FINAL

SAMPLING AND ANALYSIS PLAN
ADDENDUM NO. 1

FOR THE

WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY, RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

PREPARED FOR

US Army Corps
of Engineers®

LOUISVILLE DISTRICT
CONTRACT No. DACA62-00-D-0001
DELIVERY ORDER CY08

October 2000

SAIC

FINAL

SAMPLING AND ANALYSIS PLAN ADDENDUM NO. 1
FOR THE
WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY,
RAVENNA ARMY AMMUNITION PLANT,
RAVENNA, OHIO

October 2000

Prepared for

U.S. Army Corps of Engineers
Louisville District
Contract No. DACA62-00-D-0001
Delivery Order No. CY08

Prepared by

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
800 Oak Ridge Turnpike, P.O. Box 2502
Oak Ridge, Tennessee 37831

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not
be considered an eligible contractor for its review.

CONTENTS

PART I–SAMPLING AND ANALYSIS PLAN ADDENDUM

1.0 PROJECT DESCRIPTION 1-1
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 2-1
3.0 SCOPE AND OBJECTIVES 3-1
4.0 FIELD ACTIVITIES 4-1
5.0 SAMPLE CHAIN OF CUSTODY / DOCUMENTATION 5-1
6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS 6-1
7.0 INVESTIGATION-DERIVED WASTE 7-1
8.0 REFERENCES 8-1

APPENDICES

A SELECTED RESULTS FROM PREVIOUS ENVIRONMENTAL INVESTIGATIONS AT THE WINKLEPECK BURNING GROUNDS A-1
B FIELD COLORIMETRIC ANALYTICAL PROCEDURE B-1

PART II–QUALITY ASSURANCE PROJECT PLAN ADDENDUM

1.0 PROJECT DESCRIPTION 1-1
2.0 PROJECT ORGANIZATION AND RESPONSIBILITY 2-1
3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT 3-1
4.0 SAMPLING PROCEDURES 4-1
5.0 SAMPLE CUSTODY 5-1
6.0 CALIBRATION PROCEDURES AND FREQUENCY 6-1
7.0 ANALYTICAL PROCEDURES 7-1
8.0 INTERNAL QUALITY CONTROL CHECKS 8-1
9.0 DATA REDUCTION, VALIDATION, AND REPORTING 9-1
10.0 PERFORMANCE AND SYSTEM AUDITS 10-1
11.0 PREVENTIVE MAINTENANCE PROCEDURES 11-1
12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS 12-1
13.0 CORRECTIVE ACTIONS 13-1
14.0 QA REPORTS TO MANAGEMENT 14-1
15.0 REFERENCES 15-1

FINAL

PART I

FIELD SAMPLING PLAN ADDENDUM NO. 1 FOR THE WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY, RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

October 2000

Prepared for

U.S. Army Corps of Engineers
Louisville District
Contract No. DACA62-00-D-0001
Delivery Order No. CY08

Prepared by

Science Applications International Corporation
800 Oak Ridge Turnpike, P.O. Box 2502
Oak Ridge, Tennessee 37831

CONTENTS

PART I – FIELD SAMPLING PLAN ADDENDUM

FIGURES vii
TABLES vii
ACRONYMS ix

1.0 PROJECT DESCRIPTION 1-1
  1.1 WBG HISTORY AND CONTAMINANTS 1-1
  1.2 SUMMARY OF EXISTING DATA 1-5
  1.3 SPECIFIC SAMPLING AND ANALYSIS PROBLEMS 1-5

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 2-1

3.0 SCOPE AND OBJECTIVES 3-1
  3.1 FS SCOPE AND OBJECTIVES 3-1
  3.2 DATA QUALITY OBJECTIVES 3-1
    3.2.1 Conceptual Site Model 3-1
    3.2.2 Problem Definition 3-3
    3.2.3 Remedial Action Objectives 3-4
    3.2.4 Identify Decisions 3-5
    3.2.5 Define the Study Boundaries 3-5
    3.2.6 Identify Decision Rules 3-5
    3.2.7 Identify Inputs to the Decisions 3-5
    3.2.8 Specify Limits on Decision Error 3-5
    3.2.9 Sample Design 3-6
  3.3 DATA EVALUATION METHODS 3-6
    3.3.1 Determination of AOC Chemical Background 3-7
    3.3.2 Definition of Aggregates 3-7
    3.3.3 Data Screening 3-7
  3.4 DEVELOPMENT OF ECOLOGICAL RGOS FOR COPECS 3-8
    3.4.1 Introduction 3-8
    3.4.2 Soil 3-8
    3.4.3 Development of Sediment RGOs 3-16
    3.4.4 Development of surface water RGOs 3-17
    3.4.5 Summary 3-17
  3.5 Feasibility Study Approach 3-17
    3.5.1 Remedial Goal Options 3-17
    3.5.2 Screening of Process Options 3-17
    3.5.3 Development of Alternatives 3-18
    3.5.4 Screening of Alternatives 3-19
    3.5.5 Detailed Analysis of Alternatives 3-19

4.0 FIELD ACTIVITIES 4-1
  4.1 GROUNDWATER 4-1
    4.1.1 Rationales 4-1
    4.1.2 Monitoring Well Installation 4-5
    4.1.3 Field Measurement Procedures and Criteria 4-7

4.1.4 Sampling Methods for Groundwater (Collection of Filtered Samples) 4-7
4.1.5 Sample Containers and Preservation Techniques 4-8
4.1.6 Field Quality Control Sampling Procedures 4-8
4.1.7 Decontamination Procedures 4-8
4.1.8 In Situ Permeability Testing 4-8
4.1.9 OE Anomaly Avoidance 4-9
4.2 SUBSURFACE SOILs 4-10
4.2.1 Rationales 4-10
4.2.2 Procedures 4-12
4.3 SURFACE SOIL AND SEDIMENT 4-15
4.3.1 Rationales 4-15
4.3.2 Procedures 4-18
4.4 SITE SURVEY 4-21
4.4.1 Sample Station Survey 4-21

5.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION 5-1
5.1 FIELD LOGBOOK 5-1
5.2 PHOTOGRAPHS 5-1
5.3 SAMPLE NUMBERING SYSTEM 5-1
5.4 SAMPLE DOCUMENTATION 5-1
5.5 DOCUMENTATION PROCEDURES 5-1
5.6 CORRECTIONS TO DOCUMENTATION 5-1
5.7 MONTHLY REPORTS 5-11

6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS 6-1

7.0 INVESTIGATION-DERIVED WASTE 7-1

8.0 REFERENCES 8-1

APPENDICES

A SELECTED RESULTS FROM PREVIOUS ENVIRONMENTAL INVESTIGATIONS AT WINKLEPECK BURNING GROUNDS [PHASE II REMEDIAL INVESTIGATION (1999)] A-1
B FIELD COLORIMETRIC ANALYTICAL PROCEDURE B-1

FIGURES

1-1 General Location and Orientation of Winklepeck Burning Grounds 1-2
1-2 RVAAP Installation Map 1-3
1-3 Map of Winklepeck Burning Grounds 1-4
2-1 Project Organization Chart for the WBG FS Field Investigation 2-2
2-2 Project Schedule for the WBG FS 2-3
3-1 Relationship of Screening Criteria to Detailed Evaluation Criteria 3-20
3-2 Criteria for detailed analysis of alternatives 3-21
4-1 Monitoring Well and Sediment Sampling Locations 4-22
4-2 Surface and Subsurface Soil Sampling Locations for Pads 45, 58, 59, 60, 61, and 62 4-23
4-3 Surface and Subsurface Soil Sampling Locations for Pads 37, 38, 66, 67, and 68 4-24
4-4 Exposure Units and Sampling Grid for Random Surface Soil Samples 4-25
5-1 WBG FS Sample Identification System 5-2

TABLES

1-1 Summary Data for Identified Human Health COCs at WBG 1-6
3-1 Selection Criteria for Areas Requiring Further Characterization at WBG 3-6
3-2 Ravenna Facility-wide Surface Soil (0 to 1 foot) Background (Inorganics Only) 3-9
3-3 Ravenna Facility-wide Subsurface Soil (>1 foot) Background (Inorganics Only) 3-10
3-4 Ravenna Facility-wide Sediment Background (Inorganics Only) 3-11
3-5 Ravenna Facility-wide Unconsolidated Zone Groundwater Background (Filtered Inorganics Only) 3-12
3-6 Ravenna Facility-wide Unconsolidated Zone Groundwater Background (Unfiltered Inorganics Only) 3-13
4-1 WBG FS Sampling Rationale and Matrix 4-2
4-2 Rationale for Selection of WBG FS Geoprobe Locations 4-10
5-1 WBG FS Baseline Soil and Dry Sediment Sample Identification List 5-3
5-2 WBG FS Groundwater Baseline Sample Identification List 5-10

ACRONYMS

AOCs	areas of concern
ARAR	applicable and relevant or appropriate requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPEC	contaminant of potential ecological concern
CSM	conceptual site model
DQO	data quality objective
EE/CA	Engineering Evaluation/Cost Analysis
EEQ	ecological effects quotient
EPA	U.S. Environmental Protection Agency
ER-L	Effects Range-Low
FS	Feasibility Study
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
HTRW	Hazardous, Toxic, and Radioactive Waste
IDW	investigation-derived waste
LOAEL	lowest observed adverse effect level
MCX	Mandatory Center of Excellence
NOAEL	no observed adverse effects level
OE	ordnance and explosives
Ohio EPA	Ohio Environmental Protection Agency
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
PPE	personal protective equipment
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
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
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SRC	site-related contaminant
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TNB	trinitrobenzene
TNT	trinitrotoluene
TRV	Toxicity reference values

USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UXO	unexploded ordnance
VOCs	volatile organic compound
WBG	Winklepeck Burning Grounds
XRF	X-ray fluorescence

1.0 PROJECT DESCRIPTION

The Feasibility Study (FS) for the Winklepeck Burning Grounds (WBG) at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figure 1-1), will evaluate remedial alternatives to address identified contamination of environmental media that poses a potential risk to human health and the environment. As an element of the FS, supplemental characterization data will be collected to fill additional data needs identified from the Phase II Remedial Investigation (RI) (USACE 1999a). These supplemental data will be used to refine the nature and extent of residual contamination identified in soils and groundwater and assess areas between former burning pads heretofore believed to be uncontaminated.

This Sampling and Analysis Plan (SAP) Addendum No. 1 for the WBG FS at RVAAP has been prepared by Science Applications International Corporation (SAIC) under contract DACA62-00-D-0001, Delivery Order No. CY08, with the U.S. Army Corps of Engineers (USACE), Louisville District. This SAP Addendum has been developed to tier under and supplement the *Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2000a), referred to in this report as the Facility-wide SAP. The Facility-wide SAP provides the base documentation, technical procedures, and investigative protocols for conducting RIs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at RVAAP. This addendum to the Facility-Wide SAP describes the rationale for the planned supplemental characterization effort and outlines the approach to be taken to evaluate these additional data, perform additional ecological risk assessment, and to prepare the FS. Consequently, the scope of work for the FS cannot be implemented without the guidance provided in both documents. Where appropriate, this SAP Addendum contains references to the Facility-wide SAP for standard procedures and protocols.

Both the Facility-wide SAP and this SAP Addendum have been developed following the USACE guidance document, *Requirements for the Preparation of Sampling and Analysis Plans, EM200-1-3, September 1994* (USACE 1994a), 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.

1.1 WBG HISTORY AND CONTAMINANTS

A detailed history of process operations and waste processes for each area of concern (AOC) at RVAAP is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). Operational history, contaminant distribution and extent, and identified contaminants of concern (COCs) for WBG are described in detail in the previous SAP Addendum No. 1 for the Phase II RI (USACE 1998b) and in the Phase II RI report (USACE 1999a). A brief summary of the results of the RI activities to date is presented in the following sections.

The WBG began operation in 1941 and encompasses approximately 80.9 ha (200 acres) in the central portion of RVAAP (Figure 1-2). A site map for WBG is shown on Figure 1-3. Historical operations at WBG include melting explosives out of heavy artillery projectiles using open burning. In some instances, high-energy material such as black powder and explosives were also laid out in a string along a road and burned (USATHAMA 1978). Burning is also known to have occurred along Road D. Prior to 1980, wastes disposed by burning included hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), antimony sulfide, Composition B, lead oxide, lead thiocyanate, 2,4,6-trinitrotoluene (TNT), propellant, black powder, sludge and sawdust from load lines, and domestic wastes. Also, small amounts of laboratory chemicals were routinely disposed of during production periods. Shrapnel and other metallic munitions fragments were allowed to remain on the site after

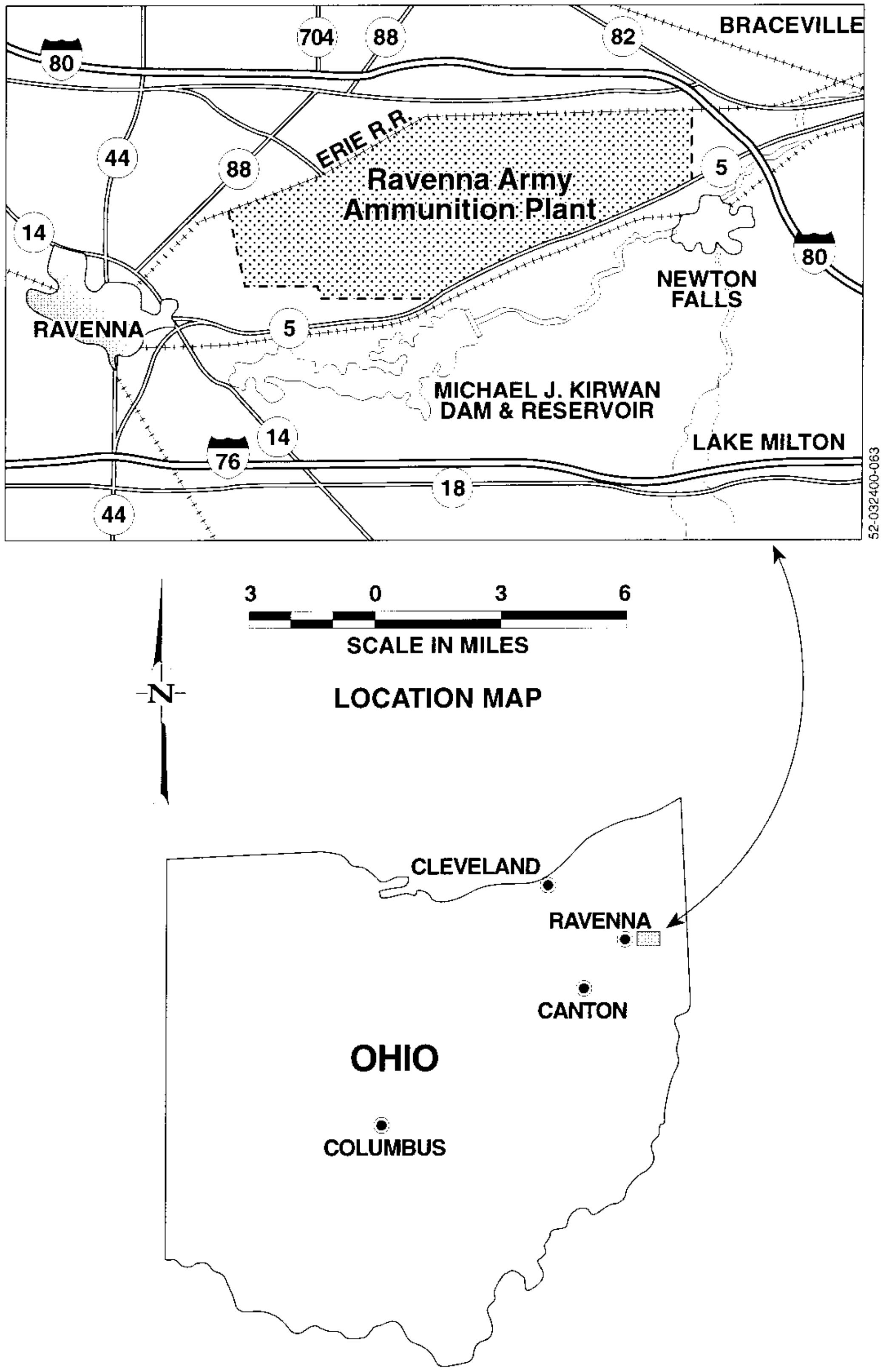
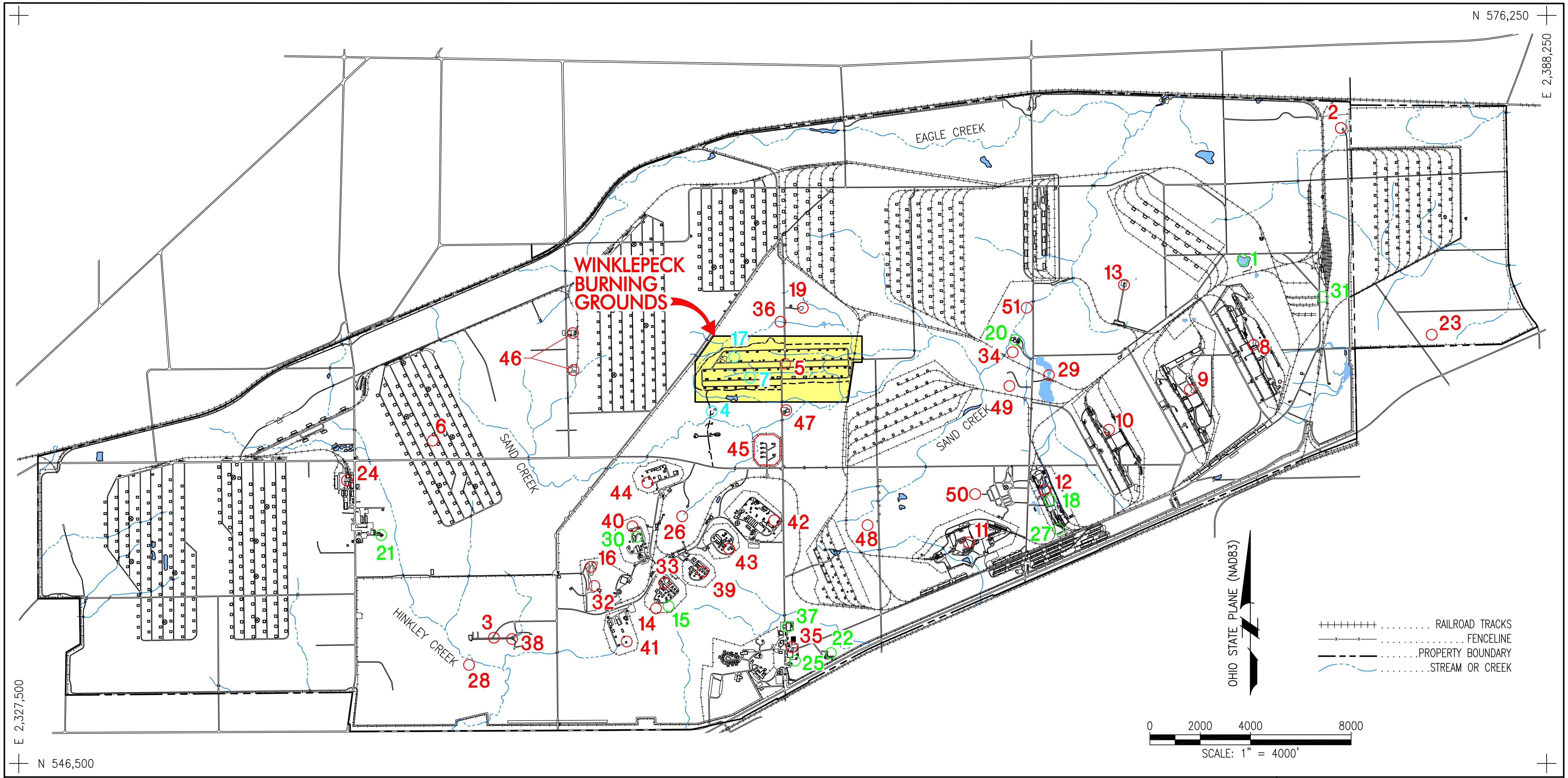


Figure 1-1. General Location and Orientation of Winklepeck Burning Grounds



LEGEND OF SITES:

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

US Army Corps
of Engineers
Louisville District

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

INSTALLATION MAP
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	0/08–18–00	/98026/DWGS/J89RVAP1.DWG

Figure 1-2. RVAAP Installation Map

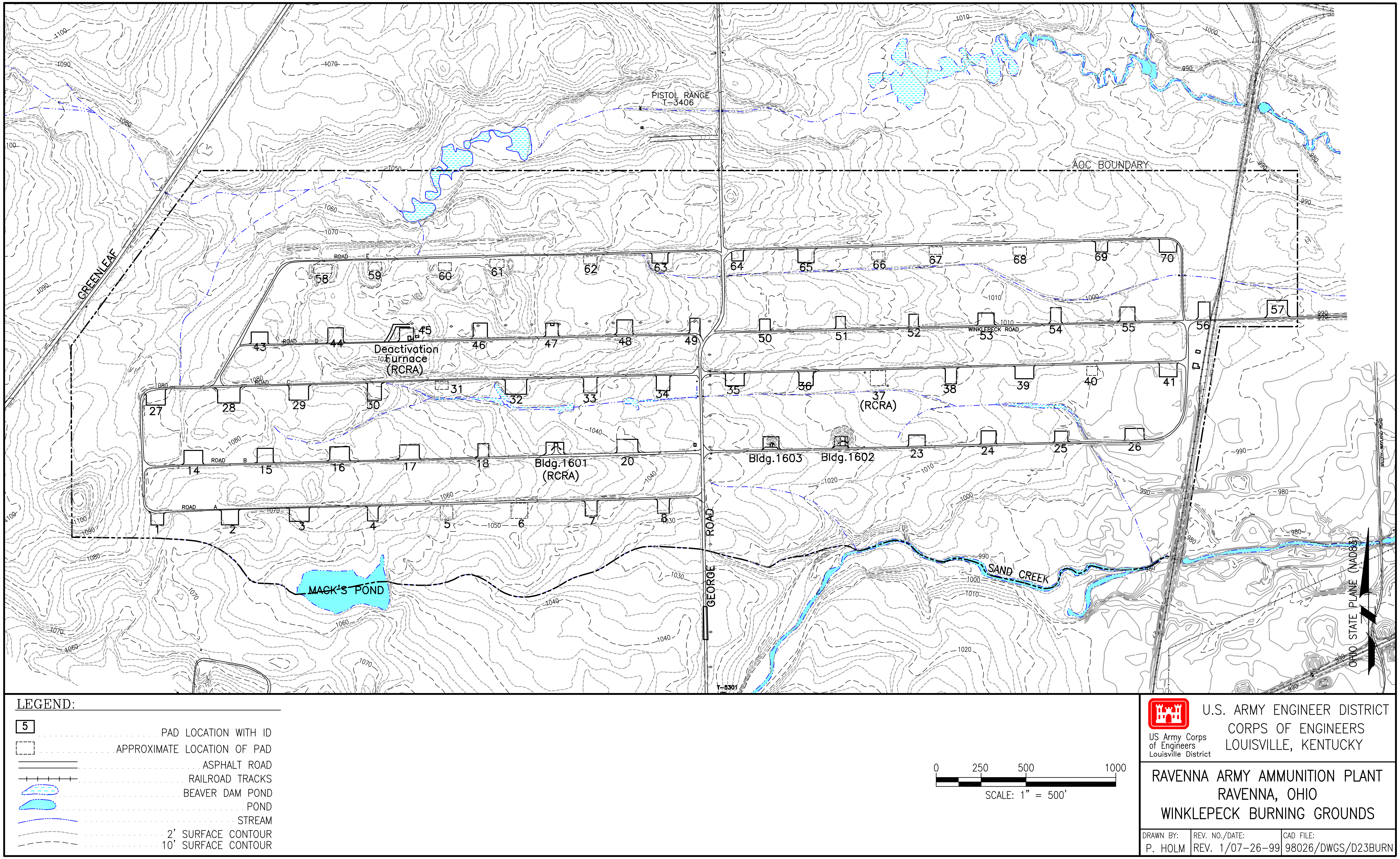


Figure 1.3. Map of Winklepeck Burning Grounds

detonation, as were possible residual explosives. Waste oil (hydraulic oils from machines and lubrication oils from vehicles) was disposed in the northeast corner of WBG until 1973.

Prior to 1980, burning was carried out in four burn pits, on burn pads, and sometimes on the roads. The burn pits consisted of areas bermed on three sides, approximately 15.2 to 22.9 m (50 to 75 ft) in width and length. It is suspected (USACE 2000b), but not presently confirmed, that the four burn pits correspond to pads 58, 59, 60, and 61, with Pit #1 corresponding to pad 58 (Figure 1-3). Of the four pits, Pit #1 was used most frequently. The burn pads generally consisted of level areas without berms 6 to 12.2 m (20 to 40 ft) in width and length. It is not known how many pads were contained within the AOC. Currently 70 burning pads have been identified from historical drawings and aerial photographs. Burning was conducted on bare ground. Ash from these areas was not collected (Jacobs Engineering 1989). Scrap metal was reclaimed and taken to the landfill north of Winklepeck (RVAAP-19).

After 1980, thermal treatment of munitions and explosives were conducted only in a 0.4 ha (1 acre) Resource Conservation and Recovery Act (RCRA) area at Burning Pad #37. Burning was conducted in metal refractory-lined trays set on top of a bed of crushed slag in an area approximately 30.5 × 30.5 m (100 x 100 ft) in size. Ash residues were drummed and stored in Building 1601 on the west side of WBG pending proper disposition. The burn trays were removed from Burning Pad #37 in 1998, and the site was closed under RCRA.

Two additional RCRA-regulated units besides Burning Pad #37 are located within WBG and have either been closed or are in the process of closure (Figure 1-3). These two units are the Deactivation Furnace Area and Building 1601. Building 1601 has been certified closed. A closure plan for the Deactivation Furnace is currently in preparation. Additional sampling of surface and subsurface soils at the Deactivation Furnace and Building 1601 in support of closure activities was conducted in the fall of 1997. Closure activities for Pad #37 consisted of the decontamination and removal of the burning trays; those at Building 1601 included sampling through the floor and outside the doors of Building 1601 with subsequent decontamination of the structure. To date, closure activities at the Deactivation Furnace have included removal of structures and sampling and analysis of the subsurface soils.

1.2 SUMMARY OF EXISTING DATA

Appendix A presents a summary of Phase II RI characterization data, which incorporates all data that met project data quality objectives (USACE 1999a). Table 1-1 presents summary data for those constituents identified as COCs in the aggregate human health risk assessment conducted as part of the Phase II RI. In addition, two historical investigations have been conducted at WBG: (1) *Hazardous Waste Management Study No. 37-26-0442-84 Phase II of AMC Open-Burning/Open-Detonation Grounds Evaluation, Ravenna Army Ammunition Plant* (USAEHA 1983); and (2) *Soil Sample Analysis, Winklepeck Burning Grounds* (USACE 1997a). A comprehensive overview of all locations previously sampled within WBG are contained in the SAP Addendum No. 1 for the Phase II RI (USACE 1998b) and the Phase II RI Report (USACE 1999a). Existing analytical data are discussed in greater detail in Chapter 4 of this SAP Addendum where the sampling rationale is presented for each medium to be further characterized.

1.3 SPECIFIC SAMPLING AND ANALYSIS PROBLEMS

Ordnance and explosives (OE) have been observed at WBG during previous field activities. Therefore, anomaly avoidance will be performed prior to and during the sampling effort as described in Chapter 4.

Table 1-1. Summary Data for Identified Human Health COCs at WBG

Chemical of Concern	Maximum Detect in Surface Soil[a]	Maximum Detect in Subsurface Soil[a]	Maximum Detect in Groundwater[b]	Maximum Detect in Sediment[a] / Surface Water[b]
Inorganics				
Antimony	27.9	2.4	ND	0.32 / ND
Arsenic	35.8	20.5	ND	18.1/ ND
Barium	10400	400	98.1	528 / ND
Cadmium	877	11.9	ND	0.56 / ND
Chromium	189	23.3	ND	21.3 / ND
Manganese	3910	3470	2920	105 / 103
Zinc	24900	184	45.6	166 / 18.4
Explosives				
1,3,5 – TNB	490	6.9	ND	0.15 / ND
2,4,6 – TNT	3800	27	ND	0.97 / ND
HMX	1700	14	8	0.12 / ND
RDX	9500	82	32	ND / ND
Semivolatile and Volatile Organics				
Benzo(a)pyrene	0.8	0.5	ND	0.39 / ND
Benzo(a)anthracene	1	0.48	ND	0.56 / ND
Benzo(b)fluoranthene	1.1	0.7	ND	0.56 / ND
Dibenzo(a,h)anthracene	0.11	0.08	ND	ND / ND
Indeno(1,2,3-cd)pyrene	0.48	0.37	ND	0.17 / ND
Chloroform	0.002	ND	1.7	0.01 / ND

[a] Results are in mg/kg
[b] Results are in µg/L
ND – not detected
TNB = trinitrobenzene
TNT = trinitrotoluene
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The WBG FS project organization and responsibilities are presented in Figure 2-1. The functional responsibilities of key personnel are described in Chapter 2.0 of the Facility-wide SAP and, therefore, are not presented here. Figure 2-2 presents the planned project schedule.

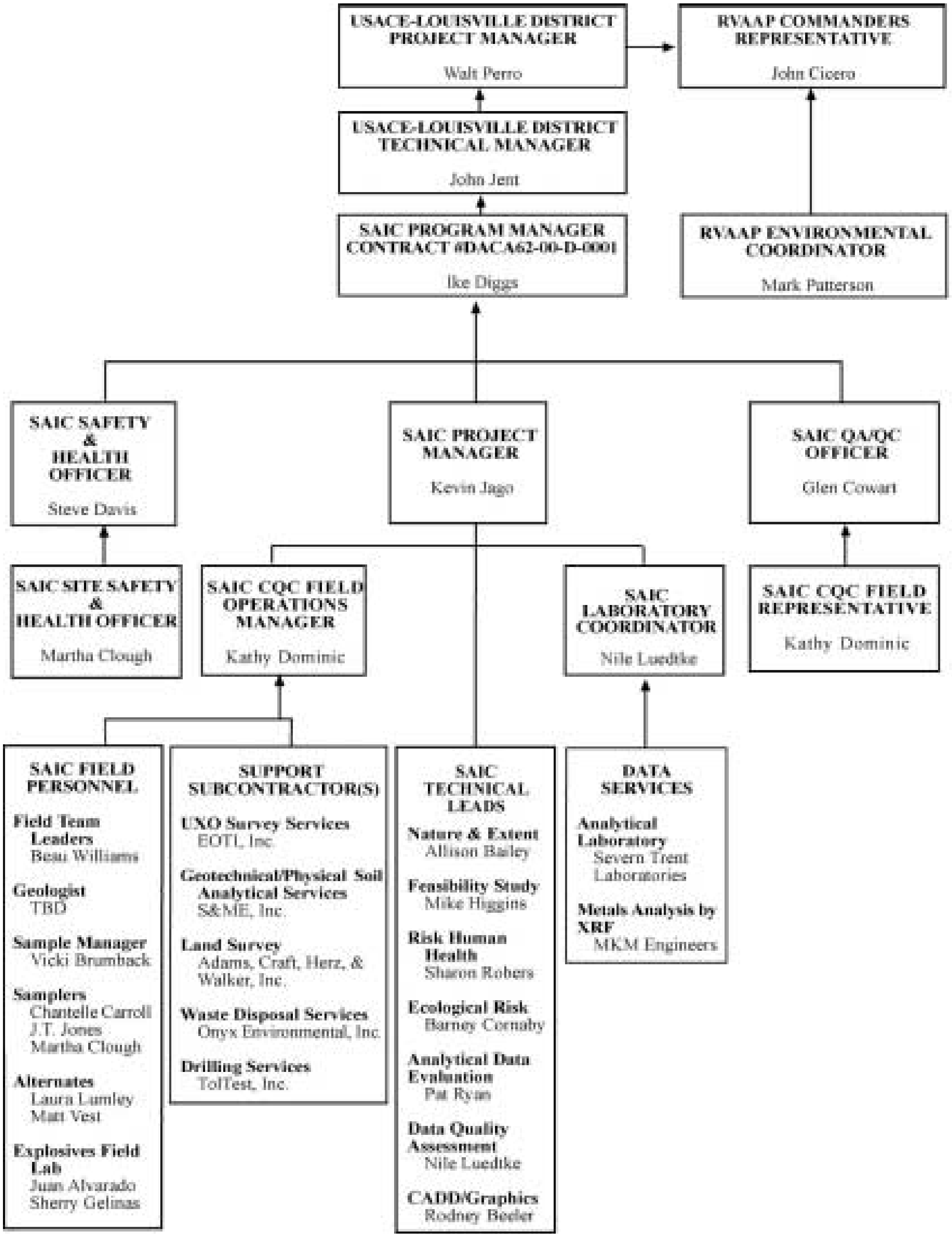
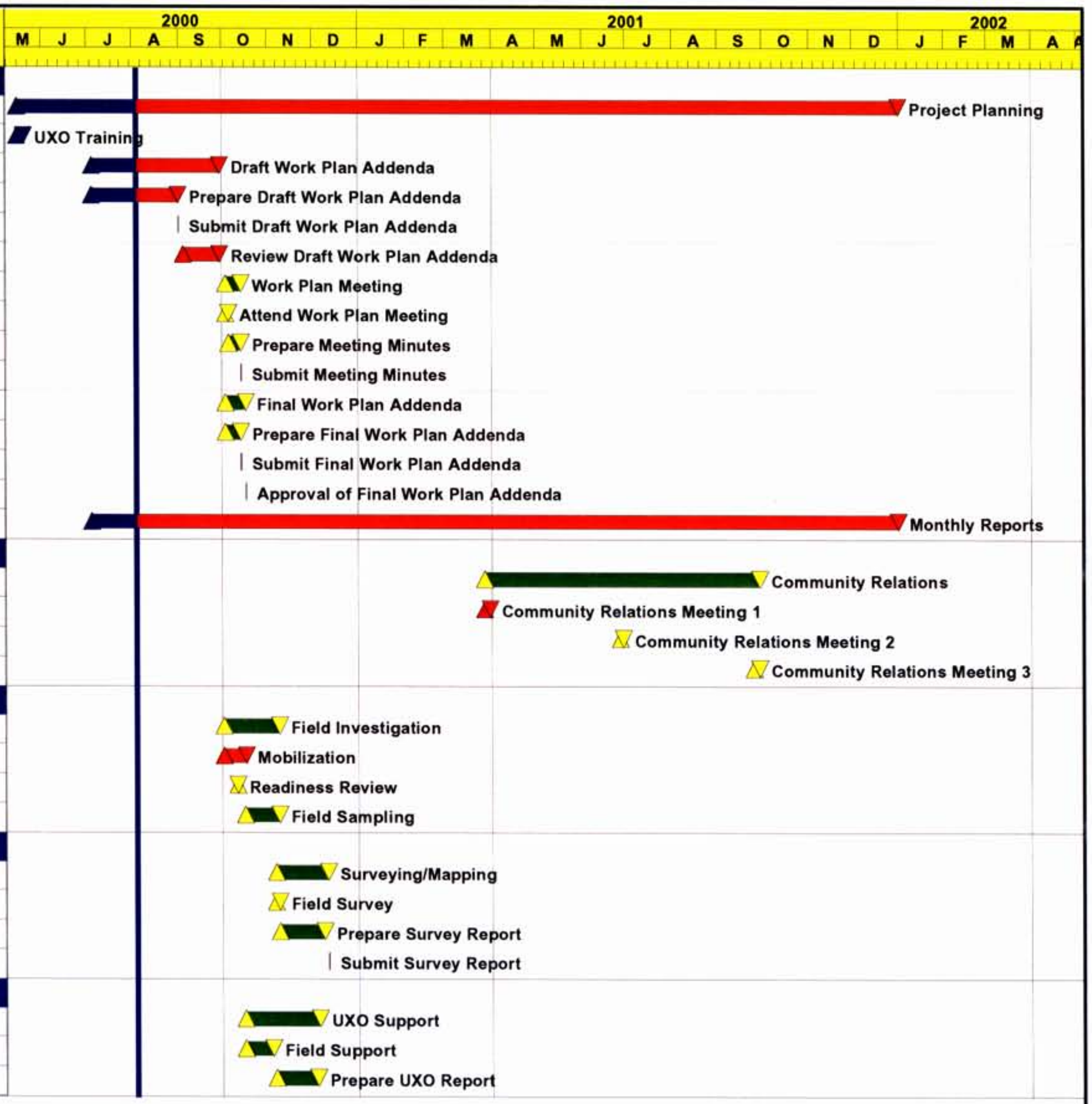


Figure 2-1. Project Organization Chart for the WBG FS Field Investigation

Activity ID	Activity Description	Orig Dur	Rem Dur	Early Start	Early Finish
Project Planning					
FS100	Project Planning	418	361	15MAY00A	31DEC01
FS120	UXO Training	1	0	15MAY00A	19MAY00A
FS130	Draft Work Plan Addenda	62*	40*	05JUL00A	29SEP00
FS130.10	Prepare Draft Work Plan Addenda	62	21	05JUL00A	01SEP00
FS130.20	Submit Draft Work Plan Addenda	0	0		01SEP00
FS130.30	Review Draft Work Plan Addenda	19	19	05SEP00	29SEP00
FS140	Work Plan Meeting	9*	9*	03OCT00	13OCT00
FS140.10	Attend Work Plan Meeting	3	3	03OCT00	05OCT00
FS140.20	Prepare Meeting Minutes	6	6	06OCT00	13OCT00
FS140.30	Submit Meeting Minutes	0	0		13OCT00
FS150	Final Work Plan Addenda	10*	10*	03OCT00	16OCT00
FS150.10	Prepare Final Work Plan Addenda	9	9	03OCT00	13OCT00
FS150.20	Submit Final Work Plan Addenda	0	0		13OCT00
FS150.30	Approval of Final Work Plan Addenda	0	0		16OCT00
FS160	Monthly Reports	384	361	05JUL00A	31DEC01
Community Relations					
FS200	Community Relations	133	133	28MAR01	28SEP01
FS210	Community Relations Meeting 1	3	3	28MAR01*	30MAR01
FS220	Community Relations Meeting 2	3	3	27JUN01	29JUN01
FS230	Community Relations Meeting 3	3	3	26SEP01	28SEP01
Field Investigation					
FS300	Field Investigation	28	28	02OCT00	08NOV00
FS310	Mobilization	11	11	02OCT00	16OCT00
FS320	Readiness Review	1	1	11OCT00	11OCT00
FS330	Field Sampling	18	18	16OCT00	08NOV00
Surveying/Mapping					
FS400	Surveying/Mapping	24	24	06NOV00	11DEC00
FS410	Field Survey	3	3	06NOV00	08NOV00
FS420	Prepare Survey Report	20	20	09NOV00	08DEC00
FS430	Submit Survey Report	0	0		11DEC00
UXO Support					
FS500	UXO Support	35	35	16OCT00	05DEC00
FS510	Field Support	15	15	16OCT00	03NOV00
FS520	Prepare UXO Report	19	19	06NOV00	04DEC00



Start Date	30MAR00
Finish Date	31DEC01
Data Date	04AUG00
Run Date	14AUG00 07:46

© Primavera Systems, Inc.

🟩 Early Bar
🟦 Progress Bar
🟥 Critical Activity

NCO2 - CY08

Sheet 1 of 2

Winklepeck Burning Grounds
Feasibility Study

Figure 2-2. Project Schedule for the WBG FS

Activity ID	Activity Description	Orig Dur	Rem Dur	Early Start	Early Finish
FS530	Submit UXO Report	0	0		05DEC00
IDW Disposition					
FS600	IDW Disposition	39	39	12JAN01	08MAR01
FS610	Draft IDW Report	28*	28*	12JAN01	21FEB01
FS610.10	Prepare Draft IDW Report	20	20	12JAN01	09FEB01
FS610.20	Submit Draft IDW Report	0	0		09FEB01
FS610.30	Review of Draft IDW Report	8	8	12FEB01	21FEB01
FS620	Final IDW Report	9*	9*	21FEB01	05MAR01
FS620.10	Prepare Final IDW Report	7	7	21FEB01	01MAR01
FS620.20	Submit Final IDW Report	0	0		01MAR01
FS620.30	Approval of Final IDW Report		2	02MAR01	05MAR01
FS630	IDW Disposal	3	3	06MAR01	08MAR01
Analytical Investigation					
FS700	Analytical Investigation	95	95	02OCT00	16FEB01
FS710	Mobilization	11	11	02OCT00	16OCT00
FS720	Laboratory Analysis	37	37	17OCT00	08DEC00
FS740	Verification and Validation		24	08DEC00	12JAN01
FS750	Data Screening and Assessment		24	16JAN01	16FEB01
Draft FS Report					
FS800	Draft FS Report	111	111	16FEB01	20JUL01
FS810	Prepare Draft FS Report	86	86	16FEB01	15JUN01
FS820	Submit Draft FS Report	0	0		15JUN01
FS830	Review Draft FS Report	25	25	18JUN01	20JUL01
Draft FS Report Meeting					
FS900	Draft FS Report Meeting	14	14	24JUL01	10AUG01
FS910	Attend Review Meeting	4	4	24JUL01	27JUL01
FS920	Prepare Meeting Minutes	11	11	27JUL01	10AUG01
FS930	Submit Meeting Minutes	0	0		10AUG01
Draft Final FS Report					
FS1000	Draft Final FS Report	80	80	30JUL01	16NOV01
FS1010	Prepare Draft Final FS Report		45	30JUL01	28SEP01
FS1020	Submit Draft Final FS Report		0		28SEP01
FS1030	Review Draft Final FS Report		35	01OCT01	16NOV01
Final FS Report					
FS1100	Final FS Report	32	32	16NOV01	31DEC01
FS1110	Prepare Final FS Report	32	32	16NOV01	31DEC01
FS1120	Submit Final FS Report	0	0		31DEC01

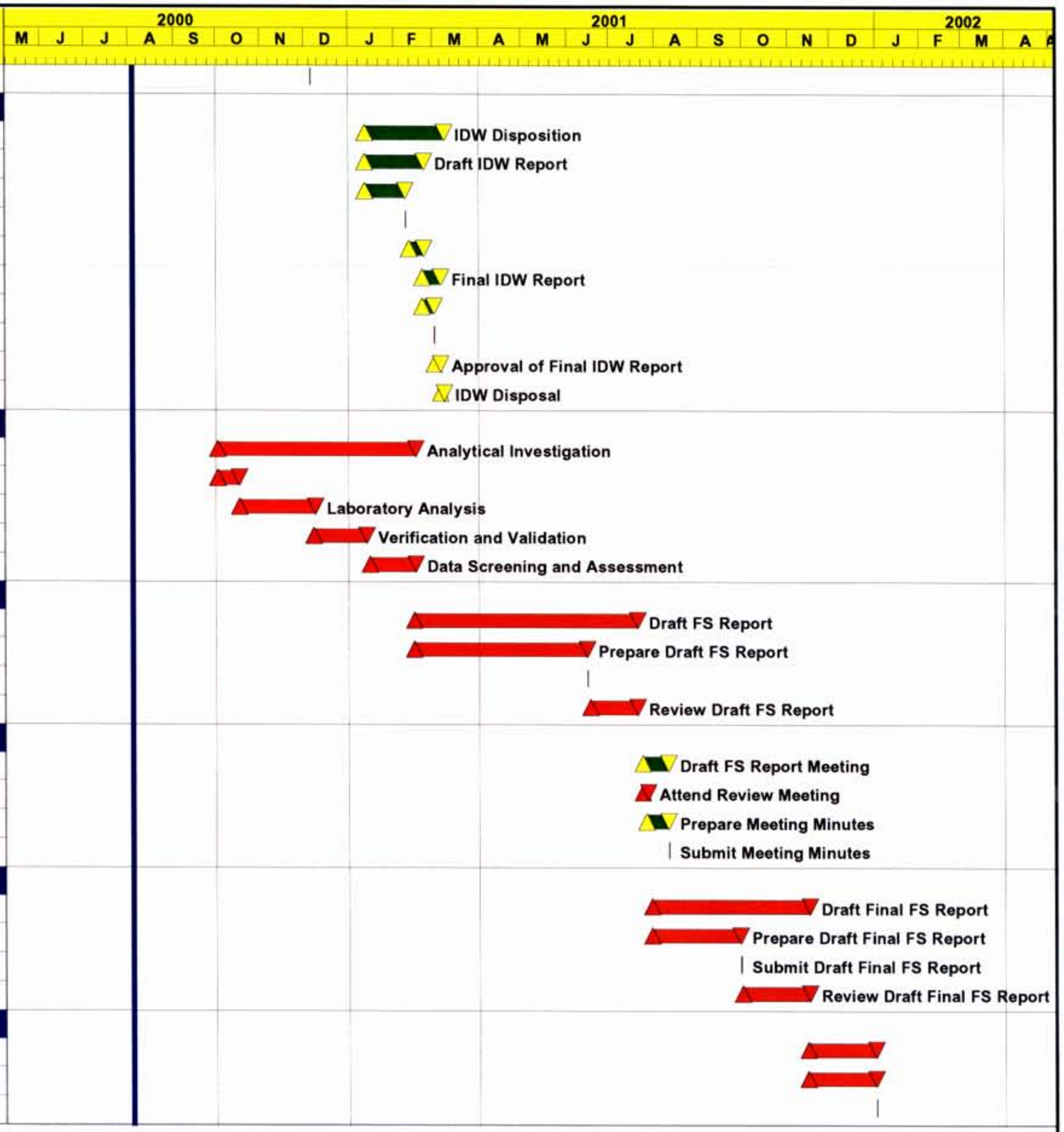


Figure 2-2. Project Schedule for the WBG FS (Cont'd)

3.0 SCOPE AND OBJECTIVES

3.1 FS SCOPE AND OBJECTIVES

The scope of the field investigation to be performed in conjunction with the WBG FS is to fill additional data needs regarding the extent of contamination in affected media (soils, sediments, and groundwater) following the Phase II RI. The primary objectives of the FS field investigation are as follows:

- Further define vertical and lateral extent of contamination at selected burning pads where available data indicate that contamination extends beyond the areas sampled during the Phase II RI.
- Perform random grid sampling in areas not thought to have been impacted by former operations to verify absence of contamination.
- Further characterize groundwater quality within the AOC to ascertain flow patterns and levels of contaminants.
- Obtain necessary data to evaluate the potential for natural attenuation using quantitative measures where possible.
- Obtain necessary data to evaluate contaminant fate and transport using quantitative measures where possible.

The data obtained from the FS field investigation will be used to update the screening level ecological risk assessment presented in the Phase II RI. The updated ecological risk assessment will incorporate the additional data generated under the field investigation and, subsequently, will be used to develop ecological risk-based remedial goal options (RGOs). Additionally, the ecological risk assessment will incorporate the results of an ongoing biological measurements study as discussed in Section 3.4.2.6. All of these data will be considered during the screening and evaluation of remedial alternatives in the FS and to determine areas exceeding RGOs and volumes of soils requiring remediation. Investigation-specific objectives have been developed using the data quality objective (DQO) approach presented in the Facility-wide SAP. Project-specific sampling objectives are presented for each environmental medium in Chapter 4 of this SAP Addendum.

During the course of the WBG FS, a public forum will be held to discuss the results of the investigations. At a minimum, one formal presentation will be prepared to communicate the objectives, status, results to date, and significance of the FS. A summary of potential remedial alternatives and the results of screening and detailed analysis will also be communicated.

3.2 DATA QUALITY OBJECTIVES

The project DQO is to provide sufficient high-quality data to address the primary project objectives identified 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 WBG for this FS field investigation. The most current version of the CSM for WBG, which includes operational information, hydrogeologic and contaminant fate and transport data, analytical data collected to date, and human health and ecological risk assessment information, is presented in the Phase II RI Report (USACE 1999a). Those elements of the CSM specific to the planned FS field investigation are as follows:

Soils

Based on characterization data to date, the CSM considers contaminated soils within and adjacent to the former burning pits and pads as potential secondary sources of contamination to sediment, surface water, and groundwater. Contaminants may be released from soil and migrate in storm runoff either in dissolved phase or adsorbed to particulates and/or colloids. Further horizontal characterization of known areas of soil contamination is planned to define contaminant nature and extent and to provide sufficient data for remedial alternatives analysis in the feasibility study. Vertical characterization is planned for the same reasons and to determine if leaching processes may be contributing to groundwater contamination. In addition, to investigate whether soil contamination is present in those portions of the AOC outside of and between the former burn areas, random grid sampling is planned.

Previous sampling data at WBG indicated explosives (primarily TNT and its degradation products) in excess of 1 mg/kg in surface soil at Pads 5, 6, 37, 38, 59, 60, 62, 66, 67, 68, and 69. Inorganics were detected at nearly all pads above background levels. Prevalent inorganic site-related contaminants include barium, cadmium, chromium, copper, lead, mercury, and zinc. The principal human health COCs include cadmium, TNT, and RDX with Pads 38, 45, 58, 60, 61, 66, and 67 exhibiting the highest risk factors [risk > 10^{-4} and/or hazard quotient (HQ) >3]. The principal ecological COCs include aluminum, cadmium, and lead with Pads 32, 37, 38, 58, 59, 60, and 66 exhibiting the highest ecological risk (HQ approximately or >1000). However, aluminum was not frequently detected above its background value (12 of 149 samples).

Explosives in subsurface soil are present at concentrations in excess of 1 mg/kg to depths of at least 1.2 m (4 ft) at Pads 60, 62, 66, 67, and 68. Analytical data show explosives in excess of 1 mg/kg to depths of at least 1.9 m (6 ft) at Pads 67 and 68. Lead values in excess of 100 mg/kg occurred at depths of 1.2m (4 ft) at Pad 60, and cadmium was present at elevated levels at Pads 60 and 61. Human health COCs for subsurface soil include cadmium and TNT.

Sediment

Sediment within ditches and tributaries represents a receptor media for contaminants eroded or leached from soils in source areas and transported by storm runoff. In addition, sediment may function as a transport mechanism considering that contaminants adsorbed to particulates may be mobilized by surface water flow. Operational data suggest that the ditches in the vicinity of former burn areas represent likely locations where contaminants may have accumulated through erosional transport and accumulation.

Site data collected to date show that explosives above 1 mg/kg were not present in sediment. Inorganics above facility-wide background were observed in two samples, with the highest levels concentrated in a sample collected at the east end of the AOC. One sample collected near Mack’s Pond contained low levels of 11 semivolatile organic compounds (SVOCs) [polycyclic aromatic hydrocarbons (PAHs)] all at concentrations less than 1 mg/kg. No human health COCs were identified for sediment exceeding risk values of 10^{-4} or hazard index (HI) > 1. Ecological COCs identified for sediment include arsenic, copper, manganese, nickel, and zinc with HI of 1 to 3. Low ecological risks (HI of 1 to 2) were associated with the SVOCs identified near Mack’s Pond. Considering the available data and the CSM, biased sampling of sediment is limited to a heretofore uncharacterized ditchline draining two of the more highly contaminated pads (Pads 59 and 60).

Surface Water

Surface water conveyances within WBG are intermittent; therefore, sediment sampling was deemed adequate for the Phase II RI to characterize any potential contaminant transport along these conveyances. Sampling of surface water from conveyances within and adjacent to WBG was conducted only at Mack's Pond during the Phase II RI. Explosives were not detected in this sample and inorganics were less than background levels. No human health or ecological COCs were identified by the Phase II RI. Modeling of potential surface water transport was conducted in the Phase II RI using the EPA Storm Water Management Model. This modeling indicated that potential contaminant migration off of the AOC is not expected to be a future problem. Accordingly, surface water characterization is not an element of the FS field investigation. Should sediment sampling along the tributary north of Pads 59 and 60 indicate a potential migration pathway off of the AOC, additional surface water sampling may be conducted.

Groundwater

Limited hydrogeologic and analytical data exist for groundwater at WBG. The CSM for WBG shows that the general groundwater flow patterns mimic the site topography and surface water drainage patterns, which indicate an overall flow gradient to the east across the AOC. The fact that WBG is elevated from 10 to 30 feet relative to surface water streams to the north and south, suggests that the AOC is a recharge area with some northeast and southeast components of shallow groundwater flow towards these surface water features. Phase II RI drilling data show that groundwater occurs under unconfined conditions in sandy interbeds within glacial till deposits at the site, which are presumed to be many tens of feet thick. Because of the heterogeneous nature of the unconsolidated glacial deposits beneath the site, these sandy units are likely discontinuous and localized variants in the overall flow patterns and preferred migration pathways (i.e., gravel or sand stringers) likely exist at the site.

Phase II RI groundwater sampling showed the presence of explosives in excess of 1 µg/L in two wells. A number of inorganics were detected in groundwater at concentration above facility-wide background, but below Ohio Maximum Contaminant Levels for drinking water. The only human health COC identified for groundwater was manganese, which had an HQ between 1 and 2; however, the facility-wide background values for this inorganic is six times the risk-based screening criterion. Contaminant migration from source areas to groundwater via leaching or surface water infiltration has not been verified as a major release mechanism in the CSM at present. However, characterization data show that the identified contaminants to date have low mobility in groundwater and would be expected to degrade or adsorb within the soil column.

Considering the uncertainties associated with the CSM noted above, the presence of groundwater contamination will be further evaluated as part of the FS field investigation. Groundwater characterization efforts include installation of monitoring wells immediately downgradient of pads having residual contamination and in locations downgradient of Pads 56 and 26 to monitor for potential migration of contamination off of the AOC.

3.2.2 Problem Definition

The open burning of explosives, explosive-contaminated wastes, and thermal treatment of munitions has contaminated surface and subsurface soils. Soil contaminants principally include explosives and inorganic analytes. Low levels of SVOCs and sporadic detections of low levels of volatile organic compounds (VOCs) also have been observed. Sediment contamination by explosives and inorganics as a result of accumulation of contaminants within low-lying areas (i.e., ditches) was documented in the Phase I and Phase II RIs. However, the extent of sediment contamination in these conveyances appears to be limited to the AOC with no evidence to date of transport beyond WBG. Similarly, evidence of contaminant migration beyond the AOC has not been observed based on data collected to date. Surface water represents the most probable contaminant exit pathway beyond WBG; consequently potential future contaminant transport in this medium was modeled using numerical simulations. These simulations suggest that future migration of contaminants will not be significant. Groundwater data collected to date show low levels of explosives contamination near source areas, but not at levels that pose a risk to human receptors. The extent and prevalence of contaminant migration to groundwater via leaching of soils or infiltration of surface water is not well defined at present. Contaminant migration to groundwater will be further evaluated based on the results of this FS field investigation. This evaluation will incorporate the use of quantitative flow and geochemical modeling techniques, as well as qualitative assessment based on the hydrogeologic characteristics of the site.

3.2.3 Remedial Action Objectives

Section 3.2.3 of the Facility-wide SAP presents general considerations for incorporating remedial action objectives (RAOs) into the sample planning process. Preliminary RAOs for WBG (final RAOs will be developed in the FS report) that were used to guide the overall sampling effort include:

- Prevention of direct contact with soil, ingestion of soil, or inhalation of airborne particles derived from soils exceeding applicable RGOs for the final agreed upon land use (i.e., National Guard, recreational, industrial, residential) for explosives, organics, and inorganics.

- Prevention of direct contact or ingestion of surface water exceeding applicable RGOs for the final agreed upon land use(s).

- Prevention of potential future groundwater users from direct contact or ingestion of groundwater exceeding applicable RGOs for the final, agreed upon land use(s).

- Prevention of soil or sediment releases that would result in surface water contaminant levels above applicable threshold criteria.

- Prevention of contaminant migration that could potentially result in contamination of groundwater or surface water at levels exceeding applicable RGOs.

A number of potential remedies for WBG have been identified at present, and RGOs based on safety and human health risk considerations are presently being developed (USACE 2000b). The potential remedial action technologies examined to date include:

- Ex situ composting of soil containing explosives contamination.

- Ex situ stabilization of soil containing inorganic and/or SVOC contamination (to be implemented in conjunction with composting where explosives are co-located with other contaminants).

- OE clearance (excavation/screening/hand removal) or OE avoidance (to be implemented in conjunction with the technologies above to address chemical contamination).

Because the potential remedial technologies identified to date involve excavation of soil, additional characterization data collected under this FS will be used to refine the areas and depths of contamination in excess of RGOs. These data, in turn, will be used to establish soil excavation volumes, which are a significant controlling variable of the remedial alternative cost evaluation. Soil area and volume estimates must be as precise as possible to allow as accurate estimation of cost as possible. The desired land use scenario by OHARNG does not exclude potential future groundwater use in perpetuity. Therefore, the need for groundwater remedial actions has not been conclusively determined at present. Accordingly, the additional groundwater data acquired under this investigation will be used to help define whether remedial actions are needed, and if so, what the most feasible action(s) would be.

This FS field investigation and attendant FS report does not address OE characterization and clearance. Remedial measures for OE are recognized as an integral part of the overall remediation of WBG and must be coordinated with remedial measures addressing hazardous, toxic, and radioactive waste contamination to ensure safety of workers and the public. OE clearance will be addressed under a separate unexploded ordnance (UXO) Engineering Evaluation/Cost Analysis (EE/CA) to be prepared under the direction of the USACE. Additional information regarding remedial action objectives is presented in Section 3.5.

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. At this stage in the RI/FS process for WBG, a number of the primary and secondary decisions have been made. For example, the need for soil remedial actions has been identified. As noted previously, the data generated from this investigation, inclusive of the ecological risk assessment results, are necessary to determine what types of response actions are most appropriate for soils and groundwater at WBG and to allow as accurate an evaluation of remedial alternatives as possible.

3.2.5 Define the Study Boundaries

The investigation area boundary for WBG is that presented in Figure 1-3. This boundary was established in the Phase I and Phase II RI to encompass all known or reported historical burning operations, adjacent support areas, and potential surface water exit pathways.

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 Phase I and Phase II RIs provided sufficient data to characterize the nature and extent of contamination such that informed decisions can be made as to the need for, and appropriate types of, remedial responses. However, as noted above, certain data needs remain following the investigation in order to: (1) more fully evaluate potential ecological risk impacts, (2) refine vertical and lateral extent of contamination in selected source areas, and (3) investigate areas not thought to have been impacted by site operations (i.e., between burning pads) to verify absence of contamination. These data will be used to conduct revised screening risk assessment, develop ecological ROGs, and evaluate potential remedial alternatives.

3.2.7 Identify Inputs to the Decisions

Inputs to the decision process are the analytical results of this and previous investigations, human-health and ecological risk-assessment results, results of an ongoing biological measurements study, and refined CSM developed from the supplemental 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 sample design for the FS field investigation at WBG is described in detail in Chapter 4.0 of this SAP Addendum. Known source areas (former burn pads and burn pits) represent specific focus areas for soil sampling. Areas thought not to have been impacted by former operations will be assessed using a random statistical grid sampling approach (Gilbert 1987) as outlined in Section 3.2.9.2 of the Facility-wide SAP (see Chapter 4.0). A minimal number of sediment samples are planned along a ditch draining burn pads 59 and 60 and potentially acting as an exit pathway flowing north towards a wetland area and intermittent pond located north of Road E (Figure 1-2). Groundwater in areas not previously characterized is also targeted to obtain additional information on flow patterns. A minimal number of contingency samples are planned for suspected source areas or exit points identified during the field effort.

The selection of source areas requiring further lateral and vertical delineation of the extent of contamination in soils included those burn pits and pads having identified COCs at concentrations exceeding human-health risk-based criteria. Selected source areas having the highest concentrations of metals and/or explosives, or where Phase II RI results showed that contamination extended to the maximum depth of sampling, also were selected for further characterization of the vertical extent of contamination.

A summary of the selection criteria noted above and a list of those areas associated with each criteria are listed in Table 3-1.

Table 3-1. Selection Criteria for Areas Requiring Further Characterization at WBG

Criterion	Areas to be Sampled to Meet Criterion
Verification of absence of contamination between former operations areas (burn pads and pits).	Areas between and outside of burning pads and pits. (To be sampled using a random grid method.)
Source areas with identified human health COCs greater than a risk factor of 10^{-4} and a HI >3 and/or COPECs having a HQ >1000.	Pads 37, 38, 45, 58, 59, 60, 61, 62, 66, 67, and 68.
Characterization of vertical extent of contamination identified at depth in the Phase II RI.	Pads 37, 38, 45, 58, 59, 62, 66, 67, and 68.
Potential exit pathway.	Drainage ditch flowing north from pads 59 and 60 (2 sediment samples).

3.3 DATA EVALUATION METHODS

The methods for identifying AOC-related chemicals are described in the following sections. The data evaluation methods are consistent with those established for WBG in the Phase I and Phase II RIs (USACE 1998a and USACE 1999a). The general process for identifying AOC-related chemicals involves: initial data reduction, defining data aggregates, data quality assessment, and screening of data against statistical, background, and weight-of-evidence criteria. Analytical results are reported by the laboratory in electronic form and loaded into a database. Site data are extracted from the database so that only one result is used for each station and depth sampled. Quality control data such as sample splits and duplicates and laboratory re-analyses and dilutions will not be included in the determination of contaminant nature and extent or in the risk assessment. Samples rejected in the validation process also will be excluded. If it is found that a significant number of samples is rejected, the entire data set will be evaluated to determine if a representative data set exists without the rejected data. The percentage of rejected data will be presented in the data quality assessment section of the FS report.

3.3.1 Determination of AOC Chemical Background

The evaluation of data generated under this FS will not require determination of separate AOC-specific chemical background. Analytical results will be screened against facility-wide background values for RVAAP developed during preparation of the Phase II RI Report for WBG. The criteria as presented in the Phase II RI report have been reviewed by the USACE and Ohio EPA. This screening step will be used to determine if detected inorganics are site-related contaminants (SRCs) or if they are naturally occurring.

3.3.2 Definition of Aggregates

Data collected from WBG will be aggregated by environmental media (soil, sediment, surface water, and groundwater). Soil data will be aggregated by depth interval [surface soils from 0- to 0.3 meter (0- to 1- ft) below ground surface (bgs)] and subsurface soil greater than 0.3 m (1 ft bgs). Data will be evaluated on an AOC-wide scale. Summary statistics (i.e., minimum detect, maximum detect, frequency of detection, mean detect, and 95% upper confidence limit), will be developed for the entire data set generated under this investigation. Evaluation of the spatial distribution of contamination within each aggregate (surface soil, subsurface soil, sediment, and groundwater) will be conducted and include factors such as Phase I and II RI results, proximity to sources and surface and groundwater flow patterns within WBG.

3.3.3 Data Screening

Data screening prior to the risk evaluation will consist of four steps: (1) a data quality assessment, (2) frequency of detection screen, (3) background screening, and (4) screening of essential human nutrients. These screens will be used to identify SRCs. Evaluation of the nature and extent of all constituent identified as SRCs will performed. Those constituents identified as SRCs will be addressed in the ecological risk evaluation. Potential ecological risk can be associated with some constituents that would normally be screened out in the above steps (i.e., some essential nutrient compounds) if they are present at high enough concentration. Therefore, the ecological risk assessment may include additional constituents not identified as SRCs.

Data Quality Assessment Screen

A detailed assessment of the quality of the analytical results generated under this investigation will take place. Data that are rejected as a result of the data quality assessment will not be evaluated further in the screening process.

Frequency of Detection Screen

Each chemical within each environmental medium (aggregate) will be evaluated to determine its frequency of detection. Chemicals that are never detected will be eliminated as SRCs. For sample aggregations with greater than 20 samples and a frequency of detection of less than 5%, a weight-of-evidence approach will be used to determine if the chemical is an SRC. The magnitudes and locations (clustering) of the detected values will be evaluated. Additionally, the occurrence of the constituent in other environmental media will be considered as part of the weight of evidence. If the detected results for a chemical show no clustering, concentrations are not substantially elevated relative to the detection limit, and the constituent is not an SRC in another aggregate, it will be considered spurious and the chemical eliminated as an SRC.

Facility-Wide Background Screen for Inorganics

For each inorganic constituent passing the frequency of detection screen, concentrations will be screened against available naturally occurring background levels. If the maximum concentration of a constituent exceeds the background value, the constituent will be considered as an SRC. These background levels are presented in Tables 3-2 through 3-6 for surface soils, subsurface soils, sediment, surface water, and groundwater within the unconsolidated interval. If groundwater samples are collected from wells installed into bedrock, the RVAAP background values for this groundwater zone will be employed for data screening. Note that in the event a constituent was never detected in the background data set, its background level is assigned as zero. This process ensures that a particular chemical detected at WBG in a particular medium cannot be eliminated simply because the chemical was never detected in background. All detected organic compounds will be considered as SRCs, evaluated as to their nature and extent, and screened using the risk evaluation.

Essential Nutrient Screen

Chemicals that are considered as essential nutrients for human health (calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) will not be evaluated as SRCs, unless grossly elevated relative to background. These chemicals are an integral part of the country’s food supply and are often added to foods as supplements; thus, these constituents are not generally addressed as contaminants (EPA 1989 and 1995). Data on essential nutrients, however, will be used to evaluate the subsurface geochemistry. Certain essential nutrients can pose a risk if present in high enough concentrations; therefore, this screen will not apply to the ecological risk assessment.

3.4 DEVELOPMENT OF ECOLOGICAL RGOS FOR COPECS

3.4.1 Introduction

Ecological RGOs will be developed for soil and sediment and are intended to protect individuals and populations of ecological receptors at the WBG exposed to contaminants of potential ecological concern (COPECs). The RGOs to be presented for soil are based on exposure and toxicity analyses, and the RGOs for sediment are empirically derived benchmark concentrations. Site-specific field-observed effects data from an ongoing biological measurements study at WBG may be used to adjust soil RGOs so that the mathematically computed RGOs selected are not below background concentrations or concentrations at which no deleterious effects were detected.

3.4.2 Soil

Risk-based RGOs for soil will be calculated by methods similar to those used for ecological risk assessment. However, instead of calculating the potential for risk from dietary exposure to soil contaminants at the existing environmental concentrations, the method calculates the highest environmental concentration at which the risk from contaminants in soil is not harmful to individuals, ecological populations, or communities.

This RGO development will focus on selected soil COPECs identified in the screening ecological risk assessment. Exposure and toxicity parameters are described and documented in the following subsections.

3.4.2.1 Problem formulation

RGOs are intended to provide exposures that do not have significant adverse impacts on individuals and populations of ecological receptors at WBG sites. A conceptual model of exposure to soil contaminants at

Table 3-2. Ravenna Facility-wide Surface Soil (0 to 1 foot) Background (Inorganics Only)

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	STD	Dist.[b]	95% Upper Tolerance Limit[c]	Nonparametric 95% UTL[b]	99th Percentile[b]	Background Criteria
Aluminum (mg/kg)	11/11	4,920.00	17,700.00	10,700.00	4,045.85	N	22,100.00	—	—	17,700.00
Antimony (mg/kg)	0/11			0.32	0.03	O	—	—	—	0.96[c]
Arsenic (mg/kg)	11/11	7.00	15.40	10.50	2.59	L	20.20	—	—	15.40
Barium (mg/kg)	11/11	47.90	88.40	65.20	13.03	L	112.00	—	—	88.40
Beryllium (mg/kg)	0/11			0.25	0.06	O	—	—	—	0.88[c]
Cadmium (mg/kg)	0/11			0.32	0.03	O	—	—	—	0.00
Calcium (mg/kg)	11/11	238.00	15,800.00	4,300.00	4,583.63	L	97,300.00	—	—	15,800.00
Chromium (mg/kg)	11/11	6.30	17.40	12.10	4.30	N	24.20	—	—	17.40
Cobalt (mg/kg)	11/11	4.10	10.40	7.53	2.36	N	14.20	—	—	10.40
Copper (mg/kg)	11/11	9.10	17.70	11.50	2.22	X	—	17.70	—	17.70
Cyanide (mg/kg)	0/11			0.32	0.03	O	—	—	—	0.00
Iron (mg/kg)	11/11	10,000.00	23,100.00	17,200.00	3,697.96	N	27,600.00	—	—	23,100.00
Lead (mg/kg)	11/11	12.80	26.10	18.40	4.00	L	32.80	—	—	26.10
Magnesium (mg/kg)	11/11	1,140.00	3,030.00	1,970.00	604.42	L	4,410.00	—	—	3,030.00
Manganese (mg/kg)	11/11	147.00	1,450.00	638.00	349.99	L	3,050.00	—	—	1,450.00
Mercury (mg/kg)	7/11	0.03	0.04	0.04	0.02	X	—	0.16	—	0.04
Nickel (mg/kg)	10/11	9.00	21.10	13.60	4.41	L	29.40	—	—	21.10
Potassium (mg/kg)	11/11	303.00	927.00	621.00	176.64	N	1,120.00	—	—	927.00
Selenium (mg/kg)	2/11	0.69	1.40	0.45	0.33	D	—	—	1.40	1.40
Silver (mg/kg)	0/11			0.65	0.07	O	—	—	—	0.00
Sodium (mg/kg)	1/11	123.00	123.00	42.80	27.35	D	—	—	123.00	123.00
Thallium (mg/kg)	0/11			0.32	0.03	O	—	—	—	0.00
Vanadium (mg/kg)	11/11	9.10	31.10	19.00	7.74	N	40.80	—	—	31.10
Zinc (mg/kg)	11/11	38.40	61.80	51.20	8.38	N	74.80	—	—	61.80

[a] Results less than the detection limit were set to 1/2 the reported detection limit.

[b] Dist. Codes:
L = Distribution most similar to lognormal, use parametric UTL or max. detect.
N = Distribution most similar to normal, use parametric UTL or max. detect.
X = Distribution significantly different from normal and lognormal, use nonparametric UTL or max. detect.
D = Nonparametric distribution: frequency of detection <50%, use 99th percentile.
O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect, then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

[c] Subsurface antimony and beryllium background used.

Table 3-3. Ravenna Facility-wide Subsurface Soil (>1 foot) Background (Inorganics Only)

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	STD	Dist.[b]	95% Upper Tolerance Limit	Nonparametric 95% UTL[b]	99th Percentile[b]	Background Criteria
Aluminum (mg/kg)	27/27	1,380.00	19,500.00	11,600.00	4,917.52	N	22,900.00	—	—	19,500.00
Antimony (mg/kg)	8/27	0.27	0.96	0.34	0.14	D	—	—	0.96	0.96
Arsenic (mg/kg)	27/27	3.50	19.80	12.10	4.04	N	21.40	—	—	19.80
Barium (mg/kg)	27/27	10.70	134.00	58.60	28.68	N	124.00	—	—	124.00
Beryllium (mg/kg)	12/27	0.26	0.88	0.37	0.25	D	—	—	0.88	0.88
Cadmium (mg/kg)	0/27			0.29	0.01	O	—	—	—	0.00
Calcium (mg/kg)	22/27	416.00	35,500.00	4,880.00	9,339.26	L	44,800.00	—	—	35,500.00
Chromium (mg/kg)	27/27	4.10	27.20	16.90	6.24	N	31.30	—	—	27.20
Cobalt (mg/kg)	27/27	2.30	23.20	9.94	4.97	L	31.00	—	—	23.20
Copper (mg/kg)	27/27	2.90	32.30	19.50	6.34	N	34.10	—	—	32.30
Cyanide (mg/kg)	0/27			0.29	0.01	O	—	—	—	0.00
Iron (mg/kg)	27/27	3,690.00	35,200.00	23,200.00	7,299.72	N	39,900.00	—	—	35,200.00
Lead (mg/kg)	27/27	2.50	19.10	11.60	3.20	X	—	19.10	—	19.10
Magnesium (mg/kg)	27/27	216.00	8,790.00	3,350.00	2,054.14	X	—	8,790.00	—	8,790.00
Manganese (mg/kg)	27/27	107.00	3,030.00	400.00	551.13	X	—	3,030.00	—	3,030.00
Mercury (mg/kg)	4/27	0.03	0.04	0.04	0.02	D	—	—	0.12	0.04
Nickel (mg/kg)	27/27	3.80	60.70	23.60	12.01	L	76.10	—	—	60.70
Potassium (mg/kg)	27/27	333.00	3,560.00	1,520.00	798.94	N	3,350.00	—	—	3,350.00
Selenium (mg/kg)	8/27	0.61	1.50	0.49	0.34	D	—	—	1.50	1.50
Silver (mg/kg)	0/27			0.58	0.03	O	—	—	—	0.00
Sodium (mg/kg)	7/23	29.90	145.00	59.50	55.32	D	—	—	524.00	145.00
Thallium (mg/kg)	3/27	0.77	0.91	0.35	0.17	D	—	—	0.91	0.91
Vanadium (mg/kg)	27/27	5.20	37.60	19.70	7.90	N	37.80	—	—	37.60
Zinc (mg/kg)	27/27	7.60	93.30	60.50	17.18	N	99.90	—	—	93.30

[a] Results less than the detection limit were set to one-half the reported detection limit.

[b] Dist. Codes: L = Distribution most similar to lognormal, use parametric UTL or max. detect.
N = Distribution most similar to normal, use parametric UTL or max. detect.
X = Distribution significantly different from normal and lognormal, use nonparametric UTL or max. detect.
D = Nonparametric distribution: frequency of detection <50%, use 99th percentile.
O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

Table 3-4. Ravenna Facility-wide Sediment Background (Inorganics Only)

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	STD	Dist.[b]	95% Upper Tolerance Limit	Nonparametric 95% UTL[b]	99th Percentile[b]	Background Criteria
Aluminum (mg/kg)	7/7	1,710.00	13,900.00	6,430.00	4,801.40	L	75,900.00	—	—	13,900.00
Antimony (mg/kg)	0/7			0.48	0.18	O	—	—	—	0.00
Arsenic (mg/kg)	7/7	3.70	19.50	9.34	5.32	L	54.40	—	—	19.50
Barium (mg/kg)	7/7	15.20	123.00	62.00	46.05	N	219.00	—	—	123.00
Beryllium (mg/kg)	2/7	0.15	0.38	0.24	0.12	D	—	—	0.64	0.38
Cadmium (mg/kg)	0/7			0.48	0.18	O	—	—	—	0.00
Calcium (mg/kg)	5/7	920.00	5,510.00	2,320.00	2,117.85	L	50,300.00	—	—	5,510.00
Chromium (mg/kg)	7/7	2.60	18.10	8.99	6.19	L	91.50	—	—	18.10
Cobalt (mg/kg)	7/7	2.10	9.10	5.61	2.84	L	34.20	—	—	9.10
Copper (mg/kg)	7/7	2.50	27.60	12.40	9.27	L	198.00	—	—	27.60
Cyanide (mg/kg)	0/7			0.48	0.18	O	—	—	—	0.00
Iron (mg/kg)	7/7	5,170.00	28,200.00	15,500.00	9,328.75	L	123,000.00	—	—	28,200.00
Lead (mg/kg)	7/7	3.40	27.40	13.00	9.13	N	44.00	—	—	27.40
Magnesium (mg/kg)	7/7	434.00	2,760.00	1,450.00	854.43	L	11,200.00	—	—	2,760.00
Manganese (mg/kg)	7/7	154.00	1,950.00	694.00	636.28	L	12,100.00	—	—	1,950.00
Mercury (mg/kg)	2/7	0.04	0.06	0.07	0.03	D	—	—	0.28	0.06
Nickel (mg/kg)	5/7	4.00	17.70	9.00	5.48	L	68.20	—	—	17.70
Potassium (mg/kg)	7/7	195.00	1950.00	745.00	607.23	L	8,070.00	—	—	1,950.00
Selenium (mg/kg)	1/7	1.70	1.70	0.62	0.50	D	—	—	1.70	1.70
Silver (mg/kg)	0/7			0.96	0.37	O	—	—	—	0.00
Sodium (mg/kg)	4/7	22.40	112.00	56.80	34.01	L	923.00	—	—	112.00
Thallium (mg/kg)	1/7	0.89	0.89	0.56	0.23	D	—	—	1.50	0.89
Vanadium (mg/kg)	7/7	3.30	26.10	12.50	8.85	L	139.00	—	—	26.10
Zinc (mg/kg)	7/7	16.20	532.00	123.00	183.06	L	3,090.00	—	—	532.00

[a] Results less than the detection limit were set to one-half the reported detection limit.

[b] Dist. Codes: L = Distribution most similar to lognormal, use parametric UTL or max. detect.
N = Distribution most similar to Normal, use parametric UTL or max. detect.
X = Distribution significantly different from normal and lognormal, use nonparametric UTL or max. detect.
D = Nonparametric distribution: frequency of detection <50%, use 99th percentile or max. detect.
O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect, then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

Table 3-5. Ravenna Facility-wide Unconsolidated Zone Groundwater Background (Filtered Inorganics Only)

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Std. Dev.[a]	Distr.[b]	Parametric 95% UTL	Nonparametric 95% UTL or 99th Percentile[b]	Background Criteria[c]
Antimony	0/ 7			2.50	0.0	O	—	—	0.00
Arsenic	1/ 7	11.70	11.70	4.29	3.49	D	—	—	11.70
Barium	4/ 7	13.80	82.10	27.40	24.43	L	218.00	—	82.10
Beryllium	0/ 7			2.00	0.0	O	—	—	0.00
Cadmium	0/ 7			2.50	0.0	O	—	—	0.00
Calcium	7/ 7	15200.00	115000.00	78300.00	40269	N	215000.00	—	115000.00
Chromium	1/ 7	7.30	7.30	5.33	0.87	D	—	10.00	7.30
Cobalt	0/ 7			25.00	0.0	O	—	—	0.00
Copper	0/ 4			10.10	4.90	O	—	—	0.00
Cyanide (mg/L)	0/ 7			0.01	0.0	O	—	—	0.00
Iron	3/ 7	208.00	279.00	136.00	113.7	D	—	279.00	279.00
Lead	0/ 7			1.50	0.0	O	—	—	0.00
Magnesium	7/ 7	4900.00	43300.00	24500.00	15180	N	76100.00	—	43300.00
Manganese	6/ 7	273.00	1020.00	414.00	308.5	N	1460.00	—	1020.00
Mercury	0/ 7			0.10	0.0	O	—	—	0.00
Nickel	0/ 7			20.00	0.0	O	—	—	0.00
Potassium	7/ 7	726.00	2890.00	1640.00	213.6	L	7000.00	—	2890.00
Selenium	0/ 7			2.50	0.0	O	—	—	0.00
Silver	0/ 7			5.00	0.0	O	—	—	0.00
Sodium	7/ 7	2530.00	45700.00	17000.00	14794	L	305000.00	—	45700.00
Thallium	0/ 7			0.86	0.23	O	—	—	0.00
Vanadium	0/ 7			25.00	0.0	O	—	—	0.00
Zinc	2/ 7	41.40	60.90	26.20	19.12	D	—	60.90	60.90

[a] Results less than the detection limit were set to one-half the reported detection limit.

[b] Dist. Codes:
L = Distribution most similar to lognormal, use parametric UTL or max. detect.
N = Distribution most similar to normal, use parametric UTL or max. detect.
X = Distribution significantly different from normal and lognormal, use nonparametric UTL or max. detect.
D = Non-parametric distribution – frequency of detection <50%, use 99th percentile or max. detect.
O = Zero detects – background criteria set to 0.00.

[c] If 95% UTL >max. detect then background criteria = max. detect.
If distribution determined not normal or lognormal or fewer than 3 results then background criteria = max. detect.
Background criteria were set to zero if there were no detects.
NA - Not applicable. Background criteria were determined for metals only.

Table 3-6. Ravenna Facility-wide Unconsolidated Zone Groundwater Background (Unfiltered Inorganics Only)

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Std. Dev.[a]	Distr.[b]	Parametric 95% UTL	Nonparametric 95% UTL or 99th Percentile[b]	Background Criteria[c]
Aluminum	7/ 7	5180.00	48000.00	23100.00	105088.	N	74400.00	—	48000.00
Antimony	1/ 7	4.30	4.30	2.76	0.68	D	—	5.00	4.30
Arsenic	7/ 7	7.90	215.00	63.20	72.6	L	1760.00	—	215.00
Barium	7/ 7	59.60	327.00	164.00	90.9	L	1080.00	—	327.00
Beryllium	0/ 7			1.45	0.69	O	—	—	0.00
Cadmium	0/ 7			2.50	0.0	O	—	—	0.00
Calcium	7/ 7	17200.00	194000.00	100000.00	58152	N	298000.00	—	194000.00
Chromium	6/ 7	15.50	85.20	37.80	27.2	L	400.00	85.20	85.20
Cobalt	4/ 7	24.60	46.30	31.40	8.96	X	—	50.00	46.30
Copper	6/ 7	16.00	289.00	94.40	97.9	L	2050.00	—	289.00
Cyanide (mg/l)	0/ 7			0.01	0.0	O	—	—	0.00
Iron	7/ 7	10700.00	195000.00	73700.00	65818	L	1620000.00	—	195000.00
Lead	7/ 7	8.00	183.00	53.80	61.9	L	1460.00	—	183.00
Magnesium	7/ 7	14000.00	58400.00	35000.00	17887	L	195000.00	—	58400.00
Manganese	7/ 7	306.00	2860.00	1410.00	917	L	14700.00	—	2860.00
Mercury	4/ 7	0.08	0.25	0.12	0.06	L	0.69	—	0.25
Nickel	6/ 7	24.40	117.00	60.60	38.48	L	445.00	—	117.00
Potassium	7/ 7	2290.00	7480.00	5840.00	2137	X	—	7480.00	7480.00
Selenium	1/ 7	5.70	5.70	2.96	1.21	D	—	5.70	5.70
Silver	0/ 7			5.00	0.0	O	—	—	0.00
Sodium	7/ 7	4710.00	44700.00	18000.00	14090	L	205000.00	—	44700.00
Thallium	1/ 7	2.40	2.40	1.21	0.58	D	—	3.00	2.40
Vanadium	7/ 7	7.90	98.10	43.80	31.4	L	633.00	—	98.10
Zinc	5/ 7	131.00	888.00	306.00	307	L	4710.00	—	888.00

[a] Results less than the detection limit were set to one-half the reported detection limit.

[b] Dist. Codes: L = Distribution most similar to lognormal, use parametric UTL or max. detect.
N = Distribution most similar to normal, use parametric UTL or max. detect.
X = Distribution significantly different from normal and lognormal, use nonparametric UTL or max. detect.
D = Non-parametric distribution – frequency of detection <50%, use 99th percentile.
O = Zero detects – background criteria set to 0.00.

[c] If 95% UTL >max. detect then background criteria = max. detect.
If distribution determined not normal or lognormal or fewer than 3 results then background criteria = max. detect.
Background criteria were set to zero if there were no detects.

WBG will be used in the development of RGOs. This is the same model used in the Phase II RI for WBG. The various ecological receptors represent physiologically similar groups of biota that are exposed to contaminants by similar exposure routes and as a result of common dietary patterns. Plants and earthworms will be chosen as representatives of biota that are exposed continuously or nearly continuously to soil and are unable or unlikely to move out of the contaminated area in which they live. Eastern cottontail (*Sylvilagus floridanus*), meadow vole (*Microtus pennsylvanicus*), and white-tailed deer (*Odocoileus virginianus*) are chosen as herbivores or predominantly herbivorous receptors with various home ranges. Short-tailed shrew (*Blarina brevicauda*) and American robin (*Turdus migratorius*) are chosen as mid-level predators (i.e., carnivores with small home ranges preying predominantly on biota with small home ranges). Red fox (*Vulpes vulpes*) and red-tailed hawk (*Buteo jamaicensis*) represent top predators (i.e., carnivores with home ranges much larger than an individual pad at WBG).

Contaminant uptake by the receptors will be modeled by using dietary intake factors, calculated concentrations of contaminants in food, receptor body weights, and toxicity of COPECs to the receptors to derive a soil concentration of COPEC that does not cause toxic exposure. The facility-wide background concentration of a COPEC will be used as the RGO if the calculated RGO is below facility-wide background criteria as developed in the Phase II RI Report for WBG.

COPECs for soil were identified by the preliminary screen. The significant ones based on the screening level ecological risk assessment and in terms of high ecological effects quotient (EEQ) are:

- aluminum;
- cadmium;
- lead;
- thallium;
- zinc;
- 2,4,6-TNT;
- octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); and
- RDX.

3.4.2.2 Exposure factors

The dietary exposure of all animals depends on the amounts and types of food in their diets and on contaminant uptake rates by the food items. Published exposure factors (e.g., EPA 1993) for representative biota and uptake factors (e.g., Baes et al. 1984, HAZWRAP 1994, DOE 1996, Sample et al. 1998) will be used for the calculation of RGOs. There will be no reliance on bio-uptake factors from other sources. The fraction of total ingested substances coming from WBG will be assumed to be 1.0. This assumption will be made to ensure protection of biota with dietary exposures similar to those of the representative receptors but having smaller home ranges. Exposure factors used to calculate RGOs and bioaccumulation factors will be presented in the FS report.

3.4.2.3 Effects evaluation

One of the goals of remediation of the environment is to protect terrestrial ecosystems, communities, and populations. To do so, it is not necessary to protect individuals unless threatened or endangered species are to be protected. Therefore, it is not necessary to use an effects threshold that protects all individuals from adverse effects [no observed adverse effects level (NOAEL)]. Instead, it is reasonable to use the lowest exposure concentration that can reliably be shown to cause an adverse effect on individuals in the test population [lowest observed adverse effect level (LOAEL)]. Toxicity reference values (TRVs) used for derivation of RGOs for mammals and birds will be reported LOAEL values or estimated by multiplying chronic NOAEL values by 10. Because most plant and earthworm benchmarks are based on LOAELs

(Efroymson et al. 1997a, 1997b), those benchmarks were retained as thresholds for RGO development. Toxicity data for birds and mammals are found in Sample et al. (1996) or other published literature. Thresholds will be estimated for each receptor by applying allometric corrections for body size and food ingestion rates for mammals, as described by Opresko et al. (1995), but no such conversion will be made for birds.

3.4.2.4 Calculation of risk-based RGOs

Risk-based RGOs will be derived by three methods: (1) modeling of exposure to determine the highest soil concentration that will not cause the exposure threshold or NOAEL to be exceeded for each receptor shown to be at risk, (2) modeling of exposure to determine the highest soil concentration that will not cause the exposure threshold or LOAEL to be exceeded for each receptor shown to be at risk, and (3) determining the highest soil concentration of each COC in soil that does not exhibit toxicity in measurements of field-observed effects. Method 2 will obtain data from the ongoing biological measurements study at WBG.

3.4.2.5 RGOs from modeled risk

RGOs will be derived from modeled exposure and estimated toxicity thresholds by a rearrangement of the equation for EEQ. That equation is:

$$\text{EEQ} = \text{Csoil} \times (\text{IRp}\times\text{BAFp} + \text{IRa}\times\text{BAFa} + \text{IRs}) / \text{TRV} \times \text{BW},$$

where:

Csoil = concentration of COPEC in soil (mg/kg soil),
IRp = ingestion rate of plants used for food (kg/day),
BAFp = bioaccumulation factor for plants used as food (kg soil/kg plant),
IRa = ingestion rate of animals used for food (kg/day),
BAFa = bioaccumulation factor for animals used as food (kg soil/kg food),
IRs = ingestion rate of soil (kg/day),
TRV = toxicity reference value (mg/kgBW/day),
BW = body weight of the receptor (kg).

The RGO is the environmental concentration of contaminant at which the EEQ is 1, so the equation is rearranged to:

$$\text{RGO (mg/kg soil)} = (\text{TRV} \times \text{BW}) / (\text{IRp}\times\text{BAFp} + \text{IRa}\times\text{BAFa} + \text{IRs}).$$

Exposure factors for all receptors, the bioaccumulation factors for all plant and animal food types, and the TRVs for all COPECs and all receptors will be presented in the FS report. RGOs will be calculated for each receptor shown to be at risk; the lowest RGOs for each COPEC for the immobile primary producers and earthworms and for the more mobile biota will be analyzed further by a simple weight-of-evidence analysis. This simple weight-of-evidence analysis for the RGOs will be based on (1) representativeness of the contaminated soil used in toxicity tests, and (2) the fraction of the contaminant that is likely bioavailable at the site. Laboratory toxicity tests are typically done by adding solutions of the test chemicals to soil rather than by using soil that has undergone leaching and weathering so that contaminants are at equilibrium with other soil components. In addition, analysis of chemicals in soil involves destructive extraction of the soil that is likely not to give an accurate estimate of the concentrations of chemicals that are readily available for uptake by biota.

3.4.2.6 RGOs from site-specific field-observed effects

The calculated RGOs will depend on assumptions based on exposure data and literature toxicity data that will be used to model RGOs. Ambient toxicity tests for soil invertebrates and most vertebrates have not been performed. However, in an ongoing biological measurements study at WBG, field-observed toxic effects of WBG soil have been measured: the effects of contaminant exposure on liver weight and sperm count in small mammals and various vegetation metrics (biomass, percent cover, species richness, and species composition) will be evaluated and will be used to determine when the modeled RGO results may be either overly or insufficiently conservative for those receptors. If the maximum COPEC concentration in tested soil exceeds the modeled RGO, but no deleterious effects are found in animals and plants from the same area, it will be concluded that the site-specific field-observed effects are a better measure of toxicity and, therefore, a better basis for an RGO for plants and small mammals than the modeled results. Accordingly, if the highest concentration of a COPEC in tested soil exceeds the threshold for plants or the modeled RGO for small mammals, the site-specific concentration will, based on the Biological Measurement work, be the RGO.

3.4.2.7 Uncertainties

Uncertainties will be part of the future work on RGOs. It is anticipated that uncertainties will be identified and discussed for problem formulation, exposure factors, effects evaluation, and actual RGO computation. The nature, as well as the direction of uncertainty (overestimate and/or underestimate), will be estimated.

3.4.3 Development of Sediment RGOs

RGOs for sediment are based on the reasonable maximum exposure background concentrations and Effects Range-Low (ER-L) values presented by Long et al. (1995). ER-Ls were derived by ranking chemical concentrations in naturally occurring sediments that were shown to have adverse effects on benthic species and choosing the lowest 10th percentile concentration of each chemical (Long et al. 1995). Alternatively, any values the State of Ohio uses in lieu of ER-Ls will be utilized. No site-specific effects data have been collected for sediment at WBG as part of the biological measurements study; therefore, these RGOs will be based only on published data extrapolated to the WBG sediment.

Sediment COPECs and the corresponding ER-Ls are:

COPEC	ER-L (mg/kg)
• arsenic	8.2
• copper	34.0
• nickel	20.9
• benzo(a)anthracene	0.26
• benzo(a)pyrene	0.43
• chrysene	0.38
• fluoranthene	0.6
• phananthrene	0.24
• pyrene	0.67

ER-Ls have not been published for manganese, tin, and acetone. SAIC will rely on published information and not develop RGOs for these substances. Note that all HQs based on mathematical relationships and published in the WBG RI (USACE 1999a) hover around 1; therefore, risk may be considered small in the field. Further, impacts on aquatic habitats may need additional documentation per the Ohio administrative code.

3.4.4 Development of surface water RGOs

There is no need to develop RGOs for surface water because there were no COPECs demonstrated in the Phase II RI at WBG.

3.4.5 Summary

RGOs will be developed for selected soil and sediment COPECs at WBG. Published data will be used to calculate RGOs based on modeled uptake of contaminants by plants and animals used for food, food consumption rates, receptor body weights, and laboratory-observed toxicity of COPECs to the receptors. These RGOs will be conservative values and can be used with confidence that they protect ecological receptors. Site-specific soil and biological field-observed effects data will be used to modify calculated RGOs so that the RGOs for plants and mammals are (1) not below background, nor (2) below concentrations associated with no measured deleterious effects to field biota.

3.5 FEASIBILITY STUDY APPROACH

This section contains general information regarding the development of RGOs and the FS process to be employed to identify remedial technologies and assemble and evaluate remedial alternatives.

3.5.1 Remedial Goal Options

RGOs are media- and chemical-specific concentrations of identified COCs corresponding to acceptable levels of exposure under selected land use or exposure scenarios. The RGOs are used to identify and evaluate remedial technologies and alternatives that may be potentially employed to address unacceptable risk at an AOC. For WBG, RGOs will be identified by evaluating:

- results of the Baseline Human Health Risk Assessment;
- results of the Baseline Environmental Risk Assessment;
- results of predictive modeling; and
- applicable and relevant or appropriate requirements (ARARs)

Preliminary RGOs based on human health risk indices at the lower and upper ends of the CERCLA risk range are currently under development. The preliminary RGOs under development include those at the minimum risk/hazard indices (risk = 10^{-6} and HI = 0.1) and the maximum risk/hazard indices (risk = 10^{-4} and HI – 1.0) for three likely future land use (exposure) scenarios: (1) open industrial, (2) National Guard managed recreational, or (3) open residential. These preliminary human health risk-based RGOs at will be finalized in the FS for agreed-upon land use/exposure scenarios. Based on the additional characterization data obtained under the FS, RGOs based on ecological risk indices will be generated for inclusion in the FS. In addition, ARARs, which include statutory requirements, as well as U.S. Army policies, guidelines, or other requirements that apply to WBG, will also be developed and included in the FS. RGOs for OE are beyond the scope of this FS and will be addressed under a separate ordnance EE/CA. However, the presence of OE at WBG invokes numerous U.S. Army requirements for OE avoidance and clearance that must be integrated into the development and evaluation of remedial alternatives for Hazardous, Toxic, and Radioactive Waste contamination.

3.5.2 Screening of Process Options

The FS will develop general response actions that satisfy the RGOs developed in Section 3.5.1. The response actions, as required, will be media specific (soil, sediment, surface water, and groundwater) and will be designed, at a minimum, for the three most likely land use scenarios that have been identified; (1) open industrial, (2) National Guard managed recreational, or (3) open residential. General response actions that will be considered include:

- Treatment
- Containment
- Removal/Clearance
- Disposal
- Institutional Controls
- No Action

For each of the general response actions, the FS will identify potentially applicable technologies and process options by media and will screen the process options for technical implementability. This preliminary screening will be conducted based on factors observed at WBG that commonly influence technology selection such as type of contaminants present at the site (ordnance and explosives, organics, inorganics, etc.) and site constraints (groundwater depth, soil type, bedrock, etc.). Technology types and process options determined not to be feasible will be eliminated from further consideration. The FS will present the technical rationale for any technologies eliminated from further consideration. The FS will not screen technologies for OE clearance. However, OE clearance will be addressed in context of its schedule and cost impacts and requirements for coordination with remediation of chemical contamination.

The technology processes that are considered to be implementable will then be evaluated using the criteria specified in EPA 1988:

- Effectiveness
- Implementability
- Cost

The effectiveness evaluation will focus on the ability of a specific process option to handle the type and volume of media anticipated at WBG and the ability to treat specific contaminants to levels defined by the RGOs. The effectiveness evaluation will also evaluate potential impacts resulting from the use of the process option, and how proven and reliable the process option is.

The implementability evaluation encompasses both the technical and administrative feasibility of implementing a technology process. Process options will be evaluated based on factors such as permitting requirements; availability of treatment, storage, and disposal capacity; the availability of specialized equipment and personnel; and compatibility with possible UXO clearance technologies that would be implemented concurrently.

The evaluation of cost at the process option screening stage of the FS will be limited to a relative evaluation (high, medium, low) based on engineering judgement. Relative capital and operation and maintenance costs will be used at this stage of the FS. A more detailed cost estimate will be performed once process options are assembled into alternatives.

Based on the results of the effectiveness, implementability, and cost evaluation, a representative process option will be selected for each technology type.

3.5.3 Development of Alternatives

Once representative process options have been identified, a preliminary set of alternatives will be developed and assembled to meet remedial action objectives for each medium of interest (soil, sediment, surface water, and groundwater). Each alternative that is identified will address the site as a whole. The alternatives will include the No Action Alternative.

The FS will include a description of each alternative in sufficient detail as to allow evaluation and comparison to other alternatives on an equal basis. The alternative description will include details such as location of areas to be treated, contained, or excavated, material volumes by media, major components of treatment trains, or containment units, and methodology for dealing with treatment residuals or emissions. The alternative description will address the sequencing and relationship of UXO clearance or removal to remedial components that address chemical contamination.

During the assembly of alternatives, the process options will be further evaluated to ensure that they are technically compatible. Additional refinement of the alternative may be required at this stage to determine viability of a particular alternative. This may include refinement of waste volumes, process flow rates, or further definition of equipment.

3.5.4 Screening of Alternatives

Prior to conducting a detailed analysis of alternatives, the preliminary set of alternatives will undergo a screening to eliminate redundant alternatives or those determined to be less effective at achieving remedial action objectives. The alternatives will be developed in sufficient detail to allow screening of similar alternatives against the general criteria of effectiveness, implementability, and cost. Although the general criteria of effectiveness, implementability, and cost for screening process options are related to the criteria used in the detailed evaluation of alternatives, the evaluation is conducted at a higher level. The relationship between the preliminary screening criteria and detailed evaluation criteria is shown in Figure 3-1. The screening will evaluate both long-term and short-term impacts.

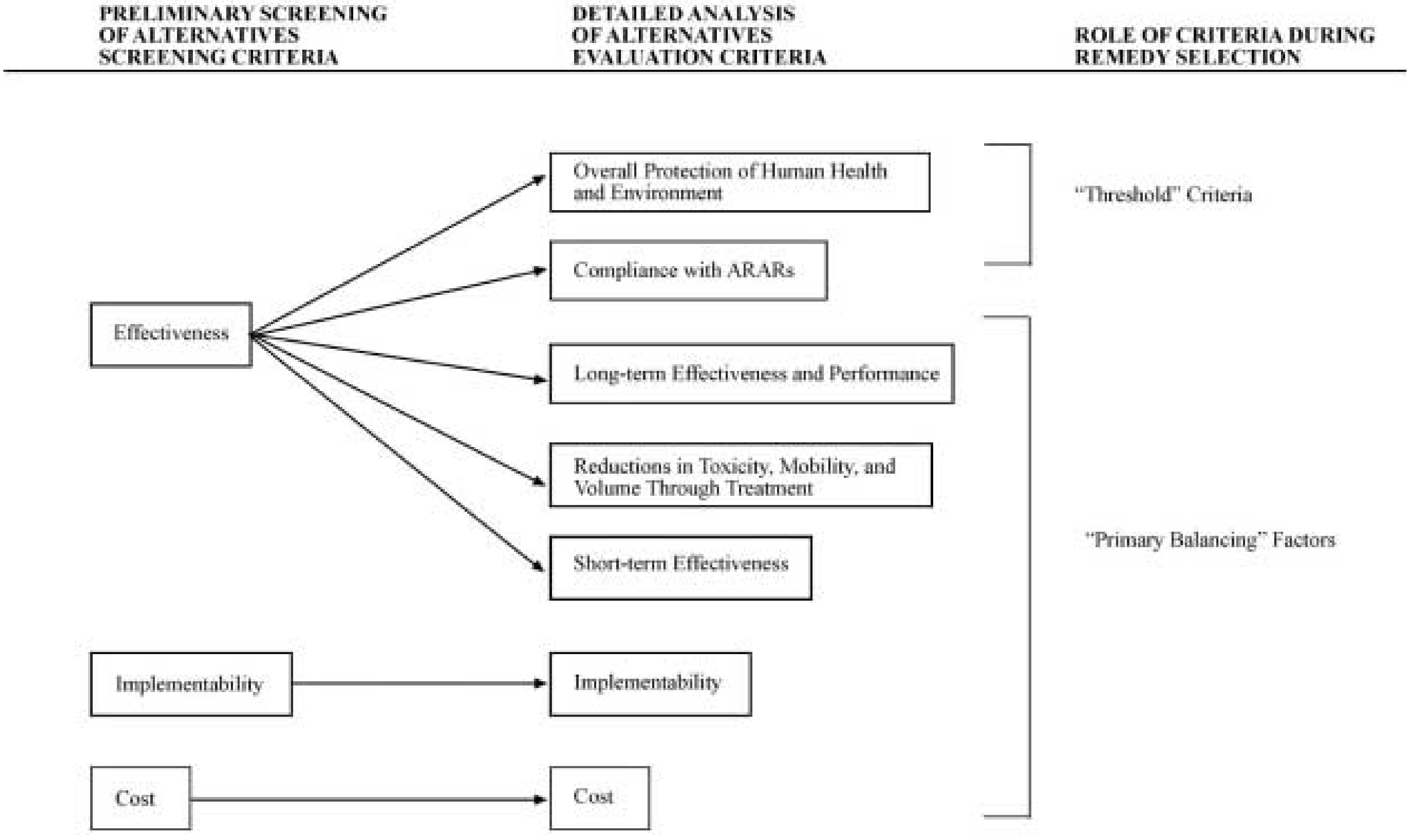
The WBG FS will carry the No Action Alternative and other technically feasible alternatives forward for detailed analysis. Where practicable, alternatives retained for detailed analysis will represent a range of treatment and containment technologies.

3.5.5 Detailed Analysis of Alternatives

The No Action Alternative and other selected alternatives will undergo a detailed analysis as described in EPA 1988. The detailed analysis will consist of comparing each of the retained alternatives against the following seven evaluation criteria:

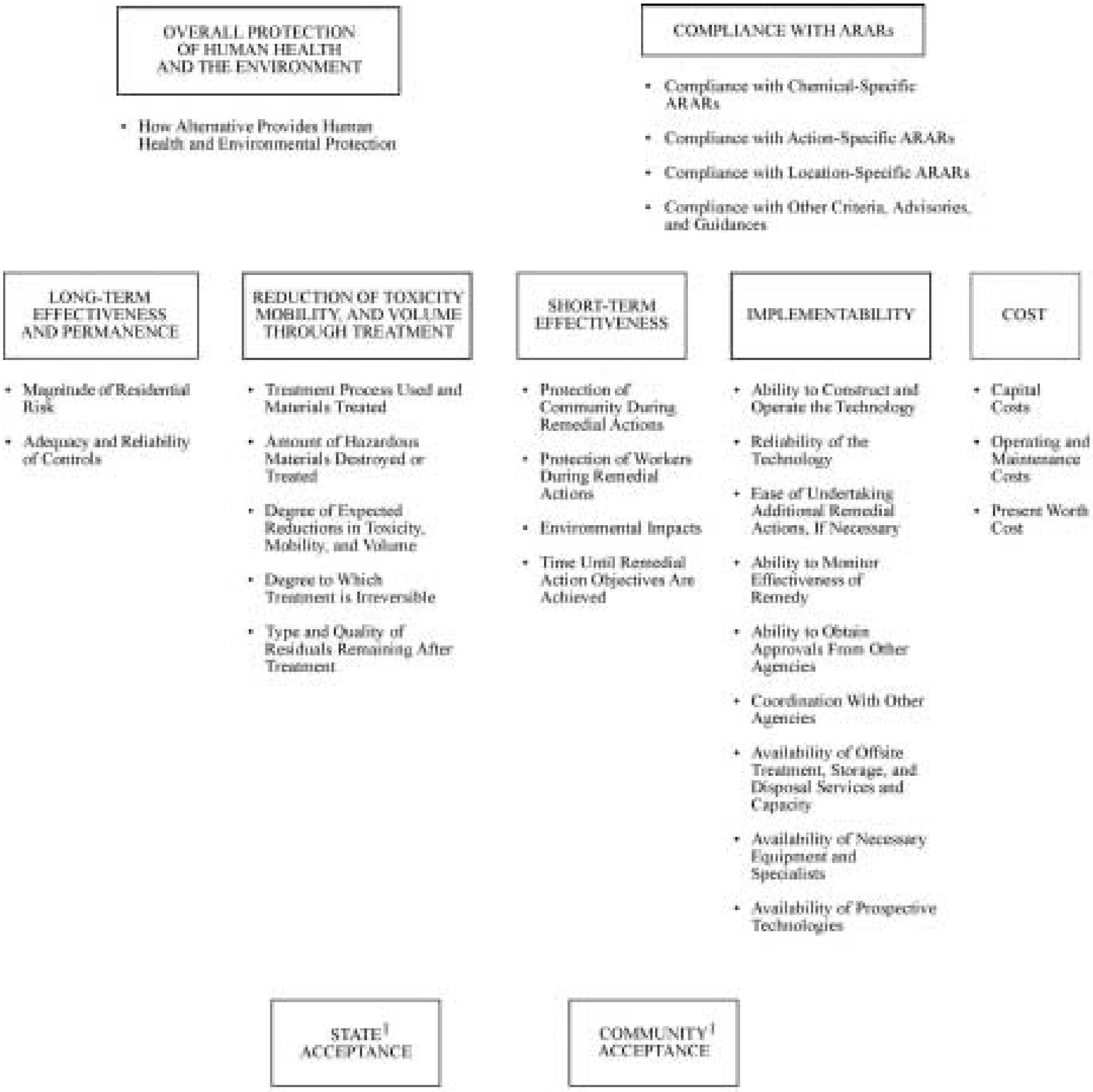
- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

The first two evaluation criteria above are considered threshold criteria that each alternative must satisfy to be eligible for selection. The last five criteria, known as balancing criteria, represent the technical criteria that will be considered during the detailed evaluation. Additional detail on factors that will be considered under each of the evaluation criteria is included in Figure 3-2. The evaluation will also identify basic assumptions associated with each alternative and any uncertainties that may affect implementation.



Source: EPA/540/G-89/004 1998

Figure 3-1. Relationship of Screening Criteria to Detailed Evaluation Criteria



OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

- How Alternative Provides Human Health and Environmental Protection

COMPLIANCE WITH ARARs

- Compliance with Chemical-Specific ARARs
- Compliance with Action-Specific ARARs
- Compliance with Location-Specific ARARs
- Compliance with Other Criteria, Advisories, and Guidances

LONG-TERM EFFECTIVENESS AND PERMANENCE

- Magnitude of Residential Risk
- Adequacy and Reliability of Controls

REDUCTION OF TOXICITY MOBILITY, AND VOLUME THROUGH TREATMENT

- Treatment Process Used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree of Expected Reductions in Toxicity, Mobility, and Volume
- Degree to Which Treatment is Irreversible
- Type and Quality of Residuals Remaining After Treatment

SHORT-TERM EFFECTIVENESS

- Protection of Community During Remedial Actions
- Protection of Workers During Remedial Actions
- Environmental Impacts
- Time Until Remedial Action Objectives Are Achieved

IMPLEMENTABILITY

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Actions, If Necessary
- Ability to Monitor Effectiveness of Remedy
- Ability to Obtain Approvals From Other Agencies
- Coordination With Other Agencies
- Availability of Offsite Treatment, Storage, and Disposal Services and Capacity
- Availability of Necessary Equipment and Specialists
- Availability of Prospective Technologies

COST

- Capital Costs
- Operating and Maintenance Costs
- Present Worth Cost

STATE[1] ACCEPTANCE

COMMUNITY[1] ACCEPTANCE

[1] These criteria are assessed following comment on the RI/FS report and the proposed plan.

Figure 3-2. Criteria for detailed analysis of alternatives

As specified in EPA guidance, two additional evaluation criteria, State Acceptance and Community Acceptance, are considered “Modifying” considerations and are assessed following completion of the FS.

Once the alternatives have been individually assessed against the evaluation criteria, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to other alternatives. The comparative analysis will describe the strengths and weaknesses of the alternatives relative to one another. The alternatives will then be ranked as to how they perform on each of the evaluation criteria.

4.0 FIELD ACTIVITIES

To organize and track sampling efforts for the WBG FS investigation, the AOC has been separated into eight functional areas based on the results of the Phase II RI and the planned sampling activities specified in the Scope of Work prepared by USACE. These functional areas include:

- Area 1 – Pads 58, 59, 60, and 61 surface and subsurface soils;
- Area 2 – Pads 37, 38, 45, 62, 66, 67, and 68 surface and subsurface soils;
- Area 3 – Pads 37, 38, 45, 58, 59, 62, 66, 67, and 68 point source soils where Phase I or II results showed the highest levels of explosives and/or metals (to be sampled using a geoprobe rig);
- Area 4 – Random grid surface soil points;
- Area 5 – Contingency soil (surface and subsurface) locations;
- Area 6 – Sediments along ditch line draining Pads 59 and 60;
- Area 7 – Existing groundwater monitoring wells; and
- Area 8 – New groundwater monitoring wells.

These functional areas along with a summary of the environmental matrices, number of sampling locations, and sampling rationale are listed in Table 4-1. The selection of these functional areas for biased sampling is based on the project DQOs and CSM described in Chapter 3.0.The sampling locations for each of the functional areas are shown on Figures 4-1 through 4-4, which are located at the end of this Chapter.

4.1 GROUNDWATER

4.1.1 Rationales

Limited hydrogeologic and analytical data exist for groundwater at WBG; therefore, an accurate assessment of flow patterns and contamination is not possible at present. Accordingly, the existing monitoring wells will be sampled and additional monitoring wells will be installed as part of the WBG FS investigation to further assess groundwater contamination and potential migration pathways. Groundwater characterization efforts include installation of monitoring wells immediately downgradient of pads identified as having residual contamination and along the eastern boundary of WBG to determine whether groundwater and potential contaminant transport is occurring off of the AOC.

4.1.1.1 Monitoring Well Locations and Installation

Eight new monitoring wells will be installed as a part of the FS investigation to monitor shallow groundwater at WBG (Figure 4-1). Table 4-1 describes the rationale for the placement of the monitoring wells. The proposed locations were selected on the basis of the project DQOs, the Phase II RI results, and the CSM

Table 4-1. WBG FS Sampling Rationale and Matrix

Investigation Area	Description	Chemicals of Potential Concern	Sampling Rationale	Sample Matrix				Applicable Figure Number
				Surface Soil/ Subsurface Station	Geoprobe Boring	Sediment Station	Monitoring Well Boring/ Groundwater Station	
Pad 58	Functional Areas 1 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II, especially outside the burning pads.	6	1			4-2
Pad 59	Functional Areas 1 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II, especially outside the burning pads.	6	1			4-2
Pad 60	Functional Area 1	Explosives, Metals	Identify contamination in and around berms.	6				4-2
Pad 61	Functional Area 1	Explosives, Metals	Identify contamination in and around berms.	6				4-2
Pad 37	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-3
Pad 38	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-3
Pad 45	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-2
Pad 62	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-2
Pad 66	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-3
Pad 67	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-3
Pad 68	Functional Areas 2 and 3	Explosives, Metals	Further define horizontal and vertical extent of contamination identified during Phase II investigation.	4	1			4-3
Random Grid	Functional Area 4	Explosives, Metals	Address potential contamination outside of the pads, but within the AOC.	30				4-4
Contingency Sample	Functional Area 5	Explosives, Metals	Identify possible contamination in soil.	6				NA

Table 4-1. (continued)

				Sample Matrix				
Investigation Area	**Description**	**Chemicals of Potential Concern**	**Sampling Rationale**	**Surface Soil/ Subsurface Station**	**Geoprobe Boring**	**Sediment Station**	**Monitoring Well Boring/ Groundwater Station**	**Applicable Figure Number**
Ditch Between Pad 59/60	Functional Area 6	Full Suite[a]	Investigate uncharacterized ditchline draining two of the more highly contaminated pads (59 and 60).			2		4-1
Existing Monitoring Wells	Functional Area 7	Full Suite[a]	Assist in characterizing the hydrogeology across the AOC.				9	4-1
New Monitoring Wells (SE of Pads 58, 45, 27, 2, 68, 38, 56, 26)	Functional Area 8	Full Suite[a]	Fully characterize the hydrogeology across the AOC, determine groundwater conditions immediately downgradient of pads having residual contamination, and monitor for potential migration of contamination off of the AOC.				8	4-1

[a] Full suite includes: explosives, propellants, Target Analyte List Metals (filtered for groundwater), volatile organic compounds, semivolatile organic compounds, pesticides/ polychlorinated biphenyls, and cyanide.

developed for WBG (Chapter 3). The new monitoring wells will be installed in association with the following pads:

- Pad 58
- Pad 45
- Pad 27
- Pad 2
- Pad 68
- Pad 38
- Pad 56
- Pad 26

Groundwater samples will be collected from each of the eight new monitoring wells, as well as from the nine existing monitoring wells. The individual samples identified, as well as the required chemical analyses, are provided in Chapter 5 in Table 5-2.

All monitoring wells will be installed using conventional drilling techniques (hollow-stem auger and air rotary, if required) as described in Section 4.1.2.1, and will be installed to screen across the top of the water table. Bedrock is not anticipated to be encountered. However, if encountered prior to intercepting the water table, the bedrock interval in each monitoring well borehole will be cored using NQ size conventional coring to characterize the bedrock lithology. It is anticipated that the depth to the water table will vary between 1.5 m (5 feet) and 5.5 m (18 feet) bgs, based on existing monitoring well information from Phase II RI and other previous studies. The maximum depth of each shallow monitoring well is expected to be ~ 9.0 m (25 feet) bgs or less. It is anticipated that the depth to bedrock will be greater than 15.1 m (50 feet).

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. Field measurement of pH, temperature, specific conductance, 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 groundwater sampling.

Filtered groundwater samples will be collected from each monitoring well and submitted for laboratory analysis of Target Analyte List (TAL) metals. Filtering will be performed in the field according to Section 4.3.5 of the Facility-wide SAP using in-line, 0.45-µm filters. Unfiltered groundwater samples will be collected and submitted for analysis of explosives, propellants, cyanide, SVOCs, VOCs, and pesticides. Table 5-2 in Chapter 5 provides the number of samples and the types of chemical analyses to be performed.

4.1.1.3 Quality Assurance (QA)/Quality Control (QC), and Blank Samples and Frequency

Field duplicate QC samples, USACE QA split samples, equipment rinsate samples, source water blanks, and trip blanks will be collected during the WBG FS investigation. Duplicates and QA splits will be selected randomly and analyzed for the same parameters as the environmental samples. Duplicate and QA split samples will be collected at a frequency of 10% of environmental samples. Equipment rinsate samples will be collected at a frequency of 5% of groundwater samples. Trip blanks will accompany shipment of all VOC groundwater samples and will be analyzed for VOCs only.

One source blank will be collected from the potable water source, which will be used for all potable wash and rinse water for equipment decontamination during the investigation. One source blank will also be collected from the deionized/distilled (ASTM Type I) water source used. The source blanks will be analyzed for the same constituents as the environmental samples.

4.1.2 Monitoring Well Installation

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

4.1.2.1 Drilling Methods and Equipment

4.1.2.1.1 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 in the WBG FS investigation.

4.1.2.1.2 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. It is anticipated that the third drilling scenario, described under Section 4.3.2.1.3, will be applicable for the installation of the monitoring wells to be drilled as part of the WBG FS investigation. Monitoring well boreholes will be drilled to sufficient depth to install the bottom of a 3-m (10-feet) well screen, ~2.1 m (7 feet) below the current water table elevation. It is anticipated that the depth to the water table will range from 1.5 m (5 ft) to 4.6 m (15 feet) below the ground surface, based on existing information. The maximum depth of each monitoring well is expected to be ~9.1 m (30 feet) below ground surface or less.

It is anticipated that the depth to bedrock will be greater than 15.1 m (50 feet). In the event that the groundwater monitoring wells must be installed in bedrock, NQ-size coring shall be performed in the bedrock interval prior to 10.2-cm (4-inch) diameter air-rotary drilling to install wells. The purpose of coring is to determine lithologies and the degree and nature of weathering and fracturing in bedrock. All rock cores will be stored in wooden boxes in such a manner as to preserve their relative positions by depth. Intervals of lost core shall be noted in the core sequence with wooden or styrofoam blocks. If there are multiple boxes, boxes will be marked on the outside to provide the boring number, cored interval, and box number. All cores collected during the investigation will be logged (including photographing the core after it has been properly placed and labeled in the core boxes) in accordance with Ohio EPA Technical Guidance for Hydrogeologic Investigations and Groundwater Monitoring (1995) and EM-1110-1-4000, Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites (USACE 1994b). The core will be stored at RVAAP unless otherwise directed by the USACE.

4.1.2.2 Materials

4.1.2.2.1 Casing/Screen

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

4.1.2.2.2 Filter Pack, Bentonite, and Grout

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

4.1.2.2.3 Surface Completion

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

4.1.2.2.4 Water Source

Potable water from a commercial source will be used during this investigation for monitoring well 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.

4.1.2.2.5 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 aboveground installations as presented in Section 4.3.2.3 of the Facility-wide SAP. Unconsolidated surficial material in each location will be drilled using a 16.5-cm (6.5-inch) inside diameter (I.D.) hollow-stem auger. Soil samples will be collected continuously from the surface to bedrock refusal or borehole termination, using a split-barrel sampler, for lithologic logging. If bedrock is encountered before borehole termination, the bedrock interval in a borehole will be drilled using air rotary with an NQ-size coring device as described in Section 4.1.2.1.2. Following coring, the core hole will be renamed to a minimum diameter of 6 inches using a tricone roller bit to ensure an adequate annular space.

4.1.2.4 Documentation

4.1.2.4.1 Logs and Well Installation Diagrams

4.1.2.4.1.1 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.

4.1.2.4.1.2 Well Construction Diagrams

All monitoring well activities will be documented according to the procedures presented in Section 4.3.2.4 of the Facility-wide SAP.

4.1.2.5 Well Abandonment

Any monitoring wells or boreholes abandoned during the WBG FS 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:

- the water is clear to the unaided eye (field turbidity measurements will be taken during development);
- the sediment thickness remaining in the well is less than 1% of the screen length or <30 mm (0.1 ft);
- a minimum of five times the standing water volume in the well has been removed (to include the well screen and casing plus saturated annulus, assuming 30% porosity); and
- indicator parameters (pH, temperature, and specific conductance) have stabilized to ±10% over three successive well volumes.

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 (Collection of Filtered Samples)

Groundwater sampling from monitoring wells will follow the procedures presented in Section 4.3.4 of the Facility-wide SAP.

4.1.4.1 Well Purging Methods

To minimize the quantity of liquid investigation-derived waste (IDW) generated as a result of well purging, wells will be micro-purged where conditions permit, in accordance with Ohio EPA technical guidance (OEPA 1995), as follows:

- a dedicated bladder or submersible pump is used for purging;
- the purge rate should not exceed 100 mL/min unless it can be shown that higher rates will not disturb the stagnant water column above the well screen (i.e., will not result in water level drawdown);

- the volume purged is either two pump and tubing volumes or a volume established through in-line monitoring and stabilization of water quality indicators such as dissolved oxygen and specific conductance;

- sample collection should occur immediately after purging.

Where micro-purging cannot be accomplished for any reason, then purging of all monitoring wells installed during the investigation will be conducted in accordance with procedures discussed in Section 4.3.4 of the Facility-wide SAP.

4.1.4.2 Filtration

When groundwater samples are collected for dissolved metals and micro-purging is utilized, the sample will be filtered using a disposable, pre-sterilized 0.45-µm pore size in-line filter that is attached to the end of the bladder pump's Teflon return line as detailed in Section 4.3.5 of the Facility-wide SAP. Immediately after collection of the sample and completion of bottle label information, each sample container will be placed into a sealable plastic bag and then will be placed in an ice-filled cooler to ensure preservation. The disposable filters used for collection of filtered groundwater samples will be discarded after each use.

Where micro-purging cannot be accomplished, then the sample for dissolved metals will be filtered by negative pressure using a hand-operated pump, collection flask, polytetrafluoroethylene tubing, and a presterilized, disposable 0.45-µm pore size filter assembly as discussed in Section 4.3.5 of the Facility-wide SAP.

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

Quality control samples for monitoring well groundwater sampling activities will include duplicates (QC) and split (QA) groundwater samples, equipment rinsates, source water blanks, and trip blanks as described in Sections 4.1.1.3 and 4.1.2.2.4. Split (QA) samples will be sent to the USACE contract laboratory for independent analyses: Environdata Group, ATTN: Bob King, 2520 Regency Road, Lexington, KY 40503, (800) 489-3506 or (800) 278-5665.

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.

4.1.8 In Situ Permeability Testing

A slug test will be performed in each of the new eight monitoring wells installed as part of the WBG FS 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. K is influenced by well construction.

The slug removal (rising head) test will be used for this investigation. If possible, the slug test will be performed in such a manner 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 a minimum of 12 hours has elapsed since sampling. The pressure transducer and decontaminated slug will be inserted into the well and the water level allowed to equilibrate to static conditions or until at least six hours have elapsed. A slug that displaces 0.3 m (1 foot) of water should be sufficient 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 m (0.01 foot) below top of casing. The total depth of the well will be measured with an electronic water level indicator and recorded to the nearest 0.003 m (0.01 ft) below top of 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.

To begin the 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 m (0.01 ft) and record them on a logarithmic scale. Water level change will be recorded for a period of six hours or until the well re-equilibrates to 90% of the pre-test water level, whichever occurs first.

The test data will be evaluated by the Bouwer and Rice method (1976, 1989) or the Cooper, et al. method (1967). If the test geometry is not conducive to analysis to either of these two methods, an alternate method will be used.

4.1.9 OE Anomaly Avoidance

SAIC will employ a qualified UXO subcontractor approved by the USACE Huntsville OE Mandatory Center of Excellence (MCX). The UXO subcontractor will employ Schonstedt Models GA-52 and GA-72 (or equivalent) magnetic locators for surface anomaly surveys, and a Schonstedt Model MG-220 magnetic gradiometer (or equivalent) for any downhole surveys. UXO technician support will be present during all field operations. The UXO Team Leader will train all field personnel to recognize and stay away from OE and propellants. Safety briefings for OE avoidance will be provided to all site personnel and visitors. All proposed well locations and access routes to both new and existing wells will be surveyed for potential OE and clearly defined prior to entry using visual and magnetometer surveys. Access routes will be at least twice as wide as the widest vehicle that will use the route. Any identified magnetic anomaly will be clearly marked and the anomaly will be avoided. The cleared approach paths shall be the only ingress/egress routes to the monitoring well. Hazardous, Toxic, and Radioactive Waste (HTRW) sampling personnel must be escorted by UXO personnel at all times in areas potentially contaminated with OE until the UXO team has completed the access surveys and the cleared areas are marked. Escorted HTRW sampling personnel will follow behind the UXO technician escort. If anomalies or OE are detected, the UXO technician will halt escorted personnel in place, select a course around the item, and instruct escorted personnel to follow. Downhole magnetometer surveys will be performed at 2-foot intervals to a depth of 4 feet or 2 feet below the top of native, undisturbed soil, whichever is greater. Should OE be discovered, the UXO team will not be tasked with the mission of disposal. In the event of UXO or bulk explosives discovery, the SAIC Field Operations Manager will contact the RVAAP Environmental Coordinator who will initiate the appropriate response actions. Specifically, these anomaly avoidance measures will be applied to existing wells WBG-mw-006 (Pad 67) and wells OBG-1, 2, 3, and 4 (Pad 37). These measures will also be applied to any and all other new or existing well locations at the discretion of the OE technical support staff and Site Health and Safety Officer. The locations of proposed wells will be placed adjacent to existing roads to the extent possible in order to further minimize the likelihood of encountering OE.

4.2 SUBSURFACE SOILS

4.2.1 Rationales

Subsurface soil samples will be collected during the WBG FS investigation to (1) define contaminant nature and extent in known areas of soil contamination, (2) provide sufficient data for remedial alternatives analysis, (3) determine if leaching processes may be contributing to groundwater contamination as described in the DQOs (Chapter 3, Section 3.2). To provide data regarding vertical distribution of contamination, subsurface soils samples will be collected to depths of 10 feet using Geoprobe equipment at the Phase I or II RI sample point exhibiting the highest degree of contamination (explosives or metals in absence of explosives contamination). Table 4-2 lists the planned Geoprobe locations along with their corresponding Phase I or II RI sample station and the rationale for selection.

Table 4-2. Rationale for Selection of WBG FS Geoprobe Locations

Pad #	FS Geoprobe Station	Corresponding Phase I or Phase II RI Sampling Station	Rationale
58	WBG-203	WBGss-114	Maximum observed metals: lead at 1020 mg/kg, mercury at 0.3 mg/kg, cadmium at 80 mg/kg.
59	WBG-210	WBGso-055	Maximum observed explosives (TNT at 33 mg/kg) and lead at 916 mg/kg.
37	WBG-227	WBGss-107	Maximum observed lead (1490 mg/kg), detected HMX, RDX, and TNT.
38	WBG-232	WBGss-034	Maximum observed lead (504 mg/kg) and cadmium (877 mg/kg). Trace levels of DNT.
45	WBG-237	WBGss-146	Maximum observed lead (2200 mg/kg), zinc (24,900 mg/kg), mercury (0.34 mg/kg), and cadmium (234 mg/kg).
62	WBG-242	WBGso-062	Maximum observed TNT (36 mg/kg), RDX (270 mg/kg), and HMX (38 mg/kg).
66	WBG-247	WBGss-069	Maximum observed TNT (3800 mg/kg) and TNB (76 mg/kg).
67	WBG-252	WBGss-071	Subsurface maximum observed HMX (14 mg/kg), RDX (82 mg/kg), TNT (26 mg/kg), and TNB (6.9 mg/kg).
68	WBG-257	WBGss-142	Maximum observed TNT (17 mg/kg) and mercury 1.2 mg/kg).

4.2.1.1 Soil Boring Locations

Subsurface soil samples will be collected at a total of 11 burning pads or pit. Subsurface soil samples will be collected from the following areas.

- Pad 37
- Pad 38
- Pad 45
- Pad 58
- Pad 59

- Pad 60
- Pad 61
- Pad 62
- Pad 66
- Pad 67
- Pad 68

At these locations, subsurface soil samples will be collected using hand augers, from the following intervals: 2 to 4 feet and 4 to 6 feet. At Pads 37, 38, 45, 58, 59, 62, 66, 67, and 68, subsurface soil samples will also be collected from one station using the Geoprobe rig at the following intervals: 0 to 1 foot, 2 to 4 feet, 4 to 6 feet, 6 to 8 feet, and 8 to 10 feet. In addition, up to four subsurface soil samples may also be collected at other contingency locations to be determined in the field based on results of field explosives analyses. Table 4-1 describes the rationale for the placement of individual soil sampling locations (see Section 4.2.1.3). The proposed locations were selected on the basis of DQOs, the Phase II RI results, and the CSM developed for WBG (Chapter 3) and are shown on Figures 4-2 and 4-3. The number of sample stations identified for each area are summarized on Table 4-1 and detailed in Chapter 5 (Table 5-1). The final sample locations will be marked in the field based on soil conditions and site access.

4.2.1.2 Discrete/Composite Soil Sampling Requirements

Subsurface soil samples will be collected during the WBG FS from each soil boring location using either hand augers or Geoprobe Rig. The subsurface sample will be a vertical composite extracted from soil that is homogenized over the depth interval. Subsurface samples will be collected in the approximate center of the three surface soil composite samples collected for explosives and/or propellant analyses (See Section 4.3). All VOC samples will be collected as discrete aliquots from the middle of the interval without homogenization. All remaining samples will be derived from homogenized soil collected by means of hand augers or hydraulic direct-push samplers (e.g., Geoprobe) over the depth interval. Soil will be collected over the depth interval, placed into a stainless steel pan or bowl, homogenized, and representative aliquots placed into sample containers in accordance with Section 4.4.2.5.2 of the Facility-wide SAP. The Geoprobe equipment used for subsurface sample collection will be a 5-cm (2-inch) outside-diameter macro-core sampling device, advanced using 2.54-cm (1-inch)-diameter steel rods attached to the hydraulic device and used in accordance with Section 4.4.2.1.5 of the Facility-wide SAP.

4.2.1.3 Sample Collection for Laboratory Analysis

All subsurface soil samples will be field screened for VOCs using a hand-held PID OVA during collection. No samples will be collected for headspace analysis of VOCs.

At the 11 burn pads, subsurface soil samples using a hand auger will be collected within the 2–4 and 4–6 ft depth ranges discussed in Section 4.2.1.1 as dictated by results of field colorimetric analysis for TNT and RDX. The purpose of this analysis is to define the vertical extent of contamination. Off-site laboratory analysis for explosive compounds will be performed where indicated by the field results or to confirm absence of field detectable explosives. The following strategy will be used:

- If the field method indicates TNT or RDX is present at >/= 1 ppm in the surface soil sample at a boring location, the boring will be deepened and subsurface soil samples from the next interval collected. These samples will be subjected to field analyses as noted in Section 4.2.2.2. In addition, a specified number (15%) of subsurface samples having no field detectable explosives will be collected and submitted to the laboratory for verification.

Subsurface soils will be collected at eight pads to depths of 10-feet using a Geoprobe rig. All of the samples will be submitted for field explosives analyses and samples submitted for fixed-base laboratory analysis as indicated above. The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area are provided on Table 5-1. All samples collected will be screened in the field for metals using X-ray fluorescence (XRF), and will be submitted for TAL metals analysis at the off-site laboratory regardless of the field result. The XRF screening analyses will include both in situ measurements taken at the ground surface at the sample station and ex situ measurements conducted in a field-based laboratory using a bench-top unit. Both the in situ and ex situ measurements will be made using Niton® instruments. The remaining chemical analysis to be performed on the subsurface soil samples is dependent on the requirements for each area to be sampled and may include VOCs, SVOCs, pesticides/PCBs, and cyanide. The types of chemical analyses and the number of samples to be analyzed for each area are provided on Table 5-1.

Requirements for sample containers and preservation techniques for subsurface soil samples are presented in Section 4.4.2.6 of the Facility-wide SAP and WBG FS Quality Assurance Project Plan (QAPP).

4.2.1.4 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.

4.2.1.5 Field Quality Control Sampling Procedures

Subsurface soil QA/QC samples will be collected during the WBG FS investigation. Duplicate (QC) and split (QA) soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Duplicates and split soil samples will both be collected at the same sample station along with the original sample. Split (QA) samples will be submitted to the following USACE contract laboratory for independent analysis: Environdata Group, ATTN: Bob King, 2520 Regency Road, Lexington, KY 40503, (800) 489-3506 or (800) 278-5665.

No source water or equipment rinsate blanks will be collected for subsurface soils. Chapter 8.0 of the WBG FS QAPP summarizes QA/QC sampling.

4.2.2 Procedures

4.2.2.1 Drilling Methods

For subsurface borings to depths of 2 to 6 feet, hand bucket augers will be used to collect soil samples in accordance with Section 4.5.2.5 of the Facility-wide SAP. For soil borings installed to depths of 8 to 10 feet, a truck-mounted direct-push (e.g., Geoprobe) will be used to sample the subsurface soils in accordance with Section 4.4.2.1.5 of the Facility-wide SAP. The Geoprobe will be used to advance the soil boring by attaching additional lengths of extension rod to the macro-core barrel sampling device and pushing the entire pipe downward to the target depth interval. The macro-core sampling device will then be retrieved and the soil sample will be collected. After the sample is collected, the Geoprobe will be used to advance the boring to the next depth interval.

4.2.2.1.1 Equipment Condition and Cleaning

Requirements for the condition and cleaning of equipment used for subsurface soil borings 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 soil borings during the WBG FS investigation.

4.2.2.2 Field Measurement Procedures and Criteria

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, except headspace gases will not be screened in the field for organic vapors. In addition, field screening methods will be used to make preliminary determinations of the concentrations of explosives (TNT and RDX) and metals in subsurface soils.

Colorimetric analysis of all subsurface soils for TNT and RDX will be performed following the field method presented in Appendix A of this SAP. The purpose of this analysis is to define the extent of contamination. Discrete subsurface soil samples will be collected at each soil boring location (where soil thickness is sufficient) and submitted for field colorimetric analysis of explosives. Off-site laboratory analysis for explosive compounds will also be performed. The following strategy will be used.

- If the concentration of TNT is >/= 1 ppm, based on field colorimetric analysis, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.

- If the concentration of TNT is <1ppm, the field colorimetric analysis for RDX will be performed.

- If the concentration of RDX is >/= 1 ppm with the field colorimetric method, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.

- 15% of all subsurface samples that show non-detects for explosives with the field method will also be sent to the off-site laboratory for confirmatory analysis.

In situ and ex situ XRF analysis of soils for metals will be performed by an approved subcontractor using procedures described in their QAPP. The purpose of the metals screening is to demonstrate the suitability of field-portable XRF spectrometry for performing real-time analysis of metals of comparable quality to laboratory analytical data. Therefore, all subsurface soil samples collected for field XRF determinations of metals will be sent to the off-site lab for corresponding TAL metals analysis regardless of the field XRF result.

Off-site laboratory analysis for cyanide, pesticides/PCBs, VOCs, and SVOCs will be performed according to Table 5-1, which summarizes the analytical parameters and methods that will be used during the WBG FS. Analytical laboratory methods, analytes, and procedures are further discussed in the QAPP.

4.2.2.3 Sampling for Geotechnical Analysis

Undisturbed subsurface soil samples will be collected from two of the eight new monitoring wells to be installed as part of the WBG FS investigation using a thin-walled (Shelby) tube sampler. Samples will be collected using this device as part of hollow-stem auger drilling of boreholes for monitoring well installation. Shelby tube sampling will proceed as discussed in Section 4.4.2.4.1 of the Facility-wide SAP.

The shelby tube samples will be collected from the 1.0 to 3.0 ft interval. Table 5.2 in Chapter 5 provides the specific number of geotechnical samples to be collected for each monitoring well boring by investigation area. All samples will be analyzed for dry unit weight, grain size distribution, moisture content, Atterburg limits, unified soil classification, total organic carbon, hydraulic conductivity, specific gravity, redox potential, and pH.

4.2.2.4 Sampling for Chemical Analysis

Procedures for sampling of subsurface soils for chemical analysis using the macro-core split-barrel sampler are presented in Section 4.4.2.5.1 of the Facility-wide SAP.

All subsurface soil samples will be analyzed for TAL metals. Subsurface soil samples will be analyzed for explosives and propellants based on field colorimetric results as discussed in Section 4.2.2.2. The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area is provide on Table 5-1. The remaining chemical analysis to be performed on the surface soil samples is dependent on the requirements for each area to be sampled. The type of chemical analyses and the number of samples to be analyzed for each area are provided on Table 5-1. In general, 10% of the subsurface soil samples collected will be also be analyzed for VOCs, SVOCs, pesticides/PCBs, and cyanide.

4.2.2.5 Sample Containers and Preservation

Requirements for sample containers and preservation techniques for subsurface soil samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the WBG FS QAPP.

Efforts will be made to ensure proper refrigeration of soil samples en route to the off-site laboratory via courier. Because of the short transit time between the field and the analytical laboratory for some samples (particularly those collected late in the day), it is not always possible for the containerized soils to reach 4° C before receipt at the laboratory. In the unlikely event of this occurrence, the sample manager will make a notation on the chain-of-custody form to document that the samples were packaged shortly before transit to the lab by the carrier.

4.2.2.6 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.

4.2.2.7 OE Anomaly Avoidance

SAIC will employ a qualified UXO subcontractor approved by the USACE Huntsville OE MCX. The UXO subcontractor will employ Schonstedt Models GA-52 and GA-72 (or equivalent) magnetic locators for surface anomaly surveys, and a Schonstedt Model MG-220 magnetic gradiometer (or equivalent) for any downhole surveys. UXO technician support will be present during all field operations. The UXO Team Leader will train all field personnel to recognize and stay away from propellants and OE. Safety briefings for OE avoidance will also be provided to all site personnel and site visitors. All sample locations and access routes into the soil sampling locations will be cleared for potential OE and clearly defined prior to entry using visual and magnetometer surveys. Access routes will be at least twice as wide as the widest vehicle that will use the route. The UXO technician will clearly mark the boundaries of the cleared soil sampling locations and access routes. If surface OE is encountered, the approach path will be diverted away from the OE, the area clearly marked, and the area will be avoided. Any identified magnetic anomaly will also be clearly marked and the anomaly will be avoided. The cleared approach paths will be the only ingress/egress routes to a particular sampling location.

HTRW sampling personnel must be escorted by UXO personnel at all times in areas potentially contaminated with OE until the UXO team has completed the access surveys and the cleared areas are marked. Escorted HTRW sampling personnel will follow behind the UXO technician escort. If anomalies or OE are detected, the UXO technician will halt escorted personnel in place, select a course around the item, and instruct escorted personnel to follow. Downhole magnetometer surveys will be performed at 2-foot intervals to a depth of 4 feet or 2 feet below the top of native, undisturbed soil, whichever is greater. Should OE be discovered, the UXO team will not be tasked with the mission of disposal. In the event of UXO or bulk explosives discovery, the SAIC Field Operations Manager will contact the RVAAP Environmental Coordinator who will initiate the appropriate response actions.

At Pads 58 and 59, a large amount of metal debris exists at the ground surface. Geoprobe boring locations at these pads will be cleared of surface debris by UXO technicians (5 × 5 ft area) to allow determination of an anomaly free area. The Geoprobe boring at Pad 67 is to be at the location that had the highest measured concentration of explosives, which is possibly an area containing raw explosives. Thus, the first sample (0 to 1 foot) will be collected using a hand-auger and performed by UXO technicians. All personnel will be kept at a distance of at least 600 feet from the pad during these activities. Once the sample stations have been cleared, the Geoprobe rig will be used for the remainder of the boring with anomaly avoidance practices. The UXO technicians responsible for the collection of soil samples will be required to participate in the Chemical Quality Control Preparatory Training and on-the-job training to ensure competency with sampling protocols. Chain-of-custody will be maintained at all times as designated in the QAPP.

4.3 SURFACE SOIL AND SEDIMENT

4.3.1 Rationales

Surface soil samples will be collected during the WBG FS investigation to (1) further define contaminant nature and extent of surface soil contamination, (2) investigate potential source areas not sampled in Phase II, and (3) provide sufficient data for remedial alternatives analysis. The soil sampling program will employ both biased (targeted to known hot spots) and statistical (random-grid) sampling to characterize not only the known problem areas but the spaces in between them. The sampling program also incorporates collection of sediments from an uncharacterized ditch draining two of the more highly contaminated pads identified during the Phase II RI (Pads 59 and 60).

4.3.1.1 Surface Soil Sampling Locations

Surface soil samples will be collected at a total of 64 locations from the 0- to 0.3-m (0- to 1-foot) interval. Of this total, six are contingency surface soil samples, which will be used to evaluate the horizontal extent of contaminated areas. Table 4-1 describes the rationale for the placement of surface soil sampling locations by sample area.

The proposed locations were selected on the basis of DQOs, the Phase II RI results, the CSM developed for WBG, and site observations. The proposed sampling locations are shown on Figures 4-2 and 4-3. The number of samples identified for each area, as well as the required chemical analyses, is provided in Table 5-1. The final sample locations will be marked in the field based on soil conditions, access considerations, visual survey of the area, and OE considerations.

Surface soil samples will be collected from the following areas:

- Pad 58
- Pad 59
- Pad 60
- Pad 61
- Pad 37

- Pad 38
- Pad 45
- Pad 62
- Pad 66
- Pad 67
- Pad 68

A biased surface soil sample will also be collected within a base soil area observed during the biological measurements study at Pad 32, which was shown in the Phase II RI to have a high ecological HQ value due to aluminum. In addition to the biased surface soil sampling within the areas described above, 30 random-grid samples will be collected at WBG following Section 3.2.9.2 of the Facility-wide SAP (Figure 4-4). The objective of random-grid sampling is to characterize areas between the pads and burn pits that were identified as contaminated in the Phase II RI, as well as areas outside the functional area of the AOC. This sampling approach will be used to confirm that no contamination in soils associated with WBG has been overlooked in the RI. Random sample points were assigned to 30 exposure units encompassing WBG. A restriction was placed on the assignment of sample.

As noted previously, contingency surface soil samples will be used to characterize any additional identified areas exhibiting obvious visual evidence of contamination. The rationale for locating contingency surface soil samples is to target areas of obvious staining or discoloration, evidence of OE, or areas in which additional sampling is deemed necessary based on field observations. If field testing indicates no explosives are present, no further sampling will be performed in that area. However, if colorimetry shows explosives >/= 1 ppm (TNT or RDX), then subsurface soil sampling (Section 4.2.1.1) will be performed as needed to determine vertical extent at one location. Additional surface soil contingency samples may also be located progressively outward from the identified contamination. Table 4-1 provides the rationale for the placement of individual sampling points.

4.3.1.2 Sediment Sampling Locations

Sediment samples will be collected from only two locations during the WBG FS investigation. The samples will be collected from the drainage ditch located between Pads 59 and 60 from the 0- to 0.15-m (0- to 0.5-foot) interval (Figure 4-1). The first sample will be collected adjacent to the north side of Road E and the second where the drainage ditch enters the small pond to the north. Table 4-1 describes the rationale for the placement of individual sediment sampling locations. The proposed locations were selected on the basis of DQOs, the Phase II RI results, and the CSM developed for WBG (Chapter 3). The required chemical analyses is provided in Chapter 5 in Table 5-1. The final sample locations will be marked in the field based on soil conditions and site access.

4.3.1.3 Discrete/Composite Soil and Sediment Sampling Requirements

All surface soil [0 to 0.3 m (0 to 1 foot)] and dry ditch sediment samples [0 to 0.15 m (0 to 0.5 ft)] collected using a hand-bucket auger to be analyzed for explosives and propellants will be composited and homogenized from three subsamples collected about 0.9 m (3 feet) from one another in a roughly equilateral triangle pattern. Each subsample will be augered to a depth of 30.48 cm (1.0 foot). Equal portions of soil from each of the subsamples will be homogenized in a stainless steel bowl following protocols in Section 4.5.2.5 of the Facility-wide SAP. Aliquots for explosives and propellant analyses will be extracted from the homogenized mixture. Once the subsamples are composited, a portion will be analyzed with the colorimetry method described in Appendix A, and another portion will be sent for laboratory analysis as described in Section 4.3.1.4.

A point located at the approximate center of the triangle will be selected for the collection of the remaining samples. Aliquots for VOC analyses will be collected at the center of the interval [15.24 cm (0.5 ft)] immediately upon extraction from the boring. No VOC sample will be collected from homogenized or composited soil sample volumes. Surface soils to be analyzed for metals, cyanide, SVOCs, and pesticides/PCBs will then be collected, placed in a stainless steel bowl, and homogenized. Sample volumes will be taken from the approximate center of the (0 to 1-ft) interval unless a zone of obvious contamination is observed.

The sediment samples will be collected as discrete samples. Sediments from the surface water basins will be collected using a stainless steel trowel or spoon, hand auger, or sediment coring device, where necessary. Sediment samples will be collected from downstream locations first and moving upstream relative to overall flow patterns. Sediment samples will not be collected from areas exhibiting turbid or rapid flow.

Surface soil samples collected from a station to be sampled with a Geoprobe rig will not be composited from three subsample points; rather, these samples will be collected from 0 to 1 foot bgs, homogenized, over the interval and aliquots submitted for analysis.

4.3.1.4 Sample Collection for Field and Laboratory Analysis

All surface soil and sediment samples will be field screened for VOCs using a hand-held PID OVA during collection. No samples will be collected for headspace analysis of VOCs.

All surface soil will be subject to field colorimetric analysis for TNT and RDX. The purpose of this analysis is to define the extent of contamination. Off-site laboratory analysis for explosive compounds will also be performed. The following strategy will be used.

- If the field method indicates TNT is present at >/= 1 ppm, the composite sample will be sent to the off-site laboratory for analysis of explosives and propellants.
- If the concentration of TNT is <1ppm, the analysis for RDX will be performed.
- If RDX is present at concentrations >/= 1 ppm, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.
- In addition, 15% of the samples showing non-detects of TNT or RDX will be sent to the off-site laboratory for analysis of explosives and propellants.

All samples collected will be screened in the field for metals using XRF, and will be submitted for TAL metals analysis at the off-site laboratory regardless of the field result. However, the contract capacity for analyses as defined in Table 5-1 will not be exceeded.

Disturbed geotechnical samples will only be collected at the two sediment locations. These samples will be analyzed for grain-size distribution, USCS classification, Atterberg Limits, moisture content, and total organic carbon. Geotechnical logging will be performed for all samples including estimates of USCS classification.

4.3.1.5 Field Quality Control Sampling Procedures

Surface soil/sediment QA/QC samples will be collected during the WBG FS investigation. Duplicate (QC) and split (QA) soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE contract laboratory for independent analysis, as denoted in Section

4.2.1.5. Duplicate and split samples will be selected on a random statistical basis and submitted for the same analyses as the environmental samples. Duplicates and splits will both be collected at the same sample station along with the original sample. No field or rinsate blanks will be collected for surface soils/sediments. Chapter 8.0 of the QAPP summarizes QA/QC sampling.

4.3.2 Procedures

4.3.2.1 Sampling Methods for Soil/Dry Sediments

4.3.2.1.1 Bucket Hand Auger Method

Surface soil and dry sediment samples will be collected with a bucket hand auger in accordance with Section 4.5.2.5 of the Facility-wide SAP. In this investigation, auger buckets 15.24 cm (6.0 inch) in length and 7.62 cm (3.0 inch) in diameter will be used. At each location, an auger will be advanced in 15.24-cm (6.0-inch) increments. As noted in Section 4.3.1.3, composite surface soil or dry sediment samples for explosives and propellant analyses will be created from three subsamples collected in a roughly equilateral triangle pattern with the subsamples positioned about 0.9 m (3 feet) apart from each other. The remaining analyte fraction will be collected from a point in the middle of the triangle formed by the three subsamples, with the volatile fraction collected first from unhomogenized material. At proposed Geoprobe sampling locations, the samples planned for the 0–1 foot interval will be collected using a bucket hand auger from a single point; composite samples will not be collected.

4.3.2.1.2 Trowel/Scoop Method

A stainless steel trowel or scoop may be used, as presented in Section 4.5.2.1.2 of the Facility-wide SAP, to collect surface soil or dry sediment samples in soft, loose soil, if feasible. The protocol for compositing, homogenization, and discrete VOC sample collection will follow that described in Section 4.3.2.1.1 for bucket hand augers.

The trowel will be used to manually obtain soil to a depth of 30.38 cm (1.0 foot) bgs or dry sediment to a depth of 15.24 cm (0.5 foot) bgs. Extracted material will be placed into a stainless steel bowl. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first materials obtained.

4.3.2.2 Sampling Methods for Subaqueous Sediments from Streams and Surface Water Basins

4.3.2.2.1 Trowel/Scoop Method

Sediment samples in locations where water depth does not exceed 15.24 cm (0.5 foot) will be collected with a stainless steel trowel or scoop. The trowel will be used to manually obtain sediment to a depth of 15.2 cm (0.5 foot) below the sediment surface. Sediment will be placed into a stainless steel bowl as it is collected. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first sediment obtained. Sample containers for the remaining nonvolatile analytes will be filled as described in Section 4.5.2.5 of the Facility-wide SAP.

4.3.2.2.2 Hand Core Sampler Method

A sediment core sampler will be used to collect sediment at locations where the depth of the surface water exceeds 15.24 cm (0.5 foot). All samples collected with the sludge sampler will be obtained following the guidelines presented in Section 4.5.2.5 of the Facility-wide SAP. The sludge sampler consists of a stainless steel, 8.26-cm (3.25-in.) outside diameter, 30.48-cm (12-in.) long capped tube, which can be fitted with either an auger- or core-type sampler end. Each sampler end is equipped with a butterfly valve to prevent loss of sample upon retrieval. In this investigation, the core-type end will be preferentially used. The auger-type sampler end will be used only in the event that the sediment becomes too gravelly or consolidated for the efficient use of the core type-end. The sludge sampler will be extended to the sampling depth by connecting 60.96-, 91.44-, 121.92-, or 152.40-cm (2-, 3-, 4-, or 5-foot) stainless steel extension rods to the sampler. The extension rods will be attached to a cross handle and will be pushed or augered by hand.

Sediment will be placed into a stainless steel bowl as it is collected. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first sediment obtained. Sample containers for the remaining nonvolatile analytes will be filled as described in Section 4.5.2.5 of the Facility-wide SAP.

4.3.2.3 Field Measurement Procedures and Criteria

4.3.2.3.1 Field determinations of explosive and metals

Colorimetric analysis of surface soils and sediment for TNT and RDX, discussed in detail in Section 4.3.1.4, will be performed following the field method presented in Appendix A of this SAP. One composite soil sample will be collected from each of the surface soil/sediment boring locations and submitted for field colorimetric analysis of explosives.

XRF analysis of surface soils and sediment for metals will be performed according to the field procedures established by the subcontracted field laboratory. One discrete soil sample will be collected from each of the sampling locations and submitted for XRF analysis of metals.

Table 5-1 summarizes the analytical parameters and methods that will be used during the WBG FS investigation. Analytical laboratory methods, analytes, and procedures are further discussed in the QAPP.

4.3.2.3.2 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. Because there were no notable detections of VOCs during the Phase II RI soil sampling, organic vapor monitoring of headspace gases is not necessary for this investigation. All OVA readings will be noted in the field boring logs.

4.3.2.4 Sampling for Geotechnical Analysis

Surface soil samples collected using the hand auger, scoop, or sediment corer methods are classified as disturbed samples. Therefore, geotechnical analysis of samples collected using these methods will be limited. Only sediment samples will be submitted for geotechnical analysis for grain size distribution, USCS classification, moisture content, Atterberg Limits, and total organic carbon (Table 5-1). Procedures for sampling for geotechnical analysis using the above sampling methods are presented in Section 4.5.2.4 of the Facility-wide SAP.

4.3.2.5 Sampling for Chemical Analysis

Procedures for sampling of surface soils and sediment for chemical analysis using the Bucket Hand Auger/Trowel and Hand Core Sampler Methods are presented in Sections 4.5.2.1.1, 4.5.2.1.2, and 4.5.2.2.2 of the Facility-wide SAP. Sediment samples will be analyzed for explosives, TAL metals, VOCs, SVOCs, pesticides/PCBs, cyanide, and total organic carbon. All of the sediment samples will be analyzed for propellants. Table 5-2 provides a summary of the chemical analyses for this media by area.

All surface soil samples will be analyzed for TAL metals. Surface soil samples will be analyzed for explosives and propellants based on field colorimetric results as discussed in Section 4.3.1.5. The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area are provided on Table 5-1. The remaining chemical analysis to be performed on the surface soil samples is dependent on the requirements for each area to be sampled. The type of chemical analyses and the number of samples to analyzed for each area are provided on Table 5-1. In general, 10% of the surface soil samples collected will be also be analyzed for VOCs, SVOCs, Pesticides/PCBs, and cyanide.

Requirements for sample containers and preservation techniques for surface soil and sediment samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the WBG FS QAPP.

4.3.2.6 Decontamination Procedures

The decontamination procedure for surface soil and sediment sampling activities is presented in Section 4.4.2.8 of the Facility-wide SAP.

4.3.2.7 OE Anomaly Avoidance

SAIC will employ a qualified UXO subcontractor approved by the USACE Huntsville OE MCX. The UXO subcontractor will employ a Schonstedt Models GA-52 and GA-72 (or equivalent) magnetic locators for surface anomaly surveys, and a Schonstedt Model MG-220 magnetic gradiometer (or equivalent) for any downhole surveys. UXO technician support will be present during all field operations. The UXO Team Leader will train all field personnel to recognize and stay away from propellants and OE. Safety briefings for OE avoidance will also be provided to all site personnel and site visitors. All sample locations and access routes into the soil sampling locations will be cleared for potential OE and clearly defined prior to entry using visual and magnetometer surveys. Access routes will be at least twice as wide as the widest vehicle that will use the route. The UXO Technician will clearly mark the boundaries of the cleared soil sampling locations and access routes. If surface OE is encountered, the approach path will be diverted away from the OE, the area clearly marked, and the area will be avoided. Any identified magnetic anomaly will also be clearly marked and the anomaly will be avoided . The cleared approach paths will be the only ingress/egress routes to a particular sampling location.

HTRW sampling personnel must be escorted by UXO personnel at all times in areas potentially contaminated with OE until the UXO team has completed the access surveys and the cleared areas are marked. Escorted HTRW sampling personnel will follow behind the UXO technician escort. If anomalies or OE are detected, the UXO technician will halt escorted personnel in place, select a course around the item, and instruct escorted personnel to follow. Downhole magnetometer surveys will be performed at 2-foot intervals to a depth of 4 feet or 2 feet below the top of native, undisturbed soil, whichever is greater. Should OE be discovered, the UXO team will not be tasked with the mission of disposal. In the event of UXO or bulk explosives discovery, the SAIC Field Operations Manager will contact the RVAAP Environmental Coordinator who will initiate the appropriate response actions.

As indicated in Section 4.2.2.7, special precautions regarding anomaly avoidance will be required at Pads 58, 59, and 67.

4.4 SITE SURVEY

4.4.1 Sample Station Survey

Following sampling and well installation activities, the horizontal coordinates of all sampling stations will be determined to within 0.3 m (1 foot). The surface elevations will be determined to within 0.06 m (0.2 foot). For soil sampling stations, the ground elevations will be determined at the point of collection. For sediment sampling stations that are not underwater (i.e., adjacent to the water edge), the ground elevation at the water's edge at the collection point will be determined. For sediment sampling stations underwater, the elevation of the water surface, depth to bottom, and elevation of the bottom will be determined. For groundwater monitoring wells, the horizontal and vertical coordinates will be determined in accordance with the current Facility-wide SAP, which requires 1.0 feet horizontally and 0.01 feet vertical accuracy.

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.

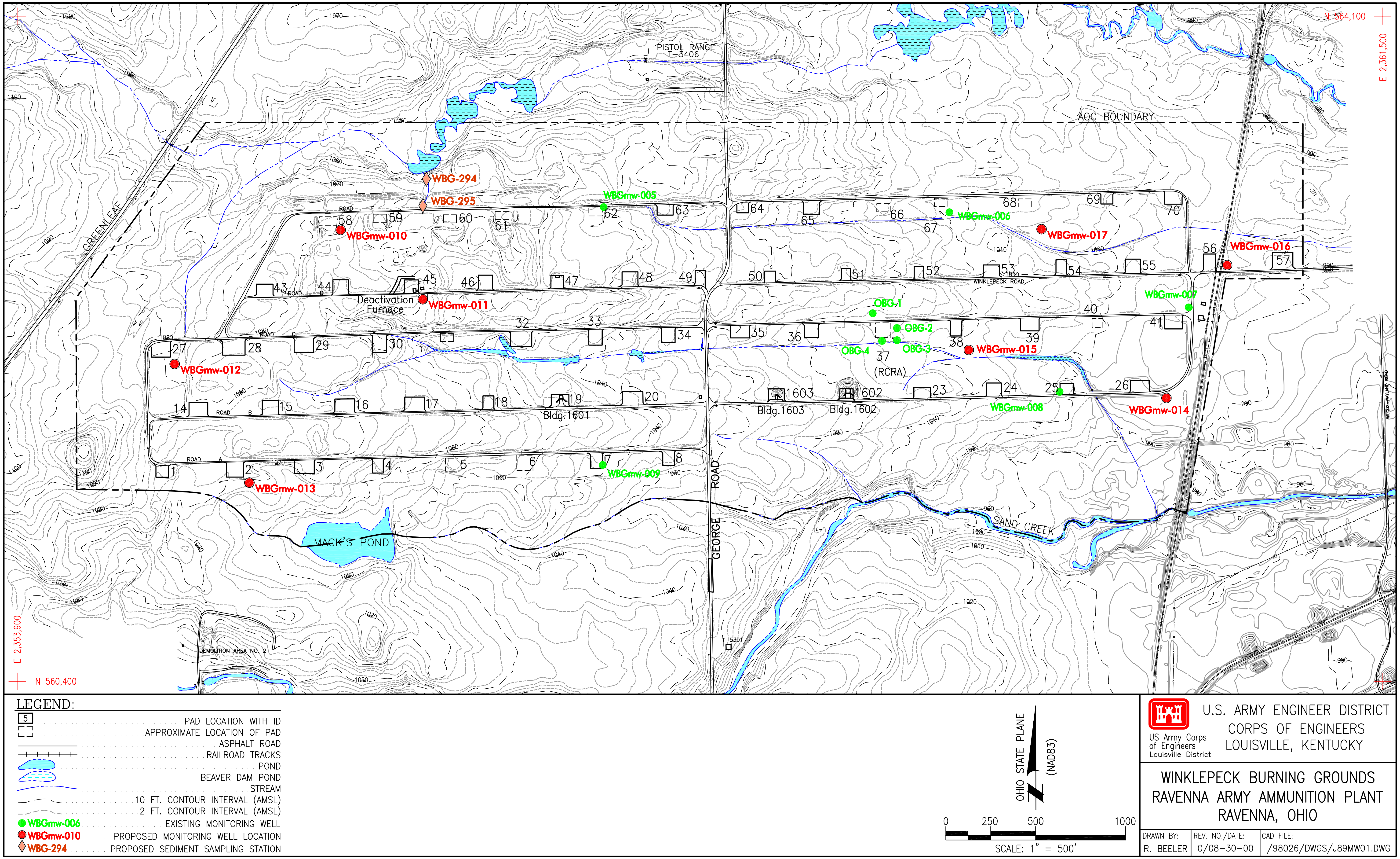


Figure 4-1. Monitoring Well and Sediment Sampling Locations

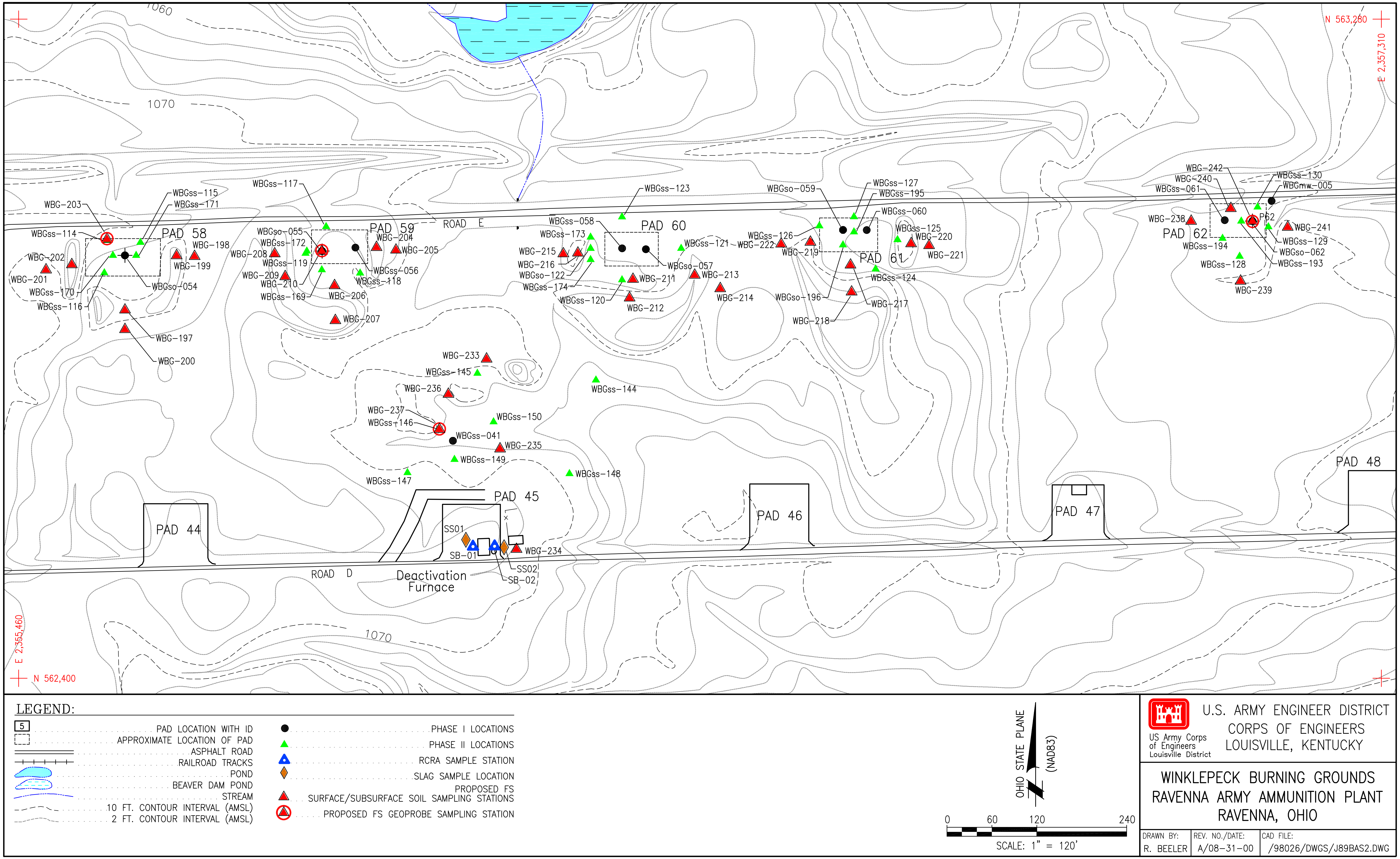


Figure 4-2. Surface and Subsurface Soil Sampling Locations for Pads 45, 58, 59, 60, 60, 61 and 62

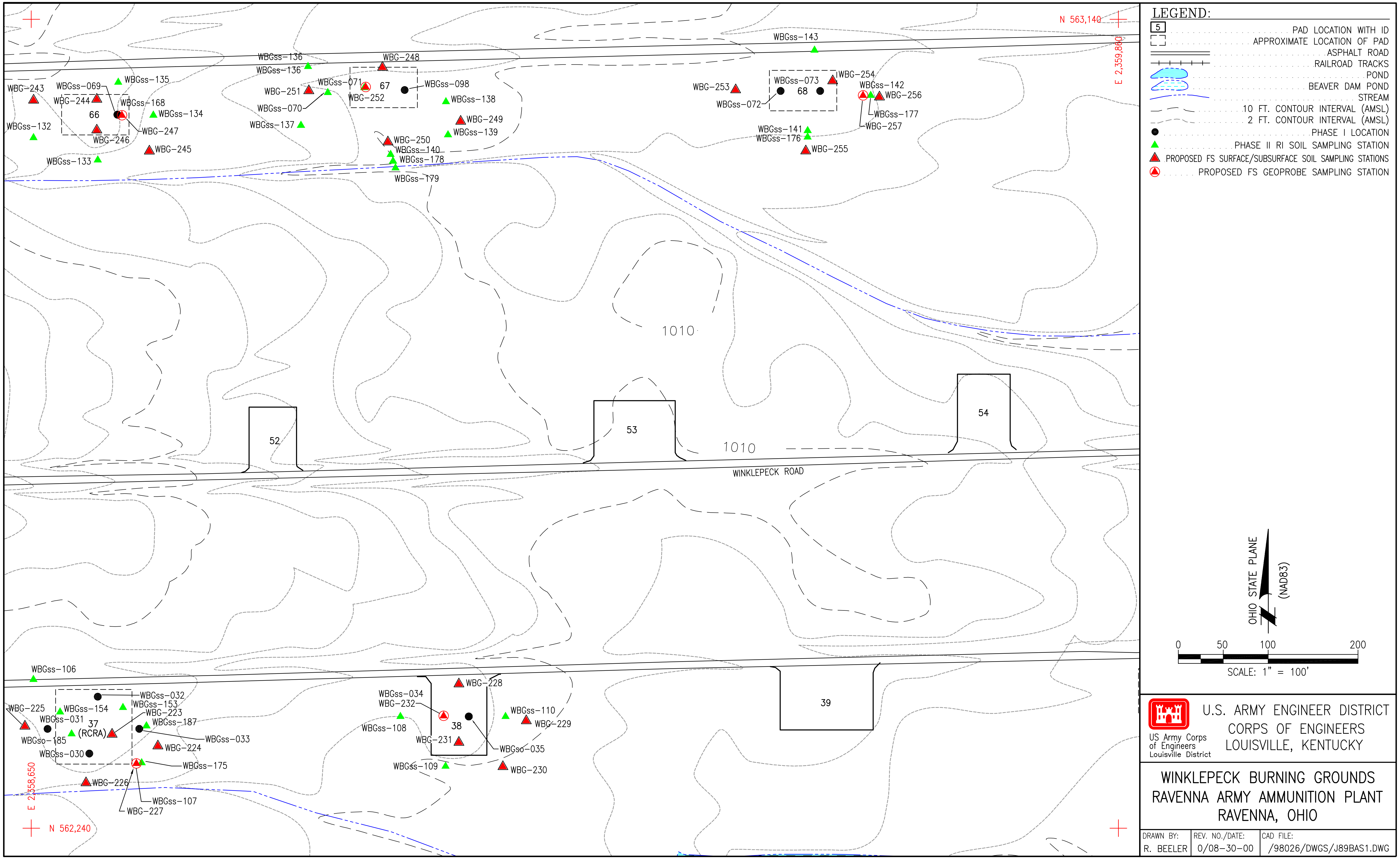
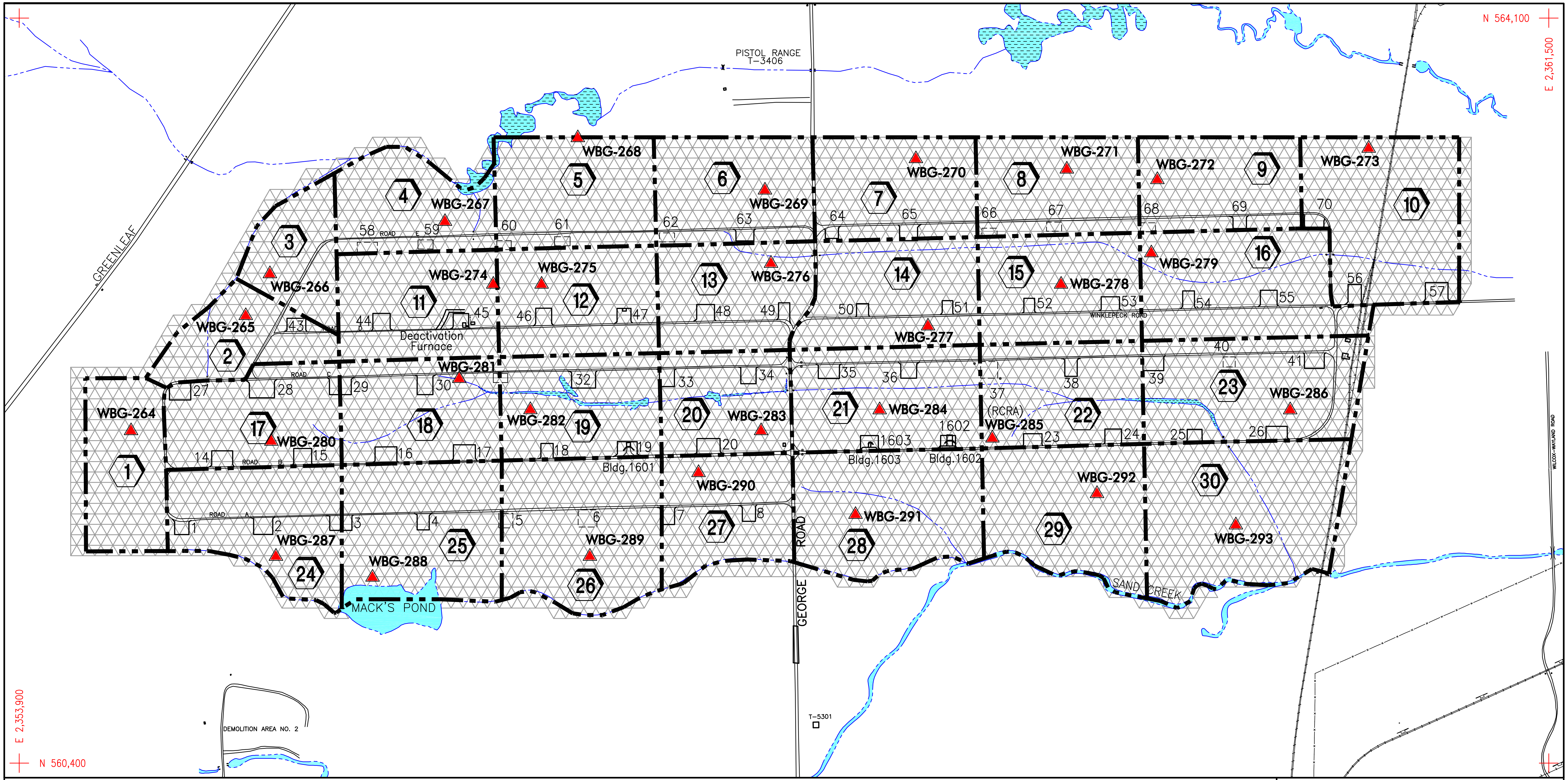


Figure 4-3. Surface and Subsurface Soil Sampling Locations for Pads 37, 38, 66, 67, and 68



LEGEND:

5	PAD LOCATION WITH ID
⌐ ¬	APPROXIMATE LOCATION OF PAD
═	ASPHALT ROAD
┼┼┼	RAILROAD TRACKS
	POND
	BEAVER DAM POND
	STREAM
	10 FT. CONTOUR INTERVAL (AMSL)
	2 FT. CONTOUR INTERVAL (AMSL)
⬡1	RANDOM SAMPLE AREA NUMBER
▲	RANDOM SAMPLE LOCATION

NOTE:

1.) ONE SURFACE SOIL SAMPLE WILL BE RANDOMLY LOCATED WITHIN EACH EXPOSURE UNIT.

2.) GRID SPACIING (60 FEET) AND SAMPLING SITE LOCATIONS WERE DETERMINED USING THE ZIRSCHKY AND GILBERT (1984) APPROACH, ASSUMING AN ELIPTICAL CONTAMINATED "HOT SPOT" WITH LONG AXIS EQUAL TO 100 FEET AND SHORT AXIS EQUAL TO 50 FEET.

OHIO STATE PLANE
(NAD83)

0 250 500 1000
SCALE: 1" = 500'

US Army Corps
of Engineers
Louisville District

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

WINKLEPECK BURNING GROUNDS
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	0/08-31-00	/98026/DWGS/J89GRID1.DWG

Figure 4-4. Exposure Unit Random Sampling Grid for Random Surface Soil Samples

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 WBG FS field 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 FS 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 field investigation for the WBG FS 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 field investigation is presented in Figure 5-1. Samples have already been collected at WBG under the Phase I and II RIs and an ongoing ecological measurements study. Therefore, sample numbering for the FS will commence at sample identification number 4000 to ensure that no overlap with ongoing investigations occur. Tables 5-1 and 5-2 present the baseline sample identification listing for the FS field investigation samples. 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 on the project field books.

5.4 SAMPLE DOCUMENTATION

All sample label, logbook, field record, and field form information will follow structures identified.

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.

RVAAP Sample Identification Format: XXXmm-NNN(n)-####-tt

XXX = Area Designator
Winklepeck Burning Grounds = WBG

mm = Sample Location Type
mw = Groundwater Monitoring Well
so = Soil Boring/Subsurface Soil Sample Location
sw = Surface Water Sample Location
sd = Sediment Sample Location
ss = Surface Soil Sample Location
tr = Trench Sample Location
sp = Seep or Spring Sample Location
wp = Groundwater Well Point

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

(n) = Special Identifier
Optional use as needed to identify special sample matrices or sample location characteristics.
c = Stream or Drainage Channel Sample
p = Pond Sample
b = Railroad Ballast Sample
d = Debris Sample
s = Slag Sample

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

tt = Sample Type
GW = Groundwater
SO = Soil Sample
SD = Sediment Sample
SW = Surface Water Sample
TB = Trip Blank
FB = Field Blank
ER = Equipment Rinsate

Figure 5-1. WBG FS Sample Identification System

Table 5-1. WBG FS Baseline Soil and Dry Sediment Sample Identification List

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES								
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide
Pad 58 - Area 1/3 (7)	WBG-197	0-1	WBGss-197-4000-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]	A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
TBD - No more than ten, 2 to 4 ft subsurface soil samples and no more than four, 4 to 6 ft samples will be analyzed for field explosives, XRF metals, and TAL metals from Area 1 pads combined.		2-4	WBGso-197-4001-SO	TBD			TBD	TBD				
		4-6	WBGso-197-4002-SO	TBD			TBD	TBD				
	WBG-198	0-1	WBGss-198-4003-SO	X			X	X				
		2-4	WBGso-198-4004-SO	TBD			TBD	TBD				
		4-6	WBGso-198-4005-SO	TBD			TBD	TBD				
	WBG-199	0-1	WBGss-199-4006-SO	X			X	X				
		2-4	WBGso-199-4007-SO	TBD			TBD	TBD				
		4-6	WBGso-199-4008-SO	TBD			TBD	TBD				
	WBG-200	0-1	WBGss-200-4009-SO	X			X	X				
		2-4	WBGso-200-4010-SO	TBD			TBD	TBD				
		4-6	WBGso-200-4011-SO	TBD			TBD	TBD				
	WBG-201	0-1	WBGss-201-4012-SO	X			X	X				
		2-4	WBGso-201-4013-SO	TBD			TBD	TBD				
		4-6	WBGso-201-4014-SO	TBD			TBD	TBD				
	WBG-202	0-1	WBGss-202-4015-SO	X			X	X				
		2-4	WBGso-202-4016-SO	TBD			TBD	TBD				
		4-6	WBGso-202-4017-SO	TBD			TBD	TBD				
WBG-203 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-114.	WBG-203	0-1	WBGss-203-4018-SO	X			X	X[d]				
		2-4	WBGso-203-4019-SO	X			X	X[d]				
		4-6	WBGso-203-4020-SO	X			X	X[d]				
		6-8	WBGso-203-4021-SO	X			X	X[d]				
		8-10	WBGso-203-4022-SO	X			X	X[d]				
Pad 59 - Area 1/3 (7)	WBG-204	0-1	WBGss-204-4023-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than ten, 2 to 4 ft subsurface soil samples and no more than four, 4 to 6 ft samples will be analyzed for field explosives, XRF metals, and TAL metals from Area 1 pads combined.		2-4	WBGss-204-4024-SO	TBD			TBD	TBD				
		4-6	WBGss-204-4025-SO	TBD			TBD	TBD				
	WBG-205	0-1	WBGss-205-4026-SO	X			X	X				
		2-4	WBGso-205-4027-SO	TBD			TBD	TBD				
		4-6	WBGso-205-4028-SO	TBD			TBD	TBD				
	WBG-206	0-1	WBGss-206-4029-SO	X			X	X				
		2-4	WBGso-206-4030-SO	TBD			TBD	TBD				
		4-6	WBGso-206-4031-SO	TBD			TBD	TBD				
	WBG-207	0-1	WBGss-207-4032-SO	X			X	X				
		2-4	WBGso-207-4033-SO	TBD			TBD	TBD				
		4-6	WBGso-207-4034-SO	TBD			TBD	TBD				
	WBG-208	0-1	WBGss-208-4035-SO	X			X	X				
		2-4	WBGso-208-4036-SO	TBD			TBD	TBD				
		4-6	WBGso-208-4037-SO	TBD			TBD	TBD				
	WBG-209	0-1	WBGss-209-4038-SO	X			X	X				
		2-4	WBGso-209-4039-SO	TBD			TBD	TBD				
		4-6	WBGso-209-4040-SO	TBD			TBD	TBD				

Table 5-1. (continued)

				CHEMICAL ANALYSES								
AREA (No. Stations)	**Sample Station ID**	**Depth (ft)**	**Sample ID**	**Field Explosives**	**Explosives**	**Propellants**	**XRF Metals**	**TAL Metals**	**VOCs**	**SVOCs**	**Pest./ PCBs**	**Cyanide**
WBG-210 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGso-055.	WBG-210	0-1	WBGss-210-4041-SO	X		A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
		2-4	WBGso-210-4042-SO	X			X	X				
		4-6	WBGso-210-4043-SO	X			X	X				
		6-8	WBGso-210-4044-SO	X			X	X				
		8-10	WBGso-210-4045-SO	X			X	X				
Pad 60 - Area 1 (6)	WBG-211	0-1	WBGss-211-4046-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than ten, 2 to 4 ft subsurface soil samples and no more than four, 4 to -6 ft samples will be analyzed for field explosives, XRF metals, and TAL metals from Area 1 pads combined.		2-4	WBGso-211-4047-SO	TBD			TBD	TBD				
		4-6	WBGso-211-4048-SO	TBD			TBD	TBD				
	WBG-212	0-1	WBGss-212-4049-SO	X			X	X				
		2-4	WBGso-212-4050-SO	TBD			TBD	TBD				
		4-6	WBGso-212-4051-SO	TBD			TBD	TBD				
	WBG-213	0-1	WBGss-213-4052-SO	X			X	X				
		2-4	WBGso-213-4053-SO	TBD			TBD	TBD				
		4-6	WBGso-213-4054-SO	TBD			TBD	TBD				
	WBG-214	0-1	WBGss-214-4055-SO	X			X	X				
		2-4	WBGso-214-4056-SO	TBD			TBD	TBD				
		4-6	WBGso-214-4057-SO	TBD			TBD	TBD				
	WBG-215	0-1	WBGss-215-4058-SO	X			X	X				
		2-4	WBGso-215-4059-SO	TBD			TBD	TBD				
		4-6	WBGso-215-4060-SO	TBD			TBD	TBD				
	WBG-216	0-1	WBGss-216-4061-SO	X			X	X				
		2-4	WBGso-216-4062-SO	TBD			TBD	TBD				
		4-6	WBGso-216-4063-SO	TBD			TBD	TBD				
Pad 61 - Area 1 (6)	WBG-217	0-1	WBGss-217-4064-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.		X	X				
TBD - No more than ten, 2 to 4 ft subsurface soil samples and no more than four, 4 to 6 ft samples will be analyzed for field explosives, XRF metals, and TAL metals from Area 1 pads combined.		2-4	WBGso-217-4065-SO	TBD			TBD	TBD				
		4-6	WBGso-217-4066-SO	TBD			TBD	TBD				
	WBG-218	0-1	WBGss-218-4067-SO	X			X	X				
		2-4	WBGso-218-4068-SO	TBD			TBD	TBD				
		4-6	WBGso-218-4069-SO	TBD			TBD	TBD				
	WBG-219	0-1	WBGss-219-4070-SO	X			X	X				
		2-4	WBGso-219-4071-SO	TBD			TBD	TBD				
		4-6	WBGso-219-4072-SO	TBD			TBD	TBD				
	WBG-220	0-1	WBGss-220-4073-SO	X			X	X				
		2-4	WBGso-220-4074-SO	TBD			TBD	TBD				
		4-6	WBGso-220-4075-SO	TBD			TBD	TBD				
	WBG-221	0-1	WBGss-221-4076-SO	X			X	X				
		2-4	WBGso-221-4077-SO	TBD			TBD	TBD				
		4-6	WBGso-221-4078-SO	TBD			TBD	TBD				

Table 5-1. (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES								
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide
	WBG-222	0-1	WBGss-222-4079-SO	X		A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
		2-4	WBGso-222-4080-SO	TBD			TBD	TBD				
		4-6	WBGso-222-4081-SO	TBD			TBD	TBD				
Pad 37- Areas 2/3 (5)	WBG-223	0-1	WBGss-223-4082-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X[d]				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-223-4083-SO	TBD			TBD	TBD				
		4-6	WBGso-223-4084-SO	TBD			TBD	TBD				
	WBG-224	0-1	WBGss-224-4085-SO	X			X	X[d]				
		2-4	WBGso-224-4086-SO	TBD			TBD	TBD				
		4-6	WBGso-224-4087-SO	TBD			TBD	TBD				
	WBG-225	0-1	WBGss-225-4088-SO	X			X	X[d]				
		2-4	WBGso-225-4089-SO	TBD			TBD	TBD				
		4-6	WBGso-225-4090-SO	TBD			TBD	TBD				
	WBG-226	0-1	WBGss-226-4091-SO	X			X	X[d]				
		2-4	WBGso-226-4092-SO	TBD			TBD	TBD				
		4-6	WBGso-226-4093-SO	TBD			TBD	TBD				
WBG-227 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-107.	WBG-227	0-1	WBGss-227-4094-SO	X			X	X				
		2-4	WBGso-227-4095-SO	X			X	X				
		4-6	WBGso-227-4096-SO	X			X	X				
		6-8	WBGso-227-4097-SO	X			X	X				
		8-10	WBGso-227-4098-SO	X			X	X				
Pad 38 - Areas 2/3 (5)	WBG-228	0-1	WBGss-228-4099-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X[d]				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-228-4100-SO	TBD			TBD	TBD				
		4-6	WBGso-228-4101-SO	TBD			TBD	TBD				
	WBG-229	0-1	WBGss-229-4102-SO	X			X	X[d]				
		2-4	WBGso-229-4103-SO	TBD			TBD	TBD				
		4-6	WBGso-229-4104-SO	TBD			TBD	TBD				
	WBG-230	0-1	WBGss-230-4105-SO	X			X	X[d]				
		2-4	WBGso-230-4106-SO	TBD			TBD	TBD				
		4-6	WBGso-230-4107-SO	TBD			TBD	TBD				
	WBG-231	0-1	WBGss-231-4108-SO	X			X	X[d]				
		2-4	WBGso-231-4109-SO	TBD			TBD	TBD				
		4-6	WBGso-231-4110-SO	TBD			TBD	TBD				
WBG-232 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-034.	WBG-232	0-1	WBGss-232-4111-SO	X			X	X[d]				
		2-4	WBGso-232-4112-SO	X			X	X[d]				
		4-6	WBGso-232-4113-SO	X			X	X[d]				
		6-8	WBGso-232-4114-SO	X			X	X[d]				
		8-10	WBGso-232-4115-SO	X			X	X[d]				

Table 5-1. (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES								
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide
Pad 45 - Areas 2/3 (5)	WBG-233	0-1	WBGss-233-4116-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]	A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X[d]	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
TBD - No more than six, 2 to4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-233-4117-SO	TBD			TBD	TBD[d]				
		4-6	WBGso-233-4118-SO	TBD			TBD	TBD				
	WBG-234	0-1	WBGss-234-4119-SO	X			X	X[d]				
		2-4	WBGso-234-4120-SO	TBD			TBD	TBD[d]				
		4-6	WBGso-234-4121-SO	TBD			TBD	TBD				
	WBG-235	0-1	WBGss-235-4122-SO	X			X	X[d]				
		2-4	WBGso-235-4123-SO	TBD			TBD	TBD[d]				
		4-6	WBGso-235-4124-SO	TBD			TBD	TBD				
	WBG-236	0-1	WBGss-236-4125-SO	X			X	X[d]				
		2-4	WBGso-236-4126-SO	TBD			TBD	TBD[d]				
		4-6	WBGso-236-4127-SO	TBD			TBD	TBD				
WBG-237 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-146.	WBG-237	0-1	WBGss-237-4128-SO	X			X	X[d]				
		2-4	WBGso-237-4129-SO	X			X	X[d]				
		4-6	WBGso-237-4130-SO	X			X	X[d]				
		6-8	WBGso-237-4131-SO	X			X	X[d]				
		8-10	WBGso-237-4132-SO	X			X	X[d]				
Pad 62 - Areas 2/3 (5)	WBG-238	0-1	WBGss-238-4133-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-238-4134-SO	TBD			TBD	TBD				
		4-6	WBGso-238-4135-SO	TBD			TBD	TBD				
	WBG-239	0-1	WBGss-239-4136-SO	X			X	X				
		2-4	WBGso-239-4137-SO	TBD			TBD	TBD				
		4-6	WBGso-239-4138-SO	TBD			TBD	TBD				
	WBG-240	0-1	WBGss-240-4139-SO	X			X	X				
		2-4	WBGso-240-4140-SO	TBD			TBD	TBD				
		4-6	WBGso-240-4141-SO	TBD			TBD	TBD				
	WBG-241	0-1	WBGss-241-4142-SO	X			X	X				
		2-4	WBGso-241-4143-SO	TBD			TBD	TBD				
		4-6	WBGso-241-4144-SO	TBD			TBD	TBD				
WBG-242 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGso-062.	WBG-242	0-1	WBGss-242-4145-SO	X			X	X				
		2-4	WBGso-242-4146-SO	X			X	X				
		4-6	WBGso-242-4147-SO	X			X	X				
		6-8	WBGso-242-4148-SO	X			X	X				
		8-10	WBGso-242-4149-SO	X			X	X				
Pad 66 - Areas 2/3 (5)	WBG-243	0-1	WBGss-243-4150-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-243-4151-SO	TBD			TBD	TBD				
		4-6	WBGso-243-4152-SO	TBD			TBD	TBD				
	WBG-244	0-1	WBGss-244-4153-SO	X			X	X				
		2-4	WBGso-244-4154-SO	TBD			TBD	TBD				
		4-6	WBGso-244-4155-SO	TBD			TBD	TBD				
	WBG-245	0-1	WBGss-245-4156-SO	X			X	X				
		2-4	WBGso-245-4157-SO	TBD			TBD	TBD				
		4-6	WBGso-245-4158-SO	TBD			TBD	TBD				

Table 5-1. (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide
	WBG-246	0-1	WBGss-246-4159-SO	X		A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
		2-4	WBGso-246-4160-SO	TBD			TBD	TBD				
		4-6	WBGso-246-4161-SO	TBD			TBD	TBD				
WBG-247 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-069.	WBG-247	0-1	WBGss-247-4162-SO	X			X	X				
		2-4	WBGso-247-4163-SO	X			X	X				
		4-6	WBGso-247-4164-SO	X			X	X				
		6-8	WBGso-247-4165-SO	X			X	X				
		8-10	WBGso-247-4166-SO	X			X	X				
Pad 67 - Areas 2/3 (5)	WBG-248	0-1	WBGss-248-4167-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-248-4168-SO	TBD			TBD	TBD				
		4-6	WBGso-248-4169-SO	TBD			TBD	TBD				
	WBG-249	0-1	WBGss-249-4170-SO	X			X	X				
		2-4	WBGso-249-4171-SO	TBD			TBD	TBD				
		4-6	WBGso-249-4172-SO	TBD			TBD	TBD				
	WBG-250	0-1	WBGss-250-4173-SO	X			X	X				
		2-4	WBGso-250-4174-SO	TBD			TBD	TBD				
		4-6	WBGso-250-4175-SO	TBD			TBD	TBD				
	WBG-251	0-1	WBGss-251-4176-SO	X			X	X				
		2-4	WBGso-251-4177-SO	TBD			TBD	TBD				
		4-6	WBGso-251-4178-SO	TBD			TBD	TBD				
WBG-252 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-071	WBG-252	0-1	WBGss-252-4179-SO	X			X	X				
		2-4	WBGso-252-4180-SO	X			X	X				
		4-6	WBGso-252-4181-SO	X			X	X				
		6-8	WBGso-252-4182-SO	X			X	X				
		8-10	WBGso-252-4183-SO	X			X	X				
Pad 68 - Areas 2/3 (5)	WBG-253	0-1	WBGss-253-4184-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]		X	X				
TBD - No more than six, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals from Area 2 pads combined.		2-4	WBGso-253-4185-SO	TBD			TBD	TBD				
		4-6	WBGso-253-4186-SO	TBD			TBD	TBD				
	WBG-254	0-1	WBGss-254-4187-SO	X			X	X				
		2-4	WBGso-254-4188-SO	TBD			TBD	TBD				
		4-6	WBGso-254-4189-SO	TBD			TBD	TBD				
	WBG-255	0-1	WBGss-255-4190-SO	X			X	X				
		2-4	WBGso-255-4191-SO	TBD			TBD	TBD				
		4-6	WBGso-255-4192-SO	TBD			TBD	TBD				
	WBG-256	0-1	WBGss-256-4193-SO	X			X	X				
		2-4	WBGss-256-4194-SO	TBD			TBD	TBD				
		4-6	WBGso-256-4195-SO	TBD			TBD	TBD				
WBG-257 samples to be collected by Geoprobe or split spoon at Phase II RI Station WBGss-142.	WBG-257	0-1	WBGss-257-4196-SO	X			X	X				
		2-4	WBGso-257-4197-SO	X			X	X				
		4-6	WBGso-257-4198-SO	X			X	X				
		6-8	WBGso-257-4199-SO	X			X	X				
		8-10	WBGso-257-4200-SO	X			X	X				

Table 5-1. (continued)

				CHEMICAL ANALYSES								
AREA (No. Stations)	**Sample Station ID**	**Depth (ft)**	**Sample ID**	**Field Explosives**	**Explosives**	**Propellants**	**XRF Metals**	**TAL Metals**	**VOCs**	**SVOCs**	**Pest./ PCBs**	**Cyanide**
Pad 32 (1)	WBG-258	0-1	WBGss-258-4201-SO	X	Samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.[a]	A total of 5 samples for propellant analyses to be collected from Areas 1, 2, 3, and 5 at locations with highest corresponding field explosives.	X	X	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.	A total of 13 samples (10%) to be collected from Areas 1, 2, 3, and 5 based on field observations and submitted for analysis.
		2-4	WBGso-258-4202-SO	TBD			TBD	TBD				
		4-6	WBGso-258-4203-SO	TBD			TBD	TBD				
Area 5 - Contingency (5)	WBG-259	0-1	WBGss-259-4204-SO	X			X	X				
TBD - No more than three, 2 to 4 ft subsurface soil samples and one, 4 to 6 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals.		2-4	WBGso-259-4205-SO	TBD			TBD	TBD				
		4-6	WBGso-259-4206-SO	TBD			TBD	TBD				
	WBG-260	0-1	WBGss-260-4207-SO	X			X	X				
		2-4	WBGso-260-4208-SO	TBD			TBD	TBD				
		4-6	WBGso-260-4209-SO	TBD			TBD	TBD				
	WBG-261	0-1	WBGss-261-4210-SO	X			X	X				
		2-4	WBGso-261-4211-SO	TBD			TBD	TBD				
		4-6	WBGso-261-4212-SO	TBD			TBD	TBD				
	WBG-262	0-1	WBGss-262-4213-SO	X			X	X				
		2-4	WBGso-262-4214-SO	TBD			TBD	TBD				
		4-6	WBGso-262-4215-SO	TBD			TBD	TBD				
	WBG-263	0-1	WBGss-263-4216-SO	X			X	X				
		2-4	WBGso-263-4217-SO	TBD			TBD	TBD				
		4-6	WBGso-263-4218-SO	TBD			TBD	TBD				
Area 4 - Random Grid (30)	WBG-264	0-1	WBGss-264-4219-SO	X			X	X				
	WBG-265	0-1	WBGss-265-4220-SO	X			X	X				
	WBG-266	0-1	WBGss-266-4221-SO	X			X	X				
	WBG-267	0-1	WBGss-267-4222-SO	X			X	X				
	WBG-268	0-1	WBGss-268-4223-SO	X			X	X				
	WBG-269	0-1	WBGss-269-4224-SO	X			X	X				
	WBG-270	0-1	WBGss-270-4225-SO	X			X	X				
	WBG-271	0-1	WBGss-271-4226-SO	X			X	X				
	WBG-272	0-1	WBGss-272-4227-SO	X			X	X				
	WBG-273	0-1	WBGss-273-4228-SO	X			X	X				
	WBG-274	0-1	WBGss-274-4229-SO	X			X	X				
	WBG-275	0-1	WBGss-275-4230-SO	X			X	X				
	WBG-276	0-1	WBGss-276-4231-SO	X			X	X				
	WBG-277	0-1	WBGss-277-4232-SO	X			X	X				
	WBG-278	0-1	WBGss-278-4233-SO	X			X	X				
	WBG-279	0-1	WBGss-279-4234-SO	X			X	X				
	WBG-280	0-1	WBGss-280-4235-SO	X			X	X				
	WBG-281	0-1	WBGss-281-4236-SO	X			X	X				
	WBG-282	0-1	WBGss-282-4237-SO	X			X	X				
	WBG-283	0-1	WBGss-283-4238-SO	X			X	X				
	WBG-284	0-1	WBGss-284-4239-SO	X			X	X				
	WBG-285	0-1	WBGss-285-4240-SO	X			X	X				
	WBG-286	0-1	WBGss-286-4241-SO	X			X	X				
	WBG-287	0-1	WBGss-287-4242-SO	X			X	X				
	WBG-288	0-1	WBGss-288-4243-SO	X			X	X				
	WBG-289	0-1	WBGss-289-4244-SO	X			X	X				
	WBG-290	0-1	WBGss-290-4245-SO	X			X	X				

Table 5-1. (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide
	WBG-291	0-1	WBGss-291-4246-SO	X			X	X				
	WBG-292	0-1	WBGss-292-4247-SO	X			X	X				
	WBG-293	0-1	WBGss-293-4248-SO	X			X	X				
Area 6 - Sediment from Ditch Between Pad 59/60, North of Road E	WBG-294[c]	0-1	WBGsd-294-4249-SD	X	X	X	X	X[d]	X	X	X	X
	WBG-295[c]	0-1	WBGsd-295-4250-SD	X		X	X	X[d]	X	X	X	X
TOTALS	99 Stations			160	58	7	160	160	15	15	15	15
FIELD DUPLICATES = 16 TOTAL				16	6	1	16	16	1	1	1	1
USACE QA SPLIT SAMPLES = 16 TOTAL					6	1		16	1	1	1	1
TRIP BLANKS = 0												
FIELD BLANKS = 0												
EQUIPMENT RINSATES = 0												

[a] Maximum number of fixed-base laboratory explosives samples for Area 1 pads = 22 samples. Assumes 18 samples are > or = to 1 mg/kg TNT and/or RDX plus 4 of the remaining samples (15%) submitted for confirmation analysis.

[b] Maximum number of fixed-base laboratory explosives samples for Area 2 pads = 31 samples. Assumes 24 samples are > or = to 1 mg/kg TNT and/or RDX plus 8 of the remaining samples (15%) submitted for confirmation analysis.

[c] Geotechnical sample (disturbed) to be collected at sediment stations. Geotechnical analyses include TOC (by analytical laboratory), grain size distribution, Atterberg Limits, moisture content, and USCS classification.

[d] TAL Metals suite is to include hexavalent chromium at these soil and sediment stations (up to 40 stations total). Four QA splits and 4 QC duplicates are also to be collected.

Table 5-2. WBG FS Groundwater Baseline Sample Identification List

				CHEMICAL ANALYSES							
AREA (No. Stations)	**Depth (ft)**	**Sample Station ID**	**Sample ID**	**Explosives**	**Propellants**	**Filtered TAL Metals**	**VOCs**	**SVOCs**	**Pest./ PCBs**	**Cyanide**	**GEO-TECHNICAL ANALYSES[b]**
Area 7 - Existing Monitoring Wells (9)	NA	OBG-1[a]	WBGmw-164-4251-GF	X	X	X	X	X	X	X	
	NA	OBG-2[a]	WBGmw-165-4252-GF	X	X	X	X	X	X	X	
	NA	OBG-3[a]	WBGmw-166-4253-GF	X	X	X	X	X	X	X	
	NA	OBG-4[a]	WBGmw-167-4254-GF	X	X	X	X	X	X	X	
	NA	WBGmw-005	WBGmw-005-4255-GF	X	X	X	X	X	X	X	
	NA	WBGmw-006	WBGmw-006-4256-GF	X	X	X	X	X	X	X	
	NA	WBGmw-007	WBGmw-007-4257-GF	X	X	X	X	X	X	X	
	NA	WBGmw-008	WBGmw-008-4258-GF	X	X	X	X	X	X	X	
	NA	WBGmw-009	WBGmw-009-4259-GF	X	X	X	X	X	X	X	
Area 8 - New Monitoring Wells (8)	NA	WBGmw-010	WBGmw-010-4260-GF	X	X	X	X	X	X	X	X
	NA	WBGmw-011	WBGmw-011-4261-GF	X	X	X	X	X	X	X	
	NA	WBGmw-012	WBGmw-012-4262-GF	X	X	X	X	X	X	X	X
	NA	WBGmw-013	WBGmw-013-4263-GF	X	X	X	X	X	X	X	
	NA	WBGmw-014	WBGmw-014-4264-GF	X	X	X	X	X	X	X	X
	NA	WBGmw-015	WBGmw-015-4265-GF	X	X	X	X	X	X	X	
	NA	WBGmw-016	WBGmw-016-4266-GF	X	X	X	X	X	X	X	X
	NA	WBGmw-017	WBGmw-017-4267-GF	X	X	X	X	X	X	X	
TOTALS		17	17	17	17	17	17	17	17	17	4
FIELD DUPLICATES = 2 TOTAL				2	2	2	2	2	2	2	
USACE QA SPLIT SAMPLES = 2 TOTAL				2	2	2	2	2	2	2	
TRIP BLANKS = 6							6				
FIELD/SOURCE WATER BLANK =2				2	2	2	2	2	2	2	
EQUIPMENT RINSATES = 1				1	1	1	1	1	1	1	

[a] Wells OBG-1, OBG-2, OBG-3, and OBG-4 were assigned station ID numbers WBGmw-164 through WBGmw-167 during the Phase II RI.

[b] Undisturbed geotechnical analyses (Shelby tube samples) include: dry weight, moisture content, bulk density, specific gravity, pH, redox potential, porosity, hydraulic conductivity, Atterberg limits, grain size (sieve), total organic carbon, USCS classification.

5.7 MONTHLY REPORTS

Monthly reports during implementation of the FS are specified by the scope of work for Delivery Order CY08. The content of the reports will conform in general to that specified in Section 5.7 of the Facility-wide SAP. In addition, the monthly reports will contain a revised project schedule. The reports will not include detailed text discussions of progress on subtasks; rather, summary information will be provided.

6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Sample packaging and shipping shall generally follow Chapter 6.0 of the Facility-wide SAP. Because the analytical laboratory is located less than 80 km (50 miles) from the site, the contract laboratory will provide same-day pickup of coolers containing samples. This will reduce the need for some of the packaging measures described in the Facility-wide SAP, which are intended for air-shipped coolers. Specifically:

- Chain-of-custody forms can be hand-carried by the courier to the laboratory.
- No airbills will be attached to couriered coolers.
- “THIS END UP” and “FRAGILE” stickers will not be required for containers transported by courier.

Coolers containing QA samples that are shipped to the USACE contract laboratory will be prepared and shipped in accordance with the Facility-wide SAP.

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.

7.0 INVESTIGATION-DERIVED WASTE

All IDW, including auger cuttings, personal protective equipment, 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. At the conclusion of field activities for the WBG FS investigation, a letter report will be submitted to the USACE and RVAAP Environmental Coordinator documenting the characterization and classification of the wastes. Upon approval of the IDW classification report, all solid and liquid IDW, including solvent wastes from the field colorimetry laboratory, will be removed from the site and disposed of by a licensed waste disposal contractor. All shipments of IDW off site will be coordinated through the RVAAP Environmental Coordinator.

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

- Soil and sediment, including residual surface and subsurface soil following sample homogenization and collection, drill cuttings, and residual sediment following sample homogenization and collection. An estimated 15, 55-gallon drums of soil and sediment IDW are anticipated.

- Development and purge water from monitoring wells. An estimated 16, 55-gallon drums of groundwater IDW are anticipated.

- Decontamination fluids, including those derived from decontamination of sampling equipment and drilling equipment. An estimated 1,500 gallons of decontamination fluid are anticipated.

- Field colorimetry laboratory liquid wastes, including spent reagents and decontamination fluid. One 55-gallon drum of this type of IDW is anticipated.

- Expendables/solid wastes, including PPE and disposable sampling equipment. Two 55-gallon drums of expendable IDW are anticipated.

Characterization and classification the different types of IDW will be based on the specific protocols described below. Expendable solid waste will be not sampled for characterization purposes.

- **Soils**: At locations where soil sampling is performed, any holes or borings below the ground surface will be filled with bentonite granules to ground surface to prevent vertical migration of any potential contamination. Drill cutting and any excess soil not used for samples will be placed in 55-gallon drums. Disposition of the drummed soil will be based on analytical results of environmental samples. Toxicity characteristic leaching procedure (TCLP) samples will be collected if analytical data indicate that the contents of a drum are potentially hazardous.

- **Sediment:** At locations where sediment sampling results in a hole that remains open, bentonite granules will be placed in the hole to ground surface. If the hole collapses or is under water, no additional measures will be taken with the hole. Any excess sediment not used for samples will be placed in 55-gallon drums. Disposition of the drummed sediment will be based on analytical results of environmental samples. A TCLP sample will be collected if analytical data indicate that the contents of the drum containing residual sediment are potentially hazardous.

- **IDW Water:** Development water from newly installed wells, purge water, and excess water not used for environmental samples will be placed in 55-gallon drums. Disposition will be based on the analytical results of the environmental samples. If results indicate that IDW water is potentially hazardous, TCLP samples will be collected.

- **Decontamination Fluids:** Decontamination fluids will be placed in drums or a polytank up to 1,500 gallons in size as needed. Disposition of decontamination liquid will be based on the collection and analysis of TCLP liquid sample(s).

- **Field Colorimetry Laboratory Liquid Wastes:** These fluids will be managed and characterized as noted above for decontamination fluids. In addition, process knowledge will be used to also characterize and classify the waste (i.e., notation of any RCRA-listed hazardous spent reagents added to the IDW container).

Drummed soil, sediment, and IDW water will be transported to Bldg. 1036, where it will be staged on wooden pallets. Decontamination fluids and field laboratory wastes will also be staged at Bldg. 1036 within secondary containment structures. To avoid potential drum rupture due to freezing conditions, Bldg. 1036 will be weather –proofed to the extent possible. Also, drums containing liquid IDW will be filled only to 75 percent capacity. Upon receipt and evaluation of characterization data, an IDW disposal report will be prepared containing recommendations for disposal per Section 7.4 of the Facility-wide SAP. Upon approval of the recommendations by RVAAP, the USACE, and Ohio EPA, IDW will be disposed of by a subcontracted waste management company in accordance with requirements mandated by the Waste Classification.

8.0 REFERENCES

American Cancer Society 1990.

ASTM (American Society for Testing and Materials) 1995. *Standard Guide for Risk-based Corrective Action Applied at Petroleum Release Sites*, ASTM Designation: E 1739-95.

Baes, C. F., III, R. D. Sharp, A. L. Sjoren, and R. W. Shor 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*. Oak Ridge National Laboratory, Oak Ridge, TN. ORNL-5786.

DOE (U.S. Department of Energy) 1996. *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*. DOE/OR/01-1455/V6&D1.

Efroymson, R. A., et al. 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. ES/ER/TM-85/R3. Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Efroymson, R. A., et al. 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. ES/ER/TM-126/R2. Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA (U.S. Environmental Protection Agency) 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004.

EPA 1989. *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002, Washington, DC.

EPA 1990.

EPA 1991. *Risk Assessment Guidance for Superfund, Vol. 1: Human Health Evaluation Manual (Part B: Development of Risk-Based Preliminary Remediation Goals)*, Interim, Publication 9285.7-01B, Office of Emergency and Remedial Response, Washington, DC.

EPA 1993. *Wildlife Exposure Factors Handbook*, Volume I of II. Office of Health and Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. December. EPA/600/R-93/187a.

EPA 1994a. *Guidance on Residential Lead-based Paint, Lead-contaminated Dust, and Lead-contaminated Soil, Office of Prevention, Pesticides, and Toxic Substances*.

EPA 1994b. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, Office of Solid Waste Emergency Response*, July 1994.

EPA 1995. *Supplemental Guidance to RAGS: Region IV Bulletins, Human Health Risk Assessment*, Atlanta, GA.

EPA 1996. *Soil Screening Guidance: Technical Background Document*, EPA/540/R-95/128, Washington, DC

EPA 1998 Region 9, On-line Database of Preliminary Remediation Goals http://www.epa.gov/region09/waste/sfund/prg/index/htm, May.

Gilbert 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold.

HAZWRAP 1994. *Loring Air Force Base Ecological Risk Methodology*. Martin Marietta Energy Systems, Inc. Draft.

Jacobs Engineering Group, Inc. 1989. *Environmental Protection Agency Technical Enforcement Support at Hazardous Waste Sites*.

Long, E. R., and L. G. Morgan 1991. *The Potential for Biological Effects of Sediment-sorbed Contaminants Tested in the National Status and Trends Program*, National Oceanic and Atmospheric Administration Technical Memorandum NOS OMA 52, Seattle, WA.

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," *Environ. Management* 19:81-97.

Mogul Corporation. 1982. *Soil and Sediment Analyses Performed for Ravenna Arsenal, Ravenna, Ohio*.

Ohio EPA 1995. *Technical Guidance for Hydrogeologic Investigations and Groundwater Monitoring*, February.

Ohio EPA 1997. *Residential Well Sampling Effort Near Load Line 1*.

Opresko, D. M., B. E. Sample, and G. W. Suter, II 1995. *Toxicological Benchmarks for Wildlife: 1995 Revision*. ES/ER/TM-86/R2. Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn.

Persaud, D., R. Jaagumagi, and A. Hayton 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*, Ontario Ministry of the Environment, Water Resources Branch, Toronto, Ontario, Log 92-2309-067, PIBS 1962 August.

Portage County Soil and Water Conservation District 1985.

Sample, B. E., J. J. Beauchamp, R. A. Efroymson, G. W. Suter, II, and T. L. Ashwood 1998. *Development and Validation of Bioaccumulation Models for Earthworms*. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM 220.

Sample, B. E., D. M. Opresko, and G. W. Suter, II 1996 *Toxicological Benchmarks for Wildlife: 1996 Revision*. ES/ER/TM-86/R3. Lockheed Martin Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn.

U.S. Bureau of the Census 1992.

USACE (U.S. Army Corps of Engineers) 1994a. *Requirements for the Preparation of Sampling and Analysis Plans,* EM 200-1-3.

USACE 1994b. *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*, EM-1110-1-4000.

USACE 1996. *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio*.

USACE 1997a. *Soil Sample Analysis, Winklepeck Burning Grounds.* Memorandum to USACE Louisville District from Dr. Tom Jenkins, U.S. Army, Cold Regions Research and Engineering Laboratory (CRREL), October 20, 1997.

USACE 1998a. *Phase I Remedial Investigation of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant, Ravenna Ohio*, DACA 69-94-D-0029, D.O. 0010 and 0022.

USACE 1998b. *Sampling and Analysis Plan Addendum for the Phase II Remedial Investigation of the Winklepeck Burning Grounds and Determination of Facility-wide Background at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. DACA 62-94-D-0029, D.O. No. 60, April.

USACE 1999a. *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio,* DACA62-94-D-0029, D.O. 0060, Draft Final, July.

USACE 1999b. Risk Assessment Handbook, Volume 1, Human Health Evaluation, EM-200-1-4.

USACE 2000a. *Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-00-D-0001, D.O. CY02, Draft.

USACE 2000b. Personal communication from John Jent, USACE CELRL-ED-DD, to Kevin Jago, SAIC, September 2000.

USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine). 1996. *Relative Risk Site Evaluation, Ravenna Army Ammunition Plant, 28 October – 1 November 1996.* Hazardous and Medical Waste Study No. 37-EF-5360-97.

USAEHA (U.S. Army Environmental Health Agency) 1983. *Hazardous Waste Management Study No. 37-26-0442-84, Phase II of AMC Open-Burning/Open-Detonation Grounds Evaluation, Ravenna Army Ammunition Plant*.

USATHAMA (U.S. Army Toxic and Hazardous Material Agency) 1978. *Installation Assessment of Ravenna Army Ammunition Plant*, Report No. 132.

USATHAMA 1980–1992. Ravenna Army Ammunition Plant Water Quality Surveillance Program (data only).

APPENDIX A

SELECTED PORTIONS FROM PREVIOUS ENVIRONMENTAL INVESTIGATIONS AT THE WINKLEPECK BURNING GROUNDS PHASE II RI (1999)

Table A-1. Summary Results for the Phase II RI for WBG-Surface Soil

Analyte	Result > Detection Limit	Minimum Detect	Maximum Detect	Average Result^a	Site Background Criteria	Detect > Site Background Criteria	SRC?
Explosives (mg/kg)							
1,3,5-Trinitrobenzene	15/ 99	0.055	490	6.282			Yes
1,3-Dinitrobenzene	1/ 99	0.084	0.084	0.6534			Yes
2,4,6-Trinitrotoluene	29/ 99	0.03	3800	79.5			Yes
2,4-Dinitrotoluene	8/ 99	0.065	0.55	0.1976			Yes
2,6-Dinitrotoluene	3/ 99	0.075	0.62	0.1974			Yes
2-Nitrotoluene	3/ 99	0.074	0.17	0.6537			Yes
3-Nitrotoluene	3/ 99	0.091	21	0.5524			Yes
4-Nitrotoluene	2/ 99	0.13	0.19	0.6545			Yes
HMX	14/ 99	0.11	1700	19.6			Yes
Nitrobenzene	2/ 99	0.035	0.054	0.6586			Yes
Nitrocellulose as N	7/ 20	2.5	315	28.07			Yes
Nitroglycerin	2/ 21	5.5	12	2.029			Yes
RDX	10/ 99	0.18	9500	100.6			Yes
Tetryl	5/ 99	0.088	0.48	1.687			Yes
Metals (mg/kg)							
Aluminum	149/ 149	1410	50100	12400	17700.00	12/149	Yes
Antimony*	38/ 77	0.48	27.9	3.36	0.96	34/ 77	Yes
Arsenic	149/ 149	2.5	35.8	13.2	15.40	31/149	Yes
Barium	148/ 149	11.7	10400	384.1	88.40	69/149	Yes
Beryllium*	21/ 76	0.23	3.4	0.4205	0.88	8/ 76	Yes
Cadmium	102/ 148	0.06	877	11.26	0.0	102/148	Yes
Calcium	77/ 77	805	111000	10180	15800.00	11/ 77	No
Chromium	149/ 149	5.4	189	19.15	17.40	54/149	Yes
Cobalt	76/ 77	1.2	12.7	7.872	10.40	5/ 77	Yes
Copper	77/ 77	9.3	16800	416.5	17.70	63/ 77	Yes
Cyanide	7/ 76	0.064	1.2	0.3293	0.0	7/ 76	Yes
Iron	77/ 77	9450	39100	22440	23100.00	36/ 77	No
Lead	149/ 149	10.2	2200	168.4	26.10	76/149	Yes
Magnesium	77/ 77	1410	16700	3194	3030.00	24/ 77	No
Manganese	149/ 149	65.4	3910	559.6	1450.00	7/149	No
Mercury	77/ 149	0.025	1.2	0.07459	0.04	63/149	Yes
Nickel	77/ 77	7.4	133	20.76	21.10	25/ 77	Yes
Potassium	77/ 77	400	3050	1212	927.00	57/ 77	No
Selenium	100/ 149	0.34	5	0.8633	1.40	17/149	Yes
Silver	25/ 149	0.22	33.2	0.8942	0.0	25/149	Yes
Sodium	42/ 76	43.5	1080	128.7	123.00	23/ 76	No
Thallium	7/ 77	1.4	3.1	0.4866	0.0	7/ 77	Yes
Vanadium	77/ 77	11.2	34	20.99	31.10	3/ 77	No
Zinc	149/ 149	28.6	24900	424.2	61.80	97/149	Yes

Table A-1 (continued)

Analyte	Result > Detection Limit	Minimum Detect	Maximum Detect	Average Result	Site Background Criteria	Detect > Site Background Criteria	SRC?
SVOCs (mg/kg)							
2-Methylnaphthalene	3/ 14	0.047	0.15	0.1616			Yes
Acenaphthene	2/ 14	0.14	0.15	0.1879			Yes
Anthracene	2/ 14	0.44	0.48	0.2329			Yes
Benzo(*a*)anthracene	4/ 14	0.043	1	0.2688			Yes
Benzo(*a*)pyrene	4/ 14	0.06	0.8	0.2486			Yes
Benzo(*b*)fluoranthene	4/ 14	0.093	1.1	0.2888			Yes
Benzo(*g,h,i*)perylene	3/ 14	0.11	0.39	0.2007			Yes
Benzo(*k*)fluoranthene	3/ 14	0.091	0.5	0.2201			Yes
Bis(2-ethylhexyl)phthalate	1/ 14	0.034	0.034	0.1867			Yes
Carbazole	2/ 14	0.2	0.27	0.2007			Yes
Chrysene	4/ 14	0.05	1	0.27			Yes
Di-*n*-butyl Phthalate	1/ 14	0.053	0.053	0.1881			Yes
Dibenzo(*a,h*)anthracene	2/ 14	0.054	0.11	0.1789			Yes
Dibenzofuran	2/ 14	0.11	0.16	0.1864			Yes
Fluoranthene	5/ 14	0.04	2.7	0.4984			Yes
Fluorene	2/ 14	0.18	0.24	0.1971			Yes
Indeno(1,2,3-*cd*)pyrene	3/ 14	0.13	0.48	0.2114			Yes
Naphthalene	1/ 14	0.076	0.076	0.1769			Yes
Phenanthrene	5/ 14	0.07	2.4	0.4118			Yes
Pyrene	5/ 14	0.036	2.1	0.4004			Yes
VOCs (mg/kg)							
Chloroform	1/ 10	0.002	0.002	0.002595			Yes
Methylene chloride	1/ 10	0.012	0.012	0.004895			Yes
Toluene	8/ 10	0.00079	0.17	0.03362			Yes

*Subsurface criteria used.

[a] Nondetects were set to one-half the reporting limit to calculate the average. In cases when detects were estimated below the reporting limit but above the method detection limit, the average may be larger than the maximum detect.

SRC – site-related contaminant based on data screening process.

Table A-2. Summary Results for the Phase II RI for WBG – Subsurface Soil

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Site Background Criteria	Detects > Site Background Criteria	SRC?
Explosives (mg/kg)							
1,3,5-Trinitrobenzene	17/ 31	0.03	6.90	0.53			Yes
1,3-Dinitrobenzene	1/ 31	0.26	0.26	0.40			Yes
2,4,6-Trinitrotoluene	20/ 31	0.04	27.00	3.06			Yes
2,4-Dinitrotoluene	8/ 31	0.03	0.11	0.11			Yes
2,6-Dinitrotoluene	3/ 31	0.07	0.22	0.13			Yes
2-Nitrotoluene	2/ 31	0.08	4.80	0.39			Yes
3-Nitrotoluene	4/ 31	0.07	0.12	0.43			Yes
4-Nitrotoluene	3/ 31	0.08	0.11	0.43			Yes
HMX	18/ 31	0.10	14.00	0.93			Yes
Nitrobenzene	4/ 31	0.03	0.36	0.40			Yes
Nitrocellulose as N	3/ 6	3.20	88.40	16.87			Yes
Nitroglycerin	1/ 31	7.40	7.40	1.45			Yes
RDX	13/ 31	0.14	82.00	3.96			Yes
Tetryl	7/ 31	0.05	0.24	1.09			Yes
Metals (mg/kg)							
Aluminum	31/ 31	6330.00	17500.00	12480.00	19500.00	0/ 31	No
Antimony	13/ 31	0.34	2.40	0.50	0.96	3/ 31	Yes
Arsenic	31/ 31	5.80	20.50	13.69	19.80	1/ 31	No
Barium	31/ 31	31.10	400.00	115.60	124.00	8/ 31	Yes
Beryllium	10/ 31	0.23	1.30	0.36	0.88	1/ 31	No
Cadmium	4/ 31	0.62	11.90	0.92	0.0	4/ 31	Yes
Calcium	30/ 31	333.00	20500.00	3853.00	35500.00	0/ 31	No
Chromium	31/ 31	9.40	23.30	16.74	27.20	0/ 31	No
Cobalt	31/ 31	5.40	25.40	10.68	23.20	1/ 31	No
Copper	31/ 31	8.30	46.90	21.52	32.30	2/ 31	Yes
Iron	31/ 31	13300.00	37100.00	24640.00	35200.00	2/ 31	No
Lead	31/ 31	9.90	105.00	20.16	19.10	9/ 31	Yes
Magnesium	31/ 31	1430.00	6520.00	3200.00	8790.00	0/ 31	No
Manganese	31/ 31	211.00	3470.00	545.60	3030.00	1/ 31	No
Mercury	5/ 31	0.03	0.07	0.04	0.04	2/ 31	Yes
Nickel	31/ 31	11.40	46.80	22.23	60.70	0/ 31	No
Potassium	31/ 31	725.00	3490.00	1515.00	3350.00	1/ 31	No
Selenium	2/ 31	0.81	0.98	0.34	1.50	0/ 31	No
Silver	1/ 31	1.50	1.50	0.64	0.0	1/ 31	Yes
Sodium	12/ 24	18.90	227.00	71.84	145.00	4/ 24	No
Thallium	3/ 31	0.76	1.10	0.36	0.91	1/ 31	No
Vanadium	31/ 31	11.70	40.50	21.90	37.60	1/ 31	No
Zinc	31/ 31	37.60	184.00	72.68	93.30	3/ 31	Yes
SVOCs (mg/kg)							
2-Methylnaphthalene	1/ 9	0.06	0.06	0.18			Yes
Anthracene	1/ 9	0.10	0.10	0.19			Yes
Benzo(*a*)anthracene	2/ 9	0.05	0.48	0.21			Yes
Benzo(*a*)pyrene	2/ 9	0.06	0.50	0.22			Yes
Benzo(*b*)fluoranthene	2/ 9	0.08	0.70	0.24			Yes
Benzo(*g,h,i*)perylene	1/ 9	0.31	0.31	0.21			Yes
Benzo(*k*)fluoranthene	1/ 9	0.29	0.29	0.21			Yes
Carbazole	1/ 9	0.09	0.09	0.19			Yes
Chrysene	2/ 9	0.06	0.56	0.22			Yes

Table A-2 (continued)

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Site Background Criteria	Detects > Site Background Criteria	SRC?
Dibenzo(*a*,*h*)anthracene	1/ 9	0.08	0.08	0.18			Yes
Fluoranthene	2/ 9	0.11	1.20	0.30			Yes
Indeno(1,2,3-*cd*)pyrene	1/ 9	0.37	0.37	0.22			Yes
Phenanthrene	2/ 9	0.09	0.53	0.22			Yes
Pyrene	2/ 9	0.08	0.91	0.26			Yes
VOCs (mg/kg)							
Acetone	1/ 5	0.05	0.05	0.02			Yes
Toluene	4/ 5	0.00	0.00	0.00			Yes

[a] Nondetects were set to one-half the reporting limit to calculate the average. In cases when detects were estimated below the reporting limit but above the method detection limit, the average may be larger than the maximum detect.

SRC – site-related contaminant based on data screening process.

Table A-3. Summary Results for the Phase II RI for WBG - Sediment

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Site Background Criteria	Detects > Site Background Criteria	SRC?
Explosives (mg/kg)							
1,3,5-Trinitrobenzene	4/ 17	0.07	0.15	0.12			Yes
1,3-Dinitrobenzene	1/ 17	0.04	0.04	0.12			Yes
2,4,6-Trinitrotoluene	4/ 17	0.09	0.97	0.20			Yes
2,4-Dinitrotoluene	1/ 17	0.04	0.04	0.12			Yes
HMX	1/ 17	0.12	0.12	0.82			Yes
Nitrobenzene	1/ 17	0.07	0.07	0.13			Yes
Metals (mg/kg)							
Aluminum	17/ 17	4740.00	17900.00	10880.00	13900.00	5/ 17	Yes
Antimony	1/ 6	0.32	0.32	0.45	0.0	1/ 6	Yes
Arsenic	17/ 17	7.70	18.10	12.29	19.50	0/ 17	No
Barium	17/ 17	36.80	528.00	132.60	123.00	6/ 17	Yes
Beryllium	2/ 6	0.45	0.60	0.33	0.38	2/ 6	Yes
Cadmium	6/ 17	0.06	0.56	0.22	0.0	6/ 17	Yes
Calcium	6/ 6	975.00	3910.00	1760.00	5510.00	0/ 6	No
Chromium	17/ 17	7.20	21.30	13.05	18.10	1/ 17	Yes
Cobalt	6/ 6	5.70	10.40	7.95	9.10	1/ 6	Yes
Copper	6/ 6	7.80	49.10	19.65	27.60	1/ 6	Yes
Cyanide	1/ 6	0.11	0.11	0.40	0.0	1/ 6	Yes
Iron	6/ 6	13900.00	24000.00	17620.00	28200.00	0/ 6	No
Lead	17/ 17	10.20	40.10	17.62	27.40	1/ 17	Yes
Magnesium	6/ 6	1180.00	3280.00	2012.00	2760.00	1/ 6	No
Manganese	17/ 17	183.00	1050.00	506.40	1950.00	0/ 17	No
Mercury	3/ 17	0.04	0.16	0.04	0.06	1/ 17	Yes
Nickel	6/ 6	10.10	28.30	17.17	17.70	2/ 6	Yes
Potassium	6/ 6	665.00	1580.00	914.70	1950.00	0/ 6	No
Selenium	6/ 17	0.37	1.70	0.45	1.70	0/ 17	No
Sodium	5/ 6	25.90	107.00	128.20	112.00	0/ 6	No
Thallium	2/ 6	1.50	1.80	0.92	0.89	2/ 6	Yes
Vanadium	6/ 6	13.00	29.20	17.30	26.10	1/ 6	Yes
Zinc	17/ 17	38.30	166.00	80.86	532.00	0/ 17	No
SVOCs (mg/kg)							
Anthracene	1/ 3	0.15	0.15	0.16			Yes
Benzo(*a*)anthracene	1/ 3	0.56	0.56	0.30			Yes
Benzo(*a*)pyrene	1/ 3	0.39	0.39	0.24			Yes
Benzo(*b*)fluoranthene	1/ 3	0.56	0.56	0.30			Yes
Benzo(*g,h,i*)perylene	1/ 3	0.13	0.13	0.15			Yes
Benzo(*k*)fluoranthene	1/ 3	0.19	0.19	0.17			Yes
Chrysene	1/ 3	0.51	0.51	0.28			Yes
Fluoranthene	1/ 3	1.50	1.50	0.61			Yes
Indeno(1,2,3-*cd*)pyrene	1/ 3	0.17	0.17	0.17			Yes
Phenanthrene	1/ 3	0.64	0.64	0.32			Yes
Pyrene	1/ 3	0.94	0.94	0.42			Yes
VOCs (mg/kg)							
Acetone	1/ 2	0.02	0.02	0.01			Yes
Chloroform	1/ 3	0.00	0.00	0.00			Yes
Toluene	1/ 3	0.03	0.03	0.01			Yes

[a] Nondetects were set to one-half the reporting limit to calculate the average. In cases when detects were estimated below the reporting limit but above the method detection limit, the average may be larger than the maximum detect.

SRC – site-related contaminant based on data screening process.

Table A-4. Summary Results for the Phase II RI for WBG – Surface Water

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result	Site Background Criteria	Detects >Site Background Criteria	SRC?
Metals (µg/L)							
Barium	1/ 1	7.90	7.90	7.90	47.50	0/ 1	No
Calcium	1/ 1	5730.00	5730.00	5730.00	41400.00	0/ 1	No
Copper	1/ 1	5.50	5.50	5.50	7.90	0/ 1	No
Iron	1/ 1	867.00	867.00	867.00	2560.00	0/ 1	No
Magnesium	1/ 1	1750.00	1750.00	1750.00	10800.00	0/ 1	No
Manganese	1/ 1	103.00	103.00	103.00	391.00	0/ 1	No
Potassium	1/ 1	524.00	524.00	524.00	3170.00	0/ 1	No
Sodium	1/ 1	1450.00	1450.00	1450.00	21300.00	0/ 1	No
Zinc	1/ 1	18.40	18.40	18.40	42.00	0/ 1	No
VOCs (µg/L)							
Acetone	1/ 1	7.20	7.20	7.20			Yes

SRC – site-related contaminant based on data screening process.

Table A-5. Summary Results for the Phase II RI for WBG - Groundwater

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result[a]	Site Background Criteria	Detects > Site Background Criteria	SRC?
Explosives (µg/L)							
1,3-Dinitrobenzene	1/ 8	0.03	0.03	0.09			Yes
2,4-Dinitrotoluene	3/ 9	0.03	0.04	0.60			Yes
3-Nitrotoluene	1/ 8	0.08	0.08	0.10			Yes
HMX	1/ 9	8.00	8.00	1.11			Yes
Nitrobenzene	1/ 8	0.06	0.06	0.09		1/ 8	Yes
RDX	2/ 9	1.10	32.00	3.87			Yes
Metals (µg/L)							
Barium	6/ 9	7.60	98.10	36.84	82.10	1/ 9	Yes
Calcium	9/ 9	46500.00	118000.00	73820.00	115000.00	1/ 9	No
Copper	2/ 7	3.30	9.80	10.80		2/ 7	Yes
Cyanide	1/ 9	19.00	19.00	6.56		1/ 9	Yes
Iron	1/ 9	155.00	155.00	65.09	279.00	0/ 9	No
Lead	1/ 9	3.10	3.10	1.68		1/ 9	Yes
Magnesium	9/ 9	10300.00	34200.00	20380.00	43300.00	0/ 9	No
Manganese	8/ 9	58.00	2920.00	549.40	1020.00	1/ 9	Yes
Mercury	1/ 9	0.08	0.08	0.10		1/ 9	Yes
Potassium	9/ 9	777.00	3250.00	1594.00	2890.00	1/ 9	No
Sodium	8/ 9	3060.00	35800.00	10820.00	45700.00	0/ 9	No
Zinc	1/ 9	45.60	45.60	20.66	60.90	0/ 9	No
SVOCs (µg/L)							
Bis(2-ethylhexyl)phthalate	1/ 8	4.50	4.50	4.94			Yes
VOCs (µg/L)							
Chloroform	3/ 9	0.64	1.70	2.05			Yes

[a] Nondetects were set to one half the reporting limit to calculate the average. In cases when detects were estimated below the reporting limit but above the method detection limit, the average may be larger than the maximum detect.

SRC – site-related contaminant based on data screening process.

APPENDIX B

FIELD COLORIMETRIC ANALYTICAL PROCEDURE

STANDARD OPERATING PROCEDURE FOR FIELD COLORIMETRIC ANALYSIS OF EXPLOSIVES FOR RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide directions for in the field chemical determination of the presence of 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in soil and sediment. This procedure will allow the quantification of these two compounds using a battery operated spectrophotometer by experienced analytical personnel.

The resulting data is intended to provide information that meets DQOs for field screening for the purpose of expedient field operation decisions. The resulting data will not meet DQOs necessary for risk assessment nor be stand-alone for feasibility studies.

2.0 METHOD SUMMARY

A 20 gram aliquot of undried sample is placed in an appropriate size container and extracted with 100 ml of acetone. After filtration and color development the background and developed color is measured at the appropriate wavelength on the spectrophotometer. After subtraction of the background color the concentration of the target compound is determined based on the absorbance measurement from the spectrophotometer.

Two separate color developments and absorbance measurements are required for the determination of TNT and RDX by this procedure. TNT detection and quantification is based on the spectrophotometric measurement at 540 nm of the red color complex resulting from the addition of potassium hydroxide (KOH) and sodium sulfite (Na_2SO_3) to the filtered acetone extract. RDX detection and quantification is based on the spectrophotometric measurement at 507 nm the red color complex resulting from the derivitization of the acetone extract with acetic acid and zinc and subsequent color development with commercially available HACH NitroVer 3 reagent.

The method concentration range for the compounds is typically 1 – 30 ppm for TNT and 2.5 – 35 ppm for RDX, wet weight. The actual range found will be dependent on the individual instrumentation and the cuvett diameter. The actual reportable concentration range needs to be determined on a project by project basis.

3.0 REFERENCES

Jenkins, T.F. (1990), “Development of a Simplified Field Method for the Determination of TNT in Soil”, U.S. Cold Regions Research and Engineering Laboratory, Special Report 90-30.

RVAAP Site Wide SAP, July 2000

RVAAP Site Wide QAPP, July 2000

Science Applications International Corporation Quality Assurance Administrative Procedures (SAIC QAAPs).

Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, Region IV Environmental Services Division, February, 1991.

Science Applications International Corporation Field Technical Procedure (SAIC TFP) May 5, 1995.

Jenkins, T.F., and Walsh, M.E. (1993). “Determination of TNT/RDX in Soils Using Colorimetry”, U.S. Cold Regions Research and Engineering Laboratory.

4.0 RESPONSIBILITIES

4.1 Contractor Program Manager

The Program Manager is responsible for approving this procedure.

4.2 Contractor Quality Assurance/Quality Control (QA/QC) Officer

The QA/QC Officer is responsible for approving this procedure and verifying that this procedure is being implemented.

4.3 Contractor Health and Safety (H&S) Officer

The H&S Officer is responsible for ensuring that appropriate and contractual H&S policies and procedures are in effect and verify enforcement of same by line management.

4.4 Contractor Program or Project Manager

The Program or Project Manager is responsible for:

- designating a qualified person to train personnel who will be using this procedure
- ensuring that this and all appropriate procedures are followed
- the interpretation of these operating instructions
- verifying that the appropriate training records are submitted to the Central Records Facility

4.5 Contractor Field Sampling Team Leader

The Field Sampling Team Leader is responsible for:

- assigning field sampling team members

- coordinating and preparing for field sampling and field analytical activities by ensuring compliance with the SAP and field procedures (including operating instructions)

- ensuring that the field sampling team members and the field analysts are appropriately trained and the training is properly documented

- overall management of field activities.

4.6 Contractor Field Sampling Team Members

The field sampling team members are responsible for:

- assisting the field sampling team leader in selecting locations and intervals for sampling as identified in the SAP

- collecting the required field samples, appropriately documenting sample collection activities, properly labeling samples, and delivering samples to the field analysts

4.7 Contractor Field Analysts

The field analysts are responsible for:

- implementation of and adherence to this field analytical procedure
- performing appropriate calibrations
- analyzing samples
- performing QC analysis
- maintaining analytical equipment
- documenting information according to the steps defined in this procedure.

5.0 GENERAL INFORMATION

- Any deviation from this procedure’s requirements will be justified to and authorized by the Contractor Project Manager or Program Manager.

- Deviations from this procedure’s requirements must be sufficiently documented to allow re-creation of the modified process.

- Refer to and implement the site- or project-specific H&S Plan for relevant H&S requirements.

- Refer to and implement the project-specific SAP for relevant sampling and analysis requirements.

- It is RVAAP policy to maintain an effective program to control employee exposure to chemical, radiological, and physical stress which is consistent with U.S. Occupational Safety and Health Administration (OSHA) established standards and requirements.

- Refer to and implement the site- or project-specific Waste Management Plan for relevant waste and waste disposal requirements.

- Subcontractor personnel who implement this procedure must provide documented evidence of having been trained in the procedure to the Program Manager or Project Manager in accordance with subsection 4.5.

- Data Quality Objectives (DQOs) for field analyses should be identified in project-specific documents (i.e., SAP, QAPP). As presented, this procedure provides appropriate guidance to produce quantitative screening data. QC includes multi-level calibration, method blank information, and control sample analysis. Duplicate analytical information is optional.

- Sample analytical reports and QC information will be provided to the Sampling Team Leader daily. In addition, sample results may be requested as determined by the Sampling Team Leader.

- Upon completion of a project, final data packages will be assembled including but not limited to; analytical results, QC data, calibration information, and a written summary of each day’s activities.

- For additional information regarding instrument calibration, adjustment, maintenance, or replacement components, consult the manufacturer’s instruction and operational manuals.

- Sampling equipment needed for the collection of soils and sediments will vary depending on project requirements and will be identified in the project-specific SAP.

- The analyst must be capable of making judgment calls and technical decisions based upon a clear understanding of Beer Lambart's Law, dilutions; along with the ability to execute proper analytical measurement techniques.

6.0 INTERFERENCES

- Several other nitroaromatic compounds have been investigated which develop a visible color when processed through the procedure and measured at 540 nm; Tetryl (orange), TNB (red), DNB (purple) and 2,4,6-dinitrotoluene (pink). These compounds, if present, may contribute to the sample absorbance and be calculated as TNT.

- Similar color development was not observed for other nitroaromatics, e.g., RDX, HMX, nitrobenzene o-nitrotoluene, m-nitrotoluene, p-nitrotoluene, nitroglycerine, 4-amino-2,6-dinitrotoluene or 2-amino-4,6-dinitrotoluene, with the TNT method. These compounds, if present, would not contribute to the color intensity at 540 nm.

- Humic organic matter in soil is extracted to some degree with the TNT method and yields a yellow color that becomes darker upon addition of the procedure's reagents. The contribution of this interference is estimated and accounted for with the background correction step outlined in this procedure.

- Percentage of H_2O (ice and water) in soil samples can alter the color development time. In addition, results should be noted as wet weight.

- The Griess Reaction that produces the red azo dye in the RDX determination will also produce similarly-colored products if HMX, nitroglycerine, nitrocellulose, PETN, or nitroguanidine are present in the soil. This reaction keys on the presence of organo-nitrates and may give false positive results for RDX in samples from areas where destruction of explosives has occurred as a result of detonation or burning.

- Humic substances that produce a background yellow color in the acetone extract are removed when the extract is acidified with acetic acid and filtered prior to RDX determination. Therefore, there is no requirement to obtain and subtract an initial absorbance from the final absorbance after color development.

7.0 SAFETY INFORMATION

- Normal safety precautions associated with laboratory use of a flammable organic solvent should be employed.

- Acetone and acetone solutions spilled on skin should be rapidly rinsed off with water.

- Organic solvents and solvent wastes must be stored separately from strong oxidizers (e.g., nitric acid) and never mixed with them.

- Flammable materials must be stored in approved containers and locations.

- Eye protection must be worn at all times and by all individuals entering the field laboratory area.

8.0 INSTRUMENTS AND SUPPLIES

8.1 Instrumentation

- Spectrophotometer – Fixed wavelength, battery-operated (e.g., HACH DR 2000) or for standard 110 v electrical if available at the project. Need a measurement path width of 25 mm (1 in.) for maximum sensitivity.

- Balance – Accurate to 0.1 gram or better. Electrical (e.g., 110 v plug in) or battery-operated preferred. Mechanical is acceptable, but calibration check needs to be performed more frequently.

8.2 Chemicals and Reagents

- TNT – Traceable to a known quality SARM, provided commercially as a certified grade neat material, or standard of known concentration in a known solvent. (Typically from commercial standards preparation as 1,000 ppm in acetone or methanol. Prefer 5,000 to 10,000 ppm if available.)

- RDX – Traceable to a known quality SARM, provided commercially as a certified grade neat material, or standard of known concentration in a known compatible solvent. (Typically available as 1,000 ppm in acetonitrile; prefer as 5,000 or 10,000 ppm in acetone or methanol.)

- Acetone – Commercially available as reagent grade from chemical suppliers. Also available off-the-shelf from local hardware or paint stores.

  Caution – Acetone is a volatile solvent and must be used only in a well ventilated temperature controlled environment.

  Caution – Acetone is often a site contaminant of concern. As such, both analyst and sampling personnel must be aware of its presence and potential impact for cross contamination of samples destined for volatile organic analyses.

- Glacial Acetic Acid – Reagent grade from chemical supplier.

- Potassium Hydroxide – Reagent grade pellets

- Sodium Sulfite – Granular, reagent grade.

- Zinc – Metal powder, reagent grade. Note: Must be kept dry in a dessicator.

- Clean Sand – Sand being used for well construction or commercially available play sand that has been acetone washed.

- Water Deionized – Commercially available from chemical supplier or off-the-shelf from local drug or food stores.

- HACH NitroVer 3 Powder Pillow.

8.3 Supplies

Caution – Acetone is a strong solvent that readily dissolves a majority of plastics. If substitutions are made to the following items, be sure they are compatible with acetone (i.e., polypropylene, nylon, glass, or Teflon) and do not attribute any color, turbidity or organo-nitrate materials.

- Bottles
  - 250-ml polypropylene bottles with screw top caps.
  - 30-ml polypropylene bottle and screw cap.

- Squeeze wash bottles with hazard label:
  - 1 liter deionized water
  - 1 liter acetone

- Serological Pipettes
  - 2 ml
  - 10 ml

- Pipette Bulbs – Safety pipette filters

- Transfer Pipettes and Tips
  - 10 ml repipet sampling pipettes
  - 10 ml repipet sampling Pipettes Tip pkg 100

- Volumetric Flasks
  - 50 ml polypropylene
  - 100 ml polypropylene
  - 25 ml glass

- Graduated Cylinders
  - 10 ml polypropylene
  - 50 ml polypropylene
  - 100 ml polypropylene

- Syringes
  - 0.250 ml Hamilton Gastight fixed needle
  - 2.50 ml Hamilton Gastight fixed needed
  - 60 ml; Luer-Lock disposable syringes

- Syringe Filters
  - 25 mm; 0.45 nm nylon filters in polypropylene housing; Luer Lock fitting (Milex SR; Whatman GD/X or equivalent)

- Spectrophotometer Cuvetts
  - 3 – matched pairs; 25 mm path length compatible with spectrophotometer

- Tongue Depressors
  - 1 box

- Desiccant system
    - 1 small desiccator cabinet
    - 2 silica gel desiccant cans

- Alumina A Cartridge
    - Alumina A ion exchange cartridge, 6 ml capacity

- 1000 ml Polypropylene beaker

9.0 METHOD CALIBRATION

9.1 Standards Preparation

Four types of standards are prepared for each of the two analytical parameters. Actual concentrations and transfer volumes will be dependent on the stock solution concentration being used. The four standards to be prepared are the: working stock, calibration, Laboratory Control Sample (LCS) spiking, and Continuous Calibration Verification (CCV).

9.1.1 Working Stock Standards

SARM Source

Dry to a consistent weight over night in a desiccator. Weigh ~0.5 g on a 4 place balance, transfer and dilute to volume in a 100 ml volumetric flask with acetone. This gives ~5,000 ppm stock solution. Store in either a sealed serum vial or tightly capped 20 ml polypropylene or glass bottle with minimal headspace that has been blackened to keep light out.

Working Stock Solution 40 ppm

Source Concentration (ppm)	Transfer Volume[1] (ml)	Final Volume (ml acetone)	Final Concentration (ppm)
10,000[2]	0.20	50	40
5,000[2,3]	0.40	50	40
1,000[2]	1.00	25	40

[1] Transfer using the 2.5 ml gastight syringe.
[2] Commercially prepared standard source.
[3] Prepared source from either a SARM or available solid material source of known purity.

9.1.2 Calibration Standards

TNT Calibration Standards

Working Stock (ppm)	Transfer[1] Volume (ml)	Final[2] Volume (ml acetone)	Water[3] Volume (ml)	Final Conc. (ppm)
40	0.5	100	3	0.2
40	1.0	100	3	0.4
40	2.0	100	3	0.8
40	5.0	50	1.5	4.0
40	10.0	50	1.5	8.0

[1] Transfer using to deliver serological pipettes.
[2] Bring up to final volume in volumetric flask with Acetone.
[3] Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 & 51.5 ml.

RDX Calibration Standards

Working Stock (ppm)	Transfer[1] Volume (ml)	Final[2] Volume (ml acetone)	Water[3] Volume (ml)	Final Conc. (ppm)
40	1.2	100	3	0.48
40	2.5	100	3	1.0
40	2.5	50	1.5	2.0
40	5	50	1.5	4.0
40	9	50	1.5	7.2

[1] Transfer using to deliver serological pipettes.
[2] Bring up to final volume in volumetric flask with Acetone.
[3] Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 & 51.5 ml.

9.1.3 Continuing Calibration Verification Standards

TNT 0.8 ppm

Working Stock (ppm)	Transfer[1] Volume (ml)	Final[2] Volume (ml acetone)	Water[3] Volume (ml)	Final Conc. (ppm)
40	2.0	100	3	0.8

[1] Transfer using serological pipettes.
[2] Bring up to final volume in volumetric flask with Acetone.
[3] Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 ml.

RDX 2.0 ppm

Working Stock (ppm)	Transfer[1] Volume (ml)	Final[2] Volume (ml acetone)	Water[3] Volume (ml)	Final Conc. (ppm)
40	5.0	100	3	2.0

[1] Transfer using serological pipettes.
[2] Bring up to final volume in volumetric flask with Acetone.
[3] Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 ml.

9.1.4 Laboratory Control Standards

The RDX and TNT LCS are prepared at the same time on the same aliquot of clean sand.

Sand Weight (g)	RDX Transfer Volume/Conc. (ml/ppm)	TNT Transfer Volume/Conc. (ml/ppm)	Water Volume (ml)	Acetone Volume (ml)	Final TNT/RDX Conc. PRM
20	5.0/40	2.0/40	3	93	0.8/2.0

Note: Typically the LCS is allowed to stand 1 hour after standard spiking and prior to water and solvent addition to allow the solvent to evaporate and the compound to come into contact with the soil. However, this is not done in this procedure due to large volume of spiking solutions being added.

9.2 Calibration

9.2.1 TNT Calibration

1. Zero spectrophotometer reading with an acetone blank.
2. Place a 25 ml aliquot of each prepared standard in a 30-ml bottle.
3. Add 4-5 KOH pellets and 0.5 g (excess) of Na_2SO_3 to each standard.
4. Cap bottle, shake, and allow a minimum of 10 minutes for color development.
5. Filter through syringe filter into cuvett and read absorbance at 540 nm.

9.2.2 RDX

1. To a measured 20 ml aliquot of each prepared standard in a 30 ml bottle, add 2 ml of acetic acid (using 10 ml sampling pipetor set to 2ml), mix and transfer to a prepared 60 ml syringe and filter unit containing ~0.3g of zinc powder.

2. Twelve seconds after pouring the standard solution into the syringe, insert the plunger and begin filtering the derivitized extract through the filter back into the original 30 ml container. Filtration must be continuous once initiated and at a rate that does not allow the extract to be in contact with the zinc for more than 25 seconds total.

3. Measure and transfer 5 ml of the filtered extract (using a 10 ml sampling pipetor set to 5ml) to a second 30 ml bottle containing 20 ml of DI water (measure and transfer using a 10 ml sampling pipetor).

4. Add content of one NitroVer 3 powder pillow.

5. Cap, shake, and allow a minimum of 15 minutes for color development.

6. Zero the spectrophotometer with DI water.

7. Measure absorbance of each standard at 507 nm.

9.3 Calculations and Acceptance Criteria

9.3.1 Response Factor

$$RF = \frac{CONC_{STD}}{ASB_{STD}}$$

where

RF = Response factor for a given standard as mg/l compound per absorbance unit,
$CONC_{STD}$ = Concentration of measured standard as mg/l,
ASBSTD = Absorbance reading of spectrophotometer for measured standard.

9.3.2 Relative Standard Deviation (% RSD)

$$\%RSD = \frac{RF_{SO}}{RF_{AVG}} \times 100$$

where

%RSD = Relative standard deviation as a percentage,
RF_{SO} = The standard deviation of all the RFs used in the calibration curve, (N is equal to 5 if all points are used or 4 if one point is eliminated)
RF_{AVG} = Average response factor for all the RFs used in the calibration curve.

9.3.3 Calibration Criteria

The calibration curve is acceptable if the % RSD is < 25%. Note the use of all 5 points is preferable; however, the elimination of one point and use of 4 points is acceptable.

9.4 Continuing Calibration Verification (CCV)

9.4.1 A CCV needs to be analyzed under the following circumstances:

- Start and end of each days work for each compound
- At the completion of a compound's analytical sequence prior to changing the spectrophotometer wavelength setting
- Prior to the start of the compound's analysis sequence after changing the spectrophotometer wavelength setting.

9.4.2 CCV Analysis

The CCV standard will be prepared as defined in Section 9.1.3 for the applicable compound. The CCV standard will be developed according to the steps defined in Section 9.2.1 for TNT and 9.2.2 for RDX.

9.4.3 CCV Calculations and Acceptance Criteria

Acceptance that the derivitization, color development, and spectrophotometric system is in control is based on the comparability of the found CCV concentration to the expected CCV concentration, (i.e., percent recovery; %R).

$$\%R = \frac{CCV_{\mathrm{MES}}}{CCV_{\mathrm{EXP}}} \times 100$$

where

%R = Percent recovered,
$\mathrm{CCV_{MES}}$ = Measured concentration of CCV using the RF from the applicable, calibration curve,
$\mathrm{CCV_{RXP}}$ = Concentration of the prepared standard used for the CCV.

A %R of 75-125% is acceptable and the system has been demonstrated to be in control. Recoveries outside this range will require appropriate corrective action and evaluation of results for affected samples.

10.0 SAMPLE PREPARATION AND ANALYSIS

10.1 Expendable Materials

The following expendable materials are needed for the analysis of a sample for both TNT and RDX.

1 – 250 ml polypropylene bottle with screw cap
3 – 60 ml syringes with fitted filters
3 – syringe filters
3 – 30 ml polypropylene bottles with screw cap
KOH pellets
Sodium sulfite
Zinc powder
1-HACH NitroVer 3 powder pillow

10.2 Sample Extraction

10.2.1 LCS and Method Blank

Weigh two 20 g aliquots of clean sand into two separate 250 ml bottles. Mark one bottle as the method blank and leave unspiked adding only 3 ml water and 100 ml acetone. Mark the second bottle as the LCS and prepare as defined in Section 9.1.4.

10.2.2 Sample Preparation

To an appropriate marked 250 ml bottle, weigh 20 g ± 0.5 g of soil/sediment sample and record to the nearest 0.1 g. Measure and add 100 ml of acetone to the soil cap and shake for a minimum of 3 minutes. Allow the bottle to set a reasonable amount of time and let the soil/sediment settle out.

For the TNT background color measurement and RDX analysis, pull 40 ml of acetone from above the sediment up through the filter into Syringe 1.

10.3 TNT Analysis

10.3.1 Color Development

For TNT analysis, remove the syringe plunger from Syringe 2 and place 4 to 5 KOH pellets and ~ 0.5 g of Na_2SO_3 into the syringe barrel and replace the plunger. Place the tip of the syringe filter into the acetone extract above the sediment and pull 25 ml of extract into the syringe. Shake and allow a minimum of 10 minutes for color development. (Note: color development rate can be temperature dependent; therefore, it may be necessary to allow more development time during cold weather.)

10.3.2 Background Measurement

Remove the filter from Syringe 1 (Section 10.2.2), and fill the 10 ml cuvett ¾ full. Measure the absorbance of the sample's background color at 540 nm on the spectrophotometer. Record the absorbance in the appropriate logbook form column.

10.3.3 TNT Color Measurement

After the color development time has elapsed, change the filter on the TNT color syringe (Syringe 2). Filter the colored extract into the 10 ml cuvett until it is ¾ full. Measure the absorbance of the sample at 540 nm on the spectrophotometer. Record the absorbance in the logbook.

Calculate the TNT concentration based on the formula in Section 11.1 and the applicable Average Response Factor from the applicable calibration curve.

10.4 RDX Analysis

10.4.1 Ion Exchange

Remove the filter from Syringe 1 (Section 10.2.2) and use the extract to fill the reservoir above the solid phase in the Supeleo Alumina-A ion exchange tube. (Note: Flow of the extract through the ion column should not exceed 5 ml/min. For the defined tubes, the acetone extract typically has a flow rate of 2 to 3 mls/min (an occasional check of the flow rate is recommended).

Discard the first 2 to 3 ml that passed through the column. Collect the next 20 ml of extract that passes through the column. Pour a measured 20 ml of the ion exchanged extract into a 30 ml bottle.

10.4.2 Derivitization

Add 2 ml of glacial acetic acid to the 20 mls of ion exchanged extract, using a preset and dedicated 10 ml sampling pipetor. (Note: In cold weather temperature <40°F arrangements need to be made to keep the acetic acid warm to keep it from crystallizing.) Transfer the entire contents of the 30 ml bottle to a prepared syringe containing ~0.3 g of dry zinc powder. Pour it into the barrel through the top with the plunger removed. After 12 seconds, replace the syringe plunger and begin to filter the derivitized extract back into the 30 ml bottle. The filtration needs to be consistent in starting at 12 seconds and not taking more than 10 to 15 seconds to complete.

10.4.3 RDX Color Development and Measurement

Measure and transfer 5 ml of the derivitized extract, using a dedicated preset sampling pipetor, to a second 30 ml bottle with 20 ml of DI water. Add the contents of one NitroVer 3 powder pillow, cap, mix, and allow 15 minutes for color development. (Note: set the remaining derivatized sample aside for re-analysis or dilutions, if necessary.)

After the color has developed, measure the absorbance at 507 nm on the spectrophotometer. Calculate the RDX concentration based on the Average Response Factor for the applicable calibration curve using the calculations found in Section 11.2.

11.0 CALCULATIONS

11.1 TNT Concentration

$$TNT_{CONC} = \frac{(ABS_{SMP} - 2XABS_{BKG}) \; X \; RF_{AVG} \; X \; DF}{WGT_{SMP}}$$

where

TNT_{CONC} = Concentration of TNT in sample as ppm wet weight,
ASB_{SMP} = Absorbance reading for the color developed sample extract,
ASB_{BKG} = Absorbance reading for the background or non-color developed sample extract,
RF_{AVG} = Average response factor for applicable calibration curve,
DF = Dilution factor (when applicable),
WGT_{SMP} = Weight of sample aliquot used for extraction and analysis.

11.2 RDX Concentration

$$RDX_{CONC} = \frac{ASB_{SMP} \; X \; RF_{AVG} \; X \; DF}{WGT_{SMP}}$$

where

RDX_{CONC} = Concentration of RDX in the sample as ppm wet weight,
ASB_{SMP} = Absorbance reading for the color developed sample extract,
RF_{AVG} = Average response factor for applicable calibration curve,
DF = Dilution factor (when applicable),
WGT_{SMP} = Weight of sample aliquot used for extraction and analysis.

12.0 Quality Control

12.1 Method Blank (MB)

Prepared as defined in Section 10.2.1. A MB is analyzed daily with first batch of samples processed and at a frequency of 1 per 20 samples, thereafter. The method blank is acceptable when the calculated concentration does not exceed 1.0 ppm for TNT or 2.0 ppm for RDX.

12.2 Laboratory Control Sample (LCS)

Prepared as defined in Section 10.2.2. The LCS is analyzed daily with first batch of samples processed and at a frequency of 1 per 20 samples thereafter. Acceptable if %R is 60-140%.

12.3 Duplicate Analysis (DUP)

One laboratory duplicate analysis is performed for every 20 field samples analyzed. Samples for duplicate analysis can be selected at a later time based on samples having a positive result. Acceptable if RPD values are <50% for samples with concentrations >10 ppm and <90% for sample concentrations <10 ppm. (Note: Method resolution needs to be taken into consideration before accepting or rejecting duplicate analysis.)

12.4 Reporting Limit

The lower reporting limit is calculated based on the concentration of the lowest standard used in the applicable calibration curve adjusted for the extraction volume and sample weight.

12.5 QC Summary

QC Parameter	Frequency	Acceptance criteria
Calibration curve	Start of project; major change to instrument or procedure; failure of CCV	% RSD < 25%
CCV	Start of day End of day Before and after changing spectrophotometer wavelength	%R 75 ± 125%
Method blank	1 per day and as needed to achieve 1 per 20 ratio	< 1 ppm TNT < 2 ppm RDX
LCS	1 per day and as needed to achieve 1 per 20 ratio	%R 60-140%
Analytical duplicate	1 per 20 samples; preferable on samples with positive hits	Concentrations > 10 ppm RPD < 50% Concentrations < 10 ppm RPD < 90%

13.0 ANALYTICAL WASTE

The major waste generated during the implementation of this procedure will be extract solutions and colored complex solutions. These solutions are caustic flammable solvent wastes and should be handled as such. These wastes must be properly containerized and labeled. Coordination must be established with the site waste manager, and disposal must be in accordance with the site Waste Management Plan.

Other general waste generated during the analysis should not represent a chemical or biological hazard, however, proper site handling and disposal procedures should be implemented.

14.0 EQUIPMENT AND SUPPLIES

14.1 NONEXPENDABLE

Item	Supplier	Catalog No.	Units	Order
DR2010 Spectrophotometer	HACH	DR2010	ea	1
10 ml DR2010 matched cuvetts	HACH	24954-02	pair	3
Top-loading balance	Cole Palmer	E11300-06	ea	1
10 ml Polypropylene seralogical pipets	Fisher	13-662-12D	ea	2
Pipet safety bulb	Fisher	13-681-51	ea	3
10 ml Sampling respirator	Fisher	13-689-26	ea	3
10 ml Polypropylene graduated cylinder	Fisher	08-572A	ea	8
50 ml Polypropylene graduated cylinder	Fisher	08-572C	ea	3
100 ml Polypropylene graduated cylinder	Fisher	08-572D	ea	3
Dessicator Cabinet	Fisher	08-647-20	ea	1
Deseccant Cans	Fisher	01-952-5	ea	2
50 ml Propylene volumetric flask	Fisher	10-198-50A	ea	5
100 ml Propylene volumetric flask	Fisher	10-198-50B	ea	5
25 ml glass volumetric flask	Fisher	10-200A	ea	3
Acetone washbottle	Fisher	03-409-23A	pkg/6	1
Water washbottle	Fisher	03-409-23G	pkg/6	1
0.250 ml Hamilton gastight syringe	Fisher	13-684-102	ea	2
2.5 ml Hamilton gastight syringe	Fisher	13-684-110	ea	3

14.2 EXPENDABLE

Item	Supplier	Catalog No.	Units	Order
60 ml disposable syringe Luer lock	Fisher	14-823-2D	Case/120	3
25 mm; 0.45 nylon; polypropylene housing syringe filters	Fisher	09-740-35Q	case/300	2
Acetone	local paint or hardware supplier		gal.	3
Zinc powder technical grade	Fisher	25-500	500g	1
DI water	Fisher	W2-4	Ll	2
Sodium sulfide technical; granular	Fisher	5447-500	500 g	1
Potassium hydroxide technical; pellets	Fisher	P250-500	500 g	1
Acetic acid glacial	Fisher	A385-500	500 ml	1
Polypropylene bottles 250 ml	Fisher	03-083-52	case/72	1
Polypropylene bottles 30 ml	Fisher	03-083-49	case/72	1
Alumina A SPME column	Supeko	5-70834	30/pkg	4
25 ml NitroVer3 powder pillow	HACH	14034-99	100/pkg	2
Sampling respirator tips	Fisher	D7-101	100/pkg	2
RDX standard 1,000 ppm in acetonitrile	Accustandard		ea	4
TNT standard 1,000 ppm in methanol	Accustandard		ea	4
Tongue depressors	Fisher	01-346	1200/box	1
100 ml Tripour polypropylene beaker	Fisher	02-593-50F	pkg/100	1

FINAL

PART II

QUALITY ASSURANCE PROJECT PLAN ADDENDUM NO. 1 FOR THE WBG FEASIBILITY STUDY AT THE RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

October 2000

Prepared for

U.S. Army Corps of Engineers
Louisville District
Contract No. DACA 62-00-D-0001
Delivery Order No. CY08

Prepared by

Science Applications International Corporation
800 Oak Ridge Turnpike, P.O. Box 2502
Oak Ridge, Tennessee 37831

CONTENTS

PART II – QUALITY ASSURANCE PROJECT PLAN ADDENDUM

TABLES v
ABBREVIATIONS v
INTRODUCTION vii

1.0 PROJECT DESCRIPTION 1-1
  1.1 SITE HISTORY/BACKGROUND INFORMATION 1-1
  1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS 1-1
  1.3 PROJECT OBJECTIVES AND SCOPE 1-1
  1.4 SAMPLE NETWORK DESIGN AND RATIONALE 1-1
  1.5 PARAMETERS TO BE TESTED AND FREQUENCY 1-1
  1.6 PROJECT SCHEDULE 1-1

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY 2-1

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT 3-1
  3.1 DATA QUALITY OBJECTIVES 3-1
  3.2 LEVEL OF QUALITY CONTROL EFFORT 3-1
  3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS 3-1
  3.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY 3-1

4.0 SAMPLING PROCEDURES 4-1

5.0 SAMPLE CUSTODY 5-1
  5.1 FIELD CHAIN-OF-CUSTODY PROCEDURES 5-1
  5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES 5-1
  5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES 5-1

6.0 CALIBRATION PROCEDURES AND FREQUENCY 6-1
  6.1 FIELD INSTRUMENTS/EQUIPMENT 6-1
  6.2 LABORATORY INSTRUMENTS 6-1

7.0 ANALYTICAL PROCEDURES 7-1
  7.1 LABORATORY ANALYSIS 7-1
  7.2 FIELD SCREENING ANALYTICAL PROTOCOLS 7-2

8.0 INTERNAL QUALITY CONTROL CHECKS 8-1
  8.1 FIELD SAMPLE COLLECTION 8-1
  8.2 FIELD MEASUREMENT 8-1
  8.3 LABORATORY ANALYSIS 8-1

9.0 DATA REDUCTION, VALIDATION, AND REPORTING 9-1
  9.1 DATA REDUCTION 9-1
  9.2 DATA VALIDATION 9-1
  9.3 DATA REPORTING 9-1

10.0 PERFORMANCE AND SYSTEM AUDITS 10-1
  10.1 FIELD AUDITS 10-1
  10.2 LABORATORY AUDITS 10-1

11.0 PREVENTIVE MAINTENANCE PROCEDURES 11-1
  11.1 FIELD INSTRUMENTS AND EQUIPMENT 11-1
  11.2 LABORATORY INSTRUMENTS 11-1

12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS 12-1
  12.1 FIELD MEASUREMENTS DATA 12-1
  12.2 LABORATORY DATA 12-1

13.0 CORRECTIVE ACTIONS 13-1
  13.1 SAMPLE COLLECTION/FIELD MEASUREMENTS 13-1
  13.2 LABORATORY ANALYSES 13-1

14.0 QA REPORTS TO MANAGEMENT 14-1

15.0 REFERENCES 15-1

TABLES

1-1 Sampling and Analytical Requirements for the WBG FS....1-2
4-1 Container Requirements for Water, Soil, and Sediment Samples for the WBG FS at Ravenna Army Ammunition Plant....4-2

ABBREVIATIONS

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
FSP	Field Sampling Plan
HTRW	Hazardous, Toxic, and Radioactive Waste
LCS	laboratory control sample
MS	matrix spike
MSD	matrix spike duplicate
QA	quality assurance
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project Plan
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
STL	Severn Trent Laboratories
TAL	Target Analyte List
TCL	Target Compound List
TNT	trinitrotoluene
USACE	U.S. Army Corps of Engineers
XRF	X-ray fluorescence

THIS PAGE INTENTIONALLY LEFT BLANK

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), which is currently issued as a draft revision under review (USACE 2000a). Any additional relevant requirements specified by the final revision of the revised Facility-wide QAPP will be addressed by field change order or addendum, as appropriate. Each QAPP section is presented documenting adherence to the Facility-wide QAPP or stipulating project-specific addendum requirements.

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 PROJECT DESCRIPTION

1.1 SITE HISTORY/BACKGROUND INFORMATION

This information is contained in Section 1.1 of the Field Sampling Plan (FSP) of the Winklepeck Burning Ground (WBG) Feasibility Study (FS) Sampling and Analysis Plan (SAP) Addendum No. 1.

1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS

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

1.3 PROJECT OBJECTIVES AND SCOPE

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

1.4 SAMPLE NETWORK DESIGN AND RATIONALE

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

1.5 PARAMETERS TO BE TESTED AND FREQUENCY

Sample matrix types, analytical parameters, and analytical methods are discussed in Chapter 4.0 of the FSP of the WBG FS SAP Addendum. These sampling and analysis requirements are summarized in Table 1-1 of this Quality Assurance Project Plan (QAPP) Addendum, in conjunction with anticipated sample numbers, quality assurance (QA) sample frequencies, and field quality control (QC) sample frequencies.

1.6 PROJECT SCHEDULE

The WBG FS project schedule is discussed in Chapter 2.0 of the FSP of the SAP Addendum.

Table 1-1. Sampling and Analytical Requirements for the WBG FS

Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water[a]	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE QA Split Samples	USACE Trip Blanks
Soils									
Volatile Organics, TCL	SW-846, 5030/8260B	13	1	-	-	-	14	1	-
Semivolatile Organics, TCL	SW-846, 3540/8270C	13	1	-	-	-	14	1	-
Pesticides, TCL	SW-846, 3540/8081A	13	1				14	1	
PCBs, TCL	SW-846, 3540/8082	13	1	-	-	-	14	1	-
Explosives	SW-846, 8330	56	6	-	-	-	62	6	-
Propellants	SW-846, 8330/9056	5	1	-	-	-	6	1	-
Metals, TAL	SW-846, 6010B/7471	158	16	-	-	-	174	16	-
Cyanide	SW-846, 9011/9010	13	1	-	-	-	14	1	-
Hexavalent Chromium	SW-846, 7196A	38	4	-	-	-	42	4	-
TOC	Walkley/Black Method	4	-	-	-	-	4	-	-
Grain Size (sieve)	ASTM D422	4	-	-	-	-	4	-	-
Moisture Content	ASTM D2216	4	-	-	-	-	4	-	-
Atterberg Limits	ASTM D4318	4	-	-	-	-	4	-	-
USCS Classification	N/A	4	-	-	-	-	4	-	-
Bulk Density	ASTM D4531	4	-	-	-	-	4	-	-
Porosity	EM1110-2-1906	4	-	-	-	-	4	-	-
Hydraulic Cond.	ASTM D5084	4	-	-	-	-	4	-	-
Specific Gravity	ASTM D854	4	-	-	-	-	4	-	-
Redox Potential	ASTM D1498	4	-	-	-	-	4	-	-
pH	SW-846 9045	4	-	-	-	-	4	-	-
Sediments									
Volatile Organics, TCL	SW-846, 5030/8260B	2	-	-	-	-	2	-	-
Semivolatile Organics, TCL	SW-846, 3540/8270C	2	-	-	-	-	2	-	-
Pesticides, TCL	SW-846, 3540/8081A	2	-	-	-	-	2	-	-
PCBs	SW-846, 3540/8082	2	-	-	-	-	2	-	-
Explosives	SW-846, 8330	2	-	-	-	-	2	-	-
Propellants	SW-846, 8330/9056	2	-	-	-	-	2	-	-
Metals, TAL	SW-846, 6010B/7471	2	-	-	-	-	2	-	-
Hexavalent Chromium	SW-846, 7196A	2	-	-	-	-	2	2	-
Cyanide	SW-846, 9011/9010	2	-	-	-	-	2	-	-

Table 1-1. Sampling and Analytical Requirements for the WBG FS (continued)

Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water[a]	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE QA Split Samples	USACE Trip Blanks
TOC	Walkley/Black Method	2	-	-	-	-	2	-	-
Atterberg limits	ASTM D4318	2	-	-	-	-	2	-	-
Grain Size (sieve)	ASTM D422	2	-	-	-	-	2	-	-
Moisture Content	ASTM D2216	2	-	-	-	-	2	-	-
USCS Classification	N/A	2	-	-	-	-	2	-	-
Surface Waters/Ground Waters									
Volatile Organics, TCL	SW-846, 5030/8260B	17	2	2	1	4	26	2	2
Semivolatile Organics, TCL	SW-846, 3520/8270C	17	2	2	1	-	22	2	-
Pesticides, TCL	SW-846, 3520/8081A	17	2	2	1	-	22	2	-
PCBs, TCL	SW-846, 3520/8082	17	2	2	1	-	22	2	-
Explosives	SW-846, 8330	17	2	2	1	-	22	2	-
Propellants	SW-846, 8330/9056	17	2	2	1	-	22	2	-
Metals (total), TAL	SW-846, 6010A/7470	17	2	2	1	-	22	2	-
Cyanide	SW-846, 9010	17	2	2	1		22	2	-

[a] Source waters = one potable water source and one ASTM water supply lot for the project.

A-E = Architect-Engineer
TCL = Target Compound List
TAL = Target Analyte List
QA = Quality Assurance
USACE = U.S. Army Corps of Engineers
RVAAP = Ravenna Army Ammunition Plant
EPA = U.S. Environmental Protection Agency
ASTM = American Society of Testing and Materials
EM = Engineering Manual (USACE)

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 WBG FS SAP Addendum No. 1.

Analytical support for this work has been assigned to Severn Trent Laboratories, Inc. (STL) (formerly Quanterra). The majority of analysis will be completed by STL's North Canton, Ohio facility, with explosive determinations being performed by the Knoxville, Tennessee facility and nitrocellulose/nitroguanidine analyses being performed by the Sacramento, California facility. These laboratories have been validated by the U.S. Army Corp of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX), Omaha, Nebraska. Severn Trent Laboratories' Quality Assurance Management Plan (QAMP), Revision 3, November 1998, is available for review upon request. The laboratory's organizational structure, roles, and responsibilities are identified in Section 1 of their QAMP and facility-specific appendices. Addresses and telephone numbers for each of the STL facilities are as follows:

Severn Trent Laboratories, Inc. – general analytical services:
North Canton, OH Facility
4101 Shuffel Drive, N.W.
North Canton, OH 44720

Tel: (330) 497-9396
Fax: (330) 497-0772

Severn Trent Laboratories, Inc. – explosives analyses:
Knoxville, TN Facility
5815 Middlebrook Pike
Knoxville, TN 37921

Tel: (423) 588-6401
Fax: (423) 584-4315

Severn Trent Laboratories, Inc. – nitrocellulose/nitroguanidine analyses:
Sacramento, CA Facility
880 Riverside Parkway
West Sacramento, CA 95605

Tel: (916) 373-5600
Fax: (916) 372-1059

S&ME, Inc. – soil and sediment geotechnical analyses:
Louisville, TN Facility
1413 Topside Road
Louisville, TN 37777

Tel: (865) 970-0003
Fax: (865) 970-2312

Field analytical support for colorimetric analysis of trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) will be provided by the Science Applications International Corporation (SAIC) field team. Also, X-ray fluorescence (XRF) metal determinations will be provided by Onsite Environmental Laboratories headquartered in Fremont, California (Tel: 510-490-8570, Fax: 510-490-8572).

Split (QA) samples will be submitted to the following USACE-approved contract laboratory for independent analysis: Environdata Group, ATTN: Bob King, 2520 Regency Road, Lexington, KY 40503, (800) 489-3506 or (800) 278-5665.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

3.1 DATA QUALITY OBJECTIVES

Summaries of the data quality objectives (DQO) for this investigation will follow Tables 3-1 and 3-2 in the Facility-wide QAPP. All QC parameters stated in the specific U.S. Environmental Protection Agency (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 (e.g., 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, 2 Nov 98 (USACE 1998) and Environmental Data Assurance Guideline, USACE-Louisville, May 2000 (USACE 2000b) 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 (LCS), laboratory duplicates, and matrix spike/matrix spike duplicate (MS/MSD) samples.

3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS

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.

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 for the WBG FS.

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.

Table 4-1. Container Requirements for Water, Soil, and Sediment Samples for the WBG FS at Ravenna Army Ammunition Plant[a]

Analyte Group	Approx. No. of Containers incl. Field QC	Container	Minimum Sample Size	Preservative	Holding Time
		Groundwater and Surface Water			
Volatile Organic Compounds	90	Three, 40-mL glass vials with Teflon®-lined septum (no headspace)	80 mL	HCl to pH <2 Cool, 4°C	14 days
Semivolatile Organic Compounds	48	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Pesticide Compounds	48	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
PCB Compounds	48	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Explosive Compounds	48	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Propellant Compounds	48	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Metals (total)	24	1-L polybottle	500 mL	HNO_3 to pH <2 Cool, 4°C	180 days
Cyanide	24	1-L polybottle	500 mL	NaOH to pH >12 Cool, 4°C	14 days
		Soils and Sediments			
Volatile Organic Compounds	17	One 2-ounce Glass jar with Teflon-lined cap (no headspace	20 grams	Cool, 4°C	14 days
Semivolatile Organic Compounds	17	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Pesticide Compounds	-	One 4-ounce glass jar with Teflon-lined cap Use same container as SVOC.	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
PCB Compounds	-	Use same container as SVOC where possible.	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Explosive Compounds	70	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Propellant Compounds	9	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Metals	192	One 4-ounce wide-mouth poly bottle	50 grams	Cool, 4°C	180 days
Cyanide	-	Use same container as metals	25 grams	Cool, 4°C	14 days
Total Organic Carbon	6	One 4-ounce glass jar with Teflon-lined cap	10 grams	Cool, 4°C	28 days
Geotechnical Parameters	6	Shelby Tube (undisturbed) or 32-ounce wide-mouth container (disturbed)	1000 grams	None	None

[a] One sample will be tripled in volume for the laboratory to perform appropriate laboratory quality control analysis.
PCB = polychlorinated biphenyl
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 chain of custody (COC) will follow handling and custody procedures identified in Section 8.5.3 of the STL QAMP.

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 Section 8.5.4 of the STL QAMP, 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.

STL’s QAMP Section 8.0 and the facility-specific addenda for the North Canton, Knoxville, and Sacramento facilities 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 Method 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 Waters and Soils, 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.
- Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, Rev. 2, 2/15/99.
- 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.

STL 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.

STL 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.

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 FSP of this SAP Addendum. Only screening of samples for organic vapors using a photoionization detector will be conducted. Headspace analysis will not be conducted.

Field screening analysis for 2,4,6-trinitrotoluene (2,4,6-TNT) and RDX will be performed using the RVAAP Standard Operating Procedure "Field Method for Determination of 2,4,6-TNT and RDX in Soil and Sediment." This SOP is a formal attachment to the Facility-wide QAPP and is contained in Appendix C of the SAP Addendum.

Field screening analysis for metals will be performed using the SW846 Method 6200 "Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment."

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 FSP of this SAP Addendum. In general, field duplicates will be collected at a frequency of 10%, field equipment rinsates and blanks will be collected at a frequency of 10% for samples collected with non-dedicated equipment, and volatile organic trip blanks will accompany all shipments containing volatile organic water samples.

8.2 FIELD MEASUREMENT

Refer to Chapter 4.0 of the FSP of this SAP Addendum for details regarding these measurements. In addition, refer to the field screening methods for TNT, RDX, and metals.

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.

STL facilities will conform to their QAMP, 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 Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b).

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 this WBG FS SAP Addendum. Laboratory data reduction will follow Severn Trent's QAMP (Section 8.6) guidance and conform to general direction provided by the Facility-wide QAPP, the USACE Shell Document (USACE 1998), and the Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b).

9.2 DATA VALIDATION

Validation of 10% of the data will follow the direction provided in the Facility-wide QAPP and the Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b). An independent data validation subcontractor qualified by USACE Louisville District will perform this data validation.

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

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 SAIC QA Officer and/or the SAIC Field Team Leader. This audit will encompass the sampling of groundwater, surface water, soil, and sediment from the wells, ditches, ponds, land areas, and storm and sanitary sewers. Surveillances will follow SAIC QAPP No. 18.3.

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 STL’s QA staff as defined in the laboratory QAMP, Section 9.2.

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 Section 8.11 of STL's QAMP.

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 Section 9.1 of STL’s QAMP.

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 Section 9.4 of STL's QAMP.

15.0 REFERENCES

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

USACE (U.S. Army Corps of Engineers) 2000a. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-00-D-0001, Delivery Order CY02, Draft, July 2000.

USACE (U.S. Army Corps of Engineers) 2000b. *Environmental Data Quality Assurance Guideline, Louisville District*, May 2000 (Draft).

Additional references to the Facility-wide QAPP are:

STL (Severen-Trent Laboratories, Inc.) 1998. *Quality Assurance Management Plan*, Revision 3, November 2, 1998.

GC/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.

Gas Chromatographic Analysis Based on Method 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 Waters and Soils, 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.

Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, Rev. 2, 2/15/99.

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, SW-846 7471A and MCAWW 245.5, CORP-MT-0007NC, Rev. 1.1, 04/17/97.

Analysis of Nitroaromatic and Nitramine Explosives by High Performance Liquid Chromatography, KNOX-LC-0001, Rev. 1, 04/28/97.

Preparation and Analysis of Nitrocellulose in Aqueous, Soil, and Sediments by Colorimetric Autoanalyzer, SAC-WC-0500, Rev. 0.0.

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.

FINAL

SITE SAFETY AND HEALTH PLAN ADDENDUM NO. 1

FOR THE

WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY

RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

PREPARED FOR

US Army Corps of Engineers®

LOUISVILLE DISTRICT

CONTRACT No. DACA62-00-D-0001
DELIVERY ORDER CY08

October 2000

SAIC

00-240P(doc)(SSHP)/100400

FINAL

SITE SAFETY AND HEALTH PLAN ADDENDUM NO. 1 FOR THE WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY, RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

October 2000

Prepared for

U.S. Army Corps of Engineers
Louisville District
Contract No. DACA62-00-D-0001
Delivery Order No. CY08

Prepared by

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
800 Oak Ridge Turnpike, P.O. Box 2502
Oak Ridge, Tennessee 37831

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not
be considered an eligible contractor for its review.

APPROVALS

SITE SAFETY AND HEALTH PLAN ADDENDUM NO. 1
FOR THE
WINKLEPECK BURNING GROUNDS FEASIBILITY STUDY,
RAVENNA ARMY AMMUNITION PLANT,
RAVENNA, OHIO

October 2000

10/10/00

Kevin Jago, Phone 865-481-4614 Date
SAIC Project Manager

10/5/2000

Stephen Davis, CIH (#4213), CSP (#10044), Phone 865-481-4755 Date
Health and Safety Officer and SSHP preparer

CONTENTS

TABLES v

ACRONYMS vii

INTRODUCTION ix

1.0 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION 1-1
  1.1 SITE DESCRIPTION 1-1
  1.2 CONTAMINANTS 1-1

2.0 HAZARD/RISK ANALYSIS 2-1
  2.1 TASK-SPECIFIC HAZARD ANALYSIS 2-2
  2.2 POTENTIAL EXPOSURES 2-2

3.0 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES 3-1

4.0 TRAINING 4-1

5.0 PERSONAL PROTECTIVE EQUIPMENT 5-1

6.0 MEDICAL SURVEILLANCE 6-1

7.0 EXPOSURE MONITORING/AIR SAMPLING PROGRAM 7-1

8.0 HEAT/COLD STRESS MONITORING 8-1

9.0 STANDARD OPERATING SAFETY PROCEDURES 9-1

10.0 SITE CONTROL MEASURES 10-1

11.0 PERSONNEL HYGIENE AND DECONTAMINATION 11-1

12.0 EMERGENCY PROCEDURES AND EQUIPMENT 12-1

13.0 LOGS, REPORTS, AND RECORD KEEPING 13-1

14.0 REFERENCES 14-1

TABLES

1-1 Maximum Concentrations of Principal Contaminants at WBG 1-2
2-1 Hazards Inventory 2-1
2-2 Hazards Analysis 2-3
2-3 Potential Exposures 2-16
3-1 Staff Organization 3-1
7-1 Monitoring Requirements and Action Limits 7-2

ACRONYMS

CIH	Certified Industrial Hygienist
CPR	cardiopulmonary resuscitation
CSP	Certified Safety Professional
DNT	dinitrotoluene
EC&HS	Environmental Compliance and Health and Safety
FP	flash point
FSHP	Facility-wide Safety and Health Plan
GFCI	ground-fault circuit interrupter
H&S	Health and Safety
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IDLH	immediately dangerous to life and health
IDW	investigation-derived waste
IP	ionization potential
LEL	lower explosive limit
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
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
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SSHO	Site Safety and Health Officer
SSHP	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
VP	vapor pressure
WBG	Winklepeck Burning Ground

INTRODUCTION

Science Applications International Corporation's (SAIC's) formal policy, stated in the Environmental Compliance and Health and Safety (EC&HS) Program manual, is to take every reasonable precaution to protect the health and safety of our employees, the public, and the environment. To this end, the Ravenna Army Ammunition Plant (RVAAP) Facility-wide Safety and Health Plan (FSHP) and this Site Safety and Health Plan (SSHP) Addendum collectively set forth the specific procedures required to protect SAIC and SAIC subcontractor personnel involved in the field activities. SAIC activities are also subject to the requirements of the SAIC corporate EC&HS Program and procedures. 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 FSHP addresses program issues and hazards and hazard controls common to the entire installation. This SSHP Addendum to the FSHP serves as the lower tier document addressing the hazards and controls specific to this project. Copies of the FSHP and this SSHP Addendum will be present at the work site during all fieldwork.

SAIC will perform field investigations at the Winklepeck Burning Grounds (WBG). This area was used for the open burning of munitions and propellants and is contaminated with residues of these activities. Previous investigations have indicated that the site is contaminated with residues of various explosives as well as metals.

Planned site activities consist of environmental sampling and support tasks. These tasks include soil sampling, sediment sampling, drilling and monitoring well installation, groundwater sampling, brush clearing, civil surveying, equipment decontamination, and operation of field metals and explosives laboratories.

The most significant hazards associated with this project are: (1) the potential to encounter unexploded ordnance, (2) physical hazards associated with equipment, and (3) contact with contaminants in the soil. Unexploded ordnance has been discovered in several locations at the WBG. Physical hazards are associated with power augers, drilling and Geoprobe equipment, and hand-operated power tools (chainsaw, etc.). The potential for chemical overexposure appears to be low given the nature of planned tasks. All of the contaminants have low vapor pressures, making overexposure through vapor inhalation very unlikely. All of the planned tasks pose minimal potential for creating airborne particulates. There is some potential for adverse effects due to dermal contact with contaminated soil. The crew will use protective gloves 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. Task-specific hazard controls have been specified for the major tasks. The SSHO will observe all site tasks during daily safety inspections and will use professional judgement, potentially coupled with instrument readings, 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, unless one of several action levels is exceeded or the potential for increased risk becomes apparent during the investigation. Protective procedures, including protective clothing, will be upgraded as necessary by the SSHO based on established action levels or judgment.

1.0 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

1.1 SITE DESCRIPTION

Ravenna Army Ammunition Plant (RVAAP) is located in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 km (3 miles) northeast of the Town of Ravenna. The installation consists of 8668 ha (21,419 acres) in a 17.7-km (11-mile) long, 5.6-km (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. Munitions handled on the installation included artillery rounds of 90 mm or more and 2000-pound bombs.

The Winklepeck Burning Grounds (WBG) is an area of approximately 200 acres that was used for the open burning of munitions and propellants including hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), antimony sulfide, Composition B, lead azide, 2,4,6-trinitrotoluene (TNT), propellant, black powder, waste oils, sludge from load lines, domestic waste, and small amounts of laboratory chemicals. Before 1980, burning occurred in pits, on pads, and on roads within the area. After 1980, burning was limited to one pad (Pad#37) and was conducted in raised refractory-lined trays. Number 2 fuel oil was used to facilitate the burning process. The burn trays were removed in 1998 and no burning has been conducted after that time. All facilities at WBG have either been closed or are in the process of closure. Data from prior studies indicate that WBG is contaminated with explosives residues and metals. The area is currently unused and is covered by vegetation. The vegetation ranges from forest to relatively open areas covered by grasses and weeds.

1.2 CONTAMINANTS

Table 1-1 lists contaminants known to occur in soil at the WBG. Inclusion in this table indicates the potential to encounter a contaminant during field activities, but does not necessarily indicate that the contaminant is present in sufficient quantity to pose a health risk to workers.

Table 1-1. Maximum Concentrations of Principal Contaminants at WBG

Contaminant	Maximum Reported Concentration[a]
Chromium	189 mg/kg in surface soil
Cadmium	877 mg/kg in surface soil
Chloroform	0.002 mg/kg in surface soil
DNT	1 mg/kg in surface soil
HMX	1,700 mg/kg in surface soil
Lead	2,200 mg/kg in surface soil
Nitrocellulose	315 mg/kg in surface soil
Phenanthrene	2.4 mg/kg in surface soil
Pyrene	2.1 mg/kg in surface soil
RDX	9,500 mg/kg in surface soil
TNB	490 mg/kg in surface soil
TNT	3,800 mg/kg in surface soil

[a] *Source*: *Phase II Remedial Investigation of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio, Draft Final, August 1999*.

DNT = dinitrotoluene

HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine

RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine

TNB = trinitrotoluene

TNT = 2,4,6-trinitrotoluene

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 (power augers, drill rigs, Geoprobe, chainsaws)
X		Fire and explosion (fuels)
X		Electrical shock (utilities and tools)
X		Exposure to chemicals (contaminants and chemical tools)
X		Temperature extremes
X		Biological hazards (poison ivy, Lyme disease)
X		Radiation or radioactive contamination (XRF instrument with radiation sources)
X		Noise (power auger, drill rig, Geoprobe, chainsaws)
	X	Drowning (no surface water sampling or work near water is planned)
X		OE (potential to encounter unexploded ordnance)

OE = ordnance and explosives

Specific tasks are as follows:

- soil sampling with hand augers or scoops;
- soil sampling with hand-operated power augers;
- vegetation clearing with machetes and chainsaws;
- sediment sampling from shallow ditches;
- field screening for metals conducted by a Science Applications International Corporation (SAIC) subcontractor in an on-site laboratory;
- field screening for explosives using colorimetric tests conducted by SAIC personnel;
- civil surveying;
- investigation-derived waste (IDW) handling and disposition;
- subsurface soil sampling, and monitoring well installation using Geoprobe rigs and 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

Prior sampling results indicate that the primary contaminants of concern are metals and explosives residues. Information on the potential contaminants, as well as the reagents and chemicals that will be used for the project is contained in Table 2-3. Exposure to chemical tools such as corrosive sample preservatives or flammable fuels is a possibility and will be controlled through standard safe handling practices.

Table 2-2. Hazards Analysis

Safety and Health Hazards	Controls	Monitoring Requirements
Civil surveys, visual surveys and similar non-intrusive activities		
General safety hazards (moving equipment, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, hardhats if overhead hazards are present. (See Section 5.0 of the FSHP). Hazardous waste safety (40-hour) and site-specific training, buddy system, proper housekeeping. At least two personnel on site with first aid and CPR training.	Daily safety inspections.
Contact with OE	Pre-entry screening survey and continuous escort by OE specialist support. On-site training in ordnance recognition for all field personnel. Withdrawal of all SAIC and subcontractor personnel from immediate area and field marking of suspect area if ordnance or suspected ordnance is discovered.	Visual and instrument surveys for ordnance conducted by OE expert personnel.
Exposure to chemicals	Nitrile or similar gloves for contact with potentially contaminated material. Gloves will be disposed after single use. Washing 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 on Saturdays during season, October and November)	Fieldwork will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day (See Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (See Section 9.0 of FSHP).	Visual survey.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.
Field screening for explosives in samples using colorimetric analyses		
General safety hazards (splash, cuts, slips, falls)	Level D PPE, including goggles or safety glasses and nitrile or PVC gloves to handle samples (see Section 5.0 of FSHP). Screening will be conducted in compliance with the Standard Operating Procedure for Field Colorimetric Analysis of Explosives for Ravenna Army Ammunition Plant, Ravenna, Ohio. Hazardous waste safety (40-hour) and site-specific training, buddy system, proper housekeeping. Exclude unauthorized personnel. At least two personnel on site will have CPR and first aid training.	Daily site safety inspections .
Noise	None, unless SSHO determines that equipment potentially exceeds 85 dBA.	Daily safety inspection.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Fire (fuels/solvents)	Screening area marked by signs indicating "No Smoking or Open Flames" or equivalent signage. Powered exhaust ventilation turned on before beginning screening each day and allowed to run until the screening activities are completed. Acetone containers kept closed or placed in outside area to vent. No containers of flammable solvent left open overnight. Fire extinguisher rated ABC within 50 feet. No ignition sources in screening area. Flammables cabinet for indoor storage of ≥25 gallons of flammable material.	Daily site safety inspections.
Exposure to chemicals	PPE (Level D) including goggles or safety glasses, nitrile or PVC gloves to handle samples and chemicals. Forced exhaust ventilation (this can be a tight-fitting fan mounted in a window and positioned to blow out the window) must be provided and screening must be performed immediately in front of the exhaust so that vapors are carried from the work area. Exhaust must be turned on before beginning screening each day and allowed to operate until screening activities are complete. No foodstuffs stored or consumed in the screening area. Wash face and hands prior to taking anything by mouth. Medical clearance for HAZARDOUS WASTE work. 15-minute eyewash within 100 feet. Site training must include hazards and controls of exposure to contaminants and chemicals used on site. MSDSs kept on site. All chemical containers labeled with contents and hazard.	Daily site safety inspections. PID or equivalent monitoring during initial sample screening to verify that exposure controls are adequate.
Electrical shock	GFCI for all electrical hand tools.	Daily safety inspection.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.
	Metals analysis by XRF performed by SAIC subcontractor in field laboratory	
General safety hazards (slips, falls)	Subcontractor personnel must comply with requirements for relevant task if they participate or closely observe activities other than laboratory analyses. The subcontractor must have standard procedures specifying training and other hazard controls to meet all applicable OSHA requirements and the procedures must be available on site. The subcontractor team leader must have documented training and experience in the operation of the XRF instrument. The XRF instrument must be operated in compliance with applicable OSHA and NRC requirements. Exclude unauthorized personnel.	Daily safety inspections conducted by laboratory supervisor.
Radiation or radioactive contamination	The XRF instrument must be operated and maintained in compliance with the manufacturer's instructions and applicable NRC and OSHA requirements. Monitoring of employee exposure must be conducted in compliance with the manufacturer's instructions and applicable NRC and OSHA requirements.	As required by subcontractor's standard procedures.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Fire (fuels/solvents)	Flammable materials, such as solvents must be treated so as to prevent flammable atmospheres. Fire extinguisher rated ABC must be kept in or near the laboratory and must be inspected monthly and serviced annually. Flammables cabinet for indoor storage of ≥25 gallons of flammable material.	Daily safety inspections conducted by subcontractor supervisor.
Exposure to chemicals	Subcontractor must have standard procedures for safely operating the on-site laboratory and these must be available on site for reference. At a minimum, laboratory personnel must: utilize processes and PPE sufficient to prevent harmful contact with chemicals, ensure adequate ventilation of the work space, handle chemicals and contaminants so as to minimize airborne concentrations in the laboratory, segregate foodstuffs from hazardous chemicals or contaminants, and wash face and hands prior to eating or drinking. Site training must include hazards and controls of exposure to contaminants and chemicals used on site. MSDSs must be kept on site. All chemical containers labeled with contents and hazards. Laboratory personnel will be briefed on the project SSHP, emergency phone numbers, site contaminants, and other health and safety information relevant to their tasks.	Daily safety inspections conducted by the subcontractor's field manager.
Electrical shock	GFCI for all electrical hand tools.	Daily safety inspection conducted by the subcontractor field manager.
Temperature extremes	If the laboratory does not have air conditioning, then administrative controls and monitoring consistent with Section 8 of the FSHP must be applied.	See Section 8 of FSHP if temperature is not controlled.
Metals analysis by XRF performed by SAIC subcontractor in situ		
General safety hazards (moving equipment, slips, falls)	PPE (Level D) including nitrile or PVC gloves to handle contaminated material. Current 40 hour hazardous waste safety training. The subcontractor team leader must have documented training and experience in the operation of the XRF instrument. At least two personnel on site must have current CPR and first aid training. Subcontractor must have standard procedures for safe operation of in-situ equipment and these must be available on site. The XRF instrument must be operated in compliance with applicable OSHA and NRC requirements. In situ instruments must be operated by experienced personnel per the subcontractor's standard procedures. Exclude unauthorized personnel. Buddy system (or observation by SAIC personnel).	Daily safety inspections.
Radiation or radioactive contamination	The XRF instrument must be operated and maintained in compliance with the manufacturer's instructions and applicable NRC and OSHA requirements. Monitoring of employee exposure must be conducted in compliance with the manufacturer's instructions and applicable NRC and OSHA requirements.	As required by subcontractor's standard procedures.
Fire (fuels/solvents)	Fire extinguisher rated ABC in work area, inspected monthly and serviced annually.	Daily safety inspections.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Exposure to chemicals	Level D PPE plus nitrile or equivalent gloves to handle contaminated material. Wash face and hands prior to taking anything by mouth. Medical clearance for HAZARDOUS WASTE work. Site training must include hazards and controls of exposure to contaminants and chemicals used on site. MSDSs must be kept on site. All chemical containers labeled with contents and hazard.	Daily safety inspections.
Electrical shock	GFCI for all electrical hand tools.	Daily safety inspection.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.
Contact with OE	Pre-entry screening survey and continuous escort by OE specialist support. On-site training in ordnance recognition for all field personnel. Withdrawal of all SAIC and subcontractor personnel from immediate area and field marking of suspect area if ordnance or suspected ordnance is discovered.	Visual and instrument surveys for ordnance conducted by OE expert personnel.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas on Friday and Saturday during season, October and November)	Fieldwork will not be conducted during hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day (See Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (See Section 9.0 of FSHP).	Visual survey.
Soil boring and soil sampling using a hand-operated power auger		
General safety hazards (rotating machinery, moving equipment, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots (see Section 5.0 of FSHP) plus hardhat if overhead hazards are present. Buddy system. Operate auger per manufacturer's directions. Only experienced operators will be allowed to operate auger. Positive action control (Deadman's switch) or easily accessible kill switch on power auger. Current 40 hour Hazardous Waste Safety training. Lifts of >50 pounds will be performed by two or more personnel or with mechanical assistance, extensive heavy lifting will require additional lifting training. Exclusion zone if there is a potential for unauthorized entry. At least two personnel on site must be trained in CPR and first aid.	Daily safety inspections.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Contact with OE	Pre-entry screening survey and continuous escort by OE specialist support. Down-hole monitoring at 2-foot intervals to depth of 4-feet or 2-feet below native soils, whichever is deeper, and clearance is given for continuous drilling by OE personnel. On-site training in ordnance recognition for all field personnel. Withdrawal of all SAIC and subcontractor personnel from immediate area and field marking of suspect area if ordnance or suspected ordnance is discovered.	Visual and instrument surveys for ordnance conducted by OE expert personnel.
Exposure to chemicals	Nitrile or similar gloves for contact with potentially contaminated material. Gloves will be disposed after single use. Washing face and hands 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 must be kept on site. All chemical containers labeled to indicate contents and hazard.	Daily safety inspections and PID or equivalent monitoring during inspections.
Gunfire (deer hunting with shotguns loaded with slugs is allowed in some areas on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Noise	Hearing protection within 7.6 m (25 feet) of equipment when operating.	Daily safety inspections.
Fire (fuels)	Fuel in safety cans with flame arrestors. No ignition sources in fuel storage or refueling areas. Fire extinguisher (inspected monthly and serviced annually) in all fuel use areas. Bonding (metal to metal) contact while pouring. Gas powered equipment must be shut down and allowed to cool for 5 minutes prior to fueling.	Daily safety inspections.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.
Electric shock	Identification and clearance of underground utilities.	Visual survey of all work areas.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Groundwater well development, groundwater monitoring, groundwater sampling and sample preservation		
General safety hazards (moving equipment, lifting, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, hardhats if overhead hazards are present (see Section 5.0 of FSHP). 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. Current 40-hour hazardous waste safety training. At least two personnel with CPR and first aid training must be present on site. Exclusion zone if there is a potential for unauthorized entry.	Daily site safety inspections.
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	PPE (Level D) 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 hazardous waste work. 15-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.	Daily site safety inspections. PID or equivalent monitoring if prior monitoring during soil boring indicated a potential for exposure.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Electrical shock	GFCI for all electrical hand tools	Daily safety inspection.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Soil boring, soil sampling, and monitoring well installation using drill rig or Geoprobe rig.		
General safety hazards (rotating machinery, suspended loads, moving equipment, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, work gloves for material handling (see Section 5.0 of FSHP) plus hard hat. Buddy system. No employees under lifted loads. At least two functional kill switches or positive action (deadman's) switch. Functional back-up alarm. Drill rig manual on site. Only experienced operators. Current 40 hour hazardous waste safety training. At least two personnel on site must have current CPR and first aid training. Exclusion zone at least equal to mast height if there is any potential for unauthorized entry.	Daily site safety inspections. Weekly drill rig inspections.
Noise	Hearing protection within 7.6 m (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	Pre-entry screening survey and continuous escort by OE specialist support. Downhole monitoring every 2 feet to a depth of 4-feet or 2-feet below the top of native soils, whichever is deeper, and clearance is given for continuous drilling by OE personnel. On-site training in ordnance recognition for all field personnel. Clearance of sites by OE personnel for intrusive work. Continuous escort by OE personnel in areas with a potential to encounter OE. Withdrawal of all non-OE personnel if ordnance or suspected ordnance is discovered.	Visual and instrument surveys by OE technicians.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Staying upwind of any dust-generating activities. 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. Medical clearance for hazardous waste work.	Daily safety inspections incorporating PID or equivalent monitoring. Additional monitoring at the discretion of the SSHO.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (See Section 8.0 of FSHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice per day. Pulse rates at the start of each break if wearing impermeable clothing.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize potential for tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.
Electric shock	Identification and clearance of overhead and underground utilities.	Visual of all work areas.
Soil sampling using hand augers or scoops		
General safety hazards (manual lifting, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety shoes or boots, safety glasses, work gloves for manual work (see Section 5.0 of FSHP). Buddy system. Current 40-hour hazardous waste safety training. At least two personnel on site must have current CPR and first aid training.	Daily site safety inspections.
Contact with unexploded ordnance	On-site training in ordnance recognition for all field personnel. Clearance of sites by OE personnel for intrusive work. Down-hole monitoring every 2 feet to a depth of 4-feet or 2-feet below the top of native soils, whichever is deeper. Continuous escort by OE personnel when in areas with potential to encounter OE. Withdrawal of all non-OE personnel if ordnance or suspected ordnance is discovered.	Visual and instrument surveys by OE technicians.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Staying upwind of any dust-generating activities. Site training must include hazards and controls for exposure to site contaminants and chemicals used on site. MSDSs for chemical tools must be kept on site. Chemical containers labeled to indicate contents and hazard. Medical clearance for hazardous waste work.	Daily safety inspection incorporating PID or equivalent monitoring. Other monitoring as determined by SSHO.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. 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 work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Sediment sampling from ditches		
General safety hazards (moving equipment, slips, falls)	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots (see Section 5.0 of FSHP). Current 40-hour hazardous waste safety training. Buddy system. At least two personnel on site with CPR and first aid training.	Daily site safety inspections.
Drowning	None, ditches are shallow and are expected to be dry.	None.
Noise	None.	None.
Fire	None.	None.
Contact with unexploded ordnance	On-site training in ordnance recognition for all field personnel. Clearance of sites by OE personnel. Continuous escort by OE personnel when in areas with potential for OE. Withdrawal of all non-OE personnel if ordnance or suspected ordnance is discovered.	Visual and instrument surveys by OE technicians.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Minimal contact. Site training must include hazards and controls for exposure to site contaminants and chemicals used on site. MSDSs for chemical tools must be kept on site. Chemical containers labeled to indicate contents and hazard. Medical clearance for hazardous waste work.	Daily site safety inspections incorporating PID or equivalent monitoring.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice a day. Pulse rates at the start of each break if wearing impermeable clothing.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day (see Section 9.0 of FSHP). Snake chaps if working in overgrown areas. Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
	Vegetation clearing with chainsaws, machetes, sling blades	
General safety hazards (contact with sharp edges, slips, falls)	Level D PPE (see Section 5.0 of FSHP) long pants, shirts with sleeves, safety shoes or boots, safety glasses, plus heavy duty work gloves and hard hat. Buddy system. Exclusion zone if there is a potential for entry of unauthorized personnel. Current 40-hour hazardous waste safety training. Only experienced operators to use chain saws. 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. At least two personnel on site with CPR and first aid training.	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 385-1-1 Section 31.	Daily inspection.
Noise (chainsaw)	Hearing protection within 7.6 m (25 feet) of operating chainsaw unless rig-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	On-site training in ordnance recognition for all field personnel. Clearance of sites by OE personnel. Escort by OE personnel when in areas with potential to encounter OE. Withdrawal of all non-OE personnel if ordnance or suspected ordnance is discovered.	Visual and instrument surveys by OE technicians.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Site training must include the hazards and appropriate controls for site contaminants and chemicals to be used or stored on site. Chemical containers labeled to indicate contents and hazard. Medical clearance for hazardous waste work.	Daily safety inspection.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice per day. Pulse rates at the start of each break if wearing impermeable clothing.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize potential for tick entry. Snake chaps if working in overgrown areas. Inspect for ticks during the day and at the end of each work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	Visual survey.
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 hardhat if overhead hazards are present (see Section 5.0 of FSHP). 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 over 50 pounds will be made with two or more personnel or with lifting equipment. At least two personnel on site will have current CPR and first aid training. Current 40-hour hazardous waste safety training. Compliance with EM 385-1-1 Sections 14 and 16.	Daily safety inspections of operations. Daily inspection of equipment to verify brakes and operating systems are in proper working condition.
Contact with unexploded ordnance	On-site training in ordnance recognition for all field personnel. Clearance of sites by OE personnel for intrusive work. Continuous escort by OE personnel if working in areas with potential for OE. Withdrawal of all non-OE personnel if ordnance or suspected ordnance is discovered.	Visual and instrument surveys by OE technicians.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Site training must include hazards and controls for exposure to site contaminants and chemicals used on site. Medical clearance for hazardous waste work.	Daily safety inspections.
Gunfire (deer hunting with shotguns loaded with slugs allowed on Saturdays during season, October and November)	Fieldwork will not be conducted on hunt days. Office work, sample management, and analytical work may be conducted in the SAIC staging building (Building 1036) if approved by the RVAAP Environmental Coordinator.	None.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
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 (inspected monthly and serviced annually) in all fuel use areas.	Daily safety inspection.
Noise	Hearing protection within 7.6 m (25 feet) of any noisy drum moving equipment unless equipment-specific monitoring indicates exposures less than 85 decibels.	Daily safety inspections.
Biological hazards (bees, ticks, Lyme disease, Histoplasmosis, wasps, snakes)	PPE (boots, work clothes). Insect repellant on pants and boots and elsewhere, as necessary. 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 work day (see Section 9.0 of FSHP). Avoidance of accumulations of bird or bat droppings (see Section 9.0 of FSHP).	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 Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). 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 (see Section 5.0 of FSHP) plus: Nitrile or PVC gloves and Face shield and Saranax or rain suit when operating steam washer. Current 40-hour hazardous waste safety training. At least two personnel on site will have current CPR and first aid training.	Daily safety inspections.
Noise (spray washer)	Hearing protection when washer is operating unless equipment-specific monitoring indicates 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 (inspected monthly and serviced annually) kept near decontamination area.	Daily safety inspection.
Exposure to chemicals	PPE (Level D) plus nitrile or equivalent gloves for contact with contaminated material. Washing face and hands prior to taking anything by mouth. Minimal contact. Site training must include hazards and controls for exposure to site contaminants and chemicals used on site. MSDSs must be kept on site. All chemical containers labeled to indicate contents and hazard. Medical clearance for hazardous waste work.	None.

Table 2-2. (continued)

Safety and Health Hazards	Controls	Monitoring Requirements
Temperature extremes	Administrative controls (see Section 8.0 of FSHP). Cooled (shaded) or warmed break area depending on the season. Routine breaks in established break area (see Section 8.0 of FSHP). Chilled drinks if temperature exceeds 70°F.	Temperature measurements at least twice a day. Pulse rates at the start of each break if wearing impermeable clothing.

EC&HS = Environmental Compliance and Health and Safety
FSHP = Facility-wide Safety and Health Plan
GFCI = ground-fault circuit interrupter
MSDS = Material Safety Data Sheet
NRC = Nuclear Regulatory Commission
OE = Ordinance and Explosives
OSHA = Occupational Safety and Health Administration
PID = photoionization detector
PPE = personal protective equipment
PVC = polyvinyl chloride
RVAAP = Ravenna Army Ammunition Plant
SAIC = Science Applications International Corporation
SSHO= Site Safety and Health Officer
SSHP = 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]
Acetone (solvent used in explosives screening)	TLV/TWA: 500 ppm IDLH: 2500 ppm	Irritation of eyes, nose, throat, skin; headache, dizziness, drowsiness.	Colorless liquid with mint-like odor; VP: 180 mm; FP: 0°F; IP: 10.66 eV	Inhalation Ingestion Contact
Acetic acid (reagent used in explosives screening)	TLV/TWA: 10 ppm	Flammable liquid; irritation of eyes, nose, skin, throat; eye and skin burns; bronchitis.	Colorless liquid or crystals with vinegar odor; VP: 11 mm; FP: 103°F; IP: 9.69 eV	Inhalation Contact
Chromium	TLV/TWA: 0.5 mg/m^3, A4 IDLH: 25 mg/m^3	Eye irritation, sensitization.	Solid; properties vary depending upon specific compound	Inhalation Ingestion Contact
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
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
Hydrochloric acid (potentially used to preserve water samples or 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
Lead	TLV/TWA: 0.05 mg/m^3, A3 PEL/TWA: 0.05 mg/m^3 IDLH: 100 mg/m^3	Weakness, anorexia, abdominal pain, anemia.	Solid metal; VP: 0 mm; FP: NA; IP: NA	Inhalation Ingestion Contact
Liquinox (used for decontamination)	TLV/TWA: None	Inhalation may cause local irritation to mucus membranes.	Yellow odorless liquid (biodegradable cleaner); FP: NA	Inhalation Ingestion

Table 2-3 (continued)

Chemical[a]	**TLV/PEL/STEL/IDLH**[b]	**Health Effects/ Potential Hazards**[c]	**Chemical and Physical Properties**[c]	**Exposure Route(s)**[c]
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
NitraVer powder pillow (reagent used in explosives screening)	TLV: none	Potential irritation of eyes or skin.	Granular powder: VP: negligible; FP: NA	Inhalation
Potassium hydroxide (pellets used in explosives screening)	TLV/TWA: C2 mg/m3	Irritation of eyes, skin, lungs; eye and skin burns.	Odorless solid; VP: negligible; IP: not specified by NIOSH; FP: NA	Inhalation Ingestion Contact
RDX (cyclonite) (contaminant and laboratory standard)	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
Sodium sulfite (granular reagent used in explosives screening)	TLV: none	Potential irritation of eyes and skin.	Granular solid: VP: negligible; FP: NA	Ingestion Contact
TNT (contaminant and laboratory standard)	TLV/TWA: 0.5 mg/m^3 Skin notation IDLH: 500 mg/m^3	Cluster headache; irritation of skin and mucus membranes, liver damage, kidney damage.	Pale solid; FP: explodes; VP: 0.0002 mm	Inhalation Absorption Ingestion Contact

[a] The potential chemicals were obtained from 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 and USACE 1999 *Phase II Remedial Investigation of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio.* DACA69-94-D-0029, D.O.0060, Draft Final.

[b] From 1999 Threshold Limit Values, *NIOSH Pocket Guide to Chemical Hazards*, 1997.

[c] From 1997 *NIOSH Pocket Guide to Chemical Hazards, the Condensed Chemical Dictionary*, Tenth Edition.

A2 = suspected human carcinogen
IP = ionization potential
PEL = permissible exposure limit
STEL = short-term exposure limit
TLV = threshold limit value
A3 = confirmed animal carcinogen with unknown relevance to humans
TWA = time-weighted average
VP = vapor pressure
NA = not available
A4 = Not Classifiable as a human carcinogen
FP = flash point
IDLH = immediately dangerous to life and health
NIOSH = National Institute for Occupational Safety and Health

THIS PAGE INTENTIONALLY LEFT BLANK

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 SAIC and subcontractor staff who will fill key roles. See the FSHP for information on the roles and responsibilities of key positions.

Table 3-1. Staff Organization

Position	Name	Phone
Program Manager (DACA62-00-D-0001)	Ike Diggs	865-481-8710
Health and Safety Manager	Steve Davis CIH, CSP	865-481-4755
Project Manager	Kevin Jago	865-481-4614
Field Operations Manager	Kathy Dominic	918-625-7614
Site Safety and Health Officer (SSHO)	Martha Clough	937-431-2249

CIH= Certified Industrial Hygienist
CSP = Certified Safety Professional

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 TRAINING

Training requirements are outlined in the FSHP and in Table 2-2. In addition to the FSHP's requirements, at least two first aid/CPR trained personnel must be on site during field activities.

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 PERSONAL PROTECTIVE EQUIPMENT

General guidelines for selection and use of PPE are presented in the FSHP. Specific PPE requirements for this work are presented in the hazard/risk analysis section (Section 2.0).

THIS PAGE INTENTIONALLY LEFT BLANK

6.0 MEDICAL SURVEILLANCE

Medical surveillance requirements are presented in the FSHP and in Table 2-2.

THIS PAGE INTENTIONALLY LEFT BLANK

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 field laboratory or 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* 1910.20. The minimum monitoring requirements and action levels are presented in Table 7-1.

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

- With the exception of field laboratory analyses, which will be performed in well-ventilated buildings, work will be performed in open areas with natural ventilation.

- The most prevalent contaminants (metals, explosives, propellants, and semivolatile organic compounds) are materials with relatively low vapor pressures.

Air monitoring of the breathing zone using a photoionization detector (PID) or equivalent is planned during soil sampling, groundwater monitoring well drilling, and Geoprobe work. 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.

Table 7-1. Monitoring Requirements and Action Limits

Hazard or Measured Parameter	Area	Interval	Limit	Action	Tasks
Airborne organics with 10.2 eV PID or equivalent	Breathing zone [0.9 m (3 ft) from source or 0.36 m (14 in.)] in front of employee's shoulder	During the SSHO's daily safety inspections. More often if measurements indicate exposure or at the SSHO's discretion.	<5 ppm >5 ppm	Level D Withdraw and evaluate • evaluate need for PPE upgrade • institute more frequent monitoring • identify contaminants • notify Project Manager and H&S Manager	Drilling, hand augering, power augering, other intrusive work.
Acetone vapor in explosives screening area using 10.2 eV PID or equivalent	Explosives screening area. Breathing zone [0.9 m (3 ft) from source or 0.36 m (14 in.)] in front of employee's shoulder	Initially during explosives screening and subsequently at the discretion of the SSHO.	<50 ppm >50 ppm for more than 30 seconds or >200 ppm instantaneously	Level D Withdraw and evaluate • evaluate need for process modification or additional ventilation • notify Project Manager and H&S Manager	Explosive screening
Flammability and oxygen content with combustible gas indicator	In areas suspected of containing flammable gases.	Not anticipated for this work.	<10% LEL and >19.5 % O_2 >10% LEL or < 19.5% O_2	Continue and evaluate source Withdraw and allow area to ventilate; notify Project Manager and H&S Manager	None unless SSHO determines necessary.
Noise	All	None required. Power augers, drill rigs, Geoprobe hammers, and any other noisy equipment (as determined by SSHO) will be assumed to exceed 85 decibels unless on-site monitoring indicates otherwise.	85 dBA and any area perceived as noisy	Require the use of hearing protection	Hearing protection will be worn by personnel within 25 feet of power augers or other noisy equipment

Table 7-1 (continued)

Hazard or Measured Parameter	Area	Interval	Limit	Action	Tasks
Visible contamination	All	Continuously	Visible contamination of skin or personal clothing	SSHO to review activities and potentially upgrade PPE to preclude contact; may include disposable coveralls, boot covers, etc.	All
Ambient temperature	All	At least twice per day; early in morning and at apparent hottest part of the day.	70 degrees or more	Conduct heat stress training Provide shaded break area Provide cooled water Allow unscheduled breaks	All
			40 degrees or less	Conduct cold stress training Provide warm break area Allow unscheduled breaks	
Visible airborne dust	All	Continuously	Visible dust generation	Stop work; use dust suppression techniques such as wetting surface	All

H&S = Health and Safety
LEL = Lower explosive limit
PID = Photoionization detector
PPE = Personal protective equipment
SSHO = Site Safety and Health Officer

8.0 HEAT/COLD STRESS MONITORING

General requirements for heat/cold stress monitoring are contained in the FSHP.

THIS PAGE INTENTIONALLY LEFT BLANK

9.0 STANDARD OPERATING SAFETY PROCEDURES

Standard operating safety procedures are described in the FSHP. The most critical task-specific requirements are presented in Table 2-2.

THIS PAGE INTENTIONALLY LEFT BLANK

10.0 SITE CONTROL MEASURES

Site control measures are described in the FSHP. No formal site control is expected to be necessary for this work because the area is somewhat remote, fenced, and bystanders are not anticipated. 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 FSHP.

THIS PAGE INTENTIONALLY LEFT BLANK

11.0 PERSONNEL HYGIENE AND DECONTAMINATION

Personal hygiene and decontamination requirements are described in the FSHP and in Section 2.0 of this addendum.

THIS PAGE INTENTIONALLY LEFT BLANK

12.0 EMERGENCY PROCEDURES AND EQUIPMENT

Emergency contacts, telephone numbers, directions to the nearest medical facility, and general procedures can be found in the FSHP. The SAIC Field Operations Manager will remain in charge of all SAIC and subcontractor personnel during emergency activities. The SAIC field office will serve as the assembly point if it becomes necessary to evacuate one or more sampling locations. During mobilization, the SSHO will verify that the emergency information in the FSHP is correct.

THIS PAGE INTENTIONALLY LEFT BLANK

13.0 LOGS, REPORTS, AND RECORD KEEPING

Logs, reports, and record keeping requirements are described in the FSHP.

THIS PAGE INTENTIONALLY LEFT BLANK

14.0 REFERENCES

Mogul Corporation 1982. *Soil and Sediment Analysis Performed for Ravenna Arsenal, Ravenna, Ohio*.

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

NIOSH (National Institute for Occupational Safety and Health) 1999. *NIOSH Pocket Guide to Chemical Hazards*.

USACE (U.S. Army Corps of Engineers) 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 (U.S. Army Corps of Engineers) 1999. *Phase II Remedial Investigation of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio.* DACA69-94-D-0029, D.O.0060, Draft Final, August.

THIS PAGE INTENTIONALLY LEFT BLANK

Draft Sampling and Analysis Addendum No. 1 for the Feasibility Study of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant
Comment Resolution

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
		William Veith, OE-CX	
1	General	The type of Geophysical instrument proposed for use on the project needs to be added to the plan.	Agreed. Specifications regarding the type(s) of geophysical equipment have been added as requested.
2	Paragraphs 4.1.9, 4.2.2.7, 4.3.2.7	All of these paragraphs say about the same thing. There are a couple of things that need to be added. First, “HTRW sampling personnel must be escorted by UXO personnel at all times in areas potentially contaminated with UXO until the team has completed the access surveys and the cleared areas are marked. Escorted HTRW personnel will follow behind the UXO escort. If anomalies or UXO are detected, The UXO escort will halt escorted personnel in place, select a course around the item, and instruct escorted personnel to follow.” In all of these paragraphs, it appears to indicate that UXO could be found and reported to the UXO personnel. That implies the HTRW personnel are working on their own. Second, “State that access routes shall be at least twice as wide as the widest vehicle that will use the route.”	Agreed. The text of the subject paragraphs has been modified as requested.
3	General	I can not tell if the contractor is going to bring in a UXO sub or if they are going to do the work themselves. In either case, the resumes of the UXO personnel and their Indianhead certificates need to be furnished to the MCX or their UXO database number needs to be sent to us. We will certify that the personnel are qualified for the position identified in the plan.	Clarification. A UXO subcontractor will be employed to support the work of the HTRW contractor in the field. The text of the paragraphs noted in Comment 2 above will be adjusted to reflect this fact. Qualification information will be provided as requested.
4	General	The UXO team will not be tasked with the mission of disposing of any UXOs or bulk explosives found at the site. The proper individual to be notified in case these items are discovered on site needs to be identified and added to the plan.	Agreed. The information has been added to the work plan as requested (reference paragraphs noted in Comment 2).
5	General	The plan states that any anomaly “indicative” of OE will be clearly marked and the approach path diverted around the anomaly. Change this to say all anomalies will be marked and avoided.	Agreed. The text has been revised (reference paragraphs noted in Comment 2) as requested.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
Elizabeth Ferguson, CELRL-ED-EE			
1	Page 3-4 Line 2.	More detail could be added as to how possible contaminant migration to groundwater will be evaluated.	Agreed. Additional text has been added denoting that contaminant migration to groundwater will be further evaluated using both quantitative geochemical modeling techniques and qualitative assessment based on geologic characteristics of the site.
2	Page 3-14 line 11.	Use of Baes, et al. is acceptable. However, it should be noted that the linear models of plant uptake create a good bit of uncertainty. The log-linear models for certain inorganics have been shown to be more realistic (Bechtel Jacobs, 1998)	Clarification. Comment is noted. Use of log-linear models for plant uptake may be discussed as part of the technical memorandum to be prepared prior to preparation of the FS and submitted to the USACE that discusses planned risk assessment scenarios and approaches to be employed. No text changes required.
3	Page 3-14	It seems the FS is the time to put more realistic numbers into the risk equations. Although you want to be protective, you also want to decrease uncertainties that you can here. Risk analysis in the RI was the place for conservatism.	Agreed. The FS is the place to balance conservatism and realism. For example, it is planned that one set of RGOs for soil will be based on NOAELs (conservative) and another on LOAELs (less conservative). Having RGOs based on NOAELs and LOAELs will provide alternative RGOs out of which consensus can follow.
4	Page 3-14, line 28	A “lowest” is missing.	Agreed. Text has been corrected as requested.
5	Section 3.4.2	Somewhere in the 3.4.2 sections should discuss development of an uncertainties analysis for the RGOs	Agreed. Uncertainties will be part of the future work on RGOs. It is anticipated that uncertainties will be identified and discussed for exposure problem formulation, exposure factors, effects evaluation, and actual RGO computation. The nature as well as the direction of uncertainty — overestimate and/or underestimate — will be estimated.
6	General	Are we going to do some extra sampling on pad 32? This pad has ecological risk of >1000 from Al but does not have very good vegetative cover compared to similarly contaminated	Clarification. Additional sampling at Pad 32 was not specified in the scope of work dated June 5, 2000. However, a total of 10 contingency samples are available for use at any area within

Draft Sampling and Analysis Addendum No. 1 for the Feasibility Study of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant
Comment Resolution

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
		areas.	the WBG. Samples may be collected at Pad 32 if directed by the USACE. No text changes required.
7	Page 4-9, line 30	Safety with regard to OE and accessibility are important factors, it is also important to put wells in such that they yield good data. Will efforts be made to assess the well locations for quality location as well as roadside location.	Clarification. Section 4.1.1 describes the hydrogeologic rationale for well placement, which was the primary driver for the selection of monitoring locations. To the extent possible in consideration of safety issues, monitoring wells were located hydraulically downgradient of pads having been identified as having residual contamination and along the eastern (downgradient) boundary of the AOC to determine: (1) if groundwater has been impacted by former operations within the burning pads, and (2) if contamination (if present) is migrating off of the AOC. No text changes required.
8	General	Will the soil sampling data from this summer's biological measurements be included with the data collected with the FS?	Clarification. The ecological field truthing investigation will be included as a component of the FS. Please reference Section 3.4.2.6 of the SAP Addendum for a description of the planned application of the results of this study. No text change required.
9	Page B-5, 5.7, line 36	Program manager OR project manager.	Agreed. Text has been corrected as requested.
		John. P. Jent, CELRL-ED-EE	
1	Page 1-5, line 8	Please elaborate on the four burn pits. Think these are the currently numbered Pads 58, 59, 60, and 61, with Pit #1 corresponding to Pad 58.	Clarification. The original studies that contained references to the four burn pits include the 1989 RCRA Facility Assessment and the USACE Preliminary Assessment of RVAAP 1996. However, these references do not contain information as to which pad numbers correspond to the referenced burning pits. Additional research will be performed and this information added to the introductory section of the FS.
2	Page 1-5, line 27	Please add to last sentence, and sampling and analyses of the subsurface soils.	Agreed. Text has been added as requested.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
3	Figures 1-3 and 1-4	Please adjust the southern boundaries on the AOC to the first west-east drainageways, i.e. inlet/outlet from Macks Pond and thence to Sand Creek; similar to Figure 4-4.	Agreed. The southern AOC boundary has been adjusted on these two figures to correspond to Figure 4-4 as requested.
4	Figure 2-1	Please change Corps PM from Melody Thompson to Walt Perro, and delete Data Validation from the Data Services.	Agreed. The figure has been modified as requested.
5	Page 3-1, line 27	Also add that the updated ecological risk assessment will incorporate results and findings of the ecological field-truthing study.	Agreed. The text of Section 3-1 has been revised as requested and a reference added to Section 3.4.2.6, which describes the application of the results of the ecological field truthing study.
6	Page 3-2, line 13	As per Figure 4.1 of the Draft Final Phase I RI of Winklepeck, please add Pads Nos. 5, 6, 38, 59, 60, 62, 68, and 69.	Agreed. Text has been added as requested.
7	Page 3-2, lines 14 and 15	Disagree that cadmium and lead exceeded 100 and 20 mg/kg, respectively at all pads tested in the Phase II RI. Please check.	Agreed. Lead exceeded its facility-wide background (26.1 mg/kg) in 76 of 149 samples. Cadmium was detected in 102 of 148 samples, with an average value of 11.26 mg/kg and a maximum value of 877 mg/kg. The text has been changed accordingly.
8	Page 3-4, line 47	Please change to Figure 1-3.	Agreed. The text has been corrected as requested.
9	Page 4-9, Para. 4.1.9	Please add that anomaly avoidance will be conducted during the drilling of each new groundwater monitoring well, in 2-foot depth intervals to at least 4-feet, and also to 2-feet below original soil materials.	Agreed. The text has been modified as requested.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
10	Page 4-11, line 5	Please clarify that the field XRF testing will be both insitu and exsitu.	Agreed. The text has been modified as requested.
11	Figure 4-2	A Please show the eco field truthing locations where soil samples and subsequent laboratory analyses were done. B At Pads 58, 59, and 60 please delete the new sample locations within the pads proper and place the new locations on and beyond the surrounding berms. C Somewhere please prepare a table or state the Phase I or II sampling location number that corresponds to the FS Geoprobe location number and also the Phase I or II levels of contaminants that were the basis for locating the Geoprobe boring. D Please add a surface soil location for the pad that the eco field truthing people thought had a bare area; think it is Pad 32. Please check w/Jimmy Groton.	A. Disagree. Figure 4-2 depicts planned sampling locations for the FS based on the Phase I and II RI results. The ecological field truthing locations were not considered in placement of the FS sample points because these data have not yet been evaluated. A discussion of ecological field truthing locations may be added in the FS report during presentation of the results of the study. B. Agreed. Locations have been moved as requested. C. Agreed. Corresponding Phase I RI locations to the FS Geoprobe locations are shown on Figures 4-2 and 4-3. However, a table cross referencing the corresponding locations and showing the Phase I or II RI levels of contamination forming the basis for selection has been added to Section 4.2.1. D. Agreed. One of the soil contingency samples will be reassigned to Pad 32 in the SAP Addendum as requested.
12	Figure 4-3	A Please clarify if a Geoprobe boring is scheduled between Pads 66 and 67 as shown on the figure. B At Pad 67, the Geoprobe location appears to be off the pad. Please ensure that it is located at the bare area of Pad 67. C At Pad 37, there appears to be two WBFss-175 locations. Please clarify. D At Pads 67 and 37, please add the Jenkins sampling locations if they are not already on the figure.	A. Clarification. A geoprobe sampling station is not planned at the location indicated. The symbol has been removed from the figure. B. Clarification. The geoprobe location at Pad 67 was placed coincident with the Phase II RI sampling point having the highest levels of explosives contamination (0-1 ft interval at WBGss-070), which was off of the pad. Station WBGss-071, located on the pad, had significantly lower levels of surface contamination, but higher levels of subsurface contamination. The geoprobe location has been re-located to be coincident with WBGss-071.

Draft Sampling and Analysis Addendum No. 1 for the Feasibility Study of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant
Comment Resolution

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
			C. Agreed. The ID number of the station located closest to the pad has been changed to WBGss-107. D. Clarification. Field explosives will be run on all surface samples indicated at Areas 1, 2, 3, and 5 pads. These analyses will form the basis for a determination whether to collected additional subsurface samples at those stations. No text changes required.
13	Figure 4-4	Thought the random areas were to extend no closer than 50-feet north and south of the burn pads. For instance, Grid Area 11; east, west OK, but north boundary at 50-feet south of Pads 58 and 59 and the south boundary 50-feet north of Pads 44 and 45. Thus, appears that Grid Sample Locations 277 (near Pad 50) and 285 (adjacent to Pad 37) need to be moved.	Clarification. Restriction of the north and south boundaries of the exposure units to within 50 ft of the pads would create 6 horizontal rows of exposures units having significantly less than 30 acres, thereby substantially increasing the number of random sample areas. An alternative approach is to place a restriction on the assignment of the random points so that no random point would fall within 50 feet of a burn pad. If a randomly selected point falls within 50 feet, a second random point would be selected and so on, until the conditions of the restriction were met. On this basis, the random grid points within exposure units 14, 17, 18, 19, 20, and 22 have been re-selected to achieve this restriction.
14	Table 5-1	A At each of the Geoprobe locations, please list the corresponding Phase I or Phase II sample location number. B Please add provisions for the additional Chromium 6 testing that is to be done.	A. Agreed. The corresponding Phase I/Phase II sample locations numbers have been added as requested. B. Agreed. Provisions for Cr+6 analyses have been added as requested. (Need to have USACE input for any specific locations of interest for Cr+6).
15	QAPP, Table 1-1	Please adjust table for Chromium 6 testing.	Agreed. Provisions for Cr+6 analyses have been added as requested.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
16	QAPP, Section 2	Please state the name and contact for the QA laboratory, which is: Environdata Group ATTN: Bob King 2520 Regency Road Lexington, KY 40503 Telephone: 800 489-3506, or 859 278-5665.	Agreed. The new QA laboratory contact has been added as requested.
Eileen Mohr, Ohio EPA			
1	General	Attached to this correspondence, you will find the most recent version of the complete list of State of Ohio, Ohio Revised Code (ORC), applicable or relevant and appropriate requirements (ARARs). From this list we need to ensure that the chemical and location-specific ARARs have been accurately determined during the Remedial Investigation (RI) phase, and that the action-specific ARARs are accurately identified during the Feasibility Study (FS). A list of potential Federal ARARs will be forthcoming. (No text change required).	Comment noted.
2	General	Please provide information as to the projected date of issue of the final Winklepeck Burning Grounds (WBG) RI report. (No text change required).	Clarification. The projected date of issue of the final WBG RI report will be established upon completion of current large-scale field tasks for Load Line 1, Load Line 12, and WBG FS.
3	General	Please provide additional information in the Response to Comments (RTC) document regarding the analyses that are being conducted for hexavalent chromium during the WBG FS, and the Phase II RI being conducted at Load Line 1 as well as at Load Line 12. Please provide the rationale for conducting these analyses and whether or not they are to consistently become a part of	Clarification. Because of the operational histories of these 3 AOCs, hexavalent chromium analyses were planned. At present, chromium analyses are not planned for other AOCs unless additional operational data surfaces that merits investigation.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
		investigative activities at the Ravenna Army Ammunition Plant (RVAAP). (No text change is required).	
4	Page 1-5, line 6	On page 1-5, line 6, please provide additional information in the revised workplan regarding the burn pits that are referenced in this portion of the text.	Clarification. Please reference the response to Jent comment number 1.
5	Page 3-2, line 17 and 39.	Please provide additional clarification in the draft workplan regarding the use of a 10^{-4} cut-off value for risk assessment purposes. (Pages 3-2, lines 17 and 39). The threshold limit utilized for the projects conducted at the Ravenna Army Ammunition Plant (RVAAP) is 10^{-6}, with the risk management range being between 10^{-6} to 10^{-4}, and greater than 10^{-4} being unacceptable. Please revise the text accordingly.	Clarification. The text discussions referenced by the comment are summarizations of Phase I and II RI findings and are intended only to convey to the reader those locations where the highest levels of contamination (i.e., sites with unacceptable risks) have been observed. The citations of locations having at least 10^{-4} risk is consistent with the Ohio EPA's risk range definition of "unacceptable" risk and, by inference, have the highest levels of contamination and merit the most concern. No text changes required.
6	Page 3-4, line 11-17	The Remedial Action Objectives (RAOs) detailed on page 3-4 (lines 11-17) would more accurately be described as general response actions or remedial technology types. A RAO would be more general in nature, for example, prevention of ingestion of groundwater within a certain risk range, etc. Please adjust the text, such that the terminology utilized is consistent with relevant US Environmental Protection Agency (USEPA) terminology used in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," Interim Final, EPA/540/G-89/004, OSWER Directive 9355.3-01, October 1988.	Agreed. A short paragraph will be added to the beginning of Section 3.2.3 describing some potential (provisional) RAOs for WBG and indicating that final RAOs will be developed in the FS report. The term "potential feasible remedies" in line 9 has been changed to "potential remedial technologies."
7	Page 3-6, Table 3-1	On Table 3-1 (page 3-6), please specify whether the second criterion (source areas with identified COCs greater than risk-based criteria) are for the human health scenarios, ecological scenarios, or both.	Clarification. The second criterion for selection of sites requiring further characterization is based on locations having the highest observed concentrations of COCs and COPECs (i.e., where human health risks >10^{-4} or HI>3 and ecological HQ>1000. Pad 32, which had an ecological HQ>1000, was not included in the SOW dated June 5, 2000, but may be addressed through contingency sampling (see response to

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
			Ferguson comment number 6). The wording of the criterion has been changed to provide more detail as noted above.
8	Page 3-6, line 17-18	On page 3-6, lines 17-18, please revise the text to indicate that the facility-wide background criteria and the processes used to generate them have already been reviewed by the Ohio EPA and USACE.	Agreed. The text has been changed as requested.
9	Page 3-6, line 20-21	Please remove lines 20-21 (page 3-6) from the text of the workplan, as this section specifically deals with the facility-wide background.	Agreed. The second to the last sentence of Section 3.3.1 has been removed (portion of lines 19 and 20).
10	Tables 3-2, 3-3, 3-4, 3-5, and 3-6	Please revise the headings for Tables 3-2, 3-3, 3-4, 3-5, and 3-6, such that they clearly indicate that the background criteria listed for each medium is the installation-wide and facility-wide background.	Agreed. The table titles have been revised as requested.
11	Page 3-12, line 9	Please revise the text on page 3-13, line 9 to read as follows: "…ongoing biological measurements study at WBG *may* be used to adjust soil RGOs…", as it is unclear as to what conclusions may be drawn from the ecological truthing effort.	Agreed. The text has been changed as requested.
12	Page 3-18, line 48 and Page 3-20, line 3	Please provide additional information in the workplan, as to how it was determined that the WBG FS will carry up to three of the most promising alternatives forward for detailed analysis. The target number of alternatives (in addition to the No Action alternative) to be carried through the screening is to be set by the project manager and lead regulatory agency on an AOC-specific basis. Please adjust the text accordingly. (Pages 3-18, line 48 and 3-20, line 3)	Clarification. The reference to the number of alternatives to be carried forward for detailed analysis has been eliminated. However, it is noted that under the fixed-price scope of work for the FS, detailed analysis of three alternatives was assumed for costing purposes.
13	Section 3.0	At an appropriate place in Section 3.0, please add in a discussion of proposed community relations activities as part of the field investigation and FS processes.	Agreed. A brief summary of potential community relations has been added to Section 3.1 as requested.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
14	Page 4-1, line 4-5 and Table 4-1	Please define the seven functional areas that are referenced on page 4-1 (lines 4-5) and in Table 4-1 found on pages 4-2 and 4-3. A description and/or map of the functional areas would be helpful.	Agreed. A tabular summary and description of the functional areas has been added to the first section of Chapter 4.0.
15	Pages 4-2 and 4-3	Please ensure that the pad numbers listed in Table 4-1 are consistent with the pads that were identified during the WBG RI as requiring additional work due to human health and ecological concerns. (Pages 4-2 and 4-3)	Clarification. See response to Ohio EPA comment 7. No specific pads requiring additional investigation were cited in the Phase II RI report recommendations; rather the pads having the “highest risk” be evaluated during remedial action phase. No text changes required.
16	Page 4-4, lines 19-21	Please revise the text on page 4-4 (lines 19-21) to indicate that filtered groundwater samples will be obtained solely for Target Analyte List (TAL) metals, and that all of the other analyses will be conducted on unfiltered samples.	Agreed. The text of Section 4.1.1.2 has been changed as requested.
17	Page 4-7, Section 4.1.2.7	Please provide information in section 4.1.2.7 that indicates that turbidity measurements will be taken as part of the development procedure for monitoring wells (Page 4-7)	Agreed. The text has been added as requested.
18	Page 4-9, Section 4.1.9	In section 4.1.9, please provide additional text in the report that indicates that during intrusive activities, screening for ordnance and explosives (OE)/unexploded ordnance (UXO) will be conducted at two foot intervals, until drilling/augering is below the interface between disturbed and native material. (Page 4-9)	Agreed. See response to Jent comment number 9.
19	Page 4-11, lines 4-5	On page 4-11, lines 4-5, please revise the text to indicate that x-ray fluorescence (XRF) metals screening will be conducted in-situ and ex-situ, in addition to being analyzed at the contract laboratory.	Agreed. See response to Jent comment number 10.
20	Page 4-14, lines 3-7	The text on page 4-14 (lines 3-7) indicates that the 0-1 foot environmental sample obtained at Pad 67 will be collected by OE technicians due to the fact that this pad had the highest concentration of explosives, and may be an area containing raw explosives. The Ohio EPA concurs that the safety of on-site personnel is of the utmost importance. However, it is requested that	Agreed. SAIC will include those UXO technicians who are to conduct the sampling in the QCQ Preparatory Phase Training and will conduct on-the-job training to ensure competency with sampling protocols. Chain-of-custody will be maintained at all times as designated in the QAPP. This information has

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
		the OE technicians that are utilized to obtain the samples are trained in the sampling techniques used on this project, and that there are no resulting chain of custody (COC) issues if the personnel are employed by a different contractor.	been added to the last paragraph of Section 4.2.2.7.
21	Page 4-15, line 10	Please revise the text on page 4-15, line 10 to read: "However, if colorimetry shows explosives >/= 1 ppm (TNT….).	Agreed. The text of Section 4.3.1.1, last paragraph has been changed as requested.
22	Page 4-15, line 40	Please revise the text on 4-15 (line 40) to read: "Surface soils to be analyzed for metals, cyanide, SVOCs, and pesticides/PCBs…"	Agreed. The text of Section 4.3.1.3 second paragraph has been changed as requested.
23	Page 4-18, lines 6-8	Please resolve the discrepancy on page 4-18 between lines 6-8 with line 14. As Table 5-1 (page 5-9) also indicates that sediment samples will be analyzed for field explosives and XRF metals, it is assumed that lines 6-8 are correct and that line 14 should be deleted from the text.	Agreed. The text of Section 4.3.2.3.1 has been changed (line 14 deleted) as requested.
24	Table 5-1	Please revise footnotes "a" and "b" to Table 5-1 (page 5-9) to indicate that the cut-off for determining whether or not a sample is automatically submitted to the laboratory for explosives and propellant analyses is whether or not TNT or RDX are determined to be >/= 1 mg/kg using the Jenkins methodology.	Agreed. The footnotes have been revised to indicate that TNT and/or RDX must be greater than or equal to 1 mg/kg as requested.
HASP - 1	General.	The Ohio EPA NEDO DERR does not have comments on the draft HASP as presented.	Comment noted.
		Brian Tucker, Ohio EPA	
1	Sect. 3.2.3, Sect. 3.5.1	Remedial Action Objectives and Remedial Goal Options states: RGOs for OE are beyond the scope of this FS and will be addressed under a separate ordnance EE/CA. This statement implies that remedial decisions will be based on the FS alone. This may not be correct. The remedial decision if necessary, should be based on information that will be included in the ordnance EE/CA and any other relevant source. Please ensure that information, such as the possibility that any particular burning pad(s) at the WBG	Clarification. The need to integrate the requirements of the ordnance EE/CA with the HTRW remedial action is noted in both sections referenced in the comment. As such, remedial decisions will not be based on the FS alone. The subject sentence in Section 3.5.1 has been revised to state: "RGOs for OE will be developed under a separate ordnance EE/CA and taken into consideration during the development of the FS.

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
		may be excavated because the presence of ordnance, is included in the FS or provided to the Ohio EPA prior to the remedy selection(s) for the WBG.	
2	Tables 3-2 through 3-6	Tables 3-2 through 3-6 appear to have an error. The values given in the columns titled Nonparametric 95% UTL and 99th Percentile contain the same data as given in the column titled Maximum Detect. The 99th percentile should not exceed the maximum detected value and the Nonparametric 95% UTL may exceed the maximum detect value, however, the value would not be the same for all chemicals as listed in Tables 3-2 through 3-6. Please correct the tables as necessary.	Clarification. Sample population size drives observed difference between the nonparametric 95% UTL and 99th percentile value. Until sample population size exceeds 59 measurements the two values will be equal (maximum detected value). As noted in the Winklepeck Burning Grounds Phase II RI Report, the parametric 95% UTL was calculated for normally or lognormally distributed data. The nonparametric 95% UTL was calculated for non-normally distributed data; because the sample population was less than 59 for each background medium, the maximum detect was established as the nonparametric UTL. If an analyte had a frequency of detection, the 99th percentile value was calculated. To avoid confusion, values from the nonparametric 95% UTL and 99th percentile columns have been detected where they do not apply based on the data distribution.
3	Sect. 3.4.2.3	No observed adverse effects levels (NOAELs) are to be used as the criteria for developing ecological based reference doses (ERfD) for use in baseline ecological risk assessments and RGO development. Also, allometric scaling is not appropriate for avian receptors, and at no time are LOAELS to be estimated from NOAELs. See the attached document titled Developing an Ecologically-Based Reference Dose, that describes the suggested toxicity assessment procedure.	Clarification. NOAELs will be used in the development of RGOs for protection of ecological receptors from soil at WBG. In addition, LOAELs will be used to provide alternative RGOs to the COE, EPA, and other risk managers. Finally, development of RGOs for WBG has the benefit of field-observed effects of vegetation and soil concentrations taken simultaneously at WBG. This information serves as ground-truthing information, e.g., chemical mixtures in the field, to supplement the traditional, mathematical way based on single chemical species from laboratory tests. Further, no allometric conversion will be made for birds. No NOAEL to LOAEL conversions are needed; the inability to do such conversion will be treated in the uncertainty section.

Draft Sampling and Analysis Addendum No. 1 for the Feasibility Study of the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant
Comment Resolution

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
4	Sect. 3.4.2.5	Additional information will be required regrading the weight-of-evidence approach to be used in evaluating the RGOs for the various receptors. Specifically, additional information must be provided that demonstrates that bioavailability of compounds, if the bioavailability of contaminants is to be used to modify any RGO value, is accurate and consistent with conditions and contaminants found at the Winklepeck Burning Grounds. Discussions with the Ohio EPA regrading the use bioavailability factors are suggested prior to submitting the FS report.	Agree. For the usual mathematical approach, bioavailability will be expressed as bioconcentration factors from the Baes et al. literature and any other literature that EPA wishes to supply that provides bioconcentration factors. Regarding site-specific information, there are soil concentration data associated with various vegetation metrics at WBG. Bioavailability is involved with the response of the vegetation to soil contamination and that should help to "bracket" bioavailability values, so better RGOs can follow. More about this will be included in the technical memorandum.
5	Sect. 3.4.3	Sediment RGOs are not to be developed until the impacts to aquatic habitats are demonstrated. Impacts to aquatic habitats are to be determined by comparing site conditions to the appropriate water quality regulations found in section 3745-01 of the Ohio administrative code (OAC).	Agree. Sediment RGOs will only be developed after impacts to aquatic systems have been better documented. Such documentation would require separating scoping and would need to be scheduled. Until then, the method proposed in the S&P document will suffice.