adequately characterize the anticpated MEC contamination in the vicinity of MRS-R01, MRS-R02 and MRS-R03. Therefore, for the purposes of the RI/FS investigation, the

areas of investigation for MRS-R01, MRS-R02, and MRS-R03 have been extended beyond the historical MRS boundary. The expanded areas of investigation boundaries are illustrated on Figure 1.

The Former Conway BGR is currently owned by private as well as public groups. The International Paper Realty Corporation and the South Carolina Department of Natural Resources are the largest land owners. The developed portions of the Former Conway BGR are used for recreational (golf courses), residential and commercial purposes. The undeveloped portions are used primarily for hunting and timber foresting. The future land use is projected to remain similar to the current usage. Additional residential development is planned.

The site background for each MRS is described below:

a. MRS-R01, Range II

(1) MRS-R01, Range II, is located in the northwest section of the Former Conway BGR. The MRS is composed of approximately 649 acres.

(2) The historical usage of MRS-R01, Range II, was practice bombing, including high- and medium-altitude bombing, skip bombing, parafrag bombing, and rocket firing. An Engineering Evaluation/Cost Analysis (EE/CA) investigation, removal action and an remedial investigation have been performed at the MRS. No MEC have been recovered from the MRS. Munitions debris (MD) related to 100-pound (lb) practice bombs; 20-lb bomb rack; an expended .50-caliber cartridge; bomb lugs; and small arms ammunition (SAA) have been recovered.

b. MRS-R02, Range III

(1) MRS-R02, Range III, is located in the southern section of the Former Conway BGR. The MRS is composed of approximately 1,961 acres. MRS-R02 overlaps the northern boundary of MRS-R09.

(2) The historical usage of MRS-R02, Range III, was high- and medium-altitude bombing, skip bombing, and rocket firing including demolition bombing, dive bombing, strafing, rocket firing, and incendiary bombing. Historical evidence at this MRS indicates that 100-lb practice bombs and 2.25-inch rockets were used. Numerous investigations and removal actions have been performed at the MRS since 2003. Recovered MEC include: MK II 1.1-inch projectile; M38A2 100-lb sand-filled practice bombs; M48 practice 20-lb fragmentation bomb; practice 5" HVAR warhead; 5-inch ZUNI rocket warhead; 2.75-inch rocket; M69 6-lb incendiary bomb; fuzes (M16 fuze burster; M16 igniter; AN-M16 white phosphorus igniter); and M57 250-lb general purpose bomb. Recovered MD include: 2.25-inch rockets; 4-lb incendiary bombs; 20-lb fragmentation bomb; and 100-lb practice bomb and SAA.

c. MRS-R03, Range IV

(1) MRS-R03, Range IV, is located in the eastern section of the Former Conway BGR. The MRS is composed of approximately 886 acres.

(2) The historical usage of MRS-R03, Range IV, was for practice bombing, including medium-altitude bombing. During the EE/CA in 2003, the following MD items were recovered: 4-lb incendiary bombs; 20-lb fragmentation bombs; and 100-lb practice bomb.

d. MRS-R09, Machine Gun/Rifle Range

(1) MRS-R09, MG/RR, is located in the southern section of the Former Conway BGR. The MRS is composed of approximately 2,503 acres. MRS-R09 overlaps the southern boundary of MRS-R02. Historical documentation indicates that activities at the MG/RR were limited to firing bomber turrets and MGs in a ground-mounted mode. The historical use of the range was reported as exclusively for small arms training activities, such as basic rifle marksmanship training. Private cleanups near MRS-R09 have recovered MEC items ranging from 37-mm projectiles to 2.36-inch rockets. Due to lack of Rights-of-Entry for this MRS, it was not characterized for MEC or MC during the 2012 RI.

5.0 EXECUTING AGENCIES

- U.S. Army Engineering and Support Center, Huntsville (USAESCH)
- U.S. Army Corps of Engineers (USACE), Charleston District
- South Carolina Department of Health and Environmental Control
- HydroGeoLogic, Inc. (HGL)

6.0 SCOPE OF INVESTIGATIVE/CHARACTERIZATION ACTION

a. A surface sweep and a manual subsurface investigation will be conducted to identify MEC within each MRS. The subsurface investigation may be supported by mechanical equipment to remove buffers layers of soil that are greater than 12 inches from an anomaly. There will be no intentional contact with MEC with mechanized equipment.

b. Table 6-1 identifies the MRS to be investigated, the acreage of the expanded investigation area, and the type of munitions response action to be performed.

Table 6-1
MRS Areas

MRS	Munitions Response Action	Historical MRS Acreage	RI/FS Expanded Investigation Acreage[1]	Acreage to be Investigated[2]
MRS-R01, Range II	Surface and Subsurface RI	649	2,210	1,561
MRS-R02, Range III [3]	Surface and Subsurface RI	1,961	4,153 [3]	1,918
MRS-R03, Range IV	Surface and Subsurface RI	886	2,056	1,170
MRS-R09, MG/RR [3]	Surface and Subsurface RI	2,503	0[4]	680[4]

[1] The RI/FS Expanded Investigation Acreage includes the Historical MRS Acreage.

[2] The Acreage to be Investigated excludes acreage covered by previous investigations and property not include in the RI/FS scope (i.e., landfill, residential areas, golf courses).

[3] For the munitions response operations, MRS-R02 and MRS-R09 will be grouped by one boundary since the areas have overlapping acreage and share the same munition with the greatest fragmentation distance. The combined acreage of MRS-R02 and MRS-R09 is 5,751 acres (Figure 4).

[4] The historical MRS-R09 boundary (2,503 acres) was not expanded for the RI/FS. For the purposes of MRS distinction in the RI/FS, the overlapping portion of MRS-R09 (approximately 905 acres) that lies within MRS-R02's expanded investigation area will be evaluated as part of MRS-R02. Of the remaining 1,598 acre portion of MRS-R09, approximately 680 acres will be investigated during the RI/FS.

7.0 SAFETY CRITERIA

a. The munition with the greatest fragmentation distance (MGFD) for each MRS is identified in Table 7-1. If MEC with a greater fragmentation distance is encountered within the MRS, the minimum separation distance (MSD) will be adjusted in accordance with DDESB TP 16, operations will continue, and an amendment to the ESP will be submitted for approval. A copy of this document will be available on site. Items with smaller fragmentation distances may be found during the RI/FS. Demolition of these items may be completed using the item-specific minimum separation distances and engineering controls in accordance with DDESB TP 16 Fragmentation Database. See Appendix B for Fragmentation Data Sheets.

b. The MSD restrictions from MEC areas to non-essential personnel will be applied during all MEC operations. The MSD identified by USAESCH for the four MRSs is presented in Table 7-1. Preliminary site work such as surveying, laying grid lanes and anomaly detection do not require the establishment of a MSD for Quantity Distance (Q-D) purposes. Essential personnel are defined as those on-site contractor and Department of Defense (DoD) personnel required to participate in the MEC removal, along with those approved and authorized visitors. All other personnel are non-essential personnel. The outer boundaries of the MSD arcs are depicted on the Q-D map on Figures 2-4. The team separation distance at this site will be the K40 overpressure distance shown in Table 7-1.

c. Positive control of the exclusion zone (EZ) based on the MSD will be maintained at all times that MEC operations are being conducted. Prior to beginning MEC operations, the contractor will ensure that there are no non-essential personnel within the EZ. The contractor will ensure that the EZ remains clear of non-essential

personnel throughout the MEC operations. Any occupied building or public roadways in the MSD area during MEC-related operations will be evacuated and/or blocked to prevent non-essential personnel from entering during the conduct of MEC operations. In addition, spotters may be used to stop work when non-essential personnel enter the MSD on a roadway during the conduct of MEC operations.

Table 7-1
Minimum Separation Distances

		MSD (feet) [1]			
		Unintentional Detonations		Intentional Detonations	
MRS	MEC	Team Separation Distance (K40)	Hazard Fragment Distance (HFD)	Without Engineering Controls	Using Single Sandbag Mitigation
MRS-R01, Range II	100lb M38A2 Practice Bomb[2]	44	44	357	N/A[3]
MRS-R02, Range III/ MRS-R09, MG/RR	250lb M57 Bomb (TNT Filled)	202	536	2,513	N/A[3]
MRS-R03, Range IV	20 lb M41 Frag Bomb (Composition B)	59	67	1,707	125

Notes:
[1] See Appendix B for DDESB Fragmentation Data Review Forms dated 21 August 2014.
[2] The 100lb M38A2 practice bomb is a non-fragmenting item. Therefore, the K40=HFD; the K328=MFD.
[3] Sandbag mitigation is not permitted per the DDESB Fragmentation Data Review Form, therefore, the Buried Explosion Module (BEM) will be implemented.

8.0 METHODS OF DISPOSAL

a. All recovered MEC deemed by the HGL Senior Unexploded Ordnance Supervisor (SUXOS) and the UXO Safety Officer (UXOSO) jointly as acceptable-to-move may be relocated within the MRS in which it was found, away from buildings and public transportation routes as necessary for disposal. Consolidated shots are planned for this project.

b. All recovered MEC will be destroyed the same day found. In the event that MEC items cannot be disposed of on the same day because of weather conditions (lightning), the MEC will be guarded until disposal operations can be conducted.

c. All explosive demolition operations will follow the procedures outlined in Technical Manual (TM) 60A-1-1-31, *EOD Disposal Procedures*, and Engineer Manual (EM) 385-1-97, *Explosives Safety and Health Requirements Manual*.

d. Sandbag mitigation may be implemented (if permitted) as the engineering control in accordance with HNC-ED-CS-S-98-7, *The Use of Sandbags for Mitigation of Fragmentation and Blast Effects Due to Intentional Detonation of Munitions*; USACE-MM-CX Safety Advisory, *Use of Jet Perforator During Intentional Detonation While Using Sandbag Mitigation for Engineering Controls*, dated 7 November 2011; and the DDESB Memorandum *Revision of DDESB Approval for Use of Sandbags for*

Mitigation of Fragmentation and Blast Effects Resulting from the Intentional Detonation of Munitions dated 22 May 2014. In addition to single sandbag mitigation, double sandbag mitigation is approved for items up to and including 81mm-diameter munitions that do not exceed the trinitrotoluene (TNT) net explosive weight (NEW) of 1.39 pounds. Tamping (single or multiple items) may be used in accordance with the procedures in DDESB TP 16 (BEM, version 6.3.2 or a later version if released by DDESB). These reports will be available onsite for all mitigation methods used.

e. Collection points are those areas used to temporarily accumulate MEC, determined to be acceptable to move by the SUXOS and UXOSO, pending destruction at the end of the day using consolidated shots. MEC items at collection points must be laid out as shown in *Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites*. The maximum NEW at a collection point will be limited such that the K40 overpressure distance for the total NEW does not exceed the HFD for the area.

f. MEC determined acceptable-to-move by the SUXOS and UXOSO may be consolidated. The USAESCH publication *Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites*, dated March 2000, will be used and a copy of this report will be available on site. The maximum NEW for a consolidated shot will be limited such that the K328 overpressure distance for the total NEW (including donor charges) does not exceed the maximum fragmentation distance- horizontal (MFD-H) for the intentional detonation.

g. Material Potentially Presenting an Explosive Hazard (MPPEH) procedures will be in accordance with DoD Instruction 4140.62 and EM 385-1-97. All MPPEH will be assessed and its explosives safety status determined and documented prior to transfer within the DoD or release from DoD control. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as Material Documented As Safe (MDAS) after a 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective.

h. On-call delivery of commercial explosives may be used. Explosives will be provided by a local vendor on an as-needed basis.

i. A Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) Type II unbarricaded magazine with an attached cap box may be used to store donor explosives. Three locations for siting the explosives storage magazine have been presented in Figure 1. The preferred location is to the north of R02 (Figure 5). Alternate locations are presented in Figures 6 and 7.

j. The magazine will be grounded in accordance with DoD 6055.09-M, Department of the Army Pamphlet (DA PAM) 385-64, National Fire Protection Agency (NFPA) 780 and EM 385-1-97. No more than 100 pounds NEW will be stored in each magazine. The inhabited building distance for this NEW quantity is 658 feet, and the public traffic route distance is 395 feet in accordance with DoD 6055.09-M, Table V3.E3.T2.

k. Before the explosives are stored, the magazine grounding will be tested and certified as acceptable in accordance with DA PAM 385-64, Chapter 12 (Ammunition and

Explosives Safety Standards). The magazine will be grounded using ¾ inch by 10 foot copper rods driven into the ground to 12 inches below grade. Two grounding rods will be placed at opposing corners in accordance with EM 1110-1-4009, Chapter 11.

l. The total maximum NEW stored in the magazine will not exceed 100 lbs Hazard Division (HD) 1.1 at any given time, and will be consist of commercial explosives used for demolition and disposal operations. These commercial explosives will have assigned DoD HD/storage compatibility groups and will be stored in accordance with DoD 6055.09-M, DA PAM 385-64, and local regulations. The magazine will be positioned in accordance with Engineering Pamphlet 1110-1-18 and Section 55.206 of ATFP 5400.7, ATF Explosives Law and Regulations (the use of ATF regulations are required by local authorities). The magazine will be secured behind a locked chain link fence in accordance with Army Regulation 190-11, Physical Security of Arms, Ammunition, and Explosives. All combustible materials will be cleared within 50 feet of the magazine. An alarm system will be installed, which will signal the SUXOS, Site Manager and Project Manager if a security breach occurs. Warning signs will be posted in accordance with local rules and regulations Donor explosives will be replenished based on rate of use and necessity during the project

m. The magazines are located on undeveloped portions of the Former Conway BGR. The traffic density at the preferred and alternate magazine locations is "low" as defined in DoD 6055.09-M Section V3.E3.1.2.1.1.5.3. The distance to the nearest public roads from each magazine is as follows:

- MRS-R02 and MRS-R09 (Preferred Location): 120 ft
- MRS-R01 (Alternate Location): 60 ft
- MRS-R03 (Alternate Location): 215 ft

9.0 MAPS

Refer to Appendix A for the maps. Figure 1 shows a general location map of the four MRSs, the expanded investigation areas, and magazine locations. Figures 2 through 4 illustrate the Explosive Safety Quantity Distances (ESQDs) for MRS-R01 (Range II), MRS-R03 (Range IV) and MRS-R02 and MRS-R09, respectively. Figure 5 presents the preferred location for the explosives storage magazine. Figures 6 and 7 present alternate locations for the explosives storage magazine.

APPENDIX A

MAPS

Figure 1 – General Location Overview
Figure 2 – MRS-R01 (Range II) ESQD Arcs
Figure 3 – MRS-R03 (Range IV) ESQD Arcs
Figure 4 – MRS-R02 (Range III) and MRS-R09 (Machine Gun/Rifle Range) ESQD Arcs
Figure 5 – Explosives Storage Magazine Location MRS-R02 (Range III) and MRS-R09 (Machine Gun/Rifle Range)
Figure 6 – Explosives Storage Magazine Location MRS-R01 (Range II)
Figure 7 – Explosives Storage Magazine Location MRS-R03 (Range IV)

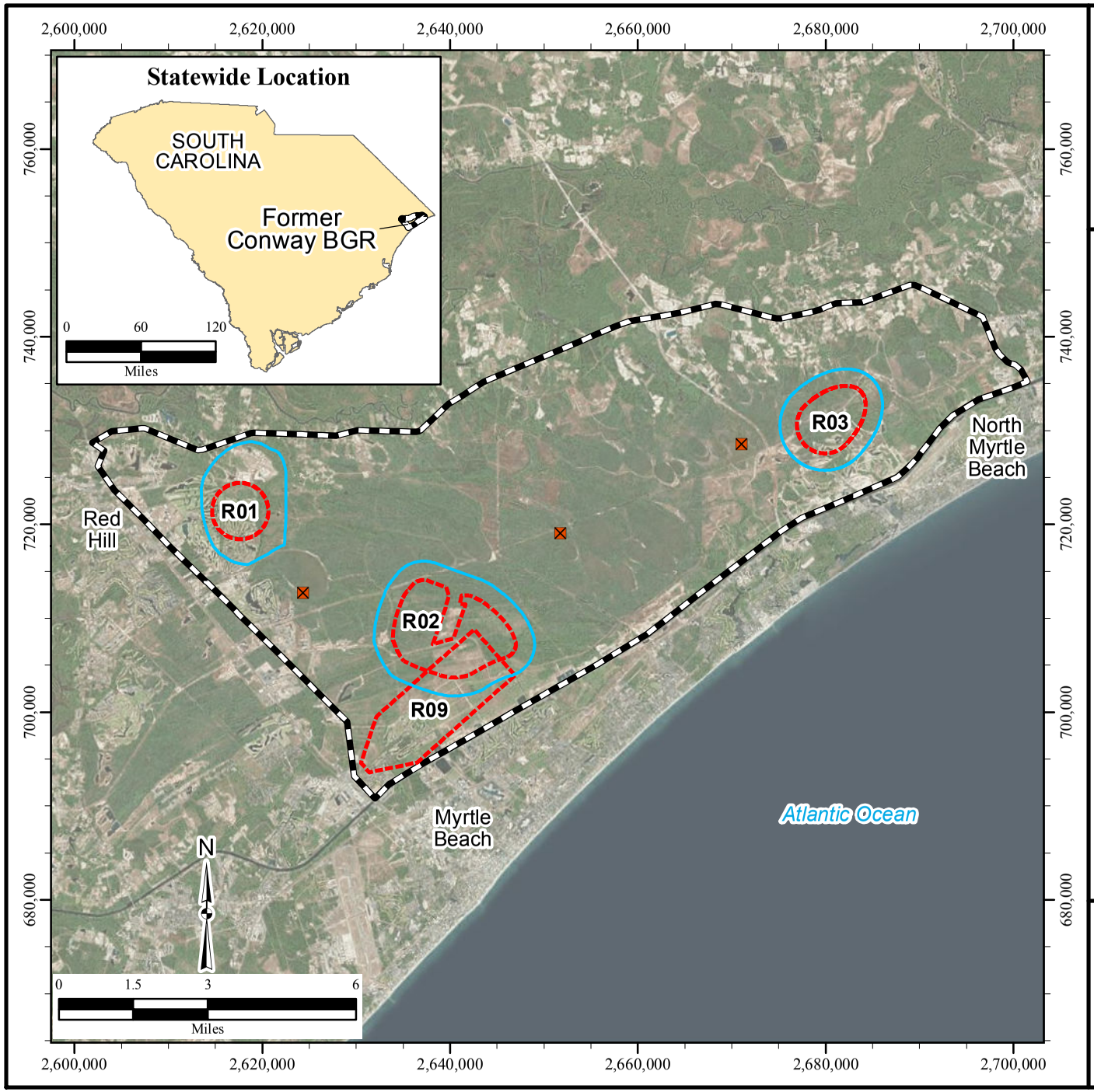

Figure 1
General Location Map
Former Conway BGR

Legend

- Explosives Storage Magazine
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area

Notes:
Only one magazine will be utilized during the RI, preferably the magazine adjacent to R02/R09. The other two magazines are presented as alternate locations.
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range

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Source: HGL, USGS, USACE
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HydroGeoLogic, Inc

HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

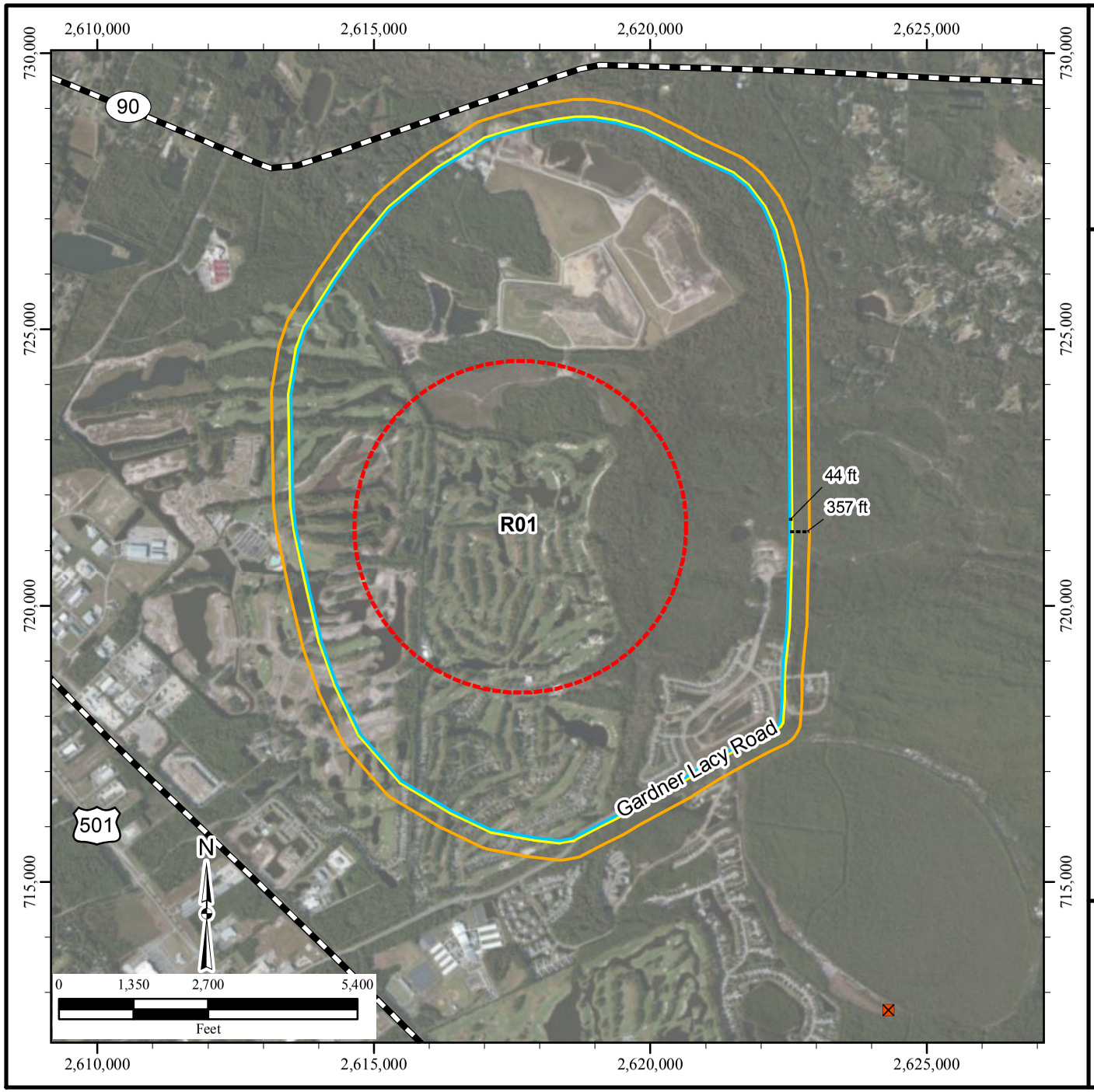

Figure 2
MRS-R01 (Range II)
ESQD Arcs
Former Conway BGR

Legend

- Explosives Storage Magazine
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area
- Hazardous Fragmentation Distance: 44 ft
- Intentional Detonation Distance without Engineering Controls: 357 ft

Notes:
MGFD: 100LB M38A2 Practice Bomb
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range
ESQD=explosives safety quantity distance
MGFD=munition with the greatest fragmentation distance
MRS=munitions response site

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Source: HGL, USGS, USACE
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HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

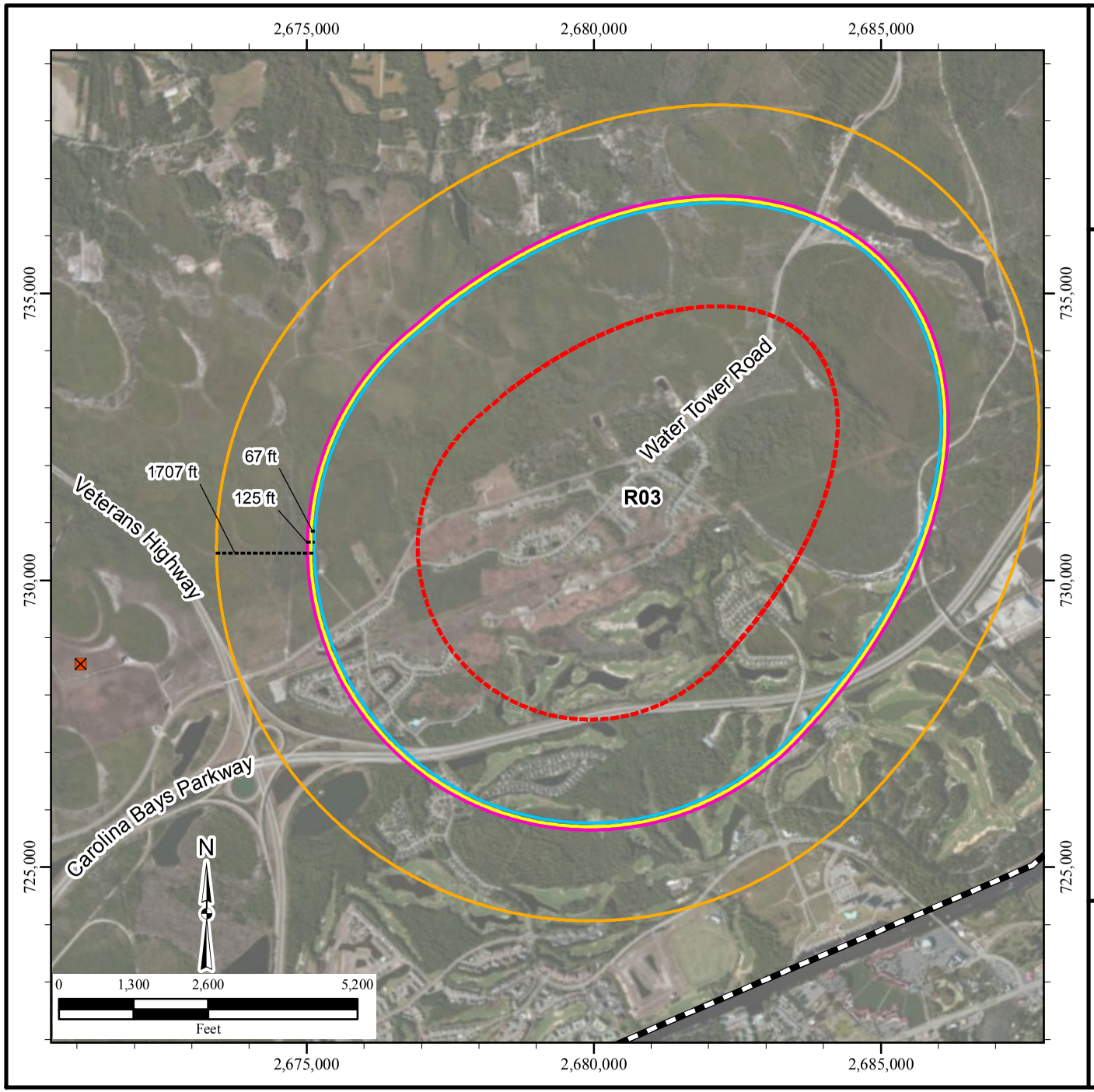

Figure 3
MRS-R03 (Range IV)
ESQD Arcs
Former Conway BGR

Legend

- Explosives Storage Magazine
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area
- Hazardous Fragmentation Distance: 67 ft
- Minimum Separation Distance using Single Sandbag Mitgation: 125 ft
- Intentional Detonation Distance without Engineering Controls: 1,707 ft

Notes:
MGFD: 20 lb M41 Frag Bomb (Composition B)
Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range
ESQD=explosives safety quantity distance
MGFD=munition with the greatest fragmentation distance
MRS=munitions response site

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Source: HGL, USGS, USACE
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HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

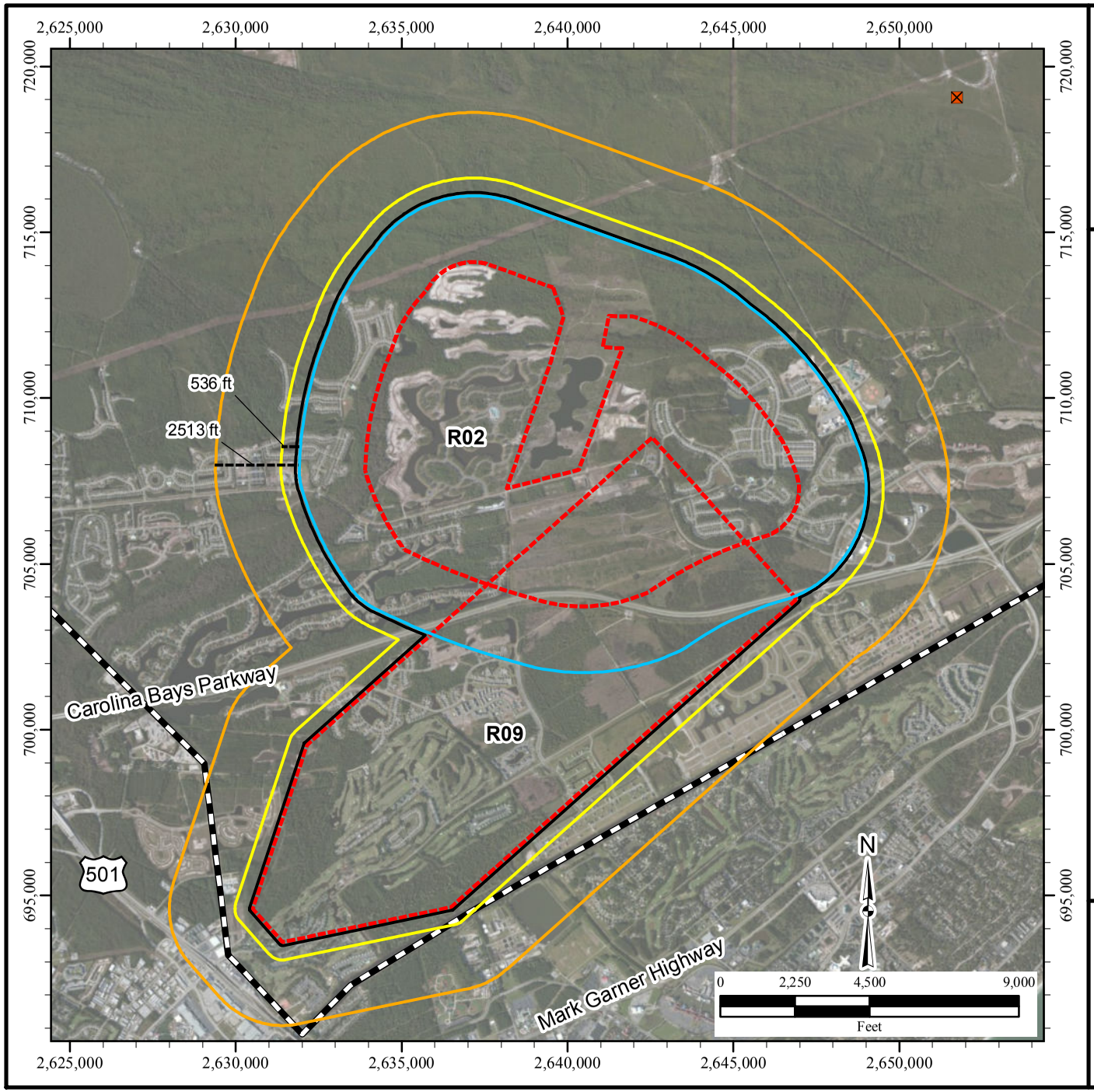

Figure 4
MRS-R02 and R09
ESQD Arcs
Former Conway BGR

Legend

- Explosives Storage Magazine
- Former Conway Bombing and Gunnery Range Boundary
- Munitions Response Site
- Expanded Investigation Area
- R02/R09 Combined Boundary
- Hazardous Fragmentation Distance: 536 ft
- Intentional Detonation Distance without Engineering Controls: 2,513 ft

Notes:
MGFD: 250 lb M57 Bomb (TNT Filled)

Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range
ESQD=explosives safety quantity distance
MGFD=munition with the greatest fragmentation distance

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Source: HGL, USGS, USACE
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HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

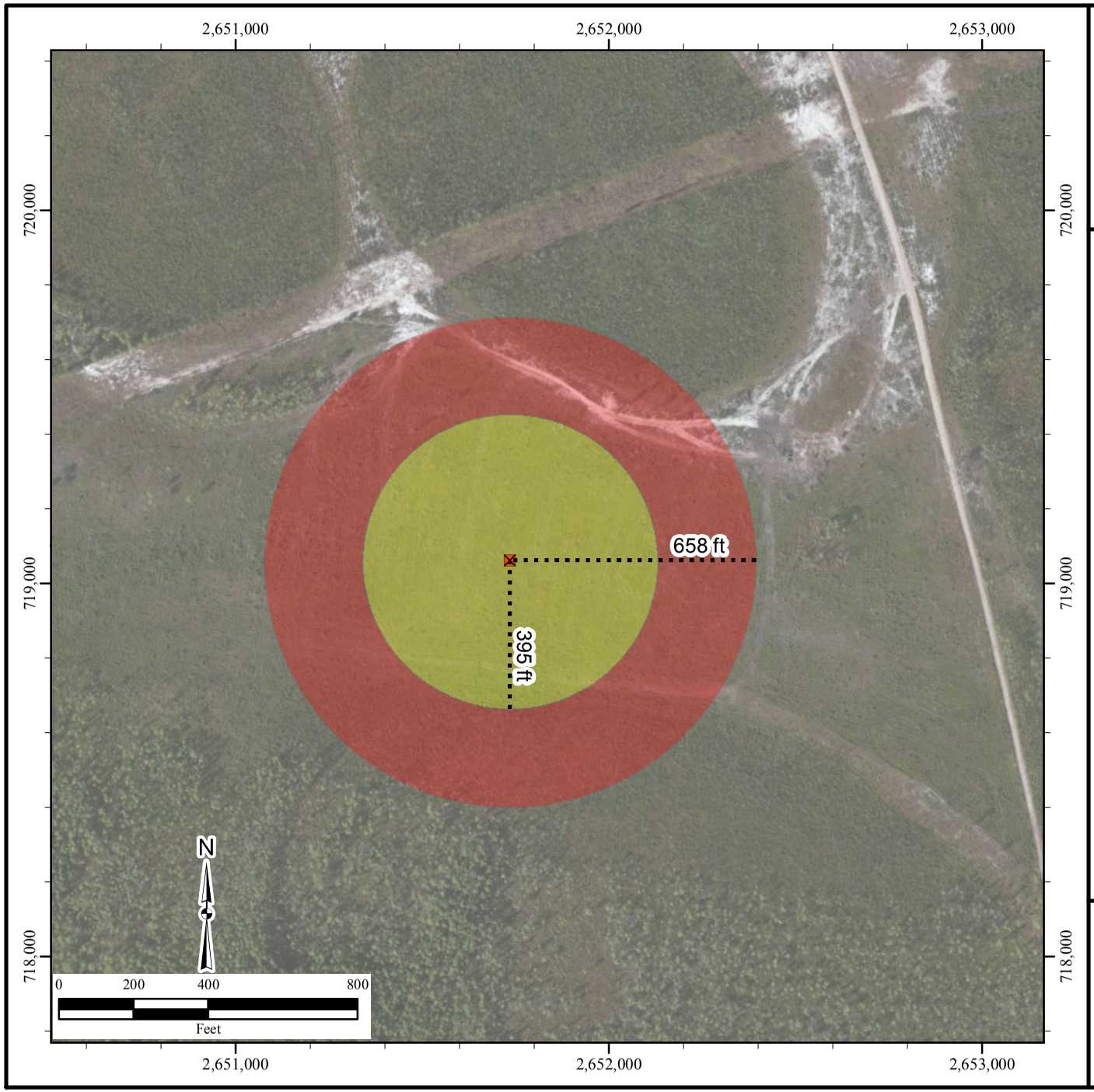

Figure 5
Explosives Storage Magazine
MRS-R02 and R09
Former Conway BGR

Legend

- Explosives Storage Magazine
- PTR (395 ft)
- IBD for 100 lbs NEW (658 ft)

Notes:
MGFD: 250 lb M57 Bomb (TNT Filled)

Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range
MGFD=munition with the greatest fragmentation distance
IBD=inhabited building distance
PTR=public transportation route

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Source: HGL, USGS, USACE
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HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

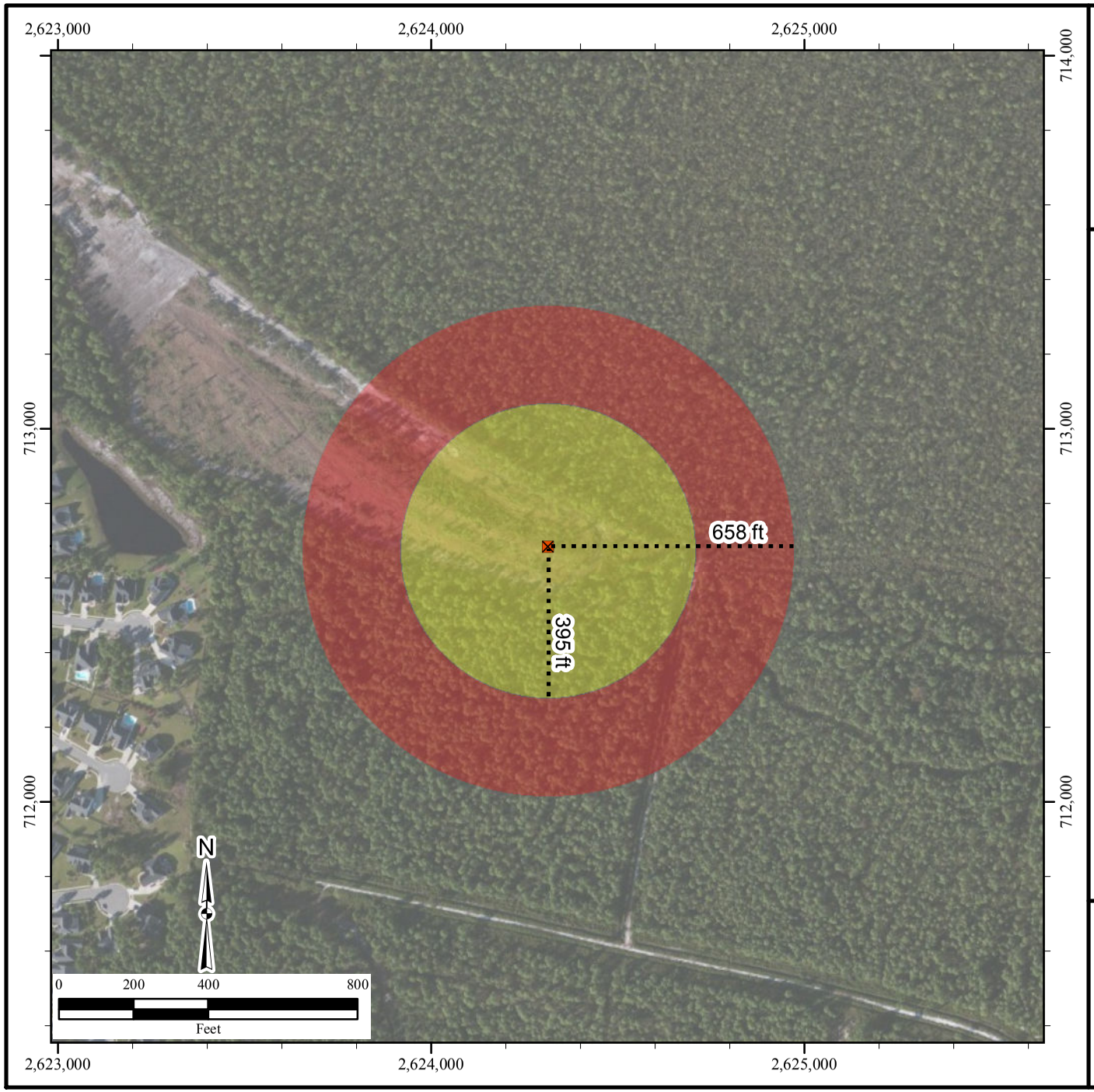

Figure 6
Explosives Storage Magazine
MRS-R01
Former Conway BGR

Legend

- Explosives Storage Magazine
- PTR (395 ft)
- IBD for 100 lbs NEW (658 ft)

Notes:
Coordinates in South Carolina Stateplane, NAD83, feet.

IBD=inhabited building distance
PTR=public transportation route

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Source: HGL, USGS, USACE
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HydroGeoLogic, Inc

HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

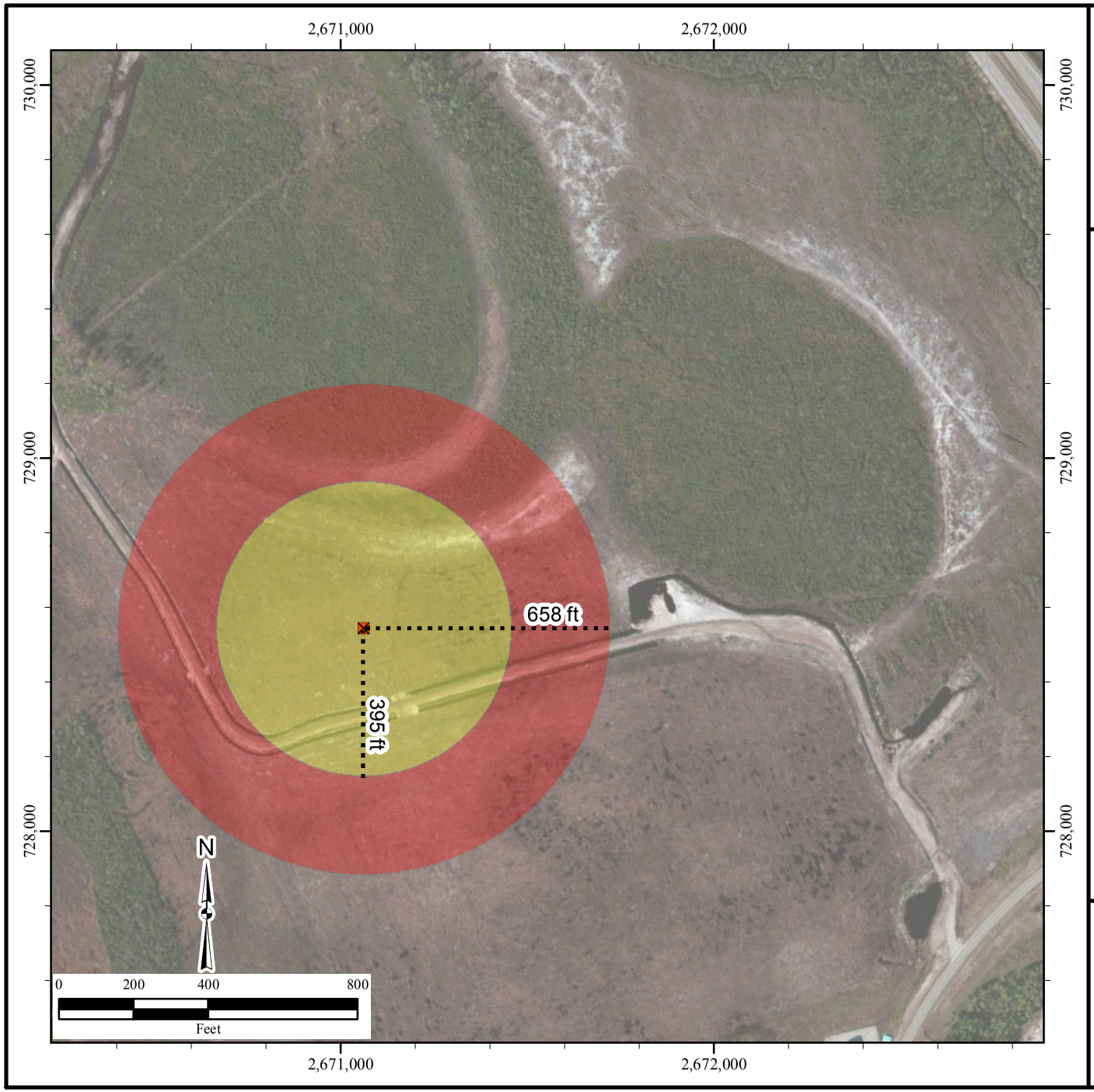

Figure 7
Explosives Storage Magazine
MRS-R03
Former Conway BGR

Legend

- Explosives Storage Magazine
- PTR (395 ft)
- IBD for 100 lbs NEW (658 ft)

Notes:
MGFD: 250 lb M57 Bomb (TNT Filled)

Coordinates in South Carolina Stateplane, NAD83, feet.

BGR=Bombing and Gunnery Range
MGFD=munition with the greatest fragmentation distance
MRS=munitions response site
NEW=net explosive weight
IBD=inhabited building distance
PTR=public transportation route

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Source: HGL, USGS, USACE
ArcGIS Online World Imagery

HydroGeoLogic, Inc

HGL—Explosives Site Plan—Former Conway Bombing and Gunnery Range, SC

APPENDIX B

FRAGMENTATION DATA SHEETS

Fragmentation Data Review Form

Database Revision Date 8/21/2014

Category:	Air-Launched HE Rounds
Munition:	20 lb M41 Frag Bomb (Composition B filled)
Case Material:	Steel, Mild
Fragmentation Method:	Pre-formed Fragmenting
Secondary Database Category:	Bomb
Munition Case Classification:	Robust

DODIC:	E207
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	12/23/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Composition B
Explosive Weight (lb):	2.8
Diameter (in):	3.7000
Cylindrical Case Weight (lb):	14.81686
Maximum Fragment Weight (Intentional) (lb):	0.1298
Design Fragment Weight (95%) (Unintentional) (lb):	0.1298
Critical Fragment Velocity (fps):	4170

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	67
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	1707
MFD-V [Maximum Fragment Distance, Vertical] (ft):	1322

Overpressure Distances

TNT Equivalent (Pressure):	1.16
TNT Equivalent Weight - Pressure (lbs):	3.248
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	27
Public Traffic Route Distance (2.3 psi); K24 Distance:	36
Inhabited Building Distance (1.2 psi), K40 Distance:	59
Intentional MSD (0.0655 psi), K328 Distance:	486

Note: Per V5.E3.2.2.1 of DoD 6055.09-M the minimum sited K328 distance may be no smaller than 200 ft.

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	1.14
TNT Equivalent Weight - Impulse (lbs):	3.192
Kinetic Energy 10^6 (lb-ft²/s²):	1.1280

Single Sandbag Mitigation

Required Wall & Roof Thickness (in)	24
Expected Max. Throw Distance (ft):	125
Minimum Separation Distance (ft):	125

Double Sandbag Mitigation

Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Water Mitigation

Minimum Separation Distance (ft):	200.000
Water Containment System:	1100 gal tank

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	7.25	7.25
Mild Steel:	1.41	1.41
Hard Steel:	1.16	1.16
Aluminum:	2.82	2.82
LEXAN:	7.21	7.21
Plexi-glass:	5.59	5.59
Bullet Resist Glass:	4.83	4.83

Item Notes

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Fragmentation Data Review Form

Database Revision Date 8/21/2014

Category:	Non-Fragmenting Rounds
Munition:	100LB M38A2 Practice Bomb
Case Material:	Steel, Mild
Fragmentation Method:	Non-Fragmenting
Secondary Database Category:	Practice Round
Munition Case Classification:	Non-Fragmenting

DODIC:	
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	
Individual Last Updated Record:	
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	3
Diameter (in):	8.1300
Cylindrical Case Weight (lb):	
Maximum Fragment Weight (Intentional) (lb):	
Design Fragment Weight (95%) (Unintentional) (lb):	
Critical Fragment Velocity (fps):	

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	0.43
TNT Equivalent Weight - Impulse (lbs):	1.290
Kinetic Energy 10^6 (lb-ft²/s²):	

Single Sandbag Mitigation

Required Wall & Roof Thickness (in)	Non-Fragmenting
Expected Max. Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Double Sandbag Mitigation

Required Wall & Roof Thickness (in)	Non-Fragmenting
Expected Max. Throw Distance (ft):	Non-Fragmenting
Minimum Separation Distance (ft):	Non-Fragmenting

Water Mitigation

Minimum Separation Distance (ft):	Non-Fragmenting
Water Containment System:	Non-Fragmenting

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	
MFD-V [Maximum Fragment Distance, Vertical] (ft):	

Overpressure Distances

TNT Equivalent (Pressure):	0.43
TNT Equivalent Weight - Pressure (lbs):	1.290
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	20
Public Traffic Route Distance (2.3 psi); K24 Distance:	26
Inhabited Building Distance (1.2 psi), K40 Distance:	44
Intentional MSD (0.0655 psi), K328 Distance:	357

Note: Per V5.E3.2.2.1 of DoD 6055.09-M the minimum sited K328 distance may be no smaller than 200 ft.

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):		
Mild Steel:		
Hard Steel:		
Aluminum:		
LEXAN:		
Plexi-glass:		
Bullet Resist Glass:		

Item Notes

This item was previously named the 100 lb Practice Bomb M38 w/ M1A1 spotting charge. The TNT equivalency for black powder rounds has been updated from 0.4 to 0.43 to agree with Rev 4 of TP 16. This has resulted in minor changes in values.

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Fragmentation Data Review Form

Database Revision Date 8/21/2014

Category:	Air-Launched HE Rounds
Munition:	250 lb M57 Bomb (TNT Fill)
Case Material:	Steel, Mild
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Bomb
Munition Case Classification:	Non-Robust

DODIC:	
Date Record Created:	9/21/2004
Record Created By:	MC
Last Date Record Updated:	12/23/2009
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	TNT
Explosive Weight (lb):	129.02
Diameter (in):	10.9000
Cylindrical Case Weight (lb):	66.83528
Maximum Fragment Weight (Intentional) (lb):	0.2895
Design Fragment Weight (95%) (Unintentional) (lb):	0.0308
Critical Fragment Velocity (fps):	8293

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	536
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	2513
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2001

Overpressure Distances

TNT Equivalent (Pressure):	1
TNT Equivalent Weight - Pressure (lbs):	129.020
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	91
Public Traffic Route Distance (2.3 psi); K24 Distance:	121
Inhabited Building Distance (1.2 psi), K40 Distance:	202
Intentional MSD (0.0655 psi), K328 Distance:	1657

Note: Per V5.E3.2.2.1 of DoD 6055.09-M the minimum sited K328 distance may be no smaller than 200 ft.

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	1
TNT Equivalent Weight - Impulse (lbs):	129.020
Kinetic Energy 10^6 (lb-ft^2/s^2):	9.9572
Single Sandbag Mitigation	
Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted
Double Sandbag Mitigation	
Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted
Water Mitigation	
Minimum Separation Distance (ft):	Not Permitted
Water Containment System:	Not Permitted

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	26.15	10.20
Mild Steel:	4.14	1.70
Hard Steel:	3.39	1.40
Aluminum:	8.12	3.53
LEXAN:	12.82	7.42
Plexi-glass:	11.95	5.78
Bullet Resist Glass:	10.87	4.85

Item Notes

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APPENDIX K

GEOPHYSICAL INVESTIGATION PLAN

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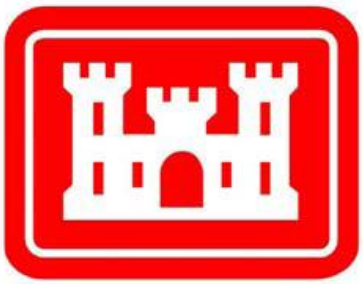
FINAL
GEOPHYSICAL INVESTIGATION PLAN
FORMER CONWAY BOMBING AND GUNNERY RANGE
HORRY COUNTY, SOUTH CAROLINA

CONTRACT NO. W912DY-10-D-0023
TASK ORDER NO. 0018

Prepared for



U.S. Army Corps of Engineers
U.S. Army Engineering and Support Center, Huntsville

Prepared by:

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11107 Sunset Hills Road
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July 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

AG	analog geophysics
ATV	all-terrain vehicle
BGR	Bombing and Gunnery Range
CD	cultural debris
cm	centimeters
DGM	digital geophysical mapping
DID	data item description
DMM	discarded military munitions
EM	electromagnetic
EM	Engineer Manual
FS	Feasibility Study
FTP	file transfer protocol
GIS	geographic information system
GPO	geophysical prove-out
GPS	Global Positioning System
GSV	Geophysical Systems Verification
HE	high explosive
HGL	HydroGeoLogic, Inc.
ID	identification
ISO	industry standard object
IVS	instrument verification strip
MD	munitions debris
MEC	munitions and explosives of concern
MR	munitions response
MRS	munitions response site
mV	millivolt
NMEA	National Marine Electronics Association
NRL	Naval Research Laboratory
PDA	personal digital assistant
PDT	project delivery team
PPK	post-processed kinematic

PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RI	Remedial Investigation
RPM	revolutions per minute
RTK	real-time kinematic
RTS	Robotic Total Station
SNR	signal to noise
STEMD	Systematic Testing and Evaluation of Metal Detectors
SUXOS	Senior UXO Supervisor
TPP	technical project planning
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineer Support Center, Huntsville
USB	Universal Serial Bus
UTM	Universal Transverse Mercator
UXO	unexploded ordnance
UXOQCS	UXO Quality Control Specialist
VSP	visual sample plan
WAAS	wide area augmentation system
WERS	Worldwide Environmental Remediation Services

K.0 INTRODUCTION

The Geophysical Investigation Plan discusses the geophysical detectors to be used during the Conway Bombing and Gunnery Range (BGR) Remedial Investigation (RI)/Feasibility Study (FS).

K.1 ANALOG AND DIGITAL DETECTORS

During the execution of the RI field activities, various instruments may be used to identify surface and subsurface anomalies. Currently, HydroGeoLogic, Inc. (HGL) is planning to use the following instruments:

- **White's All Metals Detector:** The White PI SurfMaster, XLT, and DFX 300 are frequency domain electromagnetic (EM) metal detectors that offer detection of all metals to a depth of approximately 0.3 meters. The systems are handheld, readily portable, and have been used for numerous munitions and explosives of concern (MEC) projects to aid in the detection of near-surface metallic objects. The White's will primarily be used during the intrusive investigation and along transects in mag and dig or mag and count mode.
- **Schonstedt GA-52cx Magnetic Locator (or equivalent):** Magnetic locators may be used to augment personnel safety during anomaly avoidance activities and the intrusive investigation of anomalies, because the Schonstedt is more effective than an EM sensor in identifying anomalies below surface grade as an excavation is advanced. The purpose is to help the technicians recognize proximity to an anomaly source as they are digging. The Schonstedt GA-52cx is a handheld magnetic locator consisting of two fluxgate sensors aligned and mounted apart at a fixed distance. When the instrument is passed near ferrous objects, the difference in magnetic flux between the two sensors is registered as changes in an audible tone. The Schonstedt will primarily be used during the intrusive investigation and along transects in mag and dig or mag and count mode.
- **Minelab F3:** The Minelab F3 is a time domain EM all metals detector that may be used for transects in areas of elevated soil magnetism where other handheld detectors may not provide reliable data. The Minelab F3 is capable of rejecting signals from soils and rocks with increased magnetism, while still providing ample detection capabilities for metallic objects. The system has been thoroughly tested and validated within the United States and abroad at several large-scale government supported evaluations. The Minelab F3 will primarily be used during the intrusive investigation and along transects in mag and dig or mag and count mode.
- **EM61-MK2:** The EM61-MK2 is a digital time-domain EM metal detector that detects all metals and is considered a proven technology for munitions response (MR) projects. The EM6-MK2 consists of coaxial transmitter and receiver loops in a 1- by 0.5-meter rectangular configuration. The EM61-MK2 nominally transmits EM pulses at 75 to 150 hertz and records the secondary magnetic field at four distinct time gates after each pulse. The measurements are recorded using an Allegro CX, Archer, or

comparable data logger. These data loggers support real-time graphic display of data for review during field operations and non-volatile memory for data storage. Serial port or Universal Serial Bus (USB) connections are also available for integration of Global Positioning System (GPS) data. The EM61-MK2 will primarily be used during the collection of digital geophysical mapping (DGM) data along transects and within full coverage grids.

K.2 NAVIGATION AND POSITIONING EQUIPMENT

Navigation and positioning will be obtained using a combination of wide area augmentation system (WAAS) and post-processed kinematic (PPK) GPS, real-time kinematic (RTK) GPS (optional), Robotic Total Station (RTS) (optional), and line and fiducial methods. The systems proposed for use on the project are the following:

- **WAAS GPS:** WAAS GPS will be used for the DGM transect application (i.e., density transects) and other applications where survey-grade positioning is not required to meet the project objectives. WAAS GPS is capable of approximately 10-meter accuracy (or less) and works well under canopy cover. One of the advantages of a WAAS system over other GPS systems is that it does not require the use of a local GPS base station. The GPS antenna will be mounted on the appropriate instrument or personnel in a position where it does not adversely affect the sensor measurements and the data may be streamed directly into the data logger used to capture the geophysical data.
- **PPK GPS:** PPK GPS may be used for the DGM transect application (i.e., density transects) and other applications where survey-grade positioning is not required to meet the project objectives. PPK GPS is capable of accuracies of less than 1-meter in areas where canopy is not present. A PPK GPS system (for example, a Trimble GEO XH system or equivalent) has an advantage over RTK GPS in wooded areas because a radio link is not required between the GPS base station unit and the GPS rover unit, and only four GPS satellites are required to obtain a solution. The accuracy of the GPS positioning of the transect segments may be limited by the brush and tree cover. The GPS antenna will be mounted on the appropriate instrument or personnel in a position where it does not adversely affect the sensor measurements and the data may be streamed directly into the data logger used to capture the geophysical data.
- **RTK GPS (optional):** RTK GPS may be used in any large, contiguous open areas void of thick canopy for the DGM transects or full coverage grids. An RTK GPS system (for example, a Trimble R8 base station and rover) consists of two dual-frequency geodetic quality receivers that are in radio communication with each other. The rover GPS antenna will be mounted directly over the EM61-MK2 coils at a height where it does not adversely affect the sensor measurements. The position data will be streamed directly into the data logger used to capture the EM61-MK2 data.
- **RTS (optional):** An RTS may be used to support DGM grid activities if accurate local survey control is nearby. The system consists of a motorized total station survey instrument that tracks a prism centered above the EM61-MK2 coils. The position data

are streamed, via radio modem, directly into the data logger used to capture the EM61-MK2 data.

- **Line-and-Fiducial Positioning and Wheel Mode:** Line and fiducial positioning will be used to support DGM grid activities. This method uses a relative Cartesian coordinate system that is delineated and marked with pin flags at regular intervals using calibrated survey tapes. Marks (fiducials) are emplaced into the geophysical data by the operator as the sensor passes each pin flag and the measurements are interpolated between the known points to georeference the sensor data. If the ground surface within the full coverage grids is sufficiently smooth and flat, an encoder incorporated into the EM61 wheel may be used to trigger geophysical measurements at regular intervals along each line.

K.3 GSV PROCESS

The former Conway BGR RI activities include the use of the Geophysical Systems Verification (GSV) process to validate the DGM, intrusive, and data management elements of the project. DGM data will be collected for both the instrument verification strip (IVS) and production survey using the same configurations, procedures, and parameters.

The GSV process will be implemented as described in the Strategic Environmental Research and Development Program/Environmental Security Technology Certification Program document entitled *Final Report, Geophysical System Verification: A Physics-Based Alternative to Geophysical Prove-Outs for Munitions Responses* (July 2009). The GSV process uses an IVS to verify appropriate system response and establish baseline noise levels. DGM data will be collected over several industry standard objects (ISOs) (for example, pipe nipples) along both optimal and "worst-case" orientations, which will validate detection capabilities and the data acquisition parameters for the project. The HGL team geophysicists assisted by a unexploded ordnance (UXO) technician will install the "main" IVS within an anomaly free area before production of the DGM program commences. Due to the distance between munitions response sites (MRSs), several "satellite" IVS plots may be located in the different MRSs to facilitate efficient collection of data.

As part of the GSV process, the project UXO Quality Control (QC) Specialist (UXOQCS) or their designee will place blind seeds (small, schedule 80 ISOs) within the upper 0.3 meters of the surface at randomized locations within the DGM full coverage grids. The blind seeds will be placed at a rate to ensure each DGM team encounters a minimum of one blind seed item per day. Blind seeding provides verifiable target detection and positioning over the course of the DGM survey, and serves as a QC tool for evaluating the data collection, processing, and anomaly selection procedures and intrusive investigation performance.

The value of an IVS over a geophysical prove-out (GPO) plot, is that the multiple site-specific ordnance types at multiple depths and orientations typically incorporated into the GPO can be replaced with just a few ISOs oriented for illumination of the target by the EM61-MK2 transmitter. The sensitivity of the EM61-MK2 is determined to be acceptable when the measured response from the field trial closely matches the value predicted by the Naval

Research Laboratory (NRL) detection curves (EM61-MK2 Response of Standard Munition Items, 2008) or the GSV calculator. Further, the predicted response amplitudes for the specific munitions of concern for this project will be representative of the geophysical response amplitudes obtained when illuminated by the EM61-MK2 transmitter signal in the field.

Evaluation of the predicted response versus the ambient background of the particular site provides the relevant detection parameters (the response amplitude to be expected in all four channels at known distances beneath the transmitter). This, in turn, provides the information needed to determine the maximum depth at which the minimal response will be recognized above some site-specific detection amplitude floor (threshold). Use of the IVS obviates the need for numerous targets in multiple orientations at multiple depths. The response curves and data that these parameters sought to capture can be readily extracted using the NRL detection curves for several sizes of ISOs and numerous munitions items.

K.3.1 IVS

The main IVS will be used to verify the data acquisition parameters and methodologies for the transects and full coverage grids at the commencement of the project. The location of the main IVS will be selected during the technical project planning (TPP) process. On a daily basis, DGM data will be collected along the IVS centerline and "noise" line as part of the daily instrument functional tests. The collected data will be used to demonstrate the effective performance of the deployed system(s) and to monitor the instrument "noise" throughout the project.

A background survey of the proposed IVS area will be performed with an EM61-MK2 prior to burying the ISOs. These initial data preserve the background characteristics for the IVS area. Anomalies that are detected during the background survey may be removed by UXO Technicians before construction of the IVS.

K.3.2 DESIGN

Once the background has been recorded and mapped, the construction of the IVS will be performed using the general procedures specified in the USAESCH document *Geophysical Investigations for Buried Munitions, Operational Procedures and Quality Control Manual* (USAESCH, June 2002). The coordinates for the center of each item will be determined with an RTK GPS or RTS to an accuracy of 0.03 meters. For IVS sites that are located in heavily wooded areas, the lateral location of each item along the IVS center line will be measured to an accuracy of 5 centimeters (cm) using a measuring tape. The location, depth, and orientation for each ISO also will be recorded. Due to the size of the site, it may be necessary to install several local "satellite" IVS plots. The main IVS performed at the start of the project to validate the DGM systems will be used to generate the IVS report.

The IVS will consist of a centerline that is approximately 10 to 15 meters in length. A "noise" line will be established approximately 7 meters away from and parallel to the IVS centerline. Three small ISOs will be buried within 0.3 meters of the ground surface along the IVS centerline and separated by a horizontal distance of approximately 3 to 5 meters. The ISOs

will be placed at horizontal (long axis transverse and parallel to centerline) and vertical orientations. Based on discussions with the project delivery team (PDT) during the TPP process, several inert munitions items that are not referenced in the NRL document *EM61-MK2 Response of Standard Munitions Items* (NRL, October 2008) may be included in the IVS to verify that the anomaly selection criteria meet the project objectives.

K.3.3 FIELD DATA COLLECTION

The person-portable single sensor and vehicle-towed array systems will be evaluated at the main IVS prior to production. Prior to collecting data over the IVS the instrument functional tests will be performed.

Initially, static data for each EM61-MK2 coil will be collected over a small ISO placed on the ground surface. These data will be compared to the NRL-predicted response to ensure the sensitivity of each EM61-MK2 coil before further evaluation of the DGM systems.

Static EM61-MK2 data will be acquired over the three buried ISOs at zero offset (coils centered directly over ISO) for both the person portable and array systems. For the person-portable system, static data will also be collected with the edge of the coil centered over the ISOs and offset 0.125 meters toward the center of the coil for the person portable system to simulate 0.75 meter line spacing, which is the anticipated line spacing for the full coverage grids. This procedure will assist the HGL team in determination of the minimum response expected for major orientations and to plan the blind seed program for the DGM full coverage grid application.

Dynamic data will be collected along the centerline and noise line six times in opposite directions with the person portable and vehicle towed array to determine a representative performance metric for the dynamic signal repeatability for each system. Afterwards, multiple offset lines on both sides of the centerline will be surveyed with the person portable system at line spacing of 0.75 meters to provide a complete, two-dimensional representation of the anomaly characteristics of each individual ISO.

The offsets from the centerline at 0.75 meter intervals mimic the proposed full coverage DGM surveys for the person portable system and the dynamic data will be used in conjunction with the static data collected at variable offsets over each ISO and the NRL detection curves to ensure the spatial sample density is sufficient to detect smaller MEC items. Since the main purpose of the array will be to collect transect DGM data, one swath of data will be acquired over the IVS centerline for each coil to exhibit the detection capability of the array.

HGL assumes that a client representative will be present in the field during the initial IVS activities to approve the results. Acceptance of the initial results will be based on meeting the following performance and quality metrics for the DGM systems:

- Static and Static Spike Test: 95 percent of the static measurements for all EM61-MK2 data channels will be within 2.5 millivolts (mV) of background. The static spike test

will be documented and used as the baseline for future tests, which must be within 10 percent of the initial response for all data channels.

- Personnel and Cable Shake Tests: The response for all EM61-MK2 data channels will not exhibit data spikes that exceed 3 mV.
- IVS Centerline: The mean signal intensity for the ISOs for the first six runs over the IVS centerline will be determined and used as the baseline for all future tests. The response for all EM61-MK2 data channels will exceed 75 percent of the baseline value for future tests. The accuracy of the position along the centerline for each ISO will be less than 0.38 meters (RTK GPS and RTS) and less than 0.60 meters (fiducial positioning).
- IVS Noise Line: The dynamic "noise" for all channels of the EM61-MK2 will not exceed 1.0 mV (standard deviation),
- Known Position Check: The acceptable accuracy for the positioning system will be determined by observing and recording static measurements over a monument or control point. For RTK GPS and RTS the tolerance is 0.15 meters.

If ambient EM or soil/geologic "noise" are observed at the IVS, some of the stated metrics may require modification for the production DGM survey. If any performance or quality metric requires revision based on site environmental characteristics, a detailed discussion will be provided in the IVS report.

K.3.4 DATA ANALYSIS

The proposed anomaly selection criteria, which are reviewed in Section K.7.2, and will ensure that representative MEC and MD are identified. Raw and final processed data from the initial IVS will be delivered to the client per the requirements in Attachment C of WERS-004.01.
The specific tests performed for the IVS effort will be used to validate the DGM systems in terms of the line spacing, data recording parameters, and platform noise characteristics by comparing the static and dynamic sensor responses over the ISOs to standardized, physics-based models of the ISOs from the NRL.

It is anticipated that the minimum threshold for anomaly selection will be approximately 4-5 mV (Channel 2) or an equivalent value based on a weighted sum channel. The anomaly selection criteria will be documented in the IVS report for PDT review and acceptance.

K.3.5 IVS EVALUATION AND REPORTING

The results of the initial IVS data collection will be processed and evaluated to verify equipment performance. The project geophysicist (or designee) will prepare a brief letter report presenting the details of the IVS and the DGM survey data. The report will be distributed to the PDT within five business days after the initial IVS tests are completed. The letter report will include, at a minimum, the following information:

- As-built drawing of the IVS, including depth and item orientation;

- Photographs of the seed items in place;
- Results of the instrument functional tests;
- Data profiles for the IVS centerline and noise line;
- Tabulated results of the interpretation;
- Static and dynamic responses plotted on the NRL detection curves;
- Proposed DGM system(s), data acquisition parameters, and anomaly selection criteria;
- Modifications, as necessary, to the performance and quality metrics based on specific site conditions; and
- Microsoft Access database.

K.4 DEPTH ANTICIPATED FOR MUNITIONS OF INTEREST

Table 1.4 of the Work Plan lists the munitions items of interest for the project that have been encountered during past investigations at the site.

K.4.1 PROJECT-SPECIFIC CONSTRAINTS, CONDITIONS, OR FEATURES POTENTIALLY AFFECTING GEOPHYSICAL DATA COLLECTION

K.4.1.1 Utilities and Anthropogenic Features

Features that might negatively affect the geophysical investigation include above and below ground utilities, buildings, and large metal objects (monitoring wells, vehicles, etc.). To ensure these features are accounted for during the interpretation of the DGM data, their location will be documented during the field program with the appropriate positioning system.

K.4.1.2 Site-Specific Dynamic Events

Dynamic events such as rain, lightning, and solar flares may affect geophysical data collection. Procedures for geophysical survey operations when these events occur follow.

Rain – The effect of rain on geophysical operations is primarily dependent on the instrument being used and the physical site conditions (terrain and vegetation). Most of the instruments commercially available are relatively water resistant. Under conditions of light rain (drizzle) additional measures will be taken by the survey teams (such as covering electronics with plastic and using electrical tape to secure connections) to reduce the possibility of moisture impacting the instrument's electronics. If the rain persists and the survey team leader determines that there is a potential for an impact to the quality of the data, field operations will cease and the site manager and Project Geophysicist will be notified. Operations will continue after conditions are deemed safe by the survey team leader.

Lightning – Aside from the obvious safety hazard discussed elsewhere in this WP, lightning may cause a phenomenon known as "atmospherics" or electromagnetic noise, which may

impede the performance of EM sensors. Lightning activity in the area will be monitored visually and data collection will be halted until the lightning ceases.

Solar Flares – Solar flares, a sun-generated phenomenon typically occurring in the afternoon, can temporarily generate high-magnitude magnetic noise sufficient to occasionally render EM sensors unusable for the duration of the event. Solar flares are typically readily observable by the instrument operators (throughout the area) as rapidly fluctuating signal readings with no apparent cultural or survey source. The UXOQCS will log the time intervals when solar flare activity is observed to help determine whether any data (for digital geophysics) may have been affected. The National Oceanic and Atmospheric Administration maintain a helpful website at http://spaceweather.com. Solar flare activity will be monitored by the project geophysicist on a weekly (or more often, as necessary) basis during the project.

K.4.1.3 Geologic Conditions

Sections 1.5.3 and 1.5.5 provide a review of the soils and geology at the Former Conway BGR. Soils and rocks with increased magnetism that might affect the subsurface detection capabilities of the proposed digital and analog detectors are not anticipated.

K.4.1.4 Surface and Groundwater Conditions

Section 1.5.4 provides an overview of the hydrology at the site.

K.4.2 VEGETATION

The MRSs scoped for investigation during this project contain a variety of near-surface vegetation types and mature forested areas with thick canopy.

K.4.3 DGM SENSORS AND PLATFORMS

The primary sensor that will be used for characterization along the transects and within the full coverage grids is the Geonics, Ltd. EM61-MK2 configured as a person-portable single sensor system on a wheeled platform and as an array of three sensors that will be towed by a vehicle.

K.4.3.1 Person-Portable EM61-MK2

The EM61-MK2 wheeled cart consists of two wheels and a handle that are mounted directly to the bottom coil. The wheels position the coil 40 cm above the ground surface. The power source and electronics console are mounted on a backpack (or within the lower coil and on the handle, respectively) and transported by the instrument operator. When used with a GPS, the GPS antenna will be centered over the coils at a standoff height that will be determined during the initial IVS activities.

The single sensor person-portable system is anticipated to be integrated with a WAAS GPS for transect DGM and used with line and fiducial / wheel mode positioning for the full coverage DGM grids.

EM61-MK2 wheeled cart configured with WAAS GPS

For the transect application, the EM61-MK2 measurements will be acquired at a minimum rate of 10 Hz and the position information from the National Marine Electronics Association (NMEA) GPS message will be streamed into the data logger at a minimum rate of 1 Hz. GPS fix quality and the number of satellites will be monitored during data collection.

The fiducial and wheel mode functionality of the EM61-MK2 will be used to collect data over the full coverage grids. EM61-MK2 measurements are automatically recorded using a counter attached to one of the wheels at approximately 0.2-meter intervals, and pin flags placed at approximately 7.5-meter intervals along every other data acquisition lines are used to guide the operator. Fiducial marks are placed in the data file at the location of each pin flag to support a more accurate interpolation of the measurements during data processing. Significant obstacles such as trees, fences, debris piles, ruts, etc. will be documented on the hardcopy data acquisition form for each grid so these features can be placed on the site maps and be accounted for during the analysis of the geophysical data.

K.4.3.2 Vehicle-towed EM61-MK2 Array

The towed array system consists of a non-metallic fiberglass trailer platform towed by a Kubota 900 all-terrain vehicle (ATV) or semi-amphibious vehicle. Three EM61-MK2 coils are mounted on a trailer platform 40 cm above the ground surface with the long axis of each coil perpendicular to the direction of travel, resulting in a 3-meter swath of data along the transect. An RTK or WAAS GPS antenna is mounted at a known offset from the center of the array to provide accurate positions for the EM61-MK2 measurements and a second GPS antenna is placed on the roof of the ATV vehicle and linked to a Cruizer II guidance system to provide navigation assistance for the vehicle operator.

EM61-MK2 vehicle-towed array with RTK GPS

EM61-MK2 data for all sensors are recorded at a minimum rate of 10 Hertz with a Panasonic Toughbook CF-31 field computer using the *ML61MK2xpn* software. The position information from the NMEA GPS message is streamed into the Panasonic

Toughbook serial port and integrated with the EM61-MK2 measurements in real time. HGL anticipates that an RTK GPS system will be utilized for navigation and positioning along the transects when tall canopy is not present. If tall canopy exists over large regions of a survey area WAAS GPS may be used for navigation and positioning.

Some anomalies along the array transects may be intrusively investigated for characterization purposes if the anomaly signature occurs within the inner footprint of the array. Anomalies detected within saturated areas of wetlands or within shallow water bodies will not be intrusively investigated due to safety hazards.

Before using the array at the initial IVS or for production DGM activities, a noise test will be performed to determine the minimum offset of the tow vehicle from the sensor array. The test will include collecting static EM61-MK2 data with the engine off and at variable revolutions per minute (RPM) when the engine is turned on.

K.4.4 DATA ACQUISITION

K.4.4.1 Make Up of Data Acquisition Teams

A two person team will use the single sensor EM61-MK2 wheeled cart to collect data along predefined transects in wooded areas. Each transect is marked with flagging at regular intervals by the vegetation clearance team, and one team member will pull the cart along the cleared path and the second team member will transport extra batteries and supplies and assist with navigation.

The EM61-MK2 array team will also consist of two individuals. The path for each transect will be transferred to the RTK GPS system to permit the operator to navigate along each transect using the Cruizer II guidance system. The vehicle towed array is scoped for use in relatively more open areas void of obstacles and thick canopy, including areas of wetlands and when very shallow water bodies are encountered along a transect.

K.4.4.2 Sampling Rates and Data Density

The sensor velocity will be maintained to ensure that 98 percent of the EM61-MK2 measurements have a sample to sample distance of less than 0.25 meters for the transects and full coverage grids. The EM61-MK2 wheeled cart collects a 1-meter swath of data and the vehicle towed array of three EM61-MK2 sensors collects a 3-meter swath of data.

A lane spacing of 0.75 meters (~ 2.5 feet) is planned for the DGM survey of the full coverage grids. A 0.75-meter line spacing provides overlap of the coil footprint on adjacent lines, and based on HGL's experience on other RI projects, the proposed line spacing will clearly demonstrate detection capabilities for smaller MEC items to depths that are consistent with the historical use at each MRS.

Transect spacing will be variable as needed to navigate around significant obstacles (e.g., trees, streams, large rocks, etc.).

K.4.5 PRODUCTION RATES

HGL anticipates that the equivalent of approximately 3-4 linear miles of DGM transects can be acquired with the person portable single sensor EM61-MK2 in forested areas, and approximately 5 to 6 linear miles of transect data can be acquired with the vehicle towed array in relatively open areas. Full coverage grid production is estimated to be four 15-meter square grids per day with the person-portable single sensor EM61-MK2 system.

K.5 DGM TRANSECTS AND VSP ANALYSIS

The DGM data from the transects will be imported into the VSP software and a color-coded image of the anomaly density within each MRS will be generated for analysis. The anomaly density patterns will be used to propose locations of full coverage grids in regions of high, medium, and relatively low anomaly density. A technical memorandum for each MRS will be provided to the PDT that summarizes the grid selection process, and includes the visual sample plan (VSP) parameters and summary statistics.

DGM grid coverage will be equal to a minimum of 20 percent of transect acreage. The locations and distribution of grids will be determined in consultation with the PDT after analysis of the anomaly density results from VSP. In addition, the grids will be adjusted to allow the best coverage possible based on site conditions, including vegetation and terrain, to gain the best quality geophysical and GPS data.

Full coverage DGM grids will nominally be 15 meters square (50 by 50 feet) to characterize the distribution, type, and depth of MEC and munitions debris (MD). The GPS coordinates for all four grid corners will be acquired using a GPS to reference the general grid location on site maps. Grids may also be used in "transect-like" configurations (e.g., 10 by 250 feet) centered on the boundary of the presumed target area.

All grids will be evaluated using DGM followed by intrusive investigation of select anomalies that meet the agreed to anomaly selection criteria referenced in the IVS report.

K.6 ANALOG GEOPHYSICS

The RI technical approach incorporates the use of DGM rather than analog geophysics (AG) techniques, where possible; however, in some areas DGM equipment access may not be possible due to unfavorable site conditions. In areas where DGM is not practicable, AG methods such as mag-and-count or mag and dig may be used over transect segments or full coverage grids.

The determination of the hand held detector to be used for AG will be based on the potential sources of interference in the specific area. HGL anticipates using a Schonstedt for all of the AG surveys unless magnetic soils are encountered, in which case the White's or Minelab F3 will be used. Before performing AG in any area, HGL will inform the PDT of the general scope for the AG and the handheld detector that will be used.

When AG is performed for subsurface characterization, a test strip with multiple items will be used to validate the handheld detectors and personnel on a daily basis. The UXOQCS will document the results of the daily test strip and transfer the data to the HGL geographic information system (GIS) department for inclusion into the project database.

The general procedures for conducting AG techniques are described below.

K.6.1 ANALOG GEOPHYSICS - TRANSECT AND GRID CONSTRUCTION

A hand held GPS (e.g., Trimble Juno or GEO XH) may be used to support analog geophysics operations along transects. The HGL GIS department will transfer the required start and end coordinates for the transect segment into the GPS system and these locations will be used by the field crew to for navigation along the transect segment. In areas of dense vegetation and canopy, survey lathe and /or polyvinyl chloride (PVC) pin flags may be used to identify transect segments where mag and count or mag and dig will be performed.

In order to prepare a grid for mag and count or mag and dig operations the field team will lay out measuring tape on parallel ends of the grid and mark off lanes along the tape using alternating colors of flagging, pin flags, or rope. Each search lane will be 1.5 meters in width and the boundary of the grid will be marked for reference.

K.6.2 MAG AND COUNT

The AG field crew will be composed of UXO technicians; the crew will perform subsurface analog metal detection in real time. The AG team will cover a 1.5-meter-wide search lane along the proposed transect or grid and count the number of surface and subsurface “hits” per unit distance (e.g., every 30 meters).

For transects, a GPS will be used to record the actual path traveled for the AG team. The track path will be transferred to the HGL GIS department, along with the number of hits along each segment for inclusion into the site map and project database.

When performing mag and count over full coverage grids, search lanes will be constructed that are 1.5 meters wide and 15 meters in length. The boundaries of the area will be clearly marked with survey lathe and / or pin flags.

K.6.3 MAG AND DIG

UXO technicians will compose the AG field crew and will perform subsurface analog metal detection in real time. The AG team will cover a 1.5-meter-wide search lane along the proposed transect or grid and investigate each subsurface “hit.”

A hardcopy field sheet (or digital application on a ruggedized personal digital assistant [PDA]) will be used to document the findings at each dig location, and the information will be transferred to the HGL GIS department for inclusion into the site map and project database.

When performing mag and dig over full coverage grids, search lanes will be constructed that are 1.5 meters wide and 15 meters in length. The boundaries of the area will be clearly marked with survey lathe and / or pin flags. Operators will be responsible for identifying and / or intrusively investigating anomalous responses. A single GPS point will be recorded in the center of each grid and annotated with summary information for the quantity and depth range of cultural debris (CD) and non-identifiable MD (i.e., undifferentiated high explosive [HE] fragmentation). For MEC and identifiable MD, depth, type (MEC, MD, etc.), general location within the grid, and a narrative description of each recovered item (e.g., 60mm mortar, 2.36-inch rocket fins, etc.) will be recorded at the intrusive location. If MEC is identified, the Senior UXO Supervisor (SUXOS) will be notified immediately.

K.7 DATA PROCESSING AND ANOMALY SELECTION

K.7.1 DATA PROCESSING

Data processing will be accomplished using a combination of the following software:

- Geonics Dat61MK2,
- Geomar ML61MK2xpn,
- Geosoft Oasis Montaj,
- Microsoft Excel, Word, and Access programs, and
- Text editors (Notepad ++, Wordpad, Textpad)

The primary software used to process and analyze the geophysical data is the Geosoft Oasis Montaj software.

The field geophysical lead will back up the DGM data to a field laptop and portable hard drive at the end of each day prior to correction of the platform geometry and creation of an "XYZ" file for the array using the Geomar ML61MK2xpn software. Additional tasks include checking field notes and field sketches for completeness, and generating a comprehensive README file that documents the field team responsible for data collection, file names, instrument functional tests, IVS runs, and any potential data issues. The DGM data, field notes, sketches, and README files for each day are transmitted each day to the secure HGL file transfer protocol (FTP) site for retrieval by the HGL data processor the following morning.

Upon receiving DGM data from the field team the data are organized on the HGL server in a structured format in order to ensure that the raw data are never compromised. The data processor converts the person portable data to an "XYZ" format that is easily uploaded to Oasis Montaj. The processor performs an initial check of the daily instrument functional tests for each DGM system in order to alert the field team of any issues that require immediate corrective action.

The daily instrument functional tests and production DGM data are processed in a similar fashion, and include corrections for timing or distance errors (latency or lag) and instrument drift. In representative background areas (areas free from metal) the data processor

interactively checks the leveling for each data channel to ensure representativeness. Depending on the positioning system or method used, errors that might be associated with navigation may also be assessed and fixed. Survey coverage is reviewed to identify any data gaps that may require additional data collection. For every file processed the processing parameters, file tracking information, results of the instrument functional tests, and information related to spatial sample density are documented in the project MS Access database.

The processed data for each production DGM session are be appended to a "master" Oasis Montaj geophysical database for each MRS to document the status of the DGM survey.

The raw and final processed DGM data, including the master geophysical database, packed Oasis map, and results of the instrument functional tests documented in the MS Access database will be delivered to the client at intervals specified in data item description (DID) Worldwide Environmental Remediation Services (WERS)-004.01 using a secure HGL FTP server or Share Point site.

K.7.2 ANOMALY SELECTION

The primary goal of the DGM interpretation is to identify subsurface metal related to munitions use in order to provide relevant information that can be used for site characterization. The Oasis Montaj "pick peaks along profiles" algorithm will be used for target selection along the transects, and the Blakely algorithm will be used for target selection within the full coverage DGM grids. The main IVS location is anticipated to be representative of the geology, soils, and terrain over many of the MRSs of interest; however, due to the large extent of the site some of the environmental characteristics will be different in localized areas.

Geophysics relies on contrasts between the target materials and the background matrix to identify "anomalous" responses. A geophysical anomaly or target is defined as a discrete area of geophysical response that is elevated with respect to the local background conditions, has a shape and signal intensity that is of interest to the project, and is not related to a documented cultural feature or utility. Anomaly selection will be accomplished by identification of discrete responses representative of metal objects that are distinct from background levels.

The anomaly selection criteria will be proposed in the IVS report for both the transects and full coverage grids and is anticipated to consist primarily of signal intensity and signal to noise ratio (SNR) components. The signal intensity and SNR will be used to select anomalies along each transect segment. The coordinates for each anomaly and the associated track path will be transferred to the VSP software in order to generate estimates of anomaly density for each MRS.

DGM data from the full coverage grids will be interpolated using the minimum curvature or nearest neighbor gridding routine in Oasis Montaj at a cell size of 0.015 meters to create color -coded data images that are used for analysis and target selection. Interpretation for the full coverage grids will also utilize the signal intensity and SNR components to initially screen anomalies for inclusion onto the dig list. The one dimensional anomaly shape from the data profiles for each EM61-MK2 channel and two dimensional anomaly shape are also evaluated.

The anomaly selection criteria presented below are based on past project experience and may be modified for this project:

- Signal intensity (approximately 4-5 mV (Channel 2), or equivalent sum or weighted sum intensity);
- SNR (minimum of 3:1, 3 times the standard deviation will be used as the "noise" estimate, and that value multiplied by a value of 3 will be used as the signal intensity threshold);
- >5 sample points width on data profile for each channel;
- Signal decay progression: Channel 1> Channel 2> Channel 3> Channel 4; and
- Present on at least two adjacent acquisition lanes on color-coded image at an appropriate color scale.

The target selection process will err on the side of conservatism in order to be consistent with the goals of the RI process. Anomalies that initially do not meet the anomaly selection criteria will be selected as candidates for the intrusive investigation if their related anomaly characteristics, such as footprint, shape, and decay parameters indicate a relatively deeper anomaly source. In addition, approximately 10 percent of the anomalies in presumed target areas and 30 percent of the anomalies in presumed "background" areas that do not meet all attributes of the anomaly selection criteria that are not related to man-made features or significant noise sources (e.g., above or below ground power line) will be added to the dig sheet.

The site "noise" as derived from the initial IVS may not be representative of the "noise" encountered over all areas of the site. If environmental factors such as terrain and geology/soils or manmade features are present in a specific area, the anomaly selection criteria may be revised in concert with the client.

An iterative approach will be used during this project in terms of the anomaly selection criteria. Intrusive investigation results will be continually assessed by the project geophysicist (or their designee) and the anomaly selection criteria may be modified in concert with the PDT, if necessary (e.g., excessive "no finds").

K.7.3 DIG SHEETS

After targets have been selected, hard copy and/or digital dig sheets and color-coded images will be submitted to the HGL GIS department for upload to the project GIS and distribution to the UXO dig teams. The dig sheets will be in compliance with U.S. Army Corps of Engineers (USACE) DID WERS-004.01 and will be consistent with Chapter 7 of Engineer Manual (EM) 1110-1-4009.

The geophysical data analyst or GIS specialist will assign each anomaly a unique target identifier. At a minimum, the following information will be included in the database for each targeted anomaly:

- Unique target identification (ID);
- Easting and Northing coordinates in Universal Transverse Mercator (UTM) (local coordinates for full coverage grids);
- Sensor response for Channels 1-4 and sum or weighted sum channel;
- Decay parameters;
- Dig priority based on correlation to target attributes; and
- Interpreter comments.

A color-coded image of each full coverage DGM grid will be generated with an appropriate scale and symbols identifying each target to be investigated.

K.8 ANOMALY REACQUISITION

The reacquisition team will include an experienced EM61-MK2 operator and at least one assistant. The instrument operator will proceed to the anomaly coordinate location for each target specified on the dig sheet using the local X and Y coordinate position measured from the southwest corner of each full coverage grid. The color-coded DGM image with target symbols will be used during the reacquire process as a general guide to address the presence of additional targets near the specific target of interest.

The coordinate position of the target of interest will be reacquired (tolerance +- 0.3 meters) and a mark (e.g., boot mark) or flag will be placed at the location. The team will use the EM61-MK2 and data logger in analog mode to investigate a 1-meter radius around the flagged location. The location of the peak signal intensity within the search area will be identified and marked with a pin flag with the unique target ID. The offset and direction from the dig sheet location and peak signal intensity will be documented on a hardcopy form or ruggedized PDA for inclusion into the project database.

K.9 DGM QUALITY PROGRAM

A designated area adjacent to the main IVS (or one of the satellite IVSs) will be used for the daily instrument functional checks for the DGM system. The IVS will be surveyed at least twice daily, in the morning and again at the conclusion of the day's DGM activities and the results will be transferred to the project MS Access database by the data processor. The daily test regimen will provide information on environmental sources of interference or connectivity issues and ensure that the DGM data are of sufficient quantity and quality to meet the project objectives. The daily test regimen at the IVS includes the following instrument functional tests (project quality metric in parentheses):

- Static and Static Spike (95 percent of static measurements for all data channels will be within 2.5 mV of background and response for all data channels to an ISO within +/- 10% of the response attained on the first day of instrument testing);
- Personnel and Cable Shake (No data spikes in excess of 3 mV for any data channel);

- IVS Centerline (Dynamic response for all data channels greater than 75 percent of the average response calculated from the first six passes along the IVS centerline for each ISO when SNR > 5 and dynamic positioning repeatability not to exceed 0.38 meters (RTK GPS) and 0.6 meters when fiducial positioning is used);
- IVS Noise Line (Dynamic noise does not exceed 1.0 mV (standard deviation) for all data channels); and
- Known Position Check (Offset from known control point or monument within 0.15 meters [RTK GPS]).

In addition to the quality metrics for the daily instrument functional tests, additional quality metrics for the following elements of the DGM program are proposed as follows:

- Sensor velocity (95 percent of the measurements for each data collection session will be collected at a speed of less than 1.6 meters per second);
- Along track sampling (98 percent of the measurements for each data collection session will be less than or equal to 0.25 meters);
- Grid coverage (90 percent of the full coverage DGM grid data will be acquired at a spacing of 0.75 meters or less); and
- Dynamic detection capability (blind seeds detected within 0.90 meters of their known location (line and fiducial) and 0.75 meters (RTK GPS) with a signal intensity for all data channels of at least 75 percent of the intensity measured from the worst-case orientation during the initial IVS).

During anomaly reacquire and the post-intrusive hole check phases of the project the team will utilize a static and static spike test on a daily basis to ensure the EM61-MK2 is operating within specifications.

The performance metrics for the DGM program are documented in Table K.1.

Table K.1
Digital Geophysical Quality Performance Metrics[1]

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Static Repeatability (Instrument Functionality)[3]	All	Response (mean static spike minus mean static background) +- 10% of instrument verification strip (IVS) value for all data channels. 95% of static measurements within 2.5 millivolts (mV) of background.	Minimum of once daily	Day's data fails unless blind seed item is mapped that day with repeatable anomaly characteristics (see geophysical system verification [GSV] Blind Seeding)
IVS[4]	All	Static and dynamic response for each IVS item ≥ 75% of value predicted by National Research Lab detection curves or GSV calculator.	Minimum of once daily	Day's data fails unless GSV seed item is mapped that day with repeatable anomaly characteristics (see GSV Blind Seeding)
Along-Line Measurement Spacing	All	98% <=25cm along line[5]	By dataset	Dataset submittal fails
Speed	All	95% within 1.6 meters per second.	By dataset	Dataset submittal fails unless new max speed successfully demonstrated at geophysical prove out (GPO) or IVS.
GSV Blind Seeding	All	All blind coverage seeds detected within expected instrument response ranges.[6] Positional accuracy of GSV seed within 0.90 meters for full coverage DGM grids with line and fiducial positioning. Positional accuracy of GSV blind seed within 0.75 meters for full coverage DGM grids with RTK GPS.	One or more industry standard objects (ISOs) per day per team.[7]	Dataset submittal fails

Table K.1 (continued)
Digital Geophysical Quality Performance Metrics

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Coverage(*)	Grids	>90% coverage at project design line spacing (0.75 meters).[8]	By dataset or grid[9]	Submittal fails unless gaps filled, additional data collected, or government refund for missing acreage.
Target Selection	All	All dig list targets are selected according to project design.	By grid or dataset[9]	Dataset submittal fails
Anomaly Resolution(*)[10]	Verification checking by DGM re-mapping[11] or Verification checking with original instrument of anomaly footprint after excavation[12]	100 % of intrusive locations will be assessed with the EM61-MK2 post-intrusive. Residual signals greater than a value to be determined (TBD) during the IVS will require additional verification.	Rate varies depending on lot size.[15] See Acceptance Sampling Table.	Lot submittal fails
Geodetic Equipment Functionality(*)	All	Position offset of known/temporary control point within 15 cm for real-time kinematic (RTK) GPS survey instruments; ± 5 meters for wide area augmentation system (WAAS)-capable GPS equipment in "open" areas.[16]	Daily	Redo affected work or re-process affected data
Geodetic Internal Consistency	Grids with line/fiducial positioning	Grid corners are internally consistent within 30cm on any leg or diagonal.	Per Grid	Redo affected work (corner placement & data collection, or data processing)
Geodetic Accuracy	Points used for RTK or robotic total station (RTS) base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network.[17] Project control points that are used more than once must be repeatable to within 5cm	For points used more than once, repeat occupation[18] of each point used, either monthly (for frequently used points) or before re-use (if used infrequently[19]).	Re-set points not located at original locations or resurvey point following approved WP.

Table K.1 (continued)
Digital Geophysical Quality Performance Metrics

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Geodetic Repeatability(*)	Grid centroids or corners/transect points without anomaly reacquisition	Measured locations are reoccupied within 10m.[20]	1 per lot	Lot submittal fails
Coverage(*)	Grids	>90% coverage at project design line spacing (0.75 meters).[8]	By dataset or grid[9]	Submittal fails unless gaps filled, additional data collected, or government refund for missing acreage.

[1]These are the critical requirements for RI DGM methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.
[2]All failures also require a root cause analysis.
[3]Item should be placed on a jig that ensures consistent geometry between the sensor and item to ensure repeatability, response not to exceed 500 units, or optionally use the Geonics calibration coil. Duration of data collection needed TBD by the contractor. Must compare to original to ensure instrument is consistent throughout the project. .It is recognized that this QC requirement may be redundant and could contradict results from seeding QC, however, in the event of seed failure, information from this test may aid in determining cause of failure, i.e., instrument or processing.
[4]IVS consists of at least one ISO but may also include other test items. IVS tests will be conducted at the start of fieldwork and a report will be submitted documenting error sources, background noise and expected response range for each item within the IVS.
[5]25cm based on institutional knowledge and common instrument physical dimensions. Assumes speed used achieves detection. This requirement can be relaxed if supporting documentation is provided to the Government for concurrence.
[6]Responses should fall within ranges predicted during initial IVS testing and/or within depth response curves as agreed to by PDT.
[7]Coverage seeds/GSV blind seeds are a combination of ISO standard test items (small, medium, large) and other test items or stimulants as required by the PDT.
[8]Recommended default line spacing is 0.6m for items of interest the size of 40mm grenades and smaller, else 0.8m.
[9]The terms "grid" and "dataset" refer here to logical groupings of data or data collection event. Logical groupings of data are contiguous areas mapped by the same instrument and in the same relative time-frame. These can be grids, acres, or some other unit of area. A data collection event is similar to logical groupings of data but refers to data collected over a contiguous time frame, such as "morning," "afternoon," "battery life," or some other measure of contiguous time. It is recognized that physical marking of corners on the ground is not always beneficial to the government. Additionally, size and shape of the grid is not specified.
[10]Resolved is defined as 1) there is no geophysical signal remaining at the flagged/selected location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.
[11]Mapping shall cover the required number of anomaly locations. This is used in lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.
[12]This may require leaving flags at excavated locations until QC is complete. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete. As part of this requirement location accuracy must also be demonstrated (i.e. cleared location is within dynamic positioning error radius as described above). Contractor SOPs that incorporate post-excavation inspections using digital geophysical instruments can be used to meet the excavation verification need of this requirement provided appropriate QC protocols are in place to monitor and document the SOPs are followed. Acceptance sampling or alternative QC protocols to monitor and document the reacquisition SOP would be required to demonstrate the correct locations are excavated.
[13]If MEC (or intact or partial training or practice rounds) are not detected in a lot then the information from that lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.
[14]This is a statistical test number. It does not imply there are 10% bad units. It tests there are fewer than 10% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed. Stopping rules will take precedence over this standard (i.e. for high MEC density, decision could be made to stop because the team has enough data for characterization)

Table K.1 (continued)
Digital Geophysical Quality Performance Metrics

[15]For example, if lot size is 500 anomalies, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 43 anomalies must be re-checked. If any one of the 43 is unresolved, then the confidence level has not been met, the lot submittal fails and all anomalies in that lot must be re-checked (i.e. accept on zero). The contractor shall propose the lot size for government concurrence (i.e., the contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, it is based on number of anomalies, not grids.
[16]Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.
[17]The plan for tying the project network to a common reference network must be described in the approved WP. If monumentation is part of the plan, specific monumentation procedures and DQOs will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – "Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products."
[18]Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.
[19]An example of frequently used control points would be points used as RTK digital GPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.
[20]The exact location of a single transect/grid is not critical when the information is used only for characterization by interpolating over large areas (e.g., transect spacings are larger than geodetic accuracies). The acceptable accuracy may be tightened by the PDT if more exact positioning is needed (e.g., trying to characterize extents of small MRSs). If specific anomalies/locations must be recovered this metric must be revised to meet project needs and will likely have the same accuracy needs as the Geodetic Accuracy requirement.

K.9.1 BLIND SEEDING

Blind seed items (small ISOs) will be placed in the full coverage DGM grids using MEC anomaly avoidance techniques. The location for the blind seeds will be measured in local coordinates from the southwest corner of the grid. Before burial, a unique ID will be written on each blind seed, the item sealed in a small plastic Ziploc bag, then the item buried within the top 0.3 meters of soil. The relative coordinates, unique ID, and orientation will be recorded on a hardcopy sheet or ruggedized PDA as they are buried. The DGM survey team and data processor will not have prior knowledge of seed placement locations.

The blind seeds will be emplaced at a rate to ensure each DGM team encounters a minimum of one blind seed item per day. Blind seeding provides verifiable target detection and positioning over the course of the DGM survey, as well as a tool for evaluating the data collection, processing, and anomaly picking procedures and intrusive investigation performance criteria.

The UXOQCS and the Program Geophysicist will jointly verify that blind seed items have been mapped and recovered for the DGM grids and the dynamic detection capability metric is achieved. Once a grid has achieved the requisite quality checks, the USACE representative will be notified for quality assurance (QA) inspection, if applicable.

K.9.2 ANOMALY RESOLUTION

The EM61-MK2 will be used to check 100 percent of the post-intrusive locations within the full coverage DGM grids. The residual signal intensity for each anomaly location will be documented using a hardcopy sheet or ruggedized PDA. Residual signal intensity that exceeds

the anomaly selection threshold proposed in the IVS report will require further validation and possible intrusive investigation.

Successful resolution of each anomaly post-intrusive requires that all checked anomaly locations exhibit the following:

- Residual signal from EM61-MK2 < signal intensity proposed in the IVS report;
- A signal too low to be associated with UXO/discarded military munitions (DMM), or
- A remnant signal shown to be associated with surface materials, or
- A signal, but one for which a complete rationale exists for its presence.

K.9.3 FEEDBACK PROCESS

Ground-truthing in the form of reported results from intrusive investigation of anomalies will be used to assess the representativeness of the discovered anomaly sources by comparing the intrusive results to the geophysical anomaly characteristics. Intrusive investigation results with sources that are not well understood will be reviewed by the project and/or program geophysicist (or designee) and the intrusive investigation team leader to ascertain the credibility of the reported source. Anomalies that are not resolved to the satisfaction of the project or program geophysicist may be reinvestigated by the intrusive investigation team.

K.9.4 ANALOG GEOPHYSICS QUALITY PROGRAM

When AG is used for subsurface characterization (mag and dig or mag and count) a test strip will be used to validate the detection system (sensor and operator) at the start of the project and on a daily basis thereafter when AG is used. The test strip will be designed with input from the client to ensure that the project objectives are achieved, and may be coincident with the main or satellite IVSs used to validate the DGM systems. The UXOQCS will document the results of the daily test strip and transfer the data to the HGL GIS department for inclusion into the project database.

The daily tests performed at the analog test strip will validate the sensitivity of each detection system and ensure that the results of subsequent mag and count and mag and dig operations are sufficient to meet the project objectives. Table K.2 presents the DGM quality performance requirements, standard, test frequency, and consequences of QC failures.

Table K.2
Analog Geophysical Quality Performance Metrics[1]

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Repeatability (Instrument Functionality)	All	All items in test strip detected when used for subsurface characterization (mag and dig or mag and count) (trains ear daily to items of interest)[3] Test item used at local area at least once per day prior to performing anomaly avoidance and intrusive activities.	Minimum 1 daily[4]	Remedial training and additional remedial measures as described in the approved WP if due to operator error, or replacement of faulty equipment[5]
Dynamic Repeatability	Transects used only for density estimates	Repeat a segment of transect and show number of counts repeated w/in the greater of ±20% or ±8, or w/in range of adjacent segments.	2nd party repeat of 2% per lot Proposed lot size is 150 meters	Redo lot
	Transects with digging	Repeat a segment of transect and show extra flags/digs not greater than the greater of 20% or 8 flags/digs, or w/in range of adjacent segments.	2nd party repeat of 2% per lot Proposed lot size is 150 meters.	Redo lot
Coverage(*)	Grids	Blind coverage seeds and blind detection seeds recovered[6]: 75% if MEC 90% if no MEC[7]	Variable rate at 2, 3 or 4 times the number of operators, per lot. Proposed lot size is a contiguous grid.	Redo lot
Detection and Recovery (*)	Grids With DGM QC remapping	If MEC[9]: 70% confidence <10% unresolved anomalies[10] If no MEC: 90% confidence <5% unresolved anomalies Accept on zero.[11]	Rate varies depending on lot size. [Table showing acreage rates per lot size for varying confidence levels will be provided][12]	Redo lot

Table K.2 (continued)
Analog Geophysical Quality Performance Metrics[1]

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Anomaly Resolution(*)[13]	Verification checking of excavated locations (analog or digital instrument)	2nd party checks open holes to determine: If MEC: 70% confidence <10% anomalies unresolved[14] If no MEC: 90% confidence <5% anomalies unresolved	Rate varies depending on lot size. Proposed lot size is 100 anomalies for analog geophysics.	Redo lot
	Verification checking by DGM remapping[16]	Same as Detection and Recovery	Rate varies depending on lot size. See Acceptance Sampling Table.	Redo lot
Geodetic Equipment Functionality(*)	All	Position offset of known/temporary control point within expected range as described in the approved WP.[17]	Daily	Redo affected work
Geodetic Accuracy	Points used for RTK or RTS base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network.[18]. Project control points that are used more than once must be repeatable to within 5cm	For points used more than once, repeat occupation[19] of each point used, either monthly (for frequently used points) or before re-use (if used infrequently[20]).	Re-set points not located at original locations or resurvey point following approved WP.
Geodetic Repeatability(*)	Grid corners/transect points without anomaly reacquisition	Measured locations are reoccupied within 10m.[21]	1 per lot Proposed lot size is an individual MRS.	Redo affected work

Table K.2 (continued)
Analog Geophysical Quality Performance Metrics[1]

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Dynamic Repeatability	Transects used only for density estimates	Repeat a segment of transect and show number of counts repeated w/in the greater of ±20% or ±8, or w/in range of adjacent segments.	2nd party repeat of 2% per lot Proposed lot size is 150 meters.	Redo lot
	Transects with digging	Repeat a segment of transect and show extra flags/digs not greater than the greater of 20% or 8 flags/digs, or w/in range of adjacent segments.	2nd party repeat of 2% per lot Proposed lot size is 150 meters.	Redo lot

[1]These are the critical requirements for RI analog methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.

[2]All failures also require a Root Cause Analysis.

[3]The requirement is that each operator demonstrates positive detection on a daily basis of the smallest and largest expected MEC of interest when it is placed at both its best and worst orientations and buried between 95% and 100% of their respective maximum consistent detection depth. Maximum consistent detection depth is defined as producing any above background response on a minimum of the first three time gates of the EM61MK2 optimized for site conditions and having a $0.9m^2$ size or more as calculated using the Geosoft Oasis Montaj UCEAnalyseTarget.gx or equivalent routine.

[4]Random blind reconfiguration of test strip is also required (i.e., moving/adding items) at a frequency determined by the contractor and approved in the work plan, to address the potential for simply memorizing seed locations.

[5]Some examples of additional remedial measures are: removal of operator from mapping for one day, retesting on new blind strip meeting the same requirements for seed items (could move location of items in same area), 100% QC re-inspection of initial lanes by that operator, etc.

[6]Coverage seeds are small pieces of metal that will produce relatively large amplitude anomalies over small areas, such as small nails or ball bearings. Known location accuracy of placement is not critical. See endnote #8 for description of blind detection seeds.

[7]If MEC (or intact or partial training or practice rounds) are not detected in a grid/lot then the information from that grid/lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.

[8]Detection and recovery must be consistently demonstrated for the hard to detect items; therefore, the largest expected MEC and the smallest expected MEC shall be placed between 95% and 100% of their respective maximum consistent detection depth

[9]If MEC (or intact or partial training or practice rounds) are not detected in a lot then the information from that lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.

[10]This is a statistical test number. It does not imply there are 10% bad units. It tests there are fewer than 10% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed. Stopping rules will take precedence over this standard (i.e. for high MEC density, decision could be made to stop because the team has enough data for characterization)

[11]Unresolved anomaly for 'Detection & Recovery Testing' means a significant signal remains without a complete rationale for its presence. Default values for such a 'significant signal' are peak amplitude on sum channel $>=$30mv & anomaly width $>=$1.2m or anomaly size $>=0.9m^2$. This value may change but must be agreed upon by the PDT up front.

[12]The statistical calculations for this test are in progress. This is different from sampling of excavated holes, in that a portion of the acreage is re-mapped, and the amount re-mapped must be statistically valid to show, to some confidence level, that anomalies did not go undetected.

[13]This requires leaving flags at excavated locations until QC is complete. If shovel called to a flag during QC then the failure has already occurred—it is not important that something large or small comes out of the hole. Assumption here is "mapping coverage" is addressed through other means. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete.

[14]Resolved is defined as 1) there is no geophysical signal remaining at the flagged/selected location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.

Table K.2 (continued)
Analog Geophysical Quality Performance Metrics[1]

[15]For example, if lot size is 500, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 43 anomalies must be re-checked. If any one of the 43 is unresolved, then the confidence level has not been met, the lot submittal fails and all anomalies in that lot must be re-checked (i.e. accept on zero). The contractor shall propose the lot size for government concurrence (i.e., The contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, it is based on number of anomalies, not grids.

[16]Mapping shall cover the required number of anomaly locations. This is used in-lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.

[17]Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.

[18]The plan for tying the project network to a common reference network must be described in the approved work plan. If monumentation is part of the plan, specific monumentation procedures and data quality objectives will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – "Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products."

[19]Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

[20]An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.

[21]The exact location of a single transect/grid is not critical when the information is used only for characterization by interpolating over large areas (e.g. transect spacings are larger than geodetic accuracies). The acceptable accuracy may be tightened by the PDT if more exact positioning is needed (e.g. trying to characterize extents of small MRS's). If specific locations must be recovered this metric must be revised to meet project needs and will likely have the same accuracy needs as the Geodetic Accuracy requirement, which is 30cm.

K.10 GEOPHYSICAL SUBMITTALS

Analog and DGM data will be delivered to USACE IAW the schedule specified in Table 4.2, as outlined in the PWS.

Table K.3
Geophysical Submittals and Due Dates

Submittal	With Each Submittal	24 Hours After Collection	24 Hours After Request by Government Representative	By the Following Friday	7 Days After Completed Excavations of Each Grid	CD/DVD with Final Report
ReadMe File	X					
Index Map	X					
Updated DID Tables from Access Database	X					
First Week's Mapping and QC Data		X				
Special Request Draft Data			X			
Analog and DGM Data Package for Each Week's Data Collection (raw and final mapping and QC data, maps, field data sheets, and updated associated database tables)				X		
Intrusive Results Tables					X	
All Raw and Final Digital Data, Maps, Final Access Database, Final QC Documentation						X

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TABLE

MRS/MRA	MGFD	TSD[1] (ft)	MSD[2] (ft) unintentional detonation	MSD[3] (ft) intentional detonation
MRS-R01, Range II	100-pound M38A2 Practice Bomb	44	44[4]	357[4]
MRS-R02, Range III & MRS-R09, MG/RR	250-pound M57 (TNT filled) Bomb	202	536	2,513
MRS-R03, Range IV	20-pound M41 (Composition B filled) Frag Bomb	59	67	1,707

[1] For essential personnel for manual and mechanized operations employing anomaly avoidance based on K40 of MGFD
[2] For nonessential personnel for manual and mechanized operations with anomaly avoidance based on the HFD of the MGFD
[3] For all personnel for intentional single in-grid detonations based on the MFD of the MGFD
[4] Non-fragmenting item, use K40 and K328 vice HFD and MFD

Attachment