FINAL

WORK PLAN AND SAMPLING AND ANALYSIS PLAN ADDENDA

FOR THE

GROUNDWATER MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING AT THE SUSPECTED MUSTARD AGENT BURIAL SITE (AOC-28)
RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

PREPARED FOR

US ARMY CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
CONTRACT NO. W912QR-04-M-0116

NOVEMBER 2004

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Prepared by

Spec Pro, Inc.
8451 State Route 5
Ravenna, OH 44266

Final Work Plan and Sampling and Analysis Plan for the Groundwater Monitoring Well Installation and Groundwater Sampling at the Suspected Mustard Agent Burial Site (AOC-28)

Ravenna Army Ammunition Plant,
Ravenna, Ohio

November 2004

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ACRONYMS

AE	Architectural and Engineering
amsl	above mean sea level
AOCs	areas of concern
BATF	Bureau of Alcohol, Tobacco and Firearms
bgs	below ground surface
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPCs	chemicals of potential concern
COPEC	chemicals of potential ecological concern
CSM	conceptual site model
DLA	Defense Logistics Agency
DNT	dinitrotoluene
DoD	Department of Defense
DOT	Department of Transportation
DQO	data quality objective
EMM	earth-moving machinery
EMR	electromagnetic radiation
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
EU	exposure unit
FID	flame ionization detector
FS	Feasibility Study
FSA	Field Staging Area
GPS	global positioning system
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IDW	investigation-derived waste
MS	matrix spike
MSD	matrix spike duplicate
NTU	nephelometric turbidity unit
OD	outside diameter
Ohio EPA	Ohio Environmental Protection Agency
OSC	Operations Support Command
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PID	photoionization detector
PPE	personal protective equipment
PRG	preliminary remediation goal
PVC	polyvinyl chloride

PZ	piezoelectric
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RGO	remedial goal option
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SHHRA	screening human health risk assessment
SRA	screening risk assessment
SRC	site-related contaminant
SSHP	Site Safety and Health Plan
SVOC	semivolatile organic compound
T&E	threatened and endangered
TAL	target analyte list
TKN	total kjeldahl nitrogen
TNB	trinitrobenzene
TNT	trinitrotoluene
UCL95	95 percent upper confidence limit
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
UXO	unexploded ordnance
UXOSO	unexploded ordnance safety officer
VOCs	volatile organic compound
WBG	Winklepeck Burning Grounds
WP	white phosphorous

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

A suspected mustard agent burial site (AOC-28) has been identified at the Ravenna Army Ammunition Plant (RVAAP). It has been decided that the best and safest path forward to evaluate if mustard agent is present and leaking within the suspected burial site is to determine if mustard agent breakdown products are present in the uppermost groundwater bearing zone a short distance outside of the suspected burial site. The primary objective of this investigation is to determine if mustard agent breakdown products are present in the uppermost groundwater bearing zone adjacent to the suspected mustard agent burial site.

SpecPro, Inc., under contract W912QR-04-M-0116 with the US Army Corps of Engineers (USACE), Louisville District, will complete the following general tasks to meet this objective:

- Install 4 new groundwater monitoring wells adjacent to the suspected mustard agent burial site.
- Analyze all groundwater samples collected from each of the new monitoring wells for mustard agent breakdown products (thiodiglycol, 1,4-dithiane, and 1,4-oxathiane.
- Analyze downgradient groundwater sample for explosives, propellants, TAL Metals (filtered), cyanide, VOCs, SVOCs, Pesticides, and PCBs.
- Prepare a report of the investigation.

The performance of this project will be completed using the guidance specified in the following documents:

- Facility-Wide Sampling and Analysis Plan for Environmental Investigations At the Ravenna Army Ammunition Plant (Facility-wide SAP) – March, 2001
- Quality Assurance Project Plan for Environmental Investigations at the Ravenna Army Ammunition Plant (Facility-wide QAPP) – March 2001
- Facility-Wide Site Safety and Health Plan (Facility-wide SHP) – March, 2001

This Addendum to the Facility-wide SAP (SAP Addendum) has been developed to tier under and to supplement the Facility-wide SAP and includes all of the sampling and analysis objectives, rationales, planned activities, and criteria specific to the installing and sampling groundwater monitoring wells at the suspected mustard agent burial site. The Facility-wide SAP provides the base documentation, technical procedures, and investigative protocols for conducting remedial investigations under CERCLA at RVAAP.

Both the Facility-wide SAP and SAP Addendum have been developed following

the USACE guidance document *Requirements for the Preparation of Sampling and Analysis Plans, EM200-1-3, February, 2001* (USACE 2001), to collectively meet the requirements established by the Ohio Environmental Protection Agency (Ohio EPA), Northeast District, and the U.S. Environmental Protection Agency (EPA), Region 5, for conducting CERCLA investigations.

In addition to the SAP Addenda, this document presents Addenda to the Facility-Wide QAPP (Appendix A),and the Facility-wide SHP (Appendix B). These addenda have been prepared to tier under and supplement these respective Facility-Wide Plans with site-specific information pertinent to the completion of this project. Appendix C presents the Ordnance and Explosive Avoidance Plan.

1.2 HISTORY AND SITE DESCRIPTION

Past DOD activities at the Ravenna Army Ammunition Plant (RVAAP) date back to 1940 and include the manufacturing, loading, handling and storage of military explosives and ammunition. The site is located in northeastern Ohio in Portage and Trumbull Counties (Figure 1-1). RVAAP is situated approximately 10 miles east of Ravenna, Ohio. The installation includes 21,419 acres in a tract approximately 3.5 miles wide by 11 miles long.

In 1969, the U.S. Army excavated a possible mustard agent burial site within the Demolition Area #1 grounds, west of the NACA Test Area. One 50-gallon drum and seven small rusted cans were discovered in 1969. All recovered items were empty and no contamination was discovered according to reports (CHPPM, 1996). An unidentified and undocumented source reported that the first site excavated was incorrectly identified, and that the mustard agent was buried nearby (CHPPM, 1996). The second proposed site for the mustard agent burial is located in the wooded area approximately 500 feet south of Hinckley Creek along an abandoned power line right-of-way. The location of the suspected mustard agent burial site is shown in 1-2 and 1-3. The suspected site was marked and fenced, however only remnants of the fence still exist.

Two surface soil samples were collected from this area in 1996during the Hazardous and Medical Waste Study in 1996 (CHPPM, 1996). The soil samples were tested for thiodiglycol, a mustard agent decomposition product. Thiodiglycol was not detected at or above the method detection limit (22.5 ppm). No attempts were made to collect subsurface samples due to the hazards associated with it.

SAIC conducted a geophysical survey of the suspected burial site in 1998. Several metallic anomalies were identified during this investigation, but none could be positively identified as a buried container.

An extensive review of the site conditions at RVAAP are presented in the Facility-wide SAP.

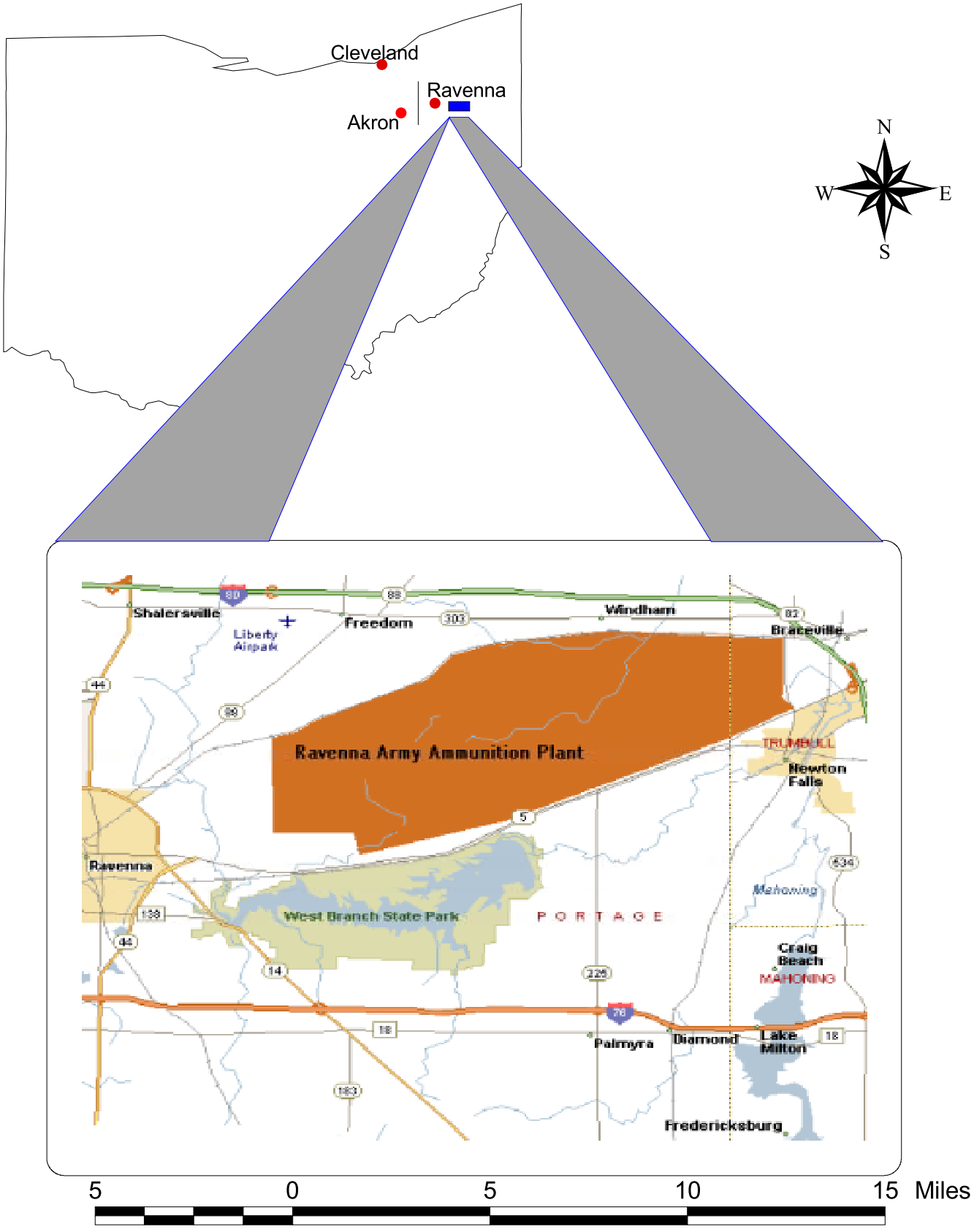
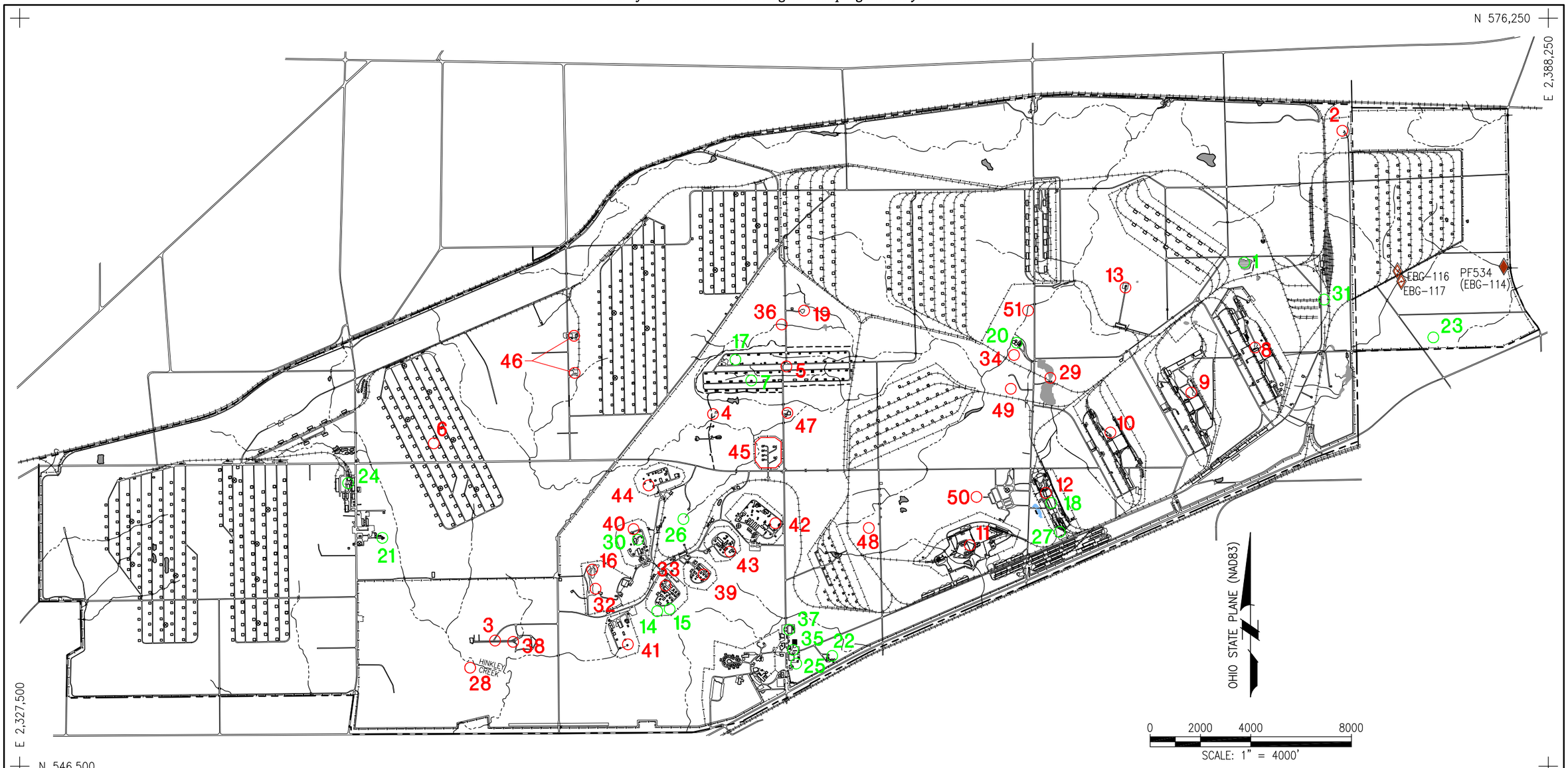


Figure 1-1 General location and orientation of RVAAP



LEGEND OF SITES:

1 RAMSDELL QUARRY LANDFILL	13 BLDG 1200 AND DILUTION/SETTLING POND	25 BLDG 1034 MOTOR POOL WASTE OIL TANK	37 PESTICIDE STORAGE BUILDING T-4452	49 CENTRAL BURN PITS
2 **ERIE BURNING GROUNDS**	14 LOAD LINE 6, EVAPORATION UNIT	26 FUZE BOOSTER AREA SETTLING TANKS	38 NACA TEST AREA	50 ATLAS SCRAP YARD
3 DEMOLITION AREA #1	15 LOAD LINE 6, TREATMENT PLANT	27 BLDG 854-PCB STORAGE	39 LOAD LINE 5 / FUZE LINE 1	51 DUMP ALONG PARIS-WINDHAM ROAD
4 DEMOLITION AREA #2	16 QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS	28 MUSTARD AGENT BURIAL SITE	40 LOAD LINE 7 / BOOSTER LINE 1	CERCLA
5 WINKLEPECK BURNING GROUNDS	17 DEACTIVATION FURNACE	29 UPPER AND LOWER COBBS POND COMPLEX	41 LOAD LINE 8 / BOOSTER LINE 2	RCRA
6 C BLOCK QUARRY	18 LOAD LINE 12 PINK WASTE WATER TREATMENT	30 LOAD LINE 7 PINK WASTEWATER TREATMENT PLANT	42 LOAD LINE 9 / DETONATOR LINE	OTHER REGULATORY
7 BLDG 1601 HAZARDOUS WASTE STORAGE	19 LANDFILL NORTH OF WINKLEPECK BURNING GROUND	31 ORE PILE RETENTION POND	43 LOAD LINE 10 / PERCUSSION ELEMENT	SURFACE WATER QUALITY MONITORING STATION PF534
8 LOAD LINE 1 AND DILUTION/SETTLING POND	20 SAND CREEK SEWAGE TREATMENT PLANT	32 40 AND 60 MM FIRING RANGE	44 LOAD LINE 11 / ARTILLERY PRIMER	SAMPLING LOCATIONS EBG PHASE I RI DOWNSTREAM
9 LOAD LINE 2 AND DILUTION/SETTLING POND	21 DEPOT SEWAGE TREATMENT PLANT	33 FIRESTONE TEST FACILITY	45 WET STORAGE AREA	
10 LOAD LINE 3 AND DILUTION/SETTLING POND	22 GEORGE ROAD SEWAGE TREATMENT PLANT	34 SAND CREEK DISPOSAL ROAD LANDFILL	46 BUILDINGS F-15 AND F-16	
11 LOAD LINE 4 AND DILUTION/SETTLING POND	23 UNIT TRAINING SITE WASTE OIL TANK	35 1037 BUILDING-LAUNDRY WASTEWATER SUMP	47 BUILDING T-5301 DECONTAMINATION	
12 LOAD LINE 12 AND DILUTION/SETTLING POND	24 RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK	36 PISTOL RANGE	48 ANCHOR TEST AREA	

US Army Corps of Engineers Louisville District

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
FACILITY MAP

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	0 / 09-02-03	/03025/DWGS/S80RVAP1

Figure 1-2. RVAAP Installation Map

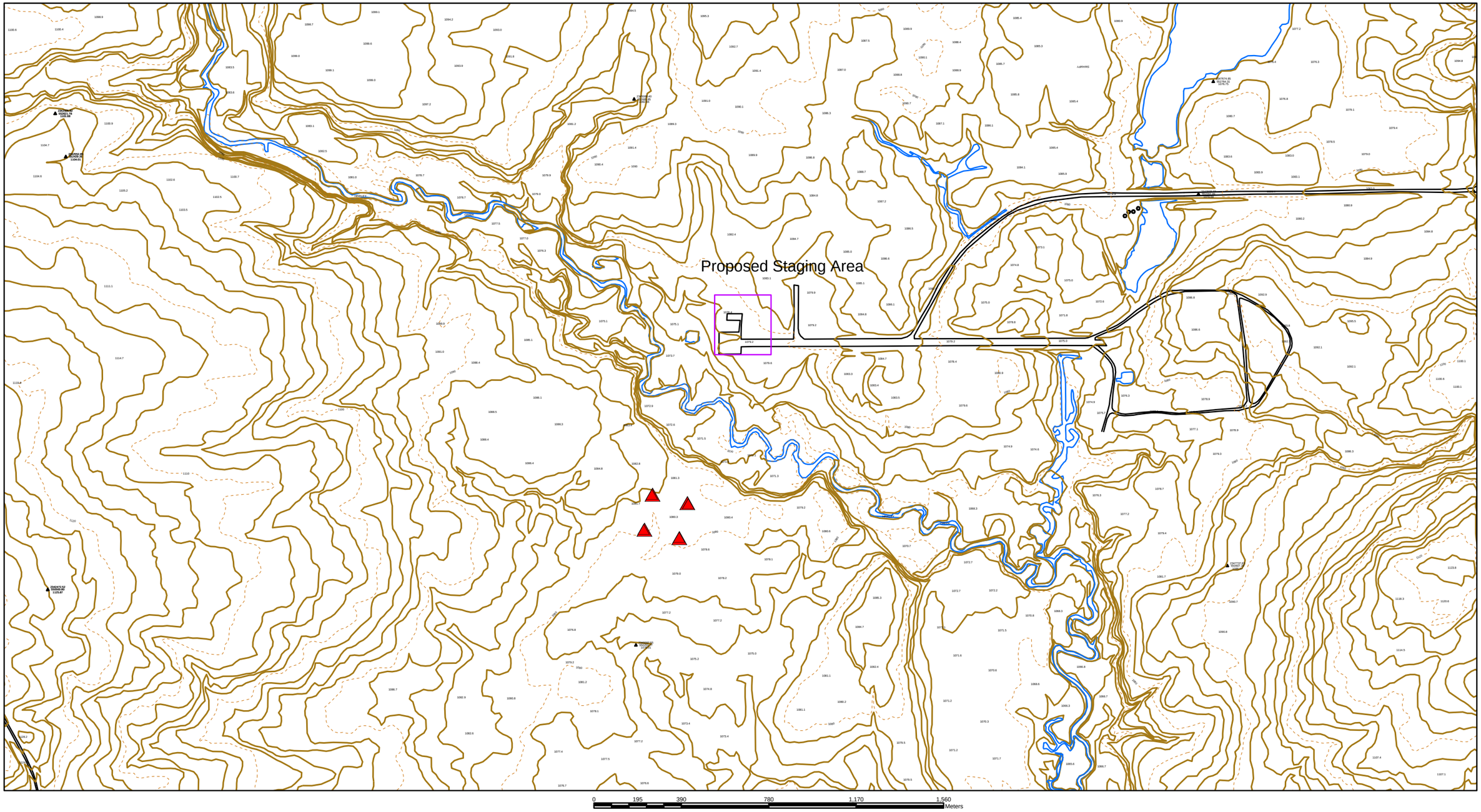


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Figure 1-3 Proposed locations for Monitoring Wells at the suspected Mustard Agent Burial Site.

Legend

- roads
- water
- vegetation
- 2 ft contour line
- 10 ft contour line
- Monitoring wells

Monitoring Well locations

Drawn By: CC

Sheet No. Figure 1-3

CAD File: FLLINE2.dgn

Date: August 23,2004

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The Mustard Agent Burial Site organization and responsibilities are presented in Figure 2-1. The functional responsibilities of all key personnel are described in Chapter 2.0 of the Facility-wide SAP and, therefore, are not presented here. The project schedule is presented in Figure 2-2.

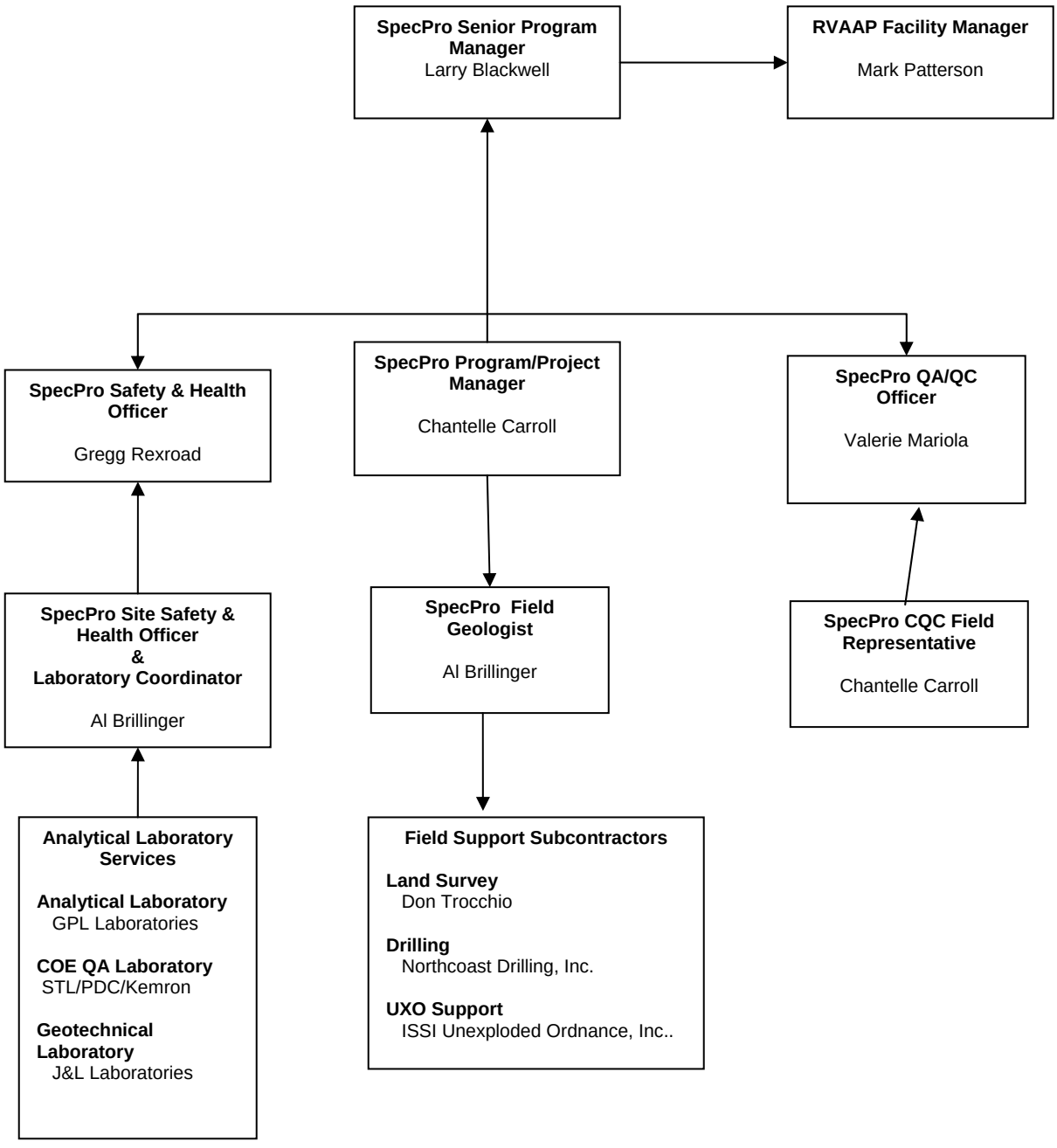
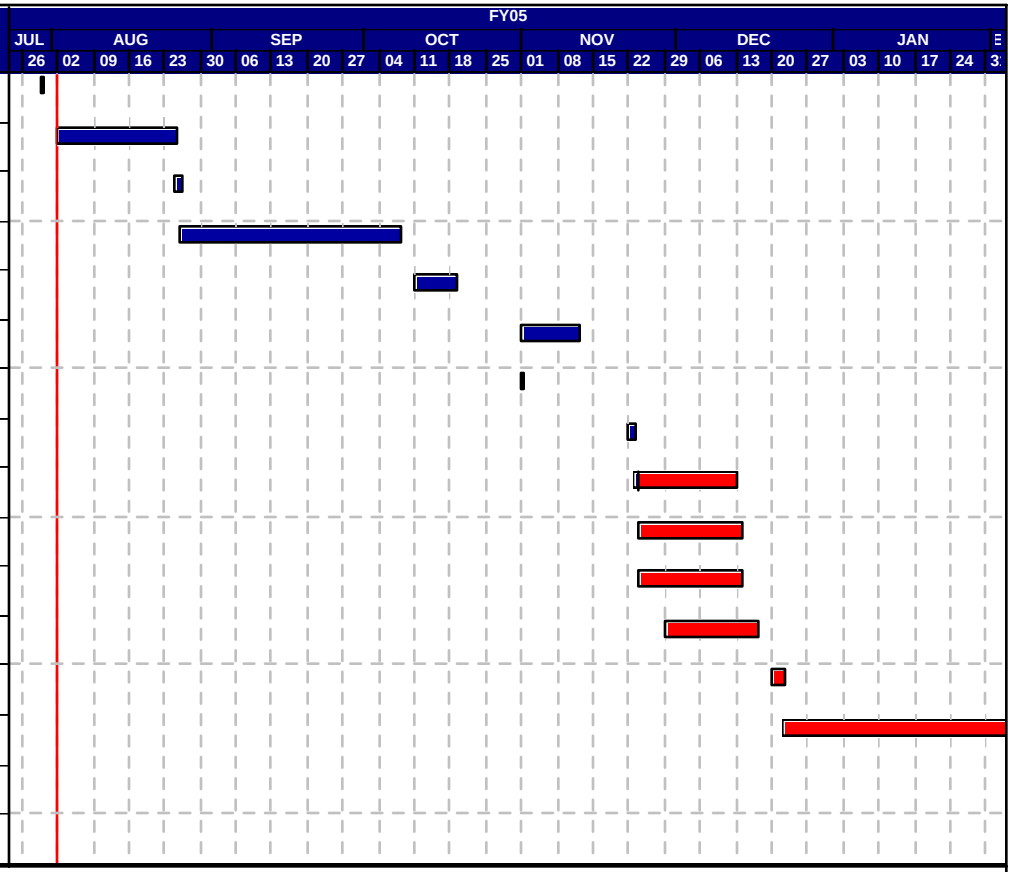


Figure 2-1. Project Organization Chart for the Suspected Mustard Agent Burial Site Drilling Project

Description	Rem Dur	Early Start	Early Finish
Notice to Proceed	0	07/30/04	07/30/04
Prepare Work Plans	0 *	08/02/04	08/25/04
Submit Work Plans	0 *	08/25/04	08/26/04
Work Plan Review	0 *	08/26/04	10/08/04
Receive Work Plan Comments and Submit	0 *	10/11/04	10/19/04
Mob/Demob	0 *	11/01/04	11/12/04
Well Installation/Development	0 *	11/01/04	11/01/04
Sample Wells	0 *	11/22/04	11/23/04
Verification	14 *	11/23/04	12/13/04
Validation	15 *	11/24/04	12/14/04
Data Analysis/Intrepretation	15 *	11/24/04	12/14/04
Preliminary Draft Development	15 *	11/29/04	12/17/04
Submit Draft Report	3 *	12/20/04	12/22/04
Draft Report Review	33 *	12/22/04	02/04/05
Prepare Final Report	6 *	02/04/05	02/11/05
Final Report Submission and Approval	6 *	02/11/05	02/18/05



Start date	07/30/04 8:00AM
Finish date	02/18/05 4:59PM
Data date	08/02/04 8:00AM
Run date	11/24/04 2:00PM
Page number	1A

Suspected Mustard Agent Burial Site

- Early bar
- Progress bar
- Critical bar
- Summary bar
- Progress point
- Critical point
- Summary point
- Start milestone point
- Finish milestone point

Figure 2-2 Project Schedule for the Suspected Mustard Agent Burial Site.

3.0 SCOPE AND OBJECTIVES

3.1 PROJECT SCOPE AND OBJECTIVES

The primary objective of this project is to evaluate if any mustard agent breakdown products are present in the uppermost groundwater bearing zone adjacent to the suspected mustard agent burial site.

In order to meet the primary objective for this project, the following tasks will be performed:

- Prepare site-specific Addenda to the Facility-wide SAP, Facility-wide SHP, and Facility-wide QAAP.
- Install and develop 4 new groundwater monitoring wells adjacent to the suspected mustard agent burial site.
- Analyze groundwater samples collected from each of the new monitoring wells for mustard agent breakdown products (thiodiglycol, 1,4-dithiane, and 1,4-oxathiane.
- Analyze groundwater collected from a downgradient well for explosives, propellants, TAL metals (filtered), cyanide, VOCs, SVOCs, pesticides, and PCBs.
- For monitoring wells with screens installed in overburden, collect Shelby tube samples from the screened intervals and analyze for moisture content, specific gravity, pH, grain size, and hydraulic conductivity, Atterberg Limits, bulk density, and porosity.
- Conduct survey to determine horizontal coordinates and surface elevations of the newly installed monitoring wells.
- If bedrock is encountered, coring will occur to accurately log the boring.
- Perform slug tests on the newly installed monitoring wells.
- Properly dispose of Investigation-Derived Waste (IDW).
- Prepare a report of the investigation.

Specific procedures for these tasks are presented in Section 4 of this addendum.

3.2 DATA QUALITY OBJECTIVES

The project Data Quality Objective (DQO) is to provide sufficient high-quality data to address the primary project objective identified above in Section 3.1.

3.2.1 Conceptual Site Model

The facility-wide hydrogeologic conceptual site model (CSM) for RVAAP, presented in the Facility-wide SAP, is applicable to the suspected mustard agent burial site. The CSM for RVAAP and other limited operational information have

been used to refine the CSM specific to the project area as outlined below.

Limited hydrogeologic and analytical data exist for groundwater for the Suspected Mustard Agent Burial Site. For the purposes of DQO development and investigation planning, the CSM presumes that the general groundwater flow patterns at the Mustard Agent Burial Site would also mimic the site topography and surface water drainage patterns.

Groundwater flow directions at the site are not known and are not apparent from studying the 2-foot contour interval maps of the site. Four groundwater monitoring wells will be installed surrounding and outside of the suspected mustard agent burial site. The monitoring well locations are planned to be far enough outside the suspected burial site so that if mustard agent is present within the burial site, only the breakdown products would be encountered in the uppermost groundwater bearing zone outside of the burial site. Monitoring well locations may be adjusted in the field in an attempt to install at least 2 downgradient wells. All monitoring well locations must remain outside of a 160-ft by 160-ft square centered on the suspected mustard agent burial site.

3.2.2 Problem Definition

It has been reported that mustard agent containers may have been buried within the old demolition grounds. An area to the west of the NACA Test Strip was excavated in 1969 and one 50-gallon drum and several small rusted cans were discovered, with no evidence of contamination. A second area approximately 500 feet south of the excavated area was proposed as the suspected site. This area was marked and fenced, although the fence has disintegrated over time. This second, marked area is the suspected mustard agent burial site to be investigated for this study. It is unknown if mustard agent is present within the suspected area, and the possible extent of the residual breakdown products beyond the suspected burial site.

3.2.3 Remedial Action Objectives

Section 3.2.3 of the Facility-wide SAP describes the process for identifying remedial action objectives for RVAAP under the CERCLA process.

3.2.4 Identify Decisions

The key decisions for all investigations at RVAAP have been identified in Section 3.2.4 and in Table 3-1 of the Facility-wide SAP. The absence of mustard agent breakdown products in the groundwater samples collected will indicate that mustard agent is not leaking into the subsurface at the site. The presence of mustard agent breakdown products in the groundwater samples collected will

indicate the mustard agent is present at the site, and is leaking into the subsurface. These determinations will indicate what type of further investigation at the suspected burial site is needed, and what type of response actions are most appropriate.

3.2.5 Define the Study Boundaries

The suspected mustard agent burial site and the proposed monitoring well locations are shown in Figure 1-3.

3.2.6 Identify Decision Rules

Decision rules used to guide remediation decisions are provided in Section 3.2.6 of the Facility-wide SAP. The purpose of this investigation is to determine if mustard agent breakdown products are present outside the suspected burial site. If the breakdown products are detected in the groundwater samples outside the suspected burial site, it will be assumed that mustard agent is buried within the site and additional investigation may be necessary.

3.2.7 Identify Inputs to the Decisions

Inputs to the decision process are the analytical results and the refined site-specific conceptual model developed from field observations and environmental data.

3.2.8 Specify Limits on Decision Error

Limits on decision errors are addressed in Section 3.2.8 of the Facility-wide SAP.

3.2.9 Sample Design

The purpose of the sampling is to detect if mustard agent breakdown products are present in the uppermost groundwater bearing zone outside the suspected burial site. Since groundwater flow direction is not known at the site, the proposed monitoring wells locations were chosen to surround the site to ensure that at least one of the wells were located downgradient of the suspected burial site. Monitoring well locations may be adjusted in the field due to observed conditions so that at least 2 wells are placed downgradient of the suspected burial site. Due to safety concerns, the proposed well locations are far enough outside the suspected burial site so that if mustard agent is leaking into the groundwater inside the burial site, only the breakdown products would be encountered outside the burial site. Additional samples will be collected from the

downgradient well to check for other possible contaminants.

4.0 FIELD ACTIVITIES

4.1 GROUNDWATER

4.1.1 Rationale

Limited hydrogeologic and analytical data exist for groundwater at AOC-28. Accordingly, monitoring wells will be installed to assess impacts to shallow groundwater and to potential migration pathways. The groundwater characterization effort will include installation of monitoring wells in a configuration that will provide data on general hydrogeologic characteristics and groundwater flow patterns. The proposed monitoring wells will be specifically installed in the vicinity of a suspected source area to evaluate whether contaminants in the suspected source area are leaching to groundwater.

4.1.1.1 Monitoring well locations and installation

Four new monitoring wells will be installed as a part of this investigation (Figure 1-3). The proposed locations were selected on the basis of DQOs, and the CSM developed for the suspected mustard agent burial site (Chapter 3.0). It is anticipated that the depth to the water table will vary between 1.5 meters (5 feet) and 9.1 meters (30 feet) bgs, based on general RVAAP site experience. Depth to bedrock is unknown, but is anticipated to be encountered within 9.1 meters (30 feet) bgs.

All monitoring wells will be installed using conventional drilling techniques (hollow-stem auger and air rotary drilling, as required) as described in Section 4.1.2.1 of the Facility-wide SAP. The maximum depth of each monitoring well is expected to be approximately 12.2 meters (40 feet) bgs or less. The screened intervals for the wells will be installed so that the first water-bearing zone (not perched) is within the screen interval. For those wells where a shallow completion is required, design and installation of the well will be coordinated/concurred with Ohio EPA prior to installation. The approach to completing shallow wells will be to follow the sequence of construction specified in Section 4.3.2.3 of the Facility-wide SAP, with thicknesses of the filter pack, bentonite, and grout layers shortened as needed to accommodate placement while maintaining integrity of the monitoring well seal. Where bedrock is encountered at depths less than the minimum required to set a well, the boring will be advanced into the first one to two feet of bedrock and the well set at that

depth and completed as described above. Borings that required bedrock drilling will be cored in accordance with Section 4.3.2.3.2 of the Facility-wide SAP.

One round of water level measurements will be performed on the same day for all the newly constructed wells at the suspected mustard agent burial site following development and prior to sampling. The newly constructed monitoring wells will be surveyed for horizontal location and surface elevation after development and prior to the water level measurements. Results of the water level measurement and survey will be used to accurately determine groundwater flow direction of the uppermost groundwater bearing zone, and thus identify the downgradient well(s).If more than one downgradient well is identified, Ohio EPA and USACE personnel will be contacted for further sampling instructions Water level measurements will also be collected from the wells at the time they are sampled. Groundwater samples will be collected from each of the 4 monitoring wells installed as part of this investigation. The individual sample identification and the required chemical analyses are provided in Chapter 5.0.

4.1.1.2 Sample collection for field and laboratory analysis

All monitoring wells will be field screened for VOCs prior to sample collection using a hand-held photo-ionization detector (PID) or flame ionization detector organic vapor analyzer (OVA). Screening will be accomplished by monitoring the headspace vapors at the top of the riser pipe. In addition, each boring will be field screened for UXO and mustard agent as per the UXO Avoidance Plan (Appendix C).

Field measurements of pH, temperature, specific conductance, turbidity, and dissolved oxygen will be recorded for each groundwater sample. No samples will be collected for additional headspace analysis. Water level measurements will be collected immediately prior to sampling of each well.

An unfiltered groundwater sample will be collected from each monitoring well and submitted for laboratory analysis of mustard agent breakdown products (thiodiglycol, 1,4-dithiane, and 1,4-oxathiane). From the well identified as downgradient, groundwater will additionally be analyzed for explosives, propellants, (including nitrocellulose, nitroguanidine, and nitroglycerin), TAL metals (filtered), cyanide, SVOCs, VOCs, pesticides, and PCBs. Filtering will be performed in the field according to Section 4.3.5 of the Facility-wide SAP. The specific number of samples and the types of chemical analyses to be performed are delineated in Chapter 5.0.

4.1.1.3 Quality assurance/quality control, and blank samples and frequency

QC duplicates, USACE QA split groundwater samples, equipment rinsate

samples, and matrix spike/matrix spike duplicates will be collected during the investigation. Duplicates and QA splits will be selected randomly (from the same locations, whenever possible) and analyzed for the same parameters as the environmental samples. Due to the limited amount of groundwater samples being collected for this project, the following QA/QC samples will be collected:

- One set each of duplicate and QA split samples, representative of the sample parameters analyzed.
- One equipment rinsate for all parameters analyzed.
- Trip blanks, which originate in the laboratory, will accompany shipment of all VOC groundwater samples and will be analyzed for VOCs only.
- One matrix spike/matrix spike duplicates for all parameters analyzed.

4.1.2 Monitoring Well Installation

In general, monitoring wells to be installed will be 2.0-inch, Schedule 40 polyvinyl chloride (PVC) wells with standard above-grade completions. Specifications for drilling, installation, completion, and development of monitoring wells are contained in the following subsections.

4.1.2.1 Drilling methods and equipment

Equipment Condition and Cleaning

Requirements for the condition and cleaning of equipment used for well installation are described in Section 4.3.2.1.1 of the Facility-wide SAP. These requirements, as applicable, will be employed for equipment used to install monitoring wells at AOC-28.

Drilling Methods

Conventional drilling techniques (hollow-stem auger and air rotary) will be used to install monitoring wells, as described in Section 4.3.2.1.2 of the Facility-wide SAP. In the event that unconsolidated materials are found to be prone to collapse, then the second drilling scenario (i.e., use of temporary surface casing) will be employed. Where depth to the water table is great enough, monitoring well boreholes will be drilled to sufficient depth to install the bottom of a 3-meter (10-foot) well screen approximately 2.1 meters (7 feet) below the first water bearing zone (not perched water). If the water table lies at too shallow a depth to place a screen across it and complete a well per specifications of the Facility-wide SAP, then the borehole will be advanced and the well completed as previously described in Section 4.1.1.1 of this SAP Addendum in consultation with the Ohio EPA and USCOE. As noted previously, it is anticipated that the depth to the water table will range from 1.5 meters (5 feet) to 9.1 meters (30 feet) bgs at AOC-28. Depth to bedrock is unknown, but is anticipated to be shallower than 9.1 meters (30 feet). The maximum depth of monitoring wells at AOC-28

is expected to be approximately 12.2 meters (40 feet) bgs.

4.1.2.2 Materials

Casing/Screen

The casing and screen materials for monitoring wells were presented in Section 4.3.2.2.1 of the Facility-wide SAP.

Filter Pack, Bentonite, and Grout

The filter pack, bentonite, and grout materials for monitoring wells were presented in Section 4.3.2.2.2 of the Facility-wide SAP.

Surface Completion

All wells will be constructed as above-ground installations, as described in Section 4.3.2.2.3 of the Facility-wide SAP.

Water Source

Potable water from a commercial source will be used during this investigation for monitoring well installation and decontamination purposes. The collection and evaluation of the source water sample will follow Section 4.3.2.2.4 of the Facility-wide SAP.

Delivery, Storage, and Handling of Materials

All monitoring well construction materials will be delivered, stored, and handled following Section 4.3.2.2.5 of the Facility-wide SAP.

4.1.2.3 Installation

All monitoring well installation will be in accordance with the procedures for above-ground installations as previously presented in Section 4.1.1.1 of this SAP Addendum. Unconsolidated surficial material in each location will be drilled using a 10.8-centimeter (4.25-inch) inside diameter hollow-stem auger having an outside diameter (OD) of at least 16.5 centimeters (6.25 inches). Soil samples will be collected continuously from the surface to bedrock refusal or borehole termination using a split spoon or split-barrel sampler for geologic logging. If and when competent bedrock is encountered, it will be cored and sampled via “N”-series coring techniques, consistent with the Facility-wide SAP to obtain maximum core recovery, and yielding a minimum core diameter of 2 inches. The core samples will be obtained, handled, described, sampled (i.e., for laboratory analysis, if necessary), measured, labeled, documented, packaged, and stored in

accordance with the Facility-wide SAP (Section 4.3.2.3.2). The first borehole that encounters rock will be cored. Subsequent boreholes that encounter bedrock will not be cored, unless bedrock is encountered at a substantially different elevation, in consultation with the Ohio EPA and USACOE.

4.1.2.4 Documentation

Logs and Well Installation Diagrams

Boring Logs. Boring logs will be completed for all monitoring well boreholes following Section 4.3.2.4.1.1 of the Facility-wide SAP. Visually determined Unified Soil Classification System (USCS) of each soil sample taken will be recorded on each boring log.

Well Construction Diagrams. All monitoring well activities will be documented according to the procedures presented in Section 4.3.2.4.1.2 of the Facility-wide SAP.

4.1.2.5 Well abandonment

Any monitoring wells or boreholes abandoned during the investigation will be abandoned according to the procedures presented in Section 4.3.2.5 of the Facility-wide SAP.

4.1.2.6 Water level measurement

Water level measurements will follow the procedure presented in Section 4.3.2.6 of the Facility-wide SAP.

4.1.2.7 Well development

Development of monitoring wells will be accomplished with a pump following Section 4.3.2.3.11 of the Facility-wide SAP. Pumps may be replaced with bottom-filling bailers where well size or slow recharge rates restrict pump usage. Development will proceed until the criteria specified in the Facility-wide SAP are met as below:

- Turbidity readings of 5 nephelometric turbidity unit (NTU) or less are attained. If values of 5 NTU or less cannot be attained, development will continue until the water is clear to the unaided eye or the maximum development time has expired (48 hours).

- The sediment thickness remaining in the well is less than 1 percent of the screen length or <30 millimeters (0.1 foot) for a 3.05-meter (10-foot) screen.

- A minimum of five times the standing water volume in the well has been purged (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity).

- Indicator parameters (pH, temperature, and specific conductance) have stabilized to ±10 percent over three successive well volumes.

If potable water is added to the boring to aid drilling of the well or to control heaving sands, 5 times the volume of any water added will be removed during development. If development to the criteria specified above cannot be achieved due to site conditions, such as slow recharge or persistent turbidity, then the SpecPro Project Manager or Field Geologist, the Ohio EPA, and the USACE Technical Manager or other field representative will be consulted to determine the appropriate course of action. For each monitoring well developed during the investigation, a record will be prepared to include the information specified in Section 4.3.2.4.2 of the Facility-wide SAP.

4.1.3 Field Measurement Procedures and Criteria

All field measurement procedures and criteria will follow Section 4.3.3 of the Facility-wide SAP. All monitoring wells will be field screened for VOCs using a PID or OVA during groundwater sample collection. Screening will be accomplished by monitoring the headspace vapors at the top of the riser pipe.

4.1.4 Sampling Methods for Groundwater

Groundwater sampling from monitoring wells will follow conventional procedures discussed in Section 4.3.4.1 of the Facility-wide SAP. An exception to the Facility-wide SAP will be that groundwater samples will be collected no earlier than 48 hours after well development rather than the mandatory 14-day waiting period.

4.1.4.1 Well Purging Methods

Purging and sampling of all monitoring wells installed during the investigation will be conducted in accordance with conventional procedures discussed in Section 4.3.4.1 of the Facility-wide SAP.

4.1.4.2 Filtration

Filtered groundwater samples will be collected for dissolved TAL metals analyses only as per Section 4.3.5 of the Facility-wide SAP. Filtration will be performed by using a negative pressure, hand-operated vacuum pump and collection flask and a disposable 0.45-µm pore size filter assembly. Filters will be replaced as they become restricted by solids buildup as well as between sample collection sites.

4.1.5 Sample Containers and Preservation Techniques

Requirements for sample containers and preservation techniques for groundwater samples are presented in Section 4.3.6 of the Facility-wide SAP.

4.1.6 Field Quality Control Sampling Procedures

QC samples for monitoring well groundwater sampling activities will include duplicates and split groundwater samples, equipment rinsates, matrix spike/matrix spike duplicates and trip blanks as described in Section 4.1.1.3 above. Split samples will be submitted to a USACE contract laboratory for independent analyses.

4.1.7 Decontamination Procedures

Decontamination of equipment associated with groundwater sampling will be in accordance with the procedure presented in Section 4.3.8 of the Facility-wide SAP. A final decontamination inspection of any equipment leaving RVAAP at the end of field activities will be conducted to ensure proper decontamination.

4.1.8 In-Situ Permeability Testing

A slug test will be performed in each of the monitoring wells installed as part of the investigation to determine the hydraulic conductivity of the geologic material surrounding each well. The slug test method involves lowering or raising the static water level in a well bore by the removal or insertion of a cylinder (slug) of known volume. The return of the water level to a pre-test static level is then measured over time. The change in water level over time is plotted on a logarithmic scale to determine hydraulic conductivity (K). K is a function of the formation permeability and the fluid in the formation and is influenced by well construction.

At a minimum, a slug insert (falling head) test will be used for this investigation. A rising head test will also be performed following the falling head test to obtain a corresponding K value for comparative purposes. If possible, the slug test will be performed in such a manner as to prevent the water level in the well from dropping below the top of the screened interval when the slug is removed. All tests will be performed after the groundwater has been sampled, as described in Section 4.1.4, and will be contingent upon a monitoring well containing sufficient water to allow testing.

Slug tests will only be initiated after the well has recovered from groundwater sampling, or after a minimum of 12 hours has elapsed since sampling. A pressure transducer will be inserted into the well and the water level allowed to equilibrate to static conditions or until at least 6 hours have elapsed. A slug that displaces 0.3 meter (1 foot) of water will be inserted to provide an adequate response for the analysis. Prior to the start of the test, plastic sheeting will be placed around the well in a manner to minimize water contact with the ground surface. The static water level will be measured with an electronic water level indicator and recorded to the nearest 0.003 meter (0.01 foot) below top of inner casing. The total depth of the well will be measured with an electronic water level indicator and recorded to the nearest 0.003 meter (0.01 foot) below top of inner casing. These measurements will be used to calculate the water column height in the well. Use of the electronic water level meter will follow procedures outlined in Section 4.3.3.1 of the Facility-wide SAP.

For the rising head test, the slug will be withdrawn quickly from the well without surging. The time of the test will begin as soon as the slug leaves the water column. Water level measurements will be recorded continuously during the test with a pressure transducer and data logger programmed to make measurements to within 0.003 meter (0.01 foot) and record them on a logarithmic scale. Water level change will be recorded for a period of 6 hours or until the well re-equilibrates to 90 percent of the pre-test water level, whichever occurs first.

The test data will be evaluated by the Bouwer and Rice method (1976, 1989). If the test geometry is not conducive to analysis to this method, an alternate method will be used subject to RVAAP team approval (USACE and Ohio EPA).

4.1.9 UXO and Chemical Warfare Material (CWM) Avoidance

Protocols for UXO avoidance during drilling or subsurface soil boring activities are discussed in Section 4.2.3. A UXO Avoidance Plan is contained in Appendix C. Specific mustard agent (CWM) screening procedures are presented in Appendix E of the UXO Avoidance Plan.

4.2 SUBSURFACE SOIL SAMPLING PROCEDURES

4.2.1 Rationale

Undisturbed geotechnical soil samples will be collected from the screened intervals of the wells completed in overburden. The samples will be analyzed to provide geotechnical information about the soil that comprise the uppermost water bearing zone.

4.2.2 Organic vapor screening

All soil borings will be field screened for VOCs using a hand-held PID OVA during sample collection. All OVA readings will be recorded in field logbooks. No samples will be collected for headspace analysis of VOCs.

4.2.3. Sampling for Geotechnical Analysis

For any new wells that are set with the screened interval in overburden, two undisturbed subsurface soil samples will be collected from the midpoint of the screened interval. The samples will be collected using a thin-walled (Shelby) tube sampler during hollow-stem auger drilling. Shelby tube sampling will proceed as discussed in Section 4.4.2.4.1 of the Facility-wide SAP. All Shelby tube/geotechnical samples will be analyzed for moisture content, specific gravity, pH, grain size, Atterberg limits, bulk density, and porosity.

4.2.4 Sample containers and preservation

The geotechnical samples will be contained in the Shelby Tubes they were collected in. Upon retrieval from the borehole, the ends of the Shelby Tube will be sealed using plastic caps and duct tape.

4.2.5 Decontamination procedures

The decontamination procedure for subsurface soil sampling activities presented in Section 4.4.2.8 of the Facility-wide SAP will be followed. A final decontamination inspection of any equipment leaving RVAAP at the end of field activities will be conducted to ensure proper decontamination.

4.2.6 UXO and Chemical Warfare Material (CWM) Avoidance

UXO and CWM Avoidance Plans are contained in Appendix C and Appendix E and will be presented as part of the initial project safety briefing. UXO support staff will be present during all field operations. The UXO Team Leader will train all field personnel to recognize and stay away from propellants, mustard agent, and UXO. Safety briefings for UXO and CWM will also be provided to all site personnel and site visitors.

All sample locations and access routes into the locations will be cleared for potential UXO prior to entry. The UXO Team Leader will clearly mark the boundaries of the cleared soil sampling locations and access routes. If surface UXO or CWM is encountered, the approach path will be diverted away from the UXO or CWM and the area clearly marked. In the event UXO or CWM is encountered, notification will be made to the RVAAP

Environmental Coordinator along with a map showing the exact location of the item. No item shall be moved without RVAAP approval. In any area where surface metallic UXO is encountered, a magnetometer will be used to ensure that no subsurface UXO exists within the approach path. Prior to collection of the first split spoon sample [0 to 0.6 meters (0 to 2 ft.)below ground surface], the UXO team leader will verify that the location is anomaly free using a magnetometer. Magnetometer readings to screen for subsurface anomalies will be taken prior to augering, and every two feet thereafter. This will be repeated until native soil or bedrock is encountered, whichever occurs first. Magnetometer equipment will be decontaminated between borings, or, in the case of hand-held magnetometers, a plastic sleeve may be used and replaced between borings.

Mustard agent screening will be performed using M256 chemical agent detector kits. This involves wiping downhole equipment that come out of the borehole wet with detector papers that turn a distinctive color when chemical warfare agents are present. In the event mustard agent is detected, the UXO Team Leader will direct personnel at the site to a safe location.

Organic Vapor Screening

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, with the following exception. Headspace gases will not be screened in the field for organic vapors

4.3 SITE SURVEY

Due to the lack of landmarks at the suspected burial site and the need to accurately place the monitoring wells outside the suspected burial site, the wells will be located in the field by a surveyor, prior to the start of drilling activities. Actual installed locations for the monitoring wells will be within ten feet of their planned locations.

Following well installation activities and prior to sampling, the horizontal and vertical coordinates will be determined in accordance with the Facility-wide SAP, which requires 1.0 foot horizontal and 0.01 foot vertical accuracy. The survey will be done at this time so that the results may be used in conjunction with water level measurements to accurately identify one of the wells as being downgradient of the suspected burial site. Additional groundwater will be collected from this well and analyzed for TAL Metals, explosives, propellants, cyanide, VOCs, SVOCs, pesticides and PCBs.

All locations will be conveyed in Ohio State Plane Coordinates (NAD83). The vertical datum for all elevations will be 1929 National Geodetic Vertical Datum. All coordinates and elevations will be recorded on the boring logs upon receipt of

quality assured survey results. In addition, electronic results will be provided to the USACE and RVAAP in ASCII format.

5.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

5.1 FIELD LOGBOOK

All field logbook information will follow structures identified in Section 5.1 of the Facility-wide SAP.

5.2 PHOTOGRAPHS

Information regarding the documentation of photographs for the Mustard Agent Burial Site Investigation is presented in Section 4.3.2.4.3 of the Facility-wide SAP. Representative photographs will be taken of the investigative measures during the investigation and any significant observations that are made during the field effort. Photographs will be suitable for presentation in a public forum, as well as for documenting scientific information.

5.3 SAMPLE NUMBERING SYSTEM

The sample numbering system that will be used to identify samples collected during the Mustard Agent Burial Site Investigation is explained in Section 5.3 of the Facility-wide SAP. The specific identifying information that will be used to implement this system during the investigation is presented in Figure 5-1. Sample Station numbers will commence with station no. MSB-001, and sample ID numbers will commence with sample no. 0001. Samples collected in addition to the baseline set will be identified sequentially by following the numbering system. If a sample in the baseline set is not collected or is reassigned to another location, a specific reason and notation will be given in the project field books.

5.4 SAMPLE DOCUMENTATION

All sample label, logbook, field record, and field form information will follow structures identified in Section 5.4 of the Facility-wide SAP.

5.5 DOCUMENTATION PROCEDURES

Documentation and tracking of samples and field information will follow the series of steps identified in Section 5.5 of the Facility-wide SAP.

5.6 CORRECTIONS TO DOCUMENTATION

Any corrections to documentation will follow guidance established in Section 5.6 of the Facility-wide SAP.

Sample Station Location Identification: XXXmm-NNN-####-tt

XXX = Area Designator
Mustard Agent Burial Site = MBS

mm = Sample Location Type
mw = Groundwater Monitoring Well
so = Soil Boring/Subsurface Soil Sample Location

NNN = Sequential Sample Location Number
Unique, sequential number for each sample location beginning with 001 and extending into any subsequent investigative phases (i.e., 001- 999).

= Sequential Sample Identification Number
Unique, sequential number for each sample beginning with 0001 and extending into any subsequent investigative phases (i.e., 0001 - 9999).

tt = Sample Type

GW =	Groundwater
GF =	Groundwater, Filtered
SO =	Soil Sample
TB =	Trip Blank
FB =	Field Blank
ER =	Equipment Rinsate

Sample Identification: XXXmm-NNN-####-tt

Figure 5-1. Mustard Agent Burial Site Sample Identification System

Table 5-4. Suspected Mustard Agent Burial Site Monitoring Well Samples

Station	Sample ID	Mustard Agent Breakdown Products	Exp	Prop	TAL Metals	PCBs/-Pest/ Cyanide	VOCs/ SVOCs	Geotech Analyses
Monitoring Well No.	Groundwater Samples							
MBS-001	MBSmw-001-0001-GW	1						AL, USCS, BD, P
MBS-002	MBSmw-002-0002-GW	1						AL, USCS, BD, P
MBS-003	MBSmw-003-0003-GW	1						AL, USCS, BD, P
MBS-004	MBSmw-004-0004-GW	1						AL, USCS, BD, P
	Undetermined downgradient well (unfiltered)		1	1		1	1	
	Undetermined downgradient well (filtered)				1			

AL = Atterberg Limits BD = Bulk Density USCS = Unified Soil Classification System
P = Porosity SVOCs = Semivolatile organic compounds
VOCs = Volatile organic compounds
PCBs = Polychlorinated biphenyls
Exp = Explosives
Prop = Propellants (nitroglycerine, nitrocellulose, nitroguanidine)

6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Sample packaging and shipping shall follow Chapter 6.0 of the Facility-wide SAP.

Coolers containing QA samples that are shipped to the USACE contract laboratory for independent analysis will be prepared and shipped in accordance with the Facility-wide SAP. On all shipments to all laboratories, a chain-of-custody form will be prepared for each cooler and the cooler number will be recorded on the chain-of-custody form.

Geotechnical samples do not require refrigeration or other preservation, and will be shipped to the contract laboratory at the conclusion of the sampling effort by conventional methods.

The addresses and points-of-contact for laboratories used for chemical and geotechnical analyses for this field effort are listed in Section 2.0 of the QAPP Addendum.

7.0 INVESTIGATION-DERIVED WASTE

All IDW, including auger cuttings, personal protective equipment (PPE), disposable sampling equipment, and decontamination fluids will be properly handled, labeled, characterized, and managed in accordance with Chapter 7.0 of the Facility-wide SAP, federal and state of Ohio large-quantity generator requirements, and RVAAP's Installation Hazardous Waste Management Plan. In addition, all field personnel will become familiarized with the RVAAP Installation Spill Contingency Plan, and will implement the procedures contained within that plan in the event of a spill.

Four types of IDW are anticipated, which will be contained separately. The types and estimated quantities for each include

- Soil and rock cuttings from borehole installations to be contained in 55-gallon drums. Twelve (12) 55-gallon drums are anticipated to be filled with soil and rock cuttings from drilling activities.

- Development and purge water from monitoring wells. An estimated twelve 55-gallon drums of groundwater IDW are anticipated.

- Decontamination fluids, including those derived from decontamination of sampling equipment and drilling equipment. An estimated ten 55-gallon drums of drill rig decontamination water and one 55-gallon drum of decontamination pad sludge is anticipated.

- Expendables/solid wastes, including PPE and disposable sampling equipment. One 55-gallon drum of expendable IDW is anticipated.

7.1 IDW COLLECTION AND CONTAINERIZATION

Indigenous solid IDW (soil and rock cuttings) generated from drilling activities will be contained in DOT-approved, closed top, 55-gallon drums. The drums will be properly labeled and staged in an approved field staging area (FSA).

All liquid indigenous (groundwater) IDW generated from monitoring well installation, development, and purging will be segregated by sample station. All liquid indigenous IDW will be collected in labeled DOT-approved, 55-gallon, closed-top drums.

All solid non-indigenous (expendable sampling equipment and trash) IDW will be segregated as non-contaminated and potentially contaminated material. Potentially contaminated and non-contaminated solid non-indigenous IDW will be identified in the field on the basis of visual inspection (e.g., soiled versus non-soiled), usage of the waste material (e.g., outer sampling gloves versus glove

liners), and field screening of the material using available field instrumentation (e.g., organic vapor analyzer). All non-indigenous IDW will be contained in trash bags with potentially contaminated non-indigenous IDW being additionally contained in a labeled DOT-approved, open-top, 55-gallon drum equipped with plastic drum liner and sealed with bung-top lid.

All liquid non-indigenous (decontamination rinse water) IDW will be segregated by waste stream (e.g., soap and water/water rinses from methanol and hydrochloric acid rinses) and contained in labeled DOT-approved, 5-gallon closed-top drums. All known potentially hazardous liquid non-indigenous IDW streams, such as methanol and hydrochloric acid rinses, will be contained separately in labeled DOT-approved, closed-top, 5-gallon (or larger) drums.

7.2 WASTE CONTAINER LABELING

All IDW containers will be labeled prior to placing IDW in them. All IDW containers (drums and roll-off boxes) will be labeled in accordance with Section 7.2 of the Facility-wide SAP.

7.3 IDW FIELD STAGING

A FSA will be designated at the NACA Test Area (AOC-38, Figure 1-2) at the beginning of field activities and approved by the RVAAP Environmental Coordinator. The 55-gallon drums will be located at the designated FSA. The FSA will be managed according to the requirements of Section 7.3 of the Facility-wide SAP.

Daily inventories of IDW will be taken and provided to the RVAAP Environmental Coordinator. A final inventory of all IDW staged at the FSA. All liquid waste not transported off of the facility within 30 days following project completion will require secondary containment.

7.4 IDW CHARACTERIZATION AND CLASSIFICATION FOR DISPOSAL

All indigenous IDW (soil, sediment, and groundwater) will be characterized for disposal on the basis of either: (1) analytical results from environmental samples collected from each sampling station; or (2) composite samples collected from segregated waste stream storage containers. Composite waste samples will be submitted for laboratory analysis of full toxicity characteristic leaching procedure (TCLP) to characterize each waste stream for disposal. Procedures for composite waste sampling are presented in Sections 7.4.1 and 7.4.2 of the Facility-wide SAP. PPE and expendable sampling equipment will be managed in accordance with Section 7.4 of the Facility-wide SAP.

At the conclusion of field activities letter reports will be submitted to the Ohio EPA, USACE and RVAAP Environmental Coordinator documenting the characterization and classification of the wastes.

7.5 IDW DISPOSAL

Upon approval of IDW classification reports, all solid and liquid IDW will be removed from the site and disposed of by a licensed waste disposal contractor in accordance with Section 7.5 of the Facility-wide SAP and all applicable state and federal rules, laws, and regulations. All shipments of IDW off-site will be coordinated through the RVAAP Environmental Coordinator, Mr. Mark Patterson.

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Appendix A

Quality Assurance Project Plan Addendum for the Groundwater Monitoring Well Installation and Groundwater Sampling at the Suspected Mustard Agent Burial Site (AOC-28), Ravenna Army Ammunition Plant, Ravenna, Ohio

November 2004

Prepared for

U.S. Army Corps of Engineers
Louisville, Kentucky
Contract No. W912QR-04-M-0116

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ACRONYMS

A-E	Architect-Engineer
ASTM	American Society of Testing and Materials
COC	chain of custody
CX	Center of Expertise
DQO	data quality objective
EM	Engineering Manual
EPA	U.S. Environmental Protection Agency
GPL	GPL Laboratories, LLLP
HTRW	Hazardous, Toxic, and Radioactive Waste
ICP	inductively coupled plasma
LCS	laboratory control sample
MS	matrix spike
MSD	matrix spike duplicate
PCB	polychlorinated biphenyls
QA	quality assurance
QMP	Quality Management Plan
QAPP	Quality Assurance Project Plan
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
TAL	Target Analyte List
TCL	Target Compound List
TNT	trinitrotoluene
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers

INTRODUCTION

This Quality Assurance Project Plan (QAPP) addendum addresses supplemental project-specific information in relation to the revised Facility-wide QAPP for the Ravenna Army Ammunition Plant (RVAAP) (USACE 2001a). Each QAPP section is presented documenting adherence to the Facility-wide QAPP or stipulating project-specific addendum requirements.

Primary analytical direction for these projects will be obtained from the identified U.S. Environmental Protection Agency (EPA) SW-846 Methods, the U.S. Army Corps of Engineers (USACE) Shell Document for Analytical Chemistry Requirements (version 1.0, 2 Nov 98), and the USACE Louisville District Chemistry Guideline (USACE 2001b).

1.0 PROJECT DESCRIPTION

1.1 SITE HISTORY/BACKGROUND INFORMATION

This information is contained in Section 1.1 of the Field Sampling Plan of this Work Plan and Sampling and Analysis Plan (SAP) Addendum (hereafter referred to as the SAP Addendum).

1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS

This information is contained in Section 1.2 of the SAP Addendum.

1.3 PROJECT OBJECTIVES AND SCOPE

This information is contained in Chapter 3.0 of the SAP Addendum.

1.4 SAMPLE NETWORK DESIGN AND RATIONALE

This information is contained in Chapter 4.0 of the SAP Addendum.

1.5 PARAMETERS TO BE TESTED AND FREQUENCY

Sample matrix types and analytical parameters are discussed in Chapter 4.0 of the SAP Addendum. These sampling and analysis requirements are summarized

in Table 1-1 of this QAPP addendum in conjunction with anticipated sample numbers, quality assurance (QA) sample frequencies, and field quality control (QC) sample frequencies. Additional sample volumes for matrix spike (MS)/matrix spike duplicates (MSD) samples will be annotated in the field logbooks.

1.6 PROJECT SCHEDULE

The schedule for this project is discussed in Chapter 2.0 of the SAP Addendum.

Table 1-1 Sampling and Analytical Requirements for the Grondwater Monitoring Well Installation and Sampling at the Suspected Mustard Agent Burial Site

Parameter	Methods	Field Samples	Field Duplicate Samples	Rinseate Samples	Trip Blanks	Total A-E Samples	MS/MSD Samples	USACE QA Split Samples	USACE Trip Blanks
Soil									
Atterberg Limits	ASTM D4318	12				12			
USCS Classification	N/A	12				12			
Bulk density	ASTM D2937	12				12			
Porosity	EM1110-2-1906	12				12			
Groundwater									
Volatile organics, TCL	SW-846, 5030/8260B	1	1	1	1	4	1	1	1
Semivolatile organics, TCL	SW-846, 3540/8270C	1	1	1		3	1	1	
Pesticides, TCL	Sw-846, 3540/8081A	1	1	1		3	1	1	
PCBs	SW-846, 3540/8082	1	1	1		3	1	1	
Explosives	SW-846, 8330	1	1	1		3	1	1	
Propellants	SW-846, 8330/9056	1	1	1		3	1	1	
Metals, TAL	SW-846, 6010B/7470A	1	1	1		3	1	1	
Cyanide	SW-9014	4	1	1		6	1	1	
Thiodiglycol	USATHAMA UW22	4	1	1		6	1	1	
1,4-dithiane	USATHAMA UL04	4	1	1		6	1	1	
1,4-oxathiane	USATHAMA UL04	4	1	1		6	1	1	

A-E = Architect-Engineer.
ASTM = American Society of Testing and Materials.
EM = Engineering Manual (USACE).
EPA = U.S. Environmental Protection Agency.
MS/MSD = Matrix Spike/Matrix Spike Duplicate
PCB = Polychlorinated biphenyls.
RVAAP = Ravenna Army Ammunition Plant.
QA = Quality Assurance.
TAL = Target analyte list.
TCL = Target compound list.
TOC = Total organic carbon.
USACE = U.S. Army Corps of Engineers.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The functional project organization and responsibilities are described in Chapter 2.0 of the Facility-wide SAP and the SAP Addendum.

Analytical support for this work will be performed by GPL Laboratories, LLLP (GPL). GPL is validated by the USACE Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX), Omaha, Nebraska. GPL's Laboratory Quality Management Plan (QMP) is available for review upon request. The laboratory's organizational structure, roles, and responsibilities are identified in their QMP. Addresses and telephone numbers for each analytical laboratory to be used as part of this project are as follows:

GPL Laboratories, LLLP - general analytical services.
202 Perry Parkway
Gaithersburg, MD 20877
Project Manager: Debbie Griffiths
Tel: (301) 926-6802
Fax: (301) 840-1209

J&L Laboratories, Inc. - Soil and sediment geotechnical analyses.
Wadsworth, Ohio Facility
215 Rainbow Street
Wadsworth, OH 44281
Project Manager: Lance Cole
Tel: (330) 335-0606
Fax: (330) 335-0908

The QA laboratories will be contracted through the Louisville USACE and will include; Severn Trent Laboratories (STL), Kemron, and PDC. Comprehensive data validation will be independently performed by the Louisville USACE.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

3.1 DATA QUALITY OBJECTIVES

Data quality objective summaries for this investigation will follow Tables 3-1 and 3-2 in the Facility-wide QAPP. All QC parameters stated in the specific EPA SW-846 methods will be adhered to for each chemical listed. The SW-846 method references found in the Facility-wide QAPP have been revised to the Update III methods (i.e., 8260A is now 8260B, 8270B is now 8270C, etc.). Laboratories are required to comply with all methods as written; recommendations are considered requirements. Concurrence with the USACE Shell Document for Analytical

Chemistry Requirements, version 1.0, November 2, 1998 (USACE 1998), and USACE Louisville District Chemistry Guideline (USACE 2001b) is expected.

3.2 LEVEL OF QUALITY CONTROL EFFORT

QC efforts will follow Section 3.2 of the Facility-wide QAPP. Field QC measurements will include field source water blanks, trip blanks, field duplicates, and equipment rinsate blanks. Laboratory QC measurements will include method blanks, laboratory control samples (LCSs), laboratory duplicates, MS/MSD samples, and surrogates, if applicable. LCS measurements will include the standard mid-level analyte concentration, plus a QC/Method Reporting Level (QC/MRL) low-level concentration per the USACE Louisville District Chemistry Guideline. It is recognized that the laboratory will routinely perform and monitor the QC/MRL; however, guidance check limits will be utilized as advisory and corrective action will not be required for individual analyte variances.

3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS

Program accuracy, precision, and sensitivity goals identified in Section 3.3 and Tables 3-1 through 3-9 of the Facility-wide QAPP will be imposed for this investigation. In addition, the USACE Louisville District Chemistry Guideline identifies analytical method quality objectives related to individual method QC protocol.

Program and project reporting levels are identified in Tables 3-1 through 3-9 of the Facility-wide QAPP. Additional information on methods regarding mustard agent breakdown products is contained in Table 1-1. Reporting limits on these breakdown products are as follows:

- Thiodiglycol – 2.0 ug/L
- 1,4-dithiane – 0.63 ug/L
- 1,4-oxathiane – 1.25 ug/L

Laboratories will make all reasonable attempts to meet these levels for each individual sample analysis. When samples require dilution, both the minimum dilution and quantified dilution must be reported. GPL will screen all samples to determine optimum dilution ranges. Dilution runs will be performed to quantitate high target analyte concentrations within the upper half of the calibration range, thus reducing the degree of dilution as much as possible. In addition, a five times less diluted run will then be performed to report other target analyte reporting levels as low as possible without destroying analytical detectors and instrumentation. If there are matrix interferences, non-target analyte, or high target analyte concentrations that preclude analysis of an undiluted sample, the laboratory project manager will contact

SpecPro and Louisville District, forward analytical and chromatographic information from diluted runs, and obtain direction on how to proceed.

3.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

Completeness, representativeness, and comparability goals identified in Section 3.4 and Tables 3-1 and 3-2 of the Facility-wide QAPP will be imposed for this investigation.

4.0 SAMPLING PROCEDURES

Sampling procedures are discussed in Chapter 4.0 of the Facility-wide SAP and SAP Addendum.

Table 4-1 summarizes sample container, preservation, and holding time requirements for the soil, sediment, and water matrices for this investigation. The number of containers required is estimated in this table.

As noted in the Facility-wide QAPP, additional sample volumes will be provided, when necessary, for the express purpose of performing associated laboratory QC (MS/MSD). These laboratory QC samples will be designated in the field records (sample manager's logbook) and identified for the laboratory on respective chain-of-custody (COC) documentation.

Table 4-1 Container Requirements for Water and Soil Samples for the Groundwater Monitoring Well Installation and Sampling at the Suspected Mustard Agent Burial Site

Analyte Group	Approx. No. of Containers Inc. Field QC	Container	Minimum Sample Size	Preservative	Holding Time
Groundwater					
Volatile Organic compounds	15	Three 40-mL glass vials with Teflon®-lined septum (no headspace)	80 mL	HCL to pH <2 Cool, 4°C	14 d
Semivolatile organic compounds	10	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
Pesticide compounds	10	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
PCB compounds	10	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
Explosive compounds	10	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
Propellant compounds	10	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
Metals (total)	5	1-L Polybottle	500 mL	HNO_3 to pH<2 Cool, 4°C	180 d
Cyanide	5	1-L Polybottle	500 mL	NaOH to pH>12 Cool, 4°C	14 d
Thiodiglycol	8	One 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
1,4-dithiane	8	One 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
1,4-oxathiane	8	One 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7d (extraction) 40 d (analysis)
Soil					
Geotechnical parameters	12	Shelby tube or 32-ounce wide-mouth container	1,000 grams	None	None

[a]Additional sample will be collected on 5 percent of the samples for the completion of matrix spike (MS)/matrix spike duplicate (MSD).
PCB = Polychlorinated biphenyl. SVOC = Semivolatile organic compound
QC = Quality control

5.0 SAMPLE CUSTODY

5.1 FIELD CHAIN-OF-CUSTODY PROCEDURES

Sample handling, packaging, and shipment procedures will follow those identified in Section 5.1 of the Facility-wide QAPP.

5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES

Laboratory COC will follow handling and custody procedures identified in the GPL QMP.

5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES

Custody of evidence files will follow those criteria defined in Section 5.3 of the Facility-wide QAPP.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 FIELD INSTRUMENTS/EQUIPMENT

Field instruments and equipment calibrations will follow those identified in Section 6.1 of the Facility-wide QAPP.

6.2 LABORATORY INSTRUMENTS

Calibration of laboratory equipment will follow procedures identified in the GPL QMP, corporate, and facility-specific operating procedures.

7.0 ANALYTICAL PROCEDURES

7.1 LABORATORY ANALYSIS

Analytical methods, parameters and quantitation or detection limits are those listed in Tables 3-3 through 3-9 of the Facility-wide QAPP.

GPL's QMP will be followed during the analysis of these samples. The following laboratory Standard Operating Procedures (SOPs) will implement the defined EPA methods.

- Gas Chromatograph (GC)/Mass Spectrometer (MS) Volatile Organics Analysis Based on Methods 8240B and 8260B, SW-846, CORP-MS-0002, rev 2, 12/15/97.

- GC/MS Semivolatile Analysis Based on Methods 8270C, SW-846, CORP-MS-0001, Rev. 2, 12/15/97.

- GC Analysis Based on Methods 8000A, 8010B, 8020A, 8021A, 8080A, 8081, 8082, 8150B, and 8051, SW-846, CORP-GC-0001, Rev. 5.1, 3/30/99.

- Extraction and Cleanup of Organic Compounds from Water and Soil, Based on SW-846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods, CORP-OP-0001, Rev. 3.4, 4/15/99.

- Analysis of Nitroaromatic and Nitramine Explosives by HPLC, KNOX-LC-0001, Rev. 1, 4/28/97.

- Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, Methods 6010B and 200.7, CORP-MT-0001, Rev. 2, 12/15/97.

- Graphite Furnace Atomic Absorption Spectroscopy, SW-846 Methods 7000A and MCAWW 200 series methods, CORP-MT-0003, Rev. 1, 08/22/95.

- Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW-846 7470A and MCAWW 245.1, CORP-MT-0005NC, Rev. 1.1, 04/19/97.

- Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW846 7471A and McAWW 245.5, CORP-MT-0005NC, Rev. 1.1, 04/19/97.

- Preparation and analysis of Nitrocellulose in Aqueous, Soil, and Sediments by Colorimetric Autoanalyzer, SAC-WC-0050, Rev. 0.

- Determination of Nitroaromatics, Nitramines, and Specialty Explosives in Water and Soil by High Performance Liquid Chromatography/Ultraviolet Detector (HPLC/UV) and Liquid Chromatography/ Thermospray/Mass Spectrometry (LC/TSP/MS), SAC-LC-0001, Rev. 5.0.

- Determination of Organosulfur compound analysis by methods USATHAMA UL04 and LL03, contained in GPL, Laboratories, LLLP SOP No. R.3, version 8, May 2004.

- HPLC Analysis of Thiodiglycol and Chloroacetic Acid in Water and Soil Samples by USATHAMA Method Numbers UW22 and LW18, contained in GPL Laboratories, LLLP SOP No. S.2, version 6, June 2003.

GPL facilities will at all times maintain a safe and contaminant-free environment for the analysis of samples. The laboratories will demonstrate, through

instrument blanks, holding blanks, and analytical method blanks, that the laboratory environment and procedures will not and do not impact analytical results.

GPL facilities will also implement all reasonable procedures to maintain project reporting levels for all sample analyses. Where contaminant and sample matrix analytical interferences impact the laboratory's ability to obtain project reporting levels, the laboratory will institute sample clean-up processes, minimize dilutions, adjust instrument operational parameters, or propose alternative analytical methods or procedures. Elevated reporting levels will be kept to a minimum throughout the execution of this work. When samples require dilution, both the minimum dilution and quantified dilution must be reported. GPL will screen all samples to determine optimum dilution ranges. Dilution runs will be performed to quantitate high target analyte concentrations within the upper half of the calibration range, thus reducing the degree of dilution as much as possible. In addition, a five times less diluted run will then be performed to report other target analyte reporting levels as low as possible without destroying analytical detectors and instrumentation. If there are matrix interferences, non-target analyte, or high target analyte concentrations that preclude analysis of an undiluted sample, the laboratory project manager will contact SpecPro and Louisville District, forward analytical and chromatographic information from diluted runs, and obtain direction on how to proceed.

7.2 FIELD SCREENING ANALYTICAL PROTOCOLS

Procedures for field analysis are identified in Chapter 6.0 of the Facility-wide SAP and in Chapter 4.0 of the SAP Addendum. Only screening of samples for organic vapors using a photoionization detector will be conducted. Headspace analysis will not be conducted.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 FIELD SAMPLE COLLECTION

Field QC sample types, numbers, and frequencies are identified in Chapters 4.0 and 5.0 of the SAP Addendum. In general, field duplicates and QA samples will be collected at a frequency of 10 percent. MS/MSD samples will be collected at a frequency of 5 percent. Field equipment rinsate will be once for equipment after drilling is completed. This will constitute a process check for the effectiveness of the decontamination procedure. Volatile organic trip blanks will accompany all coolers and all shipments containing volatile organic samples.

8.2 FIELD MEASUREMENT

Refer to Chapter 4.0 of the Facility–wide SAP and SAP Addendum for details regarding these measurements.

8.3 LABORATORY ANALYSIS

Analytical QC procedures will follow those identified in the referenced EPA methodologies. These will include method blanks, LCS, MS, MSD, laboratory duplicate analysis, calibration standards, internal standards, surrogate standards, and calibration check standards.

GPL facilities will conform to their QMP, facility-specific appendices, and implement their established SOPs to perform the various analytical methods required by the project. QC frequencies will follow those identified in Section 8.3 of the Facility-wide QAPP.

Analyses will also be consistent with direction provided by the USACE Shell Document for Analytical Chemistry Requirements (USACE 1998) and the USACE Louisville District Chemistry Guideline (USACE 2001b). The following are clarifications to this guidance relative to this project.

- The Corps Quality Control/Method Detection Limit (QC/MDL) check will be performed quarterly until criteria can be established.

- Analytical method blanks will be considered clean as long as analyte concentrations are below reporting levels. Corrective actions will be performed for any analyte detected above the established method reporting level. Any analytes detected between the method detection limit and the method reporting level will be flagged appropriately.

- Laboratory Control Standards will contain all project target compounds, however, for organic methods only the SW-846 subset of system monitoring compounds will be used to monitor method performance and to initiate analytical method corrective actions.

- For methods that have multi-responders (i.e., Aroclors and pesticides) within the same analytical process, the laboratory will not include all analytes within the matrix spiking mixture. A representative analyte will be employed for the MS evaluation.

- Inductively coupled plasma (ICP) method initial calibration curves will be confirmed through the analysis of a blank and three standards, and this documentation will be reported as part of the analytical data package.

- ICP serial dilution will be performed on a per batch basis. If the serial dilution falls outside acceptance criteria, a post-digestion spike analyses will be performed.

- Sediment samples having moisture levels that preclude soxlet extraction process will be extracted by sonication methods.
- When analyzing nitroglycerine by Method 8330, NG must be spiked in the associated LCS and MS/MSDs.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA REDUCTION

Sample collection and field measurements will follow the established protocols defined in the Facility-wide QAPP, Facility-wide SAP, and the SAP Addendum. Laboratory data reduction will follow GPL's QMP guidance and conform to general direction provided by the Facility-wide QAPP, the USACE Shell Document (USACE 1998), and the USACE Louisville District Chemistry Guideline (USACE 2001b).

9.2 DATA VERIFICATION/VALIDATION

Project data verification and validation will follow direction provided in the Facility-wide QAPP, Section 9.2 and diagrammed in Figure 9-1.

All data will be reviewed and verified by SpecPro according to the Facility-wide QAPP.

Validation of 100 percent of the data will follow the direction provided in the Facility-wide QAPP and the USACE Louisville District Chemistry Guideline (USACE 2001b). Independent third party data validation will be performed through the USACE Louisville District.

9.3 DATA REPORTING

Analytical data reports will follow the direction provided in the Facility-wide QAPP.

10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 FIELD AUDITS

A minimum of one field surveillance for the investigation will be performed by the SpecPro QA Officer (or designee) and/or the SpecPro Field Operations Manager. This audit will encompass the sampling of groundwater and soil from the wells.

USACE, EPA Region 5, or Ohio EPA audits may be conducted at the discretion of the respective agency.

10.2 LABORATORY AUDITS

Routine USACE HTRW CX on-site laboratory audits may be conducted by the USACE, EPA Region 5, or Ohio EPA at the discretion of the respective agency.

Internal performance and systems audits will be conducted by GPL's QA staff as defined in the laboratory QMP.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

11.1 FIELD INSTRUMENTS AND EQUIPMENT

Maintenance of all field analytical and sampling equipment will follow direction provided in Section 11.1 of the Facility-wide QAPP.

11.2 LABORATORY INSTRUMENTS

Routine and preventive maintenance for all laboratory instruments and equipment will follow the direction of GPL's QMP.

12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 FIELD MEASUREMENTS DATA

Field data will be assessed as outlined in Section 12.1 of the Facility-wide QAPP.

12.2 LABORATORY DATA

Laboratory data will be assessed as outlined in Section 12.2 of the Facility-wide QAPP.

13.0 CORRECTIVE ACTIONS

13.1 SAMPLE COLLECTION/FIELD MEASUREMENTS

Field activity corrective action protocol will follow directions provided in Section 13.1 of the Facility-wide QAPP.

13.2 LABORATORY ANALYSES

Laboratory activity corrective action protocol will follow directions provided in Section 13.2 of the Facility-wide QAPP and GPL's QMP and the Louisville Chemistry Guideline (USACE 2001b).

14.0 QA REPORTS TO MANAGEMENT

Procedures and reports will follow the protocol identified in Section 14.0 of the Facility-wide QAPP and those directed by GPL's QMP.

15.0 REFERENCES

GPL Laboratories, LLLP, *Quality Management Plan*, 2001.

USACE (U.S. Army Corps of Engineers) 1998. *Shell Document for Analytical Chemistry Requirements,* Version 1.0, November.

USACE 2001a. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-00-D-0001, Delivery Order CY02, Final, March.

USACE 2001b. *Louisville Chemistry Guideline,* Samir A. Mansy, Environmental Chemistry Branch, Rev. 1, January.

An 8(a) Certified Alaska Native Corporation (ANC)

FINAL
APPENDIX B
SITE SAFETY AND HEALTH PLAN
ADDENDUM NO. 1

FOR THE

GROUNDWATER MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING AT THE SUSPECTED MUSTARD AGENT BURIAL SITE (AOC-28) RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

PREPARED FOR
U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
CONTRACT No. W912QR-04-M-0116

NOVEMBER 2004

FINAL
SITE SAFETY AND HEALTH PLAN ADDENDUM NO. 1
FOR THE
GROUNDWATER MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING AT THE SUSPECTED MUSTARD AGENT BURIAL SITE (AOC-28),
RAVENNA ARMY AMMUNITION PLANT,
RAVENNA, OHIO

NOVEMBER 2004

Prepared for
U.S. Army Corps of Engineers
Contract No. W912QR-04-M-0116

Prepared by
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APPROVALS

SITE SAFETY AND HEALTH PLAN ADDENDUM NO. 1
FOR THE
GROUNDWATER MONITORING WELL INSTALLATION AND GROUNDWATER SAMPLING AT THE SUSPECTED MUSTARD AGENT BURIAL SITE (AOC-28)
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Gregg L Rexroad — 12/14/04

Chantelle Carroll, SpecPro Project Manager — Phone (330) 358-1753 — Date

Chantelle Carroll — 12/15/04

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ACRONYMS

AOC	Area of Concern
CIH	Certified Industrial Hygienist
COC	contaminant of concern
CSP	Certified Safety Professional
DNT	dinitrotoluene
EC&HS	Environmental Compliance and Health and Safety
EPA U.S.	Environmental Protection Agency
FP	flash point
Facility-wide SHP	Facility-wide Safety and Health Plan
GFCI	ground-fault circuit interruptor
H&S	Health and Safety
HAZWOPER	Hazardous Waste Site Operations
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IDLH	immediately dangerous to life and health
IP	ionization potential
LEL	lower explosive limit
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
NRR	Noise Reduction Rating
OE	ordnance and explosives
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective equipment
PVC	polyvinyl chloride
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SSHO	Site Safety and Health Officer
SHP	Site Safety and Health Plan
STEL	short-term exposure limit
TLV	threshold limit value
TNB	trinitrobenzene
TNT	2,4,6-trinitrotoluene
TWA	time-weighted average
USACE	U.S. Army Corps of Engineers
USIOC	U.S. Army Industrial Operations Command
VP	vapor pressure

INTRODUCTION

It is the formal policy of SpecPro, Inc. to provide and maintain a work environment conducive to the safety and health of its employees. Each employee of SpecPro, Inc. is responsible for maintaining a safe environment. To ensure implementation of this policy, the Ravenna Army Ammunition Plant (RVAAP) Facility-wide Safety and Health Plan (Facility-wide SHP),(USACE 2001) and this Site Safety and Health Plan (SHP) Addendum collectively set forth the specific procedures required to protect SpecPro, Inc. and it's subcontractor personnel involved in the field activities under this project. These plans are driven by requirements contained in U.S. Army Corps of Engineers (USACE) *Safety and Occupational Health Requirements for Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities* (1992) and USACE *Safety and Health Manual* (1996). All field personnel are required to comply with the requirements of these programs and plans. In addition, subcontractors are responsible for providing their employees with a safe work place and nothing in these plans relieves such subcontractors of this responsibility. If the requirements of these plans are not sufficient to protect the employees of a subcontractor, that subcontractor is required to supplement this information with work practices and procedures that will ensure the safety of its personnel.

The Facility-wide SHP addresses program issues and hazards and hazard controls common to the entire installation. This SHP Addendum to the Facility-wide SHP serves as the lower tier document addressing the hazards and controls specific to the Groundwater Monitoring Well Installation and Sampling at the Suspected Mustard Agent Burial site. Copies of the Facility-wide SHP and this SHP Addendum will be present at the work site during all fieldwork.

A suspected mustard agent burial site has been located at RVAAP. It has been determined that the best and safest path forward to evaluate if mustard agent is leaking from the suspected burial site is to determine if mustard agent breakdown products are present in the uppermost groundwater bearing zone a short distance outside of the suspected burial site. The primary objective of this investigation is to determine if mustard agent breakdown products are present in the uppermost groundwater bearing zone adjacent to the suspected mustard agent burial site. To do this, SpecPro will install and sample groundwater monitoring wells a short distance outside of a suspected mustard agent burial site.

Planned site activities for this project consist of environmental sampling and support tasks. These tasks include monitoring well installation and groundwater sampling,

Potential hazards posed by the planned tasks include injury from ordnance, mustard agent, and explosives; noise and cut hazards associated with clearing

vegetation; striking, rotation, and noise hazards from excavating and drilling equipment; lifting, noise, and strain hazards associated with operating drilling equipment; fuel or decontamination solvent fires; chemical exposure; temperature extremes; stinging/biting insects; poisonous plants; and snakes. There is no historical information that indicates explosives are present in the area.

The potential for chemical overexposure appears to be minimal, given the nature of planned tasks. All of the potential contaminants have low vapor pressures, making overexposure through vapor inhalation highly unlikely. All of the planned tasks pose minimal potential for creating airborne particulates. There may be some potential for adverse effects due to dermal contact with contaminated soil. The crew will use protective gloves which are known to be resistant to the COCs on site to handle potentially contaminated materials, and, if necessary, the Site Safety and Health Officer (SSHO) will upgrade the required personal protective equipment (PPE) to prevent dermal contact with potentially contaminated materials. Physical hazards are associated with water-borne operations, excavation and drilling equipment, and hand-operated power tools (chainsaw, etc.). Task-specific hazard controls have been specified for these tasks. The SSHO will observe all site tasks during daily safety inspections and will use professional judgment and appropriate monitoring results to determine if upgrading PPE is required. A detailed analysis of these hazards and specific appropriate controls is presented in Chapter 2.0, Table 2-2.

This investigation will be performed in Level D PPE, plus chemical-resistant gloves when handling potentially contaminated materials. If one of several action levels is exceeded or the potential for increased risk becomes apparent during the investigation, engineering controls will be instituted (if possible), or protective procedures, including protective clothing, will be upgraded as necessary by the SSHO.

1.0 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

1.1 SITE DESCRIPTION

The Ravenna Army Ammunition Plant (RVAAP) is located in northeastern Ohio within Portage and Trumbull counties, approximately 16 kilometers (10 miles) northeast of the town of Ravenna. The installation consists of 8,668 hectares (21,419 acres) in a 17.7-kilometer (11-mile) long, 5.6-kilometer (3.5-mile) wide tract bordered by a sparsely inhabited private residential area. The site is an inactive government-owned armament, munitions, and chemical command facility maintained by a contracted caretaker, TolTest, Inc.

The installation was active from 1941 to 1992. Activities included loading, assembling, storing, and packing military ammunition; demilitarization of

munitions; production of ammonium nitrate fertilizer; and disposal of "off-spec" munitions. Various munitions were handled on the installation including artillery rounds of 90 mm or more and bombs up to 2,000 pounds.

1.1.1 Site Activities

In 1969, the U.S. Army excavated a possible mustard agent burial site within Demolition Area #1, located within the NACA Test Area. One 50-gallon drum and seven small rusted cans were discovered west of the NACA Test Area. All recovered items were empty and no contamination was discovered. It was reported that the actual burial site was adjacent to the excavation. The second suspected site for the mustard agent burial is located in the wooded area approximately 500 feet south of Hinkley Creek along an abandoned power line right-of-way.

1.2 CONTAMINANTS

Limited environmental data can be found for past investigations at the suspected mustard agent burial site. Table 1-1 includes a list of contaminants that might be found during sampling. Inclusion in this table indicates the potential to encounter a contaminant during the monitoring well installation and sampling field activities, but it does not necessarily indicate that the contaminant is present in sufficient quantity to pose a health risk to workers.

Table 1-1. Other Constituents of Potential Concern That May Be Present at the Suspected Mustard Agent Burial Site

Thiodiglycol
1,4-dithiane
1,4-oxathiane
Mustard Agent
Aluminum
Antimony
Beryllium
Cobalt
Manganese
Nickel
Selenium
Thallium
Vanadium

2.0 HAZARD/RISK ANALYSIS

The purpose of the task hazard/risk analysis is to identify and assess potential hazards that may be encountered by personnel and to prescribe required controls. Table 2-1, a general checklist of hazards that may be posed by this project, indicates whether a particular major type of hazard is present. If additional tasks or significant hazards are identified during the work, this document will be modified by addendum or field change order to include the additional information.

Table 2-1. Hazards Inventory

Yes	No	Hazard
	X	Confined space entry
	X	Excavation entry
X		Heavy equipment (drill rigs, backhoe)
X		Fire and explosion
X		Electrical Shock (utilities and tools)
X		Exposure to chemicals
X		Temperature extremes
X		Biological hazards (poison ivy, Lyme disease)
	X	Radiation or radioactive contamination
X		Noise (heavy equipment)
	X	Drowning
X		OE (potential to encounter unexploded ordnance)
X		Mustard agent

OE = Ordnance and explosives.

Specific tasks are as follows:

- vegetation clearing with machetes and chainsaws;
- civil surveying;
- investigation-derived waste handling and disposition;
- subsurface soil sampling and monitoring well installation using air rigs and/or hollow stem auger drill rigs;
- well development and groundwater sampling; and
- sampling equipment decontamination.

2.1 TASK-SPECIFIC HAZARD ANALYSIS

Table 2-2 presents task-specific hazards, relevant hazard controls, and required monitoring, if appropriate, for all of the planned tasks.

2.2 POTENTIAL EXPOSURES

Limited environmental sampling has been conducted at the suspected burial site. Explosives may be present. Information on the potential contaminants, as well as the reagents and chemicals that will be used for the project, are contained in Table 2-3. It is important to note that the contaminants listed in Table 2-3 have been detected in a number of locations at RVAAP and might be expected to occur at any former operations area. Exposure to chemical tools, such as corrosive sample preservatives, or flammable fuels is a possibility and will be controlled through standard safe handling practices.

2.3 FIRST AID/TREATMENT

First Aid/Treatment for the chemicals listed in Table 2-3 are as follows:

1. Mustard Agent
   - INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.
   - EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.
   - SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid house hold bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin becomes contaminated with a thickened agent, blot/wipe the material off immediately with an absorbent pad/paper towel prior to using decontaminating solution.
   - INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately.

2. Thiodiglycol, 1,4-dithiane, and 1,4-oxathiane, isopropyl alcohol, methanol, HMX, RDX, TNT
   - ORAL EXPOSURE: If swallowed, wash out mouth with water provided person is conscious. Call a physician.
   - INHALATION EXPOSURE: If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.
   - DERMAL EXPOSURE: In case of contact, immediately wash skin with soap and copious amounts of water.

- EYE EXPOSURE: In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes.

3. Dinitrotoluene, Gasoline, Liquinox, Hydrochloric Acid

- ORAL EXPOSURE: If swallowed, wash out mouth with water provided person is conscious. Do not induce vomiting. Call a physician.
- INHALATION EXPOSURE: If inhaled, remove to fresh air. If not breathing give artificial respiration. Do not use mouth-to-mouth resuscitation. If breathing is difficult, give oxygen.
- DERMAL EXPOSURE: In case of contact, immediately wash skin with soap and copious amounts of water.
- EYE EXPOSURE: In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes. For hydrochloric acid, do not allow victim to rub eyes.

4. White Phosphorus

- ORAL EXPOSURE: If swallowed, wash out mouth with water provided person is conscious. Induce vomiting. Call a physician.
- INHALATION EXPOSURE: If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen.
- DERMAL EXPOSURE: In case of contact, immediately wash skin with copious amounts of water. Solution of 5% sodium bicarbonate can then be used if readily available. Keep burned area submerged in water or 5% sodium bicarbonate solution. Get medical attention.
- EYE EXPOSURE: In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes

Table 2-2. Hazards Analysis

Safety and Health Hazards	Controls	Monitoring Requirements
Civil Surveys and Visual Surveys in Potentially Contaminated Areas		
General safety hazards (moving equipment, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, and hard hats if overhead hazards are present (see Chapter 5.0 of the Facility-wide SHP). Hazardous waste safety (40-hour) and site-specific training, buddy system, and proper housekeeping.	Daily safety inspections.
Contact with UXO and mustard agent	Pre-entry screening survey and continuous escort by UXO specialist support. On-site training in ordnance recognition for all field personnel. Withdrawal of all SpecPro and subcontractor personnel from immediate area and field marking of suspect area if ordnance, suspected ordnance or mustard agent is discovered. Mustard Agent screening using M256 chemical detector kits.	Visual and instrument surveys for ordnance and mustard agent conducted by UXO expert personnel.
Exposure to chemicals	Nitrile or similar gloves for contact with potentially contaminated material. Gloves will be disposed after single use. Wash face and hands and any other exposed areas prior to taking anything by mouth. Hazardous waste medical clearance. Site training must include hazards and controls for exposure to site contaminants and chemicals used on-site. MSDSs on-site. All chemical containers labeled to indicate contents and hazard.	None.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas during hunting season)	Field work will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SpecPro office.	None
Biological hazards (bees, ticks, Lyme disease, histoplasmosis, wasps, snakes, West Nile Virus)	PPE (boots, work clothes). Insect repellant on boots, pants, and elsewhere, as necessary to repel ticks and mosquitoes. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each workday (see Chapter 9.0 of Facility-wide SHP). Avoidance of accumulations or bird or bat droppings (see Chapter 9.0 of Facility-wide SHP).	Visual survey.
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.
Groundwater Well Development, Groundwater Monitoring, Groundwater Sampling, and Sample Preservation		
General safety hazards (moving equipment, lifting,	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, hard hats if overhead hazards are present (see Chapter 5.0 of	Daily site safety inspections.

Safety and Health Hazards	Controls	Monitoring Requirements
slops, falls)	Facility-wide SHP). Buddy system. Lifts of >50 lbs will be performed by two or more personnel or with mechanical assistance, extensive heavy lifting will require additional lifting training. Hazardous waste safety training. Exclusion zone if there is a potential for unauthorized entry.	
Noise	None, unless SSHO determines that equipment potentially exceeds 85 dBA.	Daily safety inspection.
Fire (fuels)	Fuel stored in safety cans with flame arresters. Fire extinguisher in all fuel use areas. No ignition sources in fuel storage areas. Bonding (metal to metal contact) during pouring. Gasoline-powered equipment must be shut down and allowed to cool for 5 minutes prior to fueling.	Daily site safety inspections.
Exposure to chemicals	Level D PPE, including nitrile or PVC gloves, to handle potentially contaminated material. Minimal contact, wash face and hands prior to taking anything by mouth. Medical clearance for HAZWOPER work. Fifteen-minute eyewash within 100 feet when pouring corrosive sample preservatives; eyewash bottle within 10 feet when adding water to pre-preserved sample containers. Site training must include hazards and controls of exposure to contaminants and chemicals used on-site. MSDSs for chemical tools kept on-site. All chemical containers labeled with contents and hazard. Mustard Agent screening using M256 chemical detector kits.	Daily site safety inspections. PID monitoring if prior monitoring during soil boring indicated a potential for exposure.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas during hunting season)	Field work will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SpecPro office.	None
Electrical shock	GFCI for all electrical hand tools.	Daily safety inspection.
Biological hazards (bees, ticks, Lyme disease, histoplasmosis, wasps, snakes, West Nile Virus)	PPE (boots, work clothes). Insect repellant on boots, pants, and elsewhere, as necessary to repel ticks and mosquitoes. Pant legs tucked into boots or otherwise closed to minimize tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each workday (see Chapter 9.0 of Facility-wide SHP). Avoidance of accumulations or bird or bat droppings (see Chapter 9.0 of Facility-wide SHP).	Visual survey.
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.
Soil Boring, and Monitoring Well Installation Using Air Rotary or Auger Drill Rig		
General safety hazards (rotating machinery,	Level D PPE: long pants, shirts with sleeves, safety glasses, work gloves for material handling plus hard hat (see Chapter 5.0 of Facility-wide SHP).	Daily site safety inspections. Weekly drill rig inspections.

Safety and Health Hazards	Controls	Monitoring Requirements
suspended loads, moving equipment, slips, falls)	Buddy system. NO employees under lifted loads. At least two functional kill switches on drilling rig. Functional backup alarm. Drill rig manual on-site. Only experienced operators. Exclusion zone at least equal to mast height if there is any potential for unauthorized entry.	
Noise	Hearing protection ≥NRR 25 within 25 feet of rig unless rig-specific monitoring indicates noise exposure of less than 85 dBA.	Daily safety inspections.
Fire (vehicle fuels or subsurface contaminants)	Fuels stored in safety cans with flame arrestors. Bonding (metal to metal) and grounding during fuel transfers. Fuel storage areas marked with "no smoking or open flames" signs. Fire extinguishers in all fuel use areas.	Combustible gas indicator if buried organic material or other source of flammable gas is suspected.
Contact with unexploded ordnance or mustard agent	Downhole monitoring every 2 feet until cleared for continuous drilling by UXO personnel. On-site training in ordnance and mustard agent recognition for all field personnel. Clearance of sites by UXO personnel for intrusive work. Continuous escort by UXO personnel in areas with a potential to encounter OE or mustard agent. Withdrawal of all non-UXO personnel if ordnance, suspected ordnance or mustard agent is discovered. Mustard Agent screening using M256 chemical detector kits.	Visual and instrument surveys by UXO technicians.
Exposure to chemicals	Level D PPE plus nitrile or equivalent gloves for contact with contaminated material. Wash face and hands prior to taking anything by mouth. Stay upwind of any dust-generating activities. Hazardous waste 40-hour certification training and medical clearance must be current. Site training must include hazards and controls for site contaminants and all chemicals used on-site. MSDSs for chemical tools on-site. Chemical containers labeled to indicate contents and hazard.	PID or other sampling as appropriate.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas during hunting season)	Field work will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SpecPro office.	None
Electrical shock	Identification and clearance of overhead and underground utilities. GFCI required for electric hand tools.	Visual of all work areas.
Biological hazards (bees, ticks, Lyme disease, histoplasmosis, wasps, snakes, West Nile Virus)	PPE (boots, work clothes). Insect repellant on boots, pants, and elsewhere, as necessary to repel ticks and mosquitoes. Pant legs tucked into boots or otherwise closed to minimize tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each workday (see Chapter 9.0 of Facility-wide SHP). Avoidance of accumulations or bird or bat droppings (see Chapter 9.0 of Facility-wide SHP).	Visual survey.

Safety and Health Hazards	Controls	Monitoring Requirements
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.
Vegetation Clearing with Chainsaws, Machetes, and Sling Blades		
General safety hazards (contact with sharp edges, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety shoes or boots, safety glasses, plus heavy-duty work gloves and hard hat with face shield (see Chapter 5.0 of Facility-wide SHP). Buddy system. Only experienced operators. Personnel operating brush clearing tools must maintain separation of at least 15 feet. Machetes equipped with lanyard and lanyard looped around wrist. Tools must be inspected daily and taken out of service if damaged. Exclusion zone if there is a potential for entry of unauthorized personnel.	Daily site safety inspections.
Chainsaw kickback and related hazards	Chainsaw chaps. Saws must have automatic chain brake or kickback device. Idle speed adjusted so chain does not move when idling. Saws must not be used to cut above shoulder height. Saws must be held with both hands when operating. Additional requirements at EM 385-1-1 Section 31, and 29 CFR 1910.266.	Daily inspection
Noise (chainsaw)	Hearing protection ≥NRR 25 within 25 feet of operating chainsaw unless specific monitoring indicates noise exposure of less than 85 dBA.	Daily safety inspections.
Fire (fuels)	Fuels stored in safety cans with flame arrestors. Bonding (metal to metal) and grounding during fuel transfers. Fuel storage areas marked with "no smoking or open flames" signs. Fire extinguishers in all fuel use areas. Gasoline-powered equipment turned off and allowed to cool for at least five minutes prior to fueling.	Daily safety inspection.
Contact with unexploded ordnance or mustard agent	On-site training in ordnance and mustard agent recognition for all field personnel. Clearance of sites by UXO personnel for intrusive work. Escort by UXO personnel when in areas with potential to encounter UXO and mustard agent. Withdrawal of all non-UXO personnel if ordnance, suspected ordnance, or mustard agent is discovered. Mustard Agent screening using M256 chemical detector kits.	Visual and instrument surveys by UXO technicians.
Exposure to chemicals	Level D PPE plus nitrile or equivalent gloves for contact with contaminated material. Wash face and hands prior to taking anything by mouth. Hazardous waste 40-hour certification training and medical clearance must be current. Site training must include hazards and controls for site contaminants and all chemicals used on-site. MSDSs for chemical tools on-site. Chemical containers labeled to indicate contents and hazard.	PID or other sampling as appropriate.

Safety and Health Hazards	Controls	Monitoring Requirements
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas during hunting season)	Field work will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SpecPro office.	None
Biological hazards (bees, ticks, Lyme disease, histoplasmosis, wasps, snakes, West Nile Virus)	PPE (boots, work clothes). Insect repellant on boots, pants, and elsewhere, as necessary to repel ticks and mosquitoes. Pant legs tucked into boots or otherwise closed to minimize tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each workday (see Chapter 9.0 of Facility-wide SHP). Avoidance of accumulations or bird or bat droppings (see Chapter 9.0 of Facility-wide SHP).	Visual survey.
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.
Investigation-Derived Waste Handling		
General hazards (lifting equipment, manual lifting, slips)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, heavy-duty gloves for materials handling, and hard hat if overhead hazards are present (see Chapter 5.0 of Facility-wide SHP). Buddy system. Unnecessary personnel will stay well clear of operating equipment. Functional back-up alarm on fork trucks, Bobcats, trucks, etc. Documented forklift training for forklift operators. Only experienced operators will be allowed to operate equipment. No personnel allowed under lifted loads. Lifts of greater than 50 pounds will be made with two or more personnel or with lifting equipment. Hazardous waste safety training. Compliance with EM 385-1-1 Sections 14 and 16.	Daily safety inspections of operations. Daily inspection of equipment - verify brakes and operating systems are in proper working condition.
Contact with unexploded ordnance and mustard agent	On-site training in ordnance and mustard agent recognition for all field personnel. Clearance of sites by UXO personnel for intrusive work. Continuous escort by UXO personnel if working in areas with potential for OE and mustard agent. Withdrawal of all non-UXO personnel if ordnance, suspected ordnance, or mustard agent is discovered. Mustard Agent screening using M256 chemical detector kits.	Visual and instrument surveys by UXO technicians.
Exposure to chemicals	Level D PPE plus nitrile or equivalent gloves for contact with contaminated material. Wash face and hands prior to taking anything by mouth. Hazardous waste 40-hour certification training and medical clearance must	PID or other sampling as appropriate.

Safety and Health Hazards	Controls	Monitoring Requirements
	be current. Site training must include hazards and controls for site contaminants and all chemicals used on-site. MSDSs for chemical tools on-site. Chemical containers labeled to indicate contents and hazard.	
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas during hunting season)	Field work will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SpecPro office.	None
Fire (vehicle fuels and flammable contaminants)	Fuels stored in safety cans with flame arrestors. Bonding (metal to metal) and grounding during fuel transfers. Fuel storage areas marked with "no smoking or open flames" signs. Gasoline-powered equipment will be shut down and allowed to cool for 5 minutes before fueling. Fire extinguishers in all fuel use areas.	Daily safety inspection.
Noise	Hearing protection within 25 feet of any noisy equipment unless equipment-specific monitoring indicates exposures less than 85 dBA.	Daily safety inspections.
Biological hazards (bees, ticks, Lyme disease, histoplasmosis, wasps, snakes, West Nile Virus)	PPE (boots, work clothes). Insect repellant on boots, pants, and elsewhere, as necessary to repel ticks and mosquitoes. Pant legs tucked into boots or otherwise closed to minimize tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each workday (see Chapter 9.0 of Facility-wide SHP). Avoidance of accumulations or bird or bat droppings (see Chapter 9.0 of Facility-wide SHP)..	Visual survey.
Electric shock	Identification and clearance of overhead utilities. GFCI for all electrical hand tools.	Visual survey of all work areas.
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.
Equipment Decontamination (Hot Water Washing, Soap and Water Washing, HCl, and Methanol Rinse)		
General equipment decontamination hazards (hot water, slips, falls, equipment handling)	Level D PPE plus nitrile or PVC gloves (see Chapter 5.0 of Facility-wide SHP). Face shield and Saranax or rain suit when operating steam washer. Hazardous waste safety training.	Daily safety inspections.
Noise (spray washer)	Hearing protection when washer is operating unless equipment-specific monitoring indicated that exposure is less than 85 dBA.	None.
Fire (decontamination solvents and gasoline)	Flammable material stored in original containers or in safety cans with flame arrestors. Fire extinguisher kept near decon area.	Daily safety inspection.

Safety and Health Hazards	Controls	Monitoring Requirements
Exposure to chemicals	Level D PPE plus nitrile or equivalent gloves for contact with contaminated material. Wash face and hands prior to taking anything by mouth. Minimal contact. Hazardous waste 40-hour certification training and medical clearance must be current. Site training must include hazards and controls for site contaminants and all chemicals used on-site. MSDSs for chemical tools on-site. Chemical containers labeled to indicate contents and hazard.	None.
Temperature extremes	Administrative controls (see Chapter 8.0 of Facility-wide SHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Chapter 8.0 of Facility-wide SHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice daily. Pulse rates at the start of each break if wearing impermeable clothing.

CGI = Combustible Gas Indicator
Administration.
EC&HS = Environmental Compliance and Health and Safety.
Facility-wide SHP = Facility-wide Safety and Health Plan.
GFCI = Ground-fault circuit interrupter.
HAZWOPER = Hazardous Waste Site Operations.
MSDS = Material Safety Data Sheet.
NRR = Noise Reduction Rating.
OE = Ordnance and Explosives.
OSHA = Occupational Safety and Health

PID = Photoionization detector.
PPE = Personal protective equipment.
PVC = Polyvinyl chloride.
RVAAP = Ravenna Army Ammunition Plant.
SSHO = Site Safety and Health Officer.
SHP = Site Safety and Health Plan.
USACE = U.S. Army Corps of Engineers.

Table 2-3. Potential Exposures

Chemical[a]	TLV/PEL/STEL/IDLH[b]	Health Effects/Potential Hazards[c]	Chemical and Physical Properties[c]	Exposure Route(s)[c]
DNT (dinitrotoluene)	TLV/TWA: 0.2 mg/m^3,A2 IDLH: Ca [50 mg/m^3]	Suspected human carcinogen, anorexia, cyanosis, reproductive effects	Orange-yellow solid, VP: 1 mm; FP 404°F	Inhalation Absorption Ingestion Contact
Gasoline (used for fuel)	TLV/TWA: 300 ppm IDLH: Ca	Potential carcinogen per NIOSH, dizziness, eye irritation, dermatitis	Liquid with aromatic odor; FP: -45°F; VP: 38-300 mm	Inhalation Ingestion Absorption Contact
Hydrochloric acid (potentially used for equipment decontamination)	TLV: 5 ppm ceiling IDLH: 50 ppm	Irritation of eyes, skin, respiratory system	Liquid; VP: fuming; IP: 12.74 eV; FP: none	Inhalation Ingestion Contact
Isopropyl alcohol (potentially used for equipment decontamination)	TLV/TWA: 400 ppm STEL: 500 ppm IDLH: 2000 ppm	Irritation of eyes, skin, respiratory system; drowsiness, headache	Colorless liquid with alcohol odor; VP: 33 mm; IP: 10.10 eV; FP: 53°F	Inhalation Ingestion Contact
Liquinox (used for decontamination)	TLV/TWA: None	Inhalation may cause local irritation to mucous membranes	Yellow odorless liquid (biodegradable cleaner); FP: NA	Inhalation Ingestion
Methanol (potentially used for equipment decontamination)	TLV/TWA: 200 ppm Skin notation IDLH: 6000 ppm	Irritation of eyes, skin, respiratory system; headache; optic nerve damage	Liquid: VP: 96 mm; IP: 10.84 eV; FP: 52°F	Inhalation Absorption Ingestion Contact
HMX (octogen)	TLV/TWA: None established; toxicity assumed to be similar to RDX as compounds are very similar	Explosive; assumed irritation of eyes and skin, dizziness, weakness	Assumed similar to RDX FP: explodes VP: 0.0004 mm at 230°F	Assumed: Inhalation Absorption Ingestion Contact

Chemical[a]	TLV/PEL/STEL/IDLH[b]	Health Effects/Potential Hazards[c]	Chemical and Physical Properties[c]	Exposure Route(s)[c]
RDX (cyclonite)	TLV/TWA: 0.5 mg/m^3, A4 Skin notation IDLH: none established	Explosive; irritation of eyes and skin, dizziness, weakness	White powder FP: explodes VP: 0.0004 mm at 230°F	Inhalation Absorption Ingestion Contact
TNT (2,4,6-trinitrotoluene)	TLV/TWA: 0.5 mg/m^3 Skin notation IDLH: 500 mg/m^3	Cluster headache; irritation of skin and mucous membranes, liver damage, kidney damage	Pale solid FP: explodes VP: 0.0002 mm	Inhalation Absorption Ingestion Contact
Mustard agent	Airborne Exposure Limit: 0.003 mg/m^3	Blister-causing agent, affects both the eyes and skin. Cancer-causing agent	Pale yellow to black, clear if pure VP: 0.072 mm	Inhalation Absorption Ingestion Contact
Thiodiglycol	TLV/TWA: None ORL-RAT LD50 – 6610 mg/kg	Irritant to skin and eyes.	Liquid FP: 160° C VP: Not established	Inhalation Absorption Ingestion Contact
1,4-dithiane	TLV/TWA: None ORL-RAT LD50 – 2768 mg/kg	Irritating to eyes, respiratory system, and skin.	Solid BP: 200° C MP: 110° C	Inhalation Absorption Ingestion Contact
1,4-oxathiane	TLV/TWA: None	Irritating to eyes, respiratory system, and skin	Colorless clear liquid FP: 108° C	Inhalation Absorption Ingestion Contact
White Phosphorus	TLV/TWA: 0.1 mg/m^3 Skin notation IDLH: 5mg/m^3	Irritation of eyes, respiratory tract, skin; target organs: eyes, skin, respiratory system, liver, kidneys, jaw, teeth, blood.	White to yellow soft, waxy solid with acrid fumes in air. FP: Ignites spontaneously in moist air. VP: 0.03 mmHg	Inhalation Ingestion Contact

[a]The potential chemicals were obtained from the *Ravenna Army Ammunition Plant Phase I Remedial Investigation Report* (USACE 1998).
[b]From 1999 Threshold Limit Values, *NIOSH Pocket Guide to Chemical Hazards*.
[c]From 1997 *NIOSH Pocket Guide to Chemical Hazards, the Condensed Chemical Dictionary,* 10th ed.

A2 = Suspected human carcinogen.
A3 = Confirmed animal carcinogen with unknown Relevance to humans.
A4 = Not classifiable as a human carcinogen.
FP = Flash point.
IDLH = Immediately dangerous to life and health.
IP = Ionization potential.
NA = Not available.
NIOSH = National Institute for Occupational Safety and Health.
PEL = Permissible exposure limit.
STEL = Short-term exposure limit.
TLV = Threshold limit value.
TWA = Time-weighted average.
VP = Vapor pressure.

3.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

This section presents the personnel (and their associated telephone numbers) responsible for site safety and health and emergency response. Table 3-1 identifies the SpecPro and subcontractor staff who will fill key roles. See the Facility-wide SHP for information on the roles and responsibilities of key positions.

Table 3-1. Staff Organization

Position	Name	Phone
Sr. Program Manager	Larry Blackwell	(256) 726-4704
Health & Safety Manager	Gregg Rexroad, CEP	(321) 868-7800
Program/Project Manager	Chantelle Carroll	(330) 358-1753
Field Operations Manager	Al Brillinger	(330) 358-1753
Site Safety and Health Officer	Al Brillinger	(330) 358-1753
UXO Sr. Manager	Robert Fay	(256) 247-7050

CEP=Certified Environmental Professional

4.0 TRAINING

Training requirements are outlined in the Facility-wide SHP and in Table 2-2 of this SHP Addendum. In addition, at least one American Red Cross Professional CPR/AED certified person will be present during sampling activities at the site. All on-site personnel shall be first aid/CPR trained. In addition, all field personnel will be familiarized with the hazards associated with mustard agent that may have been buried at this site.

5.0 PERSONAL PROTECTIVE EQUIPMENT

General guidelines for selection and use of PPE are presented in the Facility-wide SHP. Specific PPE requirements for this work are presented in the hazard/risk analysis section (Chapter 2.0).

6.0 MEDICAL SURVEILLANCE

Medical surveillance requirements are presented in the Facility-wide SHP and in Table 2-2 of this SHP Addendum.

7.0 EXPOSURE MONITORING/AIR SAMPLING PROGRAM

Assessment of airborne chemical concentrations will be performed, as appropriate, to ensure that exposures do not exceed acceptable levels. Action levels, with appropriate responses, have been established for this monitoring. In addition to the specified monitoring, the SSHO may perform or require additional monitoring, such as organic vapor monitoring, in the equipment decontamination area, or personnel exposure monitoring for specific chemicals. The deployment of monitoring equipment will depend on the activities being conducted and the potential exposures. All personal exposure monitoring records will be maintained in accordance with 29 CFR 1910.120. The minimum monitoring requirements and action levels are presented in Table 7-1.

The fieldwork is not expected to pose airborne exposure hazards for the following reasons:

- Work will be performed in open areas with natural ventilation.
- The most probable contaminants are materials with relatively low vapor pressures.

Air monitoring of the breathing zone using a photoionization detector or equivalent is planned during groundwater monitoring well drilling. The SSHO will examine site conditions and will contact the Health and Safety Manager and initiate additional monitoring if there is any indication of potential airborne exposure.

Mustard agent monitoring will be performed with M256 chemical warfare detector kits. Screening will consist of wiping the detector papers on wet drilling equipment that is pulled out of the borehole. If chemical warfare agents come in contact with the detector papers, the papers turn a distinctive color. If chemical warfare agents are detected, the UXO Team Leader will direct all site personnel to a safe location and notify the Health and Safety Manager.

Table 7-1. Monitoring Requirements and Action Limits

Hazard or Measured Parameter	Area	Interval	Limit	Action	Tasks
Airborne organics with PID or equivalent	Breathing zone [0.9 meters (3 feet) from source or 0.36 meters (14 inches)] in front of employee's shoulder	From 1 to 3 feet below ground surface and if site conditions, such as discolored soil or chemical smells, indicate that monitoring is necessary	<5 ppm >5 ppm	Level D Withdraw and evaluate: • Need for PPE upgrade • Identify contaminants • Notify project manager and H&S manager	Drilling, and other intrusive work.
Noise	All	During operation of power augers and any area where there is some doubt about noise levels	85 dBA and any area perceived as noisy	Require the use of hearing protection	Hearing protection will be worn within the exclusion zone, and other motorized equipment
Visible contamination	All	Continuously	Visible contamination of skin or personal clothing	Upgrade PPE to preclude contact; may include disposable coveralls, boot covers, etc.	All
Mustard Agent Detection	All	From ground surface to native soil or bedrock	Detection with M256 CWD kit	Stop work, evacuate site, notify project and site manager	Drilling
Visible airborne dust	All	Continuously	Visible dust generation	Stop work; use dust suppression techniques such as wetting surface	All

H&S = Health & Safety. PID = Photoionization detector. PPE = Personal protective equipment.

8.0 HEAT/COLD STRESS MONITORING

General requirements for heat/cold stress monitoring are contained in the Facility-wide SHP.

9.0 STANDARD OPERATING SAFETY PROCEDURES

Standard operating safety procedures are described in the Facility-wide SHP.

10.0 SITE CONTROL MEASURES

Site control measures are described in the Facility-wide SHP. No formal site control is expected to be necessary for this work, as the work areas are somewhat remote and bystanders are not anticipated. The RVAAP installation is not open to the public, and only authorized personnel are allowed in the project areas. If the SSHO determines that a potential exists for unauthorized personnel to approach within 25 feet of a work zone or otherwise be at risk due to proximity, then exclusion zones will be established as described in the Facility-wide SHP.

11.0 PERSONNEL HYGIENE AND DECONTAMINATION

Personal hygiene and decontamination requirements are described in the Facility-wide SHP and in Chapter 2.0 of this addendum.

12.0 EMERGENCY PROCEDURES AND EQUIPMENT

Emergency contacts, telephone numbers, directions to the nearest medical facility, and general procedures can be found in the Facility-wide SHP. The SpecPro field operations manager will remain in charge of all SpecPro and subcontractor personnel during emergency activities. The SpecPro field office will serve as the assembly point if it becomes necessary to evacuate. Prior to mobilization, the SSHO will verify that the emergency information in the Facility-wide SHP is correct; in addition, directions and a map to the nearest medical facility (Robinson Memorial Hospital) will be posted in conspicuous places that are readily available to all on-site workers in case of emergency. Robinson

Memorial Hospital can handle personnel that have been exposed to mustard agent.

Each field team shall have a cell phone and a hand-held, two-way radio for communications purposes.

During field operations at the suspected mustard agent burial site, at least one American Red Cross Professional CPR/AED certified person shall be present, and all on-site personnel shall have CPR/first aid training.

If mustard agent is encountered, the following steps will be taken:

- All work stopped and site personnel directed to a safe location by the UXO Team Leader.
- The RVAAP Environmental Coordinator, SpecPro Health and Safety Manager, and the Ohio EPA will be notified.
- At the direction of the UXO Team Leader, the site will be secured with caution tape and barricades to limit site access to non-authorized personnel.
- Personnel that come in contact with mustard agent will be washed at the direction of the UXO Team Leader with a chlorine solution and the emergency number will be called (Post 1 (330) 358-2017).

13.0 LOGS, REPORTS, AND RECORD KEEPING

Logs, reports, and record keeping requirements are described in the Facility-wide SHP.

14.0 REFERENCES

NIOSH (National Institute for Occupational Safety and Health) 1997. *NIOSH Pocket Guide to Chemical Hazards, the Condensed Chemical Dictionary,* 10th Edition.

USACE (U.S. Army Corps of Engineers) 1992. *Safety and Occupational Health Requirements for Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities*. ER-385-1-92.

USACE 1996. *Safety and Health Manual*. EM-385-1-1-13, September.

USACE 1998. *Phase I Remedial Investigation of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant, Ravenna, Ohio.* DACA69-94-D-0029, D.O.0010 and 0022, February.

USACE 2001. *Facility-Wide Safety and Health Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. DACA62-00-D-0001, D.O. CY02, March.

APPENDIX C

UXO AND EXPLOSIVE AVOIDANCE PLAN

ISSI UNEXPLODED ORDNANCE, INC.
SITE SPECIFIC SAFETY AND HEALTH PLAN (SSSHP)

CHEMICAL WARFARE MATERIAL (CWM) SAMPLING FOR GROUNDWATER MONITORING WELL INSTALLATION AND SAMPLING AT THE SUSPECTED MUSTARD AGENT BURIAL SITE, RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

NOVEMBER 2004

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1.0 INTRODUCTION

1.1 GENERAL

ISSI Unexploded Ordnance, Inc. has been contracted by SpecPro, Inc. to perform Chemical Warfare Material (CWM) sampling in the area of a suspected mustard agent burial site at the Ravenna Army Ammunition Plant, Ravenna, Ohio in order to determine the presence of Mustard (HD) Chemical Warfare Agent (CWM) at that location. Specific tasks to be undertaken include preparation of a site specific Safety and Health Plan, visual surface clearance of each sampling site, and UXO avoidance at each of the four monitoring well locations.

1.2 TASKS TO BE PERFORMED

ISSI UXO, Inc., will perform the technical lead for all UXO avoidance activities at the four monitoring well locations as indicated by SpecPro, Inc personnel. They will also complete the following tasks:

- Conduct a surface visual search of each sampling site.
- Provide site specific UXO Safety Briefing for all personnel at the sites.
- Conduct a Magnetometer UXO survey of the Sampling sites for OE/UXO.
- Perform wipe tests for mustard agent at all drilling locations using M256 Chemical Warfare Agent Detector kits.

ISSI UXO, Inc., will be specifically guided by the Standard Operating Procedures (SOP's) and Chemical Warfare Material (CWM) Soil Sampling Protocols that are included as Appendix E to this SSSHP.

1.3 EQUIPMENT

The major equipment items listed below will be required to provide UXO services in support of the investigation. Details regarding geophysical survey equipment are discussed below.

EQUIPMENT	NUMBER
GEOPHYSICAL SURVEY EQUIPMENT	
Schonstedt GA-72Cd Magnetometer	1
SUPPORT EQUIPMENT	
Vehicle	1
General Support Kit	1
Level C PPE	2
M256 Chemical Agent Detector Kit	1

ISSI UXO, Inc. performs UXO clearance with Schonstedt GA-52Cx/72Cd magnetometers, for all subsurface geophysical surveys. The Schonstedt GA-52Cx/72Cd magnetometer is a dual fluxgate magnetometer and operates on the principal of passive detection. The Schonstedt GA-52Cx/72Cd Magnetometers is useful when used as an inexpensive and highly portable magnetometer to quickly screen surface and near-surface areas for ferrous content.

The instrument detailed above will be used during the investigation to locate subsurface metallic objects. It is very effective in areas where there is sparse metallic contamination and, conversely, of limited usefulness in areas that are heavily saturated with miscellaneous metallic debris and slag.

The M256 Chemical Agent Detector kits will be used to perform wipe tests on downhole equipment that pulled out of the borehole wet. The detector papers will turn a distinctive color when exposed to chemical warfare agents.

1.4 CWM SAMPLING TECHNICAL APPROACH

The task described above consists of the following activities:

- GEOPHYSICAL SURVEY - Using magnetometers and metal detectors to examine the surface and subsurface area in a non-intrusive manner. Perform downhole tests every 2 feet until 12 feet below ground surface.

- CWM SAMPLING- Using M256 Chemical Agent Detector Kit, wipe wet downhole equipment after it is pulled out of the borehole. Test equipment a the first occurrence of water, and at every water-bearing zone thereafter.

2.0 SAFETY AND HEALTH POLICY

2.1 GENERAL

ISSI UXO, Inc. is committed to providing a safe working environment for all project personnel. An established safety program emphasizes accident/incident prevention through a comprehensive training program and field monitoring. This plan provides procedures to prevent work related injuries and prevent damage to both project and public equipment. All federal and state laws will be complied with as well as regulations established by the United States Army and the Corps of Engineers (COE) at the RVAAP site.

All field supervisors and UXO Specialists are qualified former military Explosive Ordnance Disposal (EOD) personnel and are graduates of the US Naval School EOD. They will receive additional site specific training, covering ordnance and ordnance related hazards expected to be encountered as well as site specific hazards.

Accident Prevention and Personnel Safety will have top priority at all times. Personnel will comply with all established safety rules and regulations concerning this site. Violation or disregard of safety will be cause for dismissal. Each individual is responsible for his own safety and for reporting unsafe acts and conditions to his supervisor.

3.0 SPECIFIC SITE ASSIGNMENTS

Duties of ISSI UXO, Inc. personnel assigned to this project are outlined below.

Mr. Robert T. Fay Sr. will serve as ISSI UXO, Inc. Project Manager and will have overall responsibility for ISSI UXO, Inc. personnel and their performance. His presence will not be required on-site except, in the event of unforeseen difficulties, at the request of the SpecPro, Inc. Project Manager.

Mr. John Flynn will serve as the Senior UXO Supervisor (SUXOS) and will be on-site for the duration of CWM Soil Sampling activities. Mr. Flynn will be responsible for the safety of assigned personnel and the efficient performance of daily field operations.

4.0 LOCAL REQUIREMENTS

4.1 SITE ACTIVITIES

All site activities will be conduced in accordance with local, state, and federal regulations as well as all SpecPro, Inc. procedures, the United States Army ,and the COE.

Ms. Chantelle Carroll, the SpecPro, Inc Program/Project Manager, will be the primary point of contact for the duration of this project. She will be contacted for all significant activities. She will act as liaison for local authorities; and will notify them as required and in accordance with the SSSHP. She will also be the single point of contract in the event of an emergency.

4.2 FIELD OPERATIONS

ISSI UXO, Inc. UXO Specialists will escort all subcontractors and provide UXO and CWM safety and avoidance services during all operations.

4.3 TRAINING AND INITIAL INDOCTRINATION

All ISSI UXO, Inc. UXO personnel working at this site have successfully completed Naval Explosive Ordnance Disposal Training (USNAVSCLEOD) which details procedures for evaluating and disposing of UXO's containing high explosives and other fillers. All UXO Personnel will have had 40 hour OSHA Health and Safety Training, and Supervisors will have 8 hour Supervisors training in accordance with 29 CFR 1910-120. All UXO personnel are also members of the ISSI UXO, Inc. Medical Monitoring Program and have at least the minimum number of years of experience required by the current U.S. Army Corps of Engineers, Huntsville Engineering & Support Center.

4.4 TRAFFIC CONTROL

The drilling site is localized in one primary area. The site is located in a wooded area approximately one-half mile off of a limited access site road. Work will be halted momentarily if an unauthorized person enters the site.

All emergency control will be via radio or cellular telephone to the SpecPro Project Manager who will coordinate emergency services in accordance with the Facility-wide SHP.

4.5 SITE CLEANLINESS AND SANITATION

ISSI UXO, Inc. will maintain appropriate project on-site housekeeping practices during the course of the UXO services project. All waste generated by ISSI UXO, Inc. will be collected and properly disposed of.

Potable water will be brought to the site each day for drinking and washing.

4.6 COMMUNICATIONS

Cellular telephones will be the primary emergency and routine method of communication.

Portable 2-way radios will be used as a backup form of communication between site personnel and base personnel.

All communications will be tested at least once daily, normally in the morning after the daily safety briefing. It is anticipated the routine daily communications will suffice to indicate each unit is operating. This does not preclude supervisors from asking for radio checks if they feel their equipment may not be operating as expected.

If at anytime there is a breakdown of communications, operations will cease in that sector until the situation is corrected.

4.7 FIRE PROTECTION AND EMERGENCY SERVICE

Fire protection and emergency services numbers will be posted in all vehicles and in the Project Office.

Each vehicle will be equipped with a First Aid kit and fire extinguisher.

First Aid will be rendered for minor injuries on site. The SUXOS will determine if the injury requires further treatment. If further treatment is required, the injured person will be transported to the nearest Medical Facility as specified in the Facility Wide SHP. See the Facility SHP for a listing of Emergency Services and maps to locate them.

If injured personnel require an ambulance, Post 1 (330-358-2017) will be contacted by field personnel. The SpecPro Project Manager will be notified. Once contacted, medical authorities will make the decision where the injured person will be taken and the immediate treatment required.

All fires will always be reported no matter how small. Site personnel will attempt to contain the fire until the fire fighters arrive. If the fire gets out of hand or is beyond the capabilities of ISSI UXO, Inc. personnel, they will withdraw until help arrives.

In the event of unplanned explosions and explosive accidents, non-essential personnel will evacuate the site.

The ISSI UXO, Inc. SUXOS, and if applicable the SpecPro, Inc Project Representative will be notified via the quickest communication method available.

Necessary emergency support equipment and personnel will be summoned via the cellular phone.

The administration of First Aid to injured personnel will occur while waiting for emergency personnel to arrive. These procedures will consist of:

* INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

* EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

* SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent chlorine solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin becomes contaminated with a thickened agent, blot/wipe the material off immediately with an absorbent pad/paper towel prior to using decontaminating solution.

* INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately.

4.8 SITE INSPECTIONS

Site inspections are on-going and continuous at all ISSI UXO, Inc. projects on a periodic basis. Daily inspections of equipment, magnetometers, and vehicles will be conducted and the results recorded by the SUXOS.

4.10 PERSONAL PROTECTIVE EQUIPMENT

This site contains potential CWM, specifically Distilled Mustard (HD). It is not anticipated that it will be encountered. ISSI UXO, Inc. personnel will follow the requirements of this SSSHP Supplement regarding PPE and preventative actions. There are no "immediately dangerous to life or health" (IDLH) hazards other than an unplanned exposure to HD. PPE for the SUSOX during initial sampling for mustard agent is proscribed as Level “C”, until the boring location is cleared for UXO and mustard agent.

4.11 POWER TOOLS

The use of power tools is not anticipated at this time. Hand tools only will be used for excavation of UXO (**if required)**. These will include:

Shovels; picks; augurs, spoons, magnetometers and metal detectors.

4.12 DEMOLITION AND HANDLING OF EXPLOSIVES

Demolition or handing of explosives will **NOT BE REQUIRED**. If conducted ,it will be conducted as proscribed in the ISSI UXO, Inc. Explosive Safety Plan.

4.13 UXO SAFETY PLAN

All CWM Sampling will be carried out as directed in this SSSHP, and the US Army Engineering and Support Center, Huntsville (CEHND) Safety Concepts and Basic Considerations (Copy attached as Appendix A), EP385-1-95a, the ISSI UXO, Inc. Safety Plan, ISSI UXO SOP's (see Appendices C and D) and other standard policies and practices.

Special emphasis, if required, will be given to checking the area in the vicinity of a potential CWM.

5.0 ACTIVITY HAZARD ANALYSIS

The site contains possible Chemical Warfare Material (CWM), specifically Mustard Agent (HD). No IDLH threats are present, other than an unplanned exposure to CWM. A complete hazard analysis is contained in the SSHP Addendum, Table 2-2.

APPENDIX A
US ARMY ENGINEERING AND SUPPORT CENTER, HUNTSVILLE (CEHND) SAFETY CONCEPTS AND BASIC CONSIDERATIONS FOR UXO OPERATIONS EP 385-1-95a

EP 385-1-95a
ENGINEER PAMPHLET
29 June 2001
SAFETY

BASIC SAFETY CONCEPTS AND CONSIDERATIONS FOR ORDNANCE AND EXPLOSIVES OPERATIONS

"Approved for public release; distribution is unlimited."

EP 385-1-95a
29 June 01
AVAILABILITY
Electronic copies of this and other U.S. Army Corps of Engineers publications are available on
the Internet at http://www.usace.army.mil/inet/usace-docs/. This site is the only repository for all official USACE engineer regulations, circulars, manuals, and other documents originating from
HQUSACE. Publications are provided in portable document format (PDF).

DEPARTMENT OF THE ARMY
EP 385-1-95a
Pamphlet

U.S. Army Corps of Engineers
CESO Washington, DC 20314-1000

No. 385-1-95a 29 June 2001
Safety

BASIC SAFETY CONCEPTS AND CONSIDERATIONS FOR ORDNANCE AND EXPLOSIVES OPERATIONS

1. Purpose. This pamphlet establishes U.S. Army Corps of Engineers (USACE) operating procedures for dealing with ordnance and explosives (OE) items at Formerly Used Defense Sites (FUDS), Base Realignment and Closure, and Installation Restoration projects. There are no absolutely safe procedures for dealing with OE items, merely procedures considered to be least dangerous; therefore, it is essential that a planned and systematic approach to dealing with such items be established.

2. Applicability. This pamphlet applies to all Headquarters, U.S. Army Corps of Engineers elements and all USACE Commands having responsibility for performing OE response activities.

3. Distribution Statement. Approved for public release; distribution is unlimited.

4. References.
a. 27 CFR 55, Commerce in Explosives.
b. 29 CFR 1926, Subpart P, Excavations.
c. DOD 6055.9-STD, DOD Ammunition and Explosives Safety Standards.
d. AR 385-64, U.S. Army Explosives Safety Program.
e. DA Pam 385-64, Ammunition and Explosives Safety Standards.
f. TM 60A-1-1-31, Explosive Ordnance Disposal Procedures: General Information on EOD Disposal Procedures.
g. TB 700-2, Department of Defense Ammunition and Explosives Hazard Classification Procedures.
h. ER 5-1-11, Program and Project Management.
i. ER 1110-1-12, Quality Management.
j. EP 1110-1-17, Establishing a Temporary Open Burn and Open Detonation Site for Conventional Ordnance and Explosives Projects.
k. EP 1110-1-18, Ordnance and Explosives Response.
l. EM 385-1-1, Safety and Health Requirements Manual.
m. HNC-ED-CS-S-98-1, Methods for Predicting Primary Fragmentation Characteristics of Cased Explosives, January 1998. This document is available on the Internet at http://www.hnd.usace.army.mil/.

n. HNC-ED-CS-S-98-2, Method for Calculating Ranges to No More Than One Hazardous Fragment per 600 Square Feet, January 1998. This document is available on the Internet at http://www.hnd.usace.army.mil/.
o. Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites, U.S. Army Engineering and Support Center, Huntsville, August 1998. This document is available on the Internet at http://www.hnd.usace.army.mil/.
p. AFM 91-201, Explosives Safety Standards.
q. NAVSEA OP5, Ammunition and Explosives Ashore Safety Regulations for Handling, Storing, Production, Renovation, and Shipping.
r. NFPA 780, Standard for the Installation of Lightning Protection Systems.

5. Explanation of Abbreviations and Terms. Abbreviations/acronyms and special terms used in this document are explained in the glossary.

6. Policy. The policy of USACE is to produce products and services that fully meet customers' expectations of quality, timeliness, and cost effectiveness, within the bounds of legal responsibility. An acceptable level of quality does not imply perfection; however, there should be no compromise of functional, health, or safety requirements. Adherence to the principles outlined in ER 5-1-11 and ER 1110-1-12 will contribute to achieving this goal. OE response procedures must be formulated to ensure harmony with the USACE Strategic Vision and should be executed in concert with activities presented in other USACE guidance.

7. Responsibilities. USACE and contractor personnel involved with OE response projects are responsible for safely executing response actions in accordance with (IAW) the approved Site Safety and Health Plan, approved Work Plan, and all applicable laws, regulations, and policies.

8. General Safety Concerns and Procedures.

a. As a general rule, all fuzed unexploded ordnance (UXO) will be detonated in the original position found. This is the safest method to effect final disposition of munitions.
b. OE 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 OE consistent with safe and efficient operations.
c. Only UXO-qualified personnel will perform OE procedures. As an exception, a UXO Technician I may assist in the performance of OE procedures when under the supervision of a UXO Technician III or a UXO-qualified individual of higher rank than UXO Technician III. Non-UXO-qualified personnel who have been determined to be essential for the operations being performed may be utilized to perform OE-related procedures when supervised by a UXO Technician III or a UXO-qualified individual of higher rank than UXO Technician III. All personnel engaged in field operations will be thoroughly trained and capable of recognizing the specific hazards of the procedures being performed. To ensure that these procedures are performed to standards, all field

personnel will be under the direct supervision of a UXO Technician III or a UXO-qualified individual of higher rank than UXO Technician III.
d. Personnel who will be handling OE items will not wear outer or inner garments having static-electricity-generating characteristics. Materials made of 100-percent polyester, nylon, silk, and wool are highly static producing. Refer to DA Pam 385-64 for more information regarding nonstatic-producing clothing.
e. 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 condition (armed or unarmed) and the physical state/condition of the fuze, i.e., burned, broken, parts exposed/sheared, etc.
f. OE operations will be conducted only during daylight hours.

9. OE Safety Precautions.
a. Every effort will be made to identify a suspect OE item. Under no circumstances will any fuzed UXO be moved in an attempt to make a definitive identification. The OE item will be visually examined for markings and other external features such as shape, size, and external fittings. If an unknown OE item is encountered, the onsite USACE representative will be notified immediately. If there is no onsite USACE representative, the USACE district or the U.S. Army Engineering and Support Center, Huntsville (USAESCH) OE Safety Group will be notified as soon as possible. If research of documentation is required, it will be initiated by USAESCH. Following is additional guidance for the safe handling of OE items:
(1) Projectiles containing base-detonating fuzes are to be considered armed if the round is fired.
(2) Arming wires and popout pins on unarmed fuzes should be secured prior to moving OE items.
(3) Do not depress plungers, turn vanes, or rotate spindles, levers, setting rings, or other external fittings on OE items. Such actions may arm or activate the items.
(4) Do not attempt to remove any fuze(s) from OE items. Do not dismantle or strip components from any OE items.
(5) UXO personnel are not authorized to render inert any OE items found onsite.
(6) OE items will not be taken from the site as souvenirs/training aids.
(7) Civil War ordnance will be treated in the same manner as any other OE items.

b. Prior to entering areas/ranges contaminated with Improved Conventional Munitions (ICMs) or submunitions, a Department of the Army (DA) waiver must be obtained by the affected installation or for FUDS properties, the executing Corps district. If an ICM or submunition is found at a site not previously known to contain ICMs or submunitions, work will cease. The discovered item will be identified, then properly disposed of (including guarding the item if disposition is to be delayed). Work will resume only when an ICM waiver has been obtained. For guidance on the preparation of waiver requests, contact the OE Mandatory Center of Expertise.

c. Any time suspect chemical warfare materiel is encountered during conventional OE site activities, all work will immediately cease. Project personnel will withdraw along cleared paths upwind from the discovery. A team consisting of a minimum of two

personnel will secure the area to prevent unauthorized access. Personnel should position themselves as far upwind as possible while still maintaining security of the area.
(1) On FUDS properties, the UXO team will notify the local point of contact (POC) designated in the Work Plan. The local POC will facilitate explosive ordnance disposal (EOD) response, and two personnel will secure the site until the EOD unit's arrival. If the local POC designated in the Work Plan is not the local law enforcement agency, the local POC will inform the local law enforcement agency of the discovery if necessary. The EOD unit will notify the Technical Escort Unit (TEU) and secure the area until TEU's arrival. After notifying the local law enforcement agency (when necessary), the local POC will notify the USAESCH OE Safety Group of the actions taken.
(2) On active installations, the UXO team will normally notify the Range Control Officer, the Facility Engineer, post headquarters, or the POC designated in the Work Plan.

d. Avoid inhalation of and skin contact with smoke, fumes, and vapors of explosives and related hazardous materials.

e. Consider OE items which may have been exposed to fire and detonation as extremely hazardous. Chemical and physical changes may have occurred to an item's contents, which may have rendered the item more sensitive than in its original state.

f. Do not rely on the color coding of OE items for definitive identification. Munitions having incomplete or improper color codes have been encountered.

g. Avoid approaching the forward area of an OE item until it can be determined whether or not the item contains a shaped charge. The explosive jet, which is formed during detonation, can be lethal at great distances. Assume that all shaped-charge munitions contain a piezoelectric (PZ) fuzing system until investigation proves otherwise. PZ fuzing is extremely sensitive. It can function at the slightest physical change and can remain hazardous for an indefinite period of time.

h. Approach an unfired rocket motor from the rear at a 45-degree angle. Accidental ignition can cause a missile hazard and hot exhaust.

i. Do not expose unfired rocket motors to any electromagnetic radiation (EMR) sources. See DA Pam 385-64 for safe separation distances from various sources of EMR.

j. Consider an emplaced landmine to be armed until proven otherwise. It may be intentionally booby trapped to deceive.
(1) Many training mines contain spotting charges capable of inflicting serious injury.
(2) Exercise extreme care with wooden mines that have been buried for long periods of time. Certain soil conditions can cause the wood to deteriorate, and any inadvertent movement or pressure can initiate the fuze.

k. Assume that a practice OE item contains a live charge until investigation proves otherwise. Expended pyrotechnic and practice devices can contain red or white

phosphorus (WP) residue. Due to incomplete combustion, this residue may re-ignite spontaneously if the crust is broken and exposed to air.

l. Do not approach a smoking WP munition. Burning WP may detonate the explosive burster charge at any time.

m. Foreign ordnance was shipped to the United States for exploitation and subsequent disposal. Every effort will be made to research all applicable documentation prior to commencement of a project involving foreign ordnance.

10. OE Storage. During OE projects, explosives storage falls into two categories, on Department of Defense (DOD) installations and off DOD installations.

a. On DOD installations, DOD 6055.9-STD and Service requirements (Army – AR 385-64; Navy – NAVSEA OP5; Air Force – AFM 91-201) will be met. For the remainder of this pamphlet, reference to DOD standards (i.e., DOD 6055.9-STD) also implies that Service explosives safety publications will be adhered to. Generally, the installation will have an existing explosives storage facility that meets DOD standards. If not, the contractor will establish a temporary storage facility. The compatibility of explosives defined in chapter 3, DOD 6055.9-STD, will be followed. Recovered OE items awaiting final disposition will not be stored with serviceable explosives. Commercial explosives will be assigned a DOD hazard classification (i.e., 1.1, 1.2, etc.) and storage compatibility grouping by the U.S. Army Technical Center for Explosives Safety prior to being stored on a military installation.

b. Off DOD installations, the contractor will be responsible for establishing a temporary explosives storage facility. This temporary storage facility will meet local, state, 27 CFR 55, AR 385-64, and DOD 6055.9-STD requirements to the greatest extent practicable.
(1) In cases where the facility cannot meet the intermagazine, inhabited building, and public traffic route quantity-distance requirements specified in DA Pam 385-64 and DOD 6055.9-STD, a barricading plan or other engineering controls to protect the public from accidental detonation must be submitted to and approved by the USAESCH Directorate of Engineering.
(2) Magazines must meet the requirements of 27 CFR 55, and each magazine must have a Net Explosive Weight and hazard classification established for the explosives to be stored.
(3) Each magazine must be provided lightning protection IAW DA Pam 385-64. The provisions of NFPA 780, which are consistent with Army guidance, may be used to supplement Army guidance where necessary.
(4) A physical security survey will be conducted to determine if fencing or guards are required. This survey will be coordinated through local law enforcement agencies. Generally, a fence around the magazine is not needed, IAW 27 CFR 55. However, the contractor is responsible for providing the degree of protection needed to prevent the theft of OE items.

c. A fire plan for either an on- or off-installation explosives storage facility will be prepared and coordinated with the local fire department. Placarding of magazines will be IAW local rules and regulations.

11. OE Transportation, Offsite. In the event that OE items must be transported offsite, the provisions of chapter 15, EP 1110-1-18, will be followed. In addition, USACE contractors are prohibited from transporting UXO offsite for destruction until the provisions of paragraph 1-9, TB 700-2, have been met.

12. OE Transportation, Onsite. The following safety procedures will be followed for the transportation of OE items onsite:
a. Do not transport WP munitions unless they are immersed in water, mud, or wet sand.
b. If loose pyrotechnic, tracer, flare, or similar mixtures are to be transported, they will be placed in No. 10 mineral oil or equivalent to minimize the fire and explosion hazards.
c. Incendiary-loaded munitions should be placed on a bed of sand and covered with sand to help control the burn if a fire should start.
d. If an unfired rocket motor must be transported, it will be positioned in the vehicle parallel to the rear axle. This will afford maximum protection for the personnel operating the vehicle.
e. If a base-ejection projectile must be transported to a disposal facility, the base will be oriented in the vehicle such that it is parallel to the rear axle. This will afford maximum protection for the personnel operating the vehicle.
f. OE items with exposed hazardous fillers, such as High Explosive, will be placed in appropriate containers with packing material to prevent migration of the hazardous fillers. Padding should be added to protect the exposed filler from heat, shock, and friction.

13. Exclusion Zone Operations. On OE project sites, it is the responsibility of the contractor's Unexploded Ordnance Safety Officer (UXOSO) to establish the exclusion zone for each UXO work area.
a. The purpose of the exclusion zone is to protect nonessential personnel from blast overpressure and fragmentation hazards. Calculating exclusion zones with respect to intentional and unintentional detonations is discussed below.
(1) Intentional Detonations. The minimum separation distances specified in DOD 6055.9-STD, chapter 5, paragraph C5.5.4, will be used unless lesser distances have been calculated using HNC-ED-CS-S-98-1.
(2) Unintentional Detonations. If the identity of OE items on a site is unknown, the minimum separation distance specified in DOD 6055.9-STD, chapter 5, paragraph C5.5.4, will be used to establish the exclusion zones. When the identity of OE items is known, the USAESCH Directorate of Engineering will use HNC-ED-CS-S-98-1 and HNC-ED-CS-S-98-2 to determine the criteria for establishing the exclusion zones.

b. When multiple teams are working onsite, a team separation distance (TSD) will be established. The minimum TSD will be the greater of 200 feet or the K50 (0.9 pounds per square inch) overpressure distance.

c. While OE procedures are being conducted, only personnel essential for the operation will be allowed in the exclusion zone. When nonessential personnel enter the exclusion zone, all OE operations will cease. In addition to this work stoppage, the following actions will be taken:
(1) The individual(s) must receive a safety briefing and sign the visitors log prior to entering the zone.
(2) The individual(s) will be escorted by a UXO-qualified individual.

d. All personnel working within the exclusion zone will comply with the following:
(1) There will be no smoking within the exclusion zone, except in areas designated by the UXOSO.
(2) There will be no open fires for heating or cooking (gas stoves, grills, etc.) within the exclusion zone, except where authorized by the UXOSO.
(3) During geophysical detection operations, personnel will not wear any metal that would interfere with instrument operations.

14. OE Excavation Operations.
a. Hand excavation is the most reliable method for uncovering an OE item. However, hand excavation exposes personnel to the hazard of detonation . Therefore, only UXO-qualified personnel will be used to perform this task.

b. Earth-moving machinery (EMM) may be used to excavate overburden from suspected OE items. EMM will not be used to excavate within 12 inches of a suspected OE item. Once the EMM is within 12 inches of the suspected OE item, the excavation will be completed by hand excavation methods. Personnel who are not UXO qualified may operate EMM only when supervised by a UXO Technician III or a UXO-qualified individual of higher rank than UXO Technician III.
(1) If more than one earth-moving machine is to be used onsite, the same minimum separation distances required for multiple work teams apply.
(2) EMM operations will be conducted within the guidelines of EM 385-1-1 and 29 CFR 1926, subpart P.

c. Excavation operations, whether by hand or EMM, will employ a stepdown or offset access method. Under no circumstances will any excavation be made directly over suspected OE items.

15. OE Disposal Operations. All disposal operations will be conducted IAW TM 60A-1-1-31, EP 1110-1-17, and the unnumbered USAESCH publication entitled Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Ordnance and Explosives (OE) Sites.
a. As a general rule, all disposal operations will be accomplished by electrical means to ensure maximum safety. There are exceptions to this requirement in situations where static electricity or EMR hazards are present. Unintentional detonations can occur because of these induced currents (or lightning). The following precautions from DA Pam 385-64 are to be followed:

(1) Premature detonation of electric blasting caps by induced current from radio frequency signals is possible. Refer to DA Pam 385-64 for minimum safe distance with respect to transmitter power and indication of distance beyond which it is safe to conduct electric blasting even under the most adverse conditions.
(2) Lightning is a hazard with respect to both electric and nonelectric blasting caps. A direct hit or a nearby miss is almost certain to initiate either type of cap or other sensitive explosive elements such as caps in delay detonators. Lightning strikes, even at distant locations, may cause extremely high local earth currents that may initiate electrical firing circuits. of remote lightning strikes are multiplied by their proximity to conducting elements such as those found in buildings, fences, railroads, bridges, streams, and underground cables or conduits. The only safe procedure is to suspend all blasting activities when an electrical storm approaches to within 10 miles of the site.
(3) Electric power lines also pose a hazard with respect to electric initiating systems. It is recommended that any disposal operation closer than 155 meters to electric power lines be done with a nonelectric system.

b. The only acceptable disposal method is the one stated in the appropriate TM 60 Series manual for specific ordnance types. Any commercial explosives being used will be equivalent to the military explosive required for the disposal operation.

c. If justified by the situation, protective measures to reduce shock, blast over-pressure, and fragmentation will be taken. The USAESCH Directorate of Engineering will assist in any design work and will review for approval all proposed protective measures.

d. Minimum separations distances for personnel during OE disposal will be IAW DOD 6055.9-STD, chapter 5.

e. During open detonation operations, lifting lugs, strong backs, base plates, etc., will be oriented away from personnel locations.

f. Once disposal operations are completed, a thorough search of the immediate area will be conducted, with a magnetometer to ensure that a complete disposal was accomplished.

g- Inert ordnance will not be disposed of as scrap until the internal tillers/voids have been exposed and unconfined.
FOR THE COMMANDER:
ROBERT L. DAVIS
Colonel, Corps of Engineers
Chief of Staff

GLOSSARY

AFM ..... Air Force Manual
AR ..... Army Regulation
CFR ..... Code of Federal Regulations
DA ..... Department of the Army
DA Pam ..... Department of the Army Pamphlet
DOD ..... Department of Defense
EMM ..... Earth-Moving Machinery
EMR ..... Electromagnetic Radiation
EOD ..... Explosive Ordnance Disposal
FUDS ..... Formerly Used Defense Sites
IAW ..... In Accordance With
ICM ..... Improved Conventional Munition
NAVSEA OP ..... Naval Sea Systems Command Ordnance Pamphlet
NFPA ..... National Fire Protection Association
OE ..... Ordnance and Explosives
POC ..... Point of Contact
PZ ..... Piezoelectric
STD ..... Standard
TB ..... Technical Bulletin
TEU ..... Technical Escort Unit
TSD ..... Team Separation Distance
USACE ..... U.S. Army Corps of Engineers
USAESCH ..... U.S. Army Engineering and Support Center, Huntsville
UXO ..... Unexploded Ordnance
UXOSO ..... Unexploded Ordnance Safety Officer
WP ..... White Phosphorus

APPENDIX B
MSDS DISTILLED MUSTARD (HD)

Material Safety Data Sheet –
Sulfur Mustards (HD and THD)

Section I: General Information
Section II: Composition
Section III: Physical Data
Section IV: Fire and Explosion Data
Section V: Health Hazard Data
Section VI: Reactivity Data
Section VII: Spill, Leak and Disposal Procedures
Section VIII: Special Protection Information
Section IX: Special Precautions
Section X: Transportation Data
Addendum A: Additional Information for Thickened HD

Section I: General Information

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS:

U.S. Army Armament, Munitions and Chemical Command
Chemical Research, Development and Engineering Center
ATTN: SMCCR-CMS-E
Aberdeen Proving Ground, MD 21010-5423

CAS REGISTRY NUMBER: 505-60-2, 39472-40-7, 68157-62-0

CHEMICAL NAME AND SYNONYMS:

* Sulfide, bis (20chloroethyl)
* Bis (beta-chloroethyl) sulfide
* Bis (2-chloroethyl) sulfide
* (beta-chloroethylthio) ethane
* beta, beta'-dichlorodiethyl sulfide
* 2,2' dichlorodiethyl sulfide
* Di-2-chloroethyl sulfide
* beta, beta'-dichloroethyl sulfide
* 2,2'-dichloroethyl sulfide

TRADE NAME AND SYNONYMS:

* HD
* Senfgas
* H
* Sulfur mustard
* S-lost
* HS

* Iprit
* Suphur mustard gas
* Kampstoff "Lost"
* S-yperite
* Lost
* Yellow Cross Liquid
* Mustard Gas

* Yperite

CHEMICAL FAMILY: chlorinated sulfur compound

FORMULA: C4(H8)C12(S)

NFPA 704 SIGNAL:

* Health - 4
* Flammability - 1

* Reactivity - 1

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Section II: Composition

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
Sulfur Mustard	C4(H8)C12(S)	100	0.003 mg/m3 (8 hr-TWA)

Section III: Physical Data

BOILING POINT DEG F (DEG C): 422 DEG F. (217 DEG C)

VAPOR PRESSURE (mm Hg): 0.072 mm Hg @ 20 DEG C (0.11 mm Hg @ 25 DEG C)

VAPOR DENSITY (AIR=1): 5.5

SOLUBILITY IN WATER: Negligible. Soluble in acetone, CH3(C1), tetrachloroethane, ethylbenzoate, and ether.

SPECIFIC GRAVITY (H20=1): 1.27 @ 20 DEG C
VOLATILITY: 610 mg/m3 @ 20 DEG C; 920 mg/m3 @ 25 DEG C

APPEARANCE AND ODOR: Water clear if pure. Normally pale yellow to black. Slight garlic type odor. The odor threshold for HD is 0.0006 mg/m3

Section IV: Fire and Explosion Data

FLASHPOINT (METHOD USED): 105 DEG C (ignited by large explosive charges)

FLAMMABILITY LIMITS (% by volume): Unknown

EXTINGUISING MEDIA: Water, fog, foam, CO2. Avoid using extinguishing methods that will splash or spread mustard.

SPECIAL FIRE FIGHTING PROCEDURES:

All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations.

Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

Section V: Health Hazard Data

AIRBORNE EXPOSURE LIMIT (REL): The AEL for HD is 0.003 mg/m3 as proposed in the USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD and HT." No individual should be intentionally exposed to any direct skin or eye contact.

EFFECTS OF OVEREXPOSURE: HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. HD has been found to be a human carcinogen by the International Agency for Research on Cancer (IARC).

Median doses of HD in man are:

* LD50 (skin) = 100 mg/kg
* ICt50 (skin) = 2000 mg-min/m3 at 70-80 DEG F (humid environment); = 1000 mg-min/m3 at 90 DEG F (dry environment)
* ICt50 (eyes) = 200 mg-min/m3
* ICt50 (inhalation)=1500 mg-min/m3 (Ct unchanged with time)
* LD50 (oral) = 0.7 mg/kg

Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m3, respectively.

ACUTE PHYSIOLOGICAL ACTION OF HD IS CLASSIFIED AS LOCAL AND SYSTEMIC:

* LOCALLY, HD affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HD can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

* SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal dose of HD can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in increased susceptibilty to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

* CHRONIC EXPOSURE to HD can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), and cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

* INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

* EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

* SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid house hold bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility. If the skin

becomes contaminated with a thickened agent, blot/wipe the material off immediately with an absorbent pad/paper towel prior to using decontaminating solution.

* INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention immediately.

Section VI: Reactivity Data
STABILITY: Stable at ambient temperatures. Decomposition temperature is 149 DEG C to 177 DEG C. Mustard is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

INCOMPATIBILITY: Conditions to avoid. Rapidly corrosive to brass @ 65 DEG C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 DEG C.

HAZARDOUS DECOMPOSITION PRODUCTS: Mustard will hydrolyze to form HCI and thiodiglycol.

HAZARDOUS POLYMERIZATION: Will not occur.

Section VII: Spill, Leak and Disposal Procedures
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing (see Section 8) will remain in area where mustard is spilled.

RECOMMENDED FIELD PROCEDURES:

The mustard should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25 percent Sodium Hypochlorite solution.

Scoop all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 5.25 percent Sodium Hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite Decontamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB). WARNING: Pure, undiluted Calcium Hypochlorite (HTH) will burn on contact with liquid blister agent.

RECOMMENDED LABORATORY PROCEDURES:

A minimum of 65 grams of decon per gram of HD is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of Potassium Iodine and swirl to dissolve. Add 3 ml of 50 wt percent Sulfuric Acid water and swirl. IMMEDIATE Iodine color indicates the presence of active chlorine. If negative, add additional 5.25 percent Sodium Hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt percent Calcium hypochlorite (HTH) mixture may be substituted for Sodium Hypochlorite. Use 65 grams of decon per gram of HD and continue the test as described for Sodium Hypochlorite.

Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (see Section 8).

NOTE: Surfaces contaminated with HD and then rinse decontaminated may evolve sufficient mustard vapor to produce a physiological response.

WASTE DISPOSAL METHOD:

All decontaminated material should be collected, contained and chemically decontaminated or thermally decomposed in an EPA approved incinerator, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the procedures outlined above with the following exception:

HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited.

NOTE: Some states define decontaminated surety material as a RCRA Hazardous Waste.

Section VIII: Special Protection Information
RESPIRATORY PROTECTION:

Concentration mg/m3	Respiratory Protection/Ensemble Required
Less than or equal to 0.003 as an 8-hr TWA	Protective mask not required provided that: (a) Continuous real-time monitoring (with alarm capability is conducted in the work area at the 0.003 mg/m3 level of detection. (b) M9, M17 or M40 mask is available and donned if ceiling concentrations exceed 0.003 mg/m3. (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices. If these conditions are not met then the following applies: Full facepiece, chemical canister, air purifying respirators. (The M9, M17 or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)
Greater than 0.003 as an 8 hr TWA	The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to two hours or less.

NOTE: When 30 mil DPE is not available the M9 or M40 series mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour. As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

VENTILATION:

Local Exhaust: Mandatory. Must be filtered or scrubbed.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross- drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke-producing devices shall be performed in assessing the ability of the hood to contain agent HD.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl toxicological agent protective gloves (M3, M4, gloveset).

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazards use goggles and faceshield.

OTHER PROTECTIVE EQUIPMENT:

Full protective clothing will consist of the m3 butyl rubber suit with hood, M2A1 butyl boots, M3 gloves, impregnated underwear, M9 series mask and coveralls (if desired), or the Demilitarization Protective Ensemble (DPE). For general lab work. gloves and lab coat shall be worn with M9 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Available monitoring equipment for agent HD is the M8/M9 Detector paper, blue bank tube, M256/M256A1 kits, bubbler. Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), and the Miniature Chemical Agent Monitor (MINICAM).

Section IX: Special Precautions

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HD must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday. No smoking, eating, or drinking is permitted at the work site.

Decontaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: For additional information, see AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB, and VX" and USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT."

Section X: Transportation Data
PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison gas

DOT MARKING: Poisonous liquid, n.o.s. (Sulfide, bis 2-chloroethyl) NA 1955

DOT PLACARD: POISON GAS

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Section IV, and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION:

Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

Addendum A: Additional Information for Thickened HD
TRADE NAME AND SYNONYMS: Thickened HD, THD

HAZARDOUS INGREDIENTS: K125 (acryloid copolymer, 5%) is used to thicken HD, K125 is not known to be hazardous except in a finely-divided, powder form.

PHYSICAL DATA: Essentially the same as HD except for viscosity. The viscosity of HV is between 1000 and 1200 centistokes @ 25 DEG C.

FIRE AND EXPLOSION DATA: Same as HD.

HEALTH HAZARD DATA: Same as HD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing IMMEDIATELY. IMMEDIATELY scrape the HV from the skin surface, then wash the contaminated surface with acetone. Seek medical attention IMMEDIATELY.

SPILL, LEAK, AND DISPOSAL PROCEDURES:

If spills or leaks of HV occur, follow the same procedures as those for HD, but dissolve the THD in acetone prior to introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. The THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD.

NOTE: Surfaces contaminated with THD or HD and then rinse-decontaminated may evolve sufficient mustard vapor to produce a physiological response.

SPECIAL PROTECTION INFORMATION: Same as HD.

SPECIAL PRECAUTIONS: Same as HD with the following addition. Handling the THD requires careful observation of the "stringers" (elastic, thread-like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

TRANSPORTATION DATA: Same as HD.

APPENDIX C
STANDARD OPERATING PROCEDURES FOR GEOPHYSICAL UXO SURVEYS

STANDARD OPERATING PROCEDURES (SOP) FOR GEOPHYSICAL UXO SURVEYS

STEP DESCRIPTION	SPECIFIC INSTRUCTIONS
1. Daily Operations	a. All personnel report to the work site at time designated by the Senior UXO Specialist. b. The Senior UXO Specialist will give the daily safety briefing to all site workers and give specific instructions for the day's work. c. The project command post (CP) will be designated and all personnel not directly involved in down-range operations will remain at the CP. Visitors requesting to observe down-range operations will be escorted by the Senior UXO Specialist or his representative. d. Communications with down-range personnel are mandatory. Radios, if required, will be tested prior to beginning UXO operations. e. At minimum of two qualified UXO Technicians will be onsite during all UXO operations. f. The Senior UXO Specialist will maintain at log detailing all field operations in accordance with direction contained In the work plan.
2. Geophysical Survey Procedures	a. The UXO Supervisor will verify and survey area. b. The ISSI UXO, Inc. Crew, consisting of at minimum of two UXO Technicians, will conduct at visual inspection of the survey area to locate any obvious surface UXO hazards. c. The survey area will be divided into six-foot wide search lanes using wooden stakes at the starting points and Pin Flags to clearly mark the lanes.

	d. The geophysical instruments to be used to conduct the survey will be assembled and operationally checked in the CP area, by testing the instrument response to known objects buried at known depths, prior beginning the geophysical survey. e. All subsurface metallic contracts will be marked with a red pin flag.
3. UXO Disposal Procedures	a. All confirmed UXO will be identified, recorded, and marked with four pin flags surrounding the UXO. The SpecPro Project Manager, RVAAP environmental project manager, USACE and Ohio EPA will be notified daily of all located UXO.
4. Post-Operations Procedures	a. The Senior UXO Specialist will ensure all equipment is properly stored and secured. b. The Senior UXO Specialist will conduct a daily debrief of the project and briefly outline the next day's objectives. c. Prior to departing the work site the Senior UXO Specialist will ensure that the project area is clear and free of UXO and industrial hazards.

APPENDIX D
CWM SAMPLING AND DECONTAMINATION PROTOCOL

1.0 Chemical Agent Detection Procedures:

A. The following procedures will be preformed at each of the sites suspected of being contaminated with the Chemical Agent Mustard, H, HD or L.
B. At any suspected moist or liquid discovered on the surface or in the drilling process the suspect material will be checked with the M256 Chemical Agent Detector kits that uses M8 and M9 detector paper as listed below. In the event that a positive reading is indicated an addition test will be conducted with the M256 Detector kit, also listed below.

2.0 VGH-ABC M8 Chemical Detector Paper:

A. It is an off-white paper that has been treated with a combination of dyes that produces a distinctive color change when in contact with liquid agent. When exposed to liquid agent, the paper turns to a deep-red color for mustard, scarlet for Lewisite, yellow for GB, and dark green for VX. The paper will not detect vapor or extremely small droplets of agent.
B. When the suspected sample is chosen the M8 paper will be rubbed in the moist soil or dipped in the suspect liquid. Proper PPE such as double gloves, Respirator , Boot covers, and Tyvek coveralls will be worn with all entry points sleeves and boots) being sealed with Chemical Protective Tape.. Care should be given to eliminate any contact with the sample other then the M8 Paper.
C. If the sample being checked turns the **M8** Paper red a positive reading for Mustard is indicated. Testing with the M256 Chemical Agent Detector Kit must then be performed.

3.0 M9 Chemical Agent Detector Paper

A. M9 Chemical Agent Detector Paper detects small droplets (greater than 50 microns) of liquid agent. The paper is gray/green in color and turns red in contact with agent droplets or liquid. It does not distinguish between mustard or nerve agents. M8/M9 papers are subject to interference and should not be used as a sole verification of the presence of an agent.
B. The same procedure as listed in 2.0.B and C, apply.

4.0 M256 Chemical Agent Detector Kit:

A. The M256 chemical agent detector (fig. 9-4) is a portable, expendable item that consists of a carrying case with straps, 12 sampler-detectors, one book of M-8 paper, and a set of operational instruction cards. You will use the sampler detectors to test for chemical agents in the vapor form. The M-8 paper is used to check for chemical agents in the liquid form. The 12 sampler-detectors are individually wrapped. Each sampler-detector consists of eight glass ampoules (each filled with chemical reagent),

three test spots, a chemical heater, protective strips, and tabs. Each sampler-detector has instructions for its use printed on the outside of its protective bag. Formed channels in the plastic sheets direct the flow of the reagents from the finger-crushable ampoules to wet the test spots at the time of testing. SAFE/DANGER observations are printed on each sampler-detector. They show the approximate color that each spot develops if the agent is present and if it is absent. To detect mustards (H and HD) and phosgene oxime (CX), the square test spot is used with the blister reagent ampoules and the chemical heater. To detect lewisite (L), the lewisite detecting tablet and the lewisite tablet rubbing tab are used. A pull tab covers the lewisite detecting table. The kits will detect mustard agent 0.02 milliliters and greater.

B. When using the M256 kit to detect vapors in the air, you should use the following procedures:

- Remove the three operational instruction cards from the kit. Read these instructions before proceeding.
- Remove a sampler-detector from the kit. Check to ensure that it has not exceeded its discard expiration date. Do not use an outdated sampler-detector because it will not give you a reliable test indication.

- Read the instructions on both sides of the protective bag before proceeding.
- Open the sampler-detector bag by tearing the bag along the tear line that is marked with arrows. Hold the sampler-detector on the wind-ward side from you to keep from picking up vapors from your protective equipment. Do not allow excessive moisture, such as rain and dew, to come in contact with the sampler-detector.
- Carefully remove the sampler-detector from its protective bag. Save the protective bag to refer to the instructions that are printed on it. Do not touch the sampler-detector agent test spots because incorrect test results may be produced.
- Handle the sampler-detector carefully. Hold it by the hinged protective strip in the closed position. Keep the protective strip in the closed position to protect the test spots.
- Swing the hinged heater assembly away from the test spot and discard the two loose protective strips under the hinged heater assembly.
- Make sure that the hinged heater assembly is away from the test spot. The heater produces hot vapors and is hot to the touch. Keep the sampler-detector away from your face and bare skin once the ampoules have been broken.
- Crush one of the two green ampoules (marked 4) with your finger. Immediately swing the hinged heater assembly over the test spot. Vent the vapor away from your body. Leave the hinged heater assembly in place for 2 minutes.
- Swing the hinged heater assembly and the hinged protective strip away from the test spot after the 2 minutes have passed.
- Hold the sampler-detector by the hinged protective strip.

- Expose the test spots to the air for 10 minutes while shielding the sampler-detector from direct sunlight.
- Crush the second green ampoule (marked 4) with your finger. Swing the hinged heater assembly over the test spot, and vent the vapor away from you. Leave the hinged heater assembly in place for 1 minute.
- Swing the hinged heater assembly away from the test spot after 1 minute has passed.
- Hold the sampler-detector vertically with the test spots down.
- Crush the remaining ampoules (marked 5) with your finger. Force the liquid from the two ampoules through the formed channels to the test spots to ensure wetting.
- Rerun the lewisite detecting tablet with the lewisite tablet rubbing tab. Make sure that the second rub mark is next to the first rub mark.
- Immediately turn the sampler-detector over to determine whether safe or danger conditions exist. Observe the lewisite tablet rubbing tab for a difference in color between the two rub marks.

  Also, you can use the operational instruction cards to make a color comparison. You can compare the blood agent and the lewisite tests immediately after the prescribed exposure time. The blister agents (H and CX) develop color immediately after all of the ampoules are broken. At low concentrations, a change in the lewisite tablet rubs. Mark may be very slight. Compare the first rub mark with the second rub mark before making a judgment. A pink or blue color must be present for the test to be positive. If the suspected surface contamination is in the form of a liquid, use the M-8 paper as discussed earlier.

C. If a Positive Detection Occurs:

- Immediately stop work and evacuate all personnel to a safe area at least 500 feet upwind from the site,
- Post a guard with proper PPE at all entry to the site, maintaining at least 500 feet upwind and 2400 feet down wind.
- Notify the responsible site and COE personnel as designated in Letter CEMP-CE Notification Procedures for Discovery of Recovered Chemical Warfare Material (RCWM) during USACE Projects, dtd. 23 April 2004
- Decontaminate all onsite personnel before leaving the site.

Appendix D

Geophysical Survey Results, Possible Mustard Agent Burial Site (AOC-28), Ravenna Army Ammunition Plant, Ravenna, Ohio

April 1998

Prepared for

U.S. Army Corps of Engineers
Louisville, Kentucky
Contract No. DACA27-97-D-0025, Delivery Order No. 25

Prepared by

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513.980417.001

17 April 1998

Mr. John Jent
U.S. Army Corps of Engineers
Louisville District
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Louisville, KY 40202

Reference: Contract No. DACA27-97-D-0025, Delivery Order No. 25: RCRA Field Investigations at Ravenna Army Ammunition Plant

Subject: Geophysical Survey Results, Possible Mustard Agent Burial Site (RVAAP-28)

Dear John,

SAIC is pleased to present herein the results of the evaluation of the possible Mustard Agent Burial Site at Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. This submittal includes the text that incorporates reviewer comments of 3 April 1998. Color figures have not changed since the last submittal, and are not included in this package.

BACKGROUND INFORMATION AND SITE SETTING

RVAAP records indicate that in 1969, the U.S. Army had excavated a possible mustard agent (dichlorodiethyl sulfide and thiodiglycol) burial site within the old demolition grounds, now known as Training Areas D and G. The burial of these containers was purportedly prior to 1950. One 50-gallon drum and seven small rusted cans were discovered. All recovered items were empty, and no contamination was discovered. Following the excavation to recover these objects, an unnamed and undocumented source reported that the site had not been correctly identified, and that the actual Mustard Agent site was in an area adjacent to the excavation.

This second proposed site for the mustard agent burial is located in the wooded area approximately 152 m (500 ft) south of Hinkley Creek along an abandoned power line. The site, measuring approximately 4.5 x 5.5 m (approximately 15 x 18 ft), was reportedly enclosed by a cyclone fence. The fence had collapsed before this investigation. It is not known if this is the exact location of the possible mustard agent burial.

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PURPOSE AND SCOPE

The U.S. Army Corps of Engineers (USACE) undertook a non-intrusive investigation to identify the location of the possible mustard agent burial site. SAIC performed a two-part geophysical investigation in order to delineate the boundaries of the possible burial site, and to identify anomalies that potentially represent buried containers. SAIC used an EM-61 high-sensitivity metal detector (capable of detecting targets at depths of 10 ft) and an EM-31 conductivity meter (capable of detecting targets at a maximum depth of ~ 15 ft) in the investigation. Both instruments are manufactured by Geonics, Ltd., of Mississauga, Ontario, Canada. Near-surface drainage variations, disturbed soils, or an inverted soil column, as well as surficial metal objects, may cause anomalous readings on these instruments.

SURVEY GRID SETUP/SITE PREPARATION

SAIC prepared a land position survey in the area to be investigated. Wooden reference stakes were placed at the corners of a 48-meter by 48-meter (137.5 by 137.5 ft) area centered on the cyclone fence. Reference points were marked by flagging at one-meter (3.28-ft) intervals along the north and south boundaries of the study area. These reference flags were the basis for the site-wide grid.

The cyclone fence and remaining fence posts posed a potential source of interference to the EM-31 and EM-61 instruments. These were removed, wherever possible, by site personnel. However, portions of the fence that had been embedded in growing trees could not be removed. Also, the base of the chain-link fence had been partially buried, and the buried portion had decomposed in the soil, leaving many links protruding from the ground. Many of these were removed from the survey area. Fragments of metal sheets were also found on the ground.

SAIC surveyed the corners of the study area and cultural features with a PRO-XR global positioning system (GPS) rover. The GPS used for this effort has an accuracy < 1m because it calculates corrected position every second. The GPS data were compared with data from the USACE's temporary on-site base station, which calculates corrected positions every 30 seconds, and has an accuracy +/- 1 to 5 m. These position data were incorporated into the EM-31 and EM-61 output maps.

EM-61 DATA COLLECTION

The survey parameters included measurements every 0.61 m (2 ft) inline, with the lines spaced at 1-m (3.28-ft) intervals. Fifty north-south trending traverses were investigated. A total of 3,996 survey points, representing 7,992 linear feet of data, were collected. Inline positioning was maintained through a hip-chain measuring device and reconciled with the processed GPS data for final mapping.

The EM-61 results are present in map view in Figure 1. Several anomalies were identified, particularly within the formerly fenced area. Some of these features may be related to the metal fencing embedded in trees or a nearby metal fence post, fallen and buried in leaves, that was discovered after the survey was completed.

Several other anomalies were also identified using EM-61, some of which appear to be evenly spaced in a linear pattern. Based on presence of at least three fence posts in the field (as noted in Figure 1), some, if not all, of the anomalies in this feature may result from a former barbed wire fence that trended north-south across the area.

EM-31 DATA COLLECTION

The vertical dipole data was used for this survey, because it has a greater depth penetration than the horizontal dipole. Depths of burial of potential containers were not known, so it was decided to investigate to the greatest depth capability of the instrument.

For this survey, the parameters included measurements every 0.61 m (2 ft) inline, with lines spaced at 3-m (9.84-ft) intervals. Seventeen north-south trending survey lines were traversed. A total of 1,360 survey points, representing 2,720 linear feet of data, were collected. Inline positioning was maintained through a hip-chain measuring device and reconciled with the processed GPS data for final mapping.

The EM-31 survey results are presented in map view in Figure 2. The in-phase data represents those anomalies related to ferrous iron. Only one anomaly was identified with a metallic response. This anomaly appears to be positioned between a fence post and a nearby tree that had grown through a portion of the former cyclone fence. It appears that this anomaly is a better conductor than either the fence post or the tree. It is not known at what depth this anomaly occurs; however, typically the depth range of this instrument is approximately 10 ft.

CONCLUSIONS

Based on the results of the EM-31 and EM-61 geophysical surveys, several anomalies were identfied which may have been caused by metallic objects being present. Some, if not all, may be related to surface cultural features at or near the ground surface. Given the site conditions, it is difficult to discriminate these interferences from any potential buried waste containers. There was no signature of disturbed soils or numerous buried metallic objects that would indicate a former burial site. However, the possibility that one anomaly shown on Figure 2 may represent a buried container cannot be ruled out.

All of the aforementioned anomalies can be relocated on the ground to an accuracy of +/- 1 to 5 m, using a GPS and a hand-held metal detector without a base station, should that become necessary.

If you have any questions regarding these findings, please do not hesitate to contact either Jeff Warren, at 717-944-5501, or me, at 937-431-2239.

Respectfully submitted,

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
Kathryn L. Dominic

(no attachments)

FIGURE 1

THE RAVENNA ARMY AMMUNITION PLANT
MUSTARD AGENT BURIAL SITE
EM-61 SURVEY RESULTS