APPENDIX I

PBA08 Remedial Investigation Summary

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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ACRONYMS AND ABBREVIATIONS

ADR	Automated Data Review
AOC	Area of Concern
bgs	Below Ground Surface
DoD	U.S. Department of Defense
DPT	Direct-Push Technology
DQO	Data Quality Objective
FCR	Field Change Request
FWCUG	Facility-wide Cleanup Goal
FWSAP	*Facility-Wide Sampling And Analysis Plan*
HQ	Hazard Quotient
IDW	Investigation-Derived Waste
Ohio EPA	Ohio Environmental Protection Agency
PAH	Polycyclic Aromatic Hydrocarbon
PBA08 RI	Performance-Based Acquisition 2008 Remedial Investigation
PBA08 SAP	Performance Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

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I.0 REMEDIAL INVESTIGATION

This section presents the methods used for developing data quality objectives (DQOs), collecting field data, and managing analytical data and laboratory programs for the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at Upper and Lower Cobbs Pond. The PBA08 RI was implemented in accordance with the Performance Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1 (PBA08 SAP) to supplement historical data and complete the remedial investigation (RI) phase of the Comprehensive Environmental Response, Compensation, and Liability Act process. The results of the PBA08 RI sampling completed in 2010 and 2011 are combined with the results of the 2004 Characterization of 14 Areas of Concern (AOCs) and 2007 Investigation of Under Slab Surface Soil investigation to evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct human health risk assessments and ecological risk assessments, and evaluate the need for remedial alternatives.

As part of the PBA08 RI DQOs, an initial screening approach was used to help focus the investigation on specific chemicals and areas to be further evaluated by assessing the nature and extent of contamination observed in historical samples (Section 3.2.2 of the PBA08 SAP). The screening approach presented in the PBA08 SAP compared sample results from previous investigations at Upper and Lower Cobbs Pond to the most protective chemical-specific facility-wide cleanup goals (FWCUGs) at the 1E-06 cancer risk level and non-carcinogenic risk hazard quotient (HQ) of 0.1, as presented in the Ravenna Army Ammunition Plant (RVAAP) Facility-wide Human Health Risk Assessors Manual (USACE 2005). The most protective FWCUGs are referred to as "screening criteria." Previous results were also compared to FWCUGs at the higher target risk of 1E-05 and HQ of 1 to facilitate identification of potential source areas that may require additional sampling to refine the extent of contamination. The decision rules for surface and subsurface soil sampling outlined in the PBA08 SAP are shown in Figures I-1 and I-2. Table I-1 lists the chemicals with detected concentrations that exceed screening criteria in historical soil samples.

Table I-1**. Chemicals Detected at Concentrations Above Screening Criteria in Previous Investigations**

Surface Soil	Subsurface Soil	Sediment	Surface Water
Aluminum	Not Previously Sampled	Aluminum	Arsenic
Arsenic		Arsenic	Manganese
Chromium		Cadmium	
Cobalt		Chromium	
Thallium		Chromium, hexavalent	
Benzo(a)pyrene		Copper	
Dibenz(a,h)anthracene		Silver	
N-Nitroso-di-n-propylamine		Thallium	
		Benz(a)anthracene	
		Benzo(a)pyrene	
		Benzo(b)fluoranthene	
		Indeno(1,2,3-cd)pyrene	

Source: Phase I Remedial Investigation Report for High Priority Areas of Concern (USACE 1998) and Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds (MKM 2005).

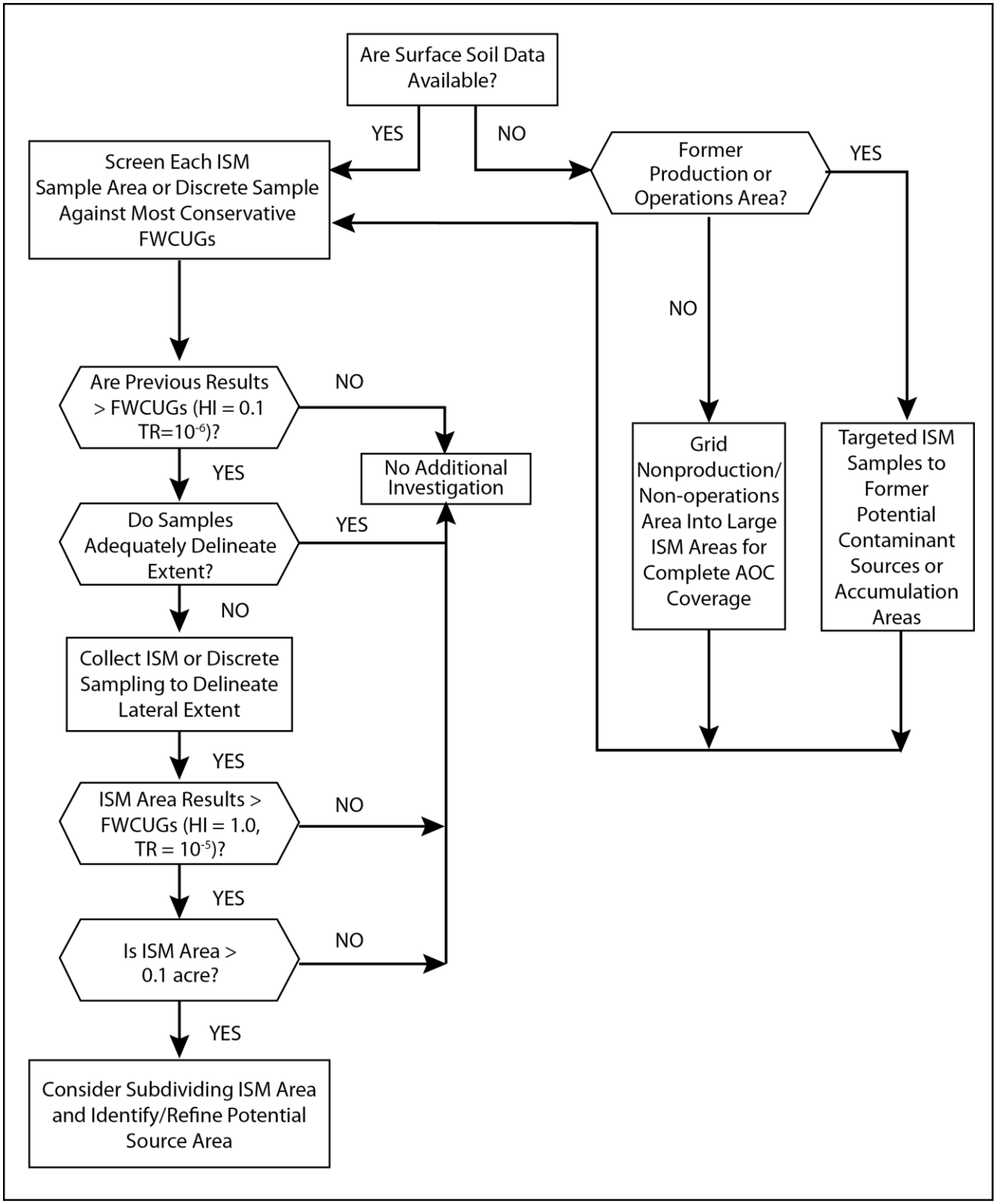

Figure I-1. PBA08 RI Surface Soil Sampling Decision Flowchart

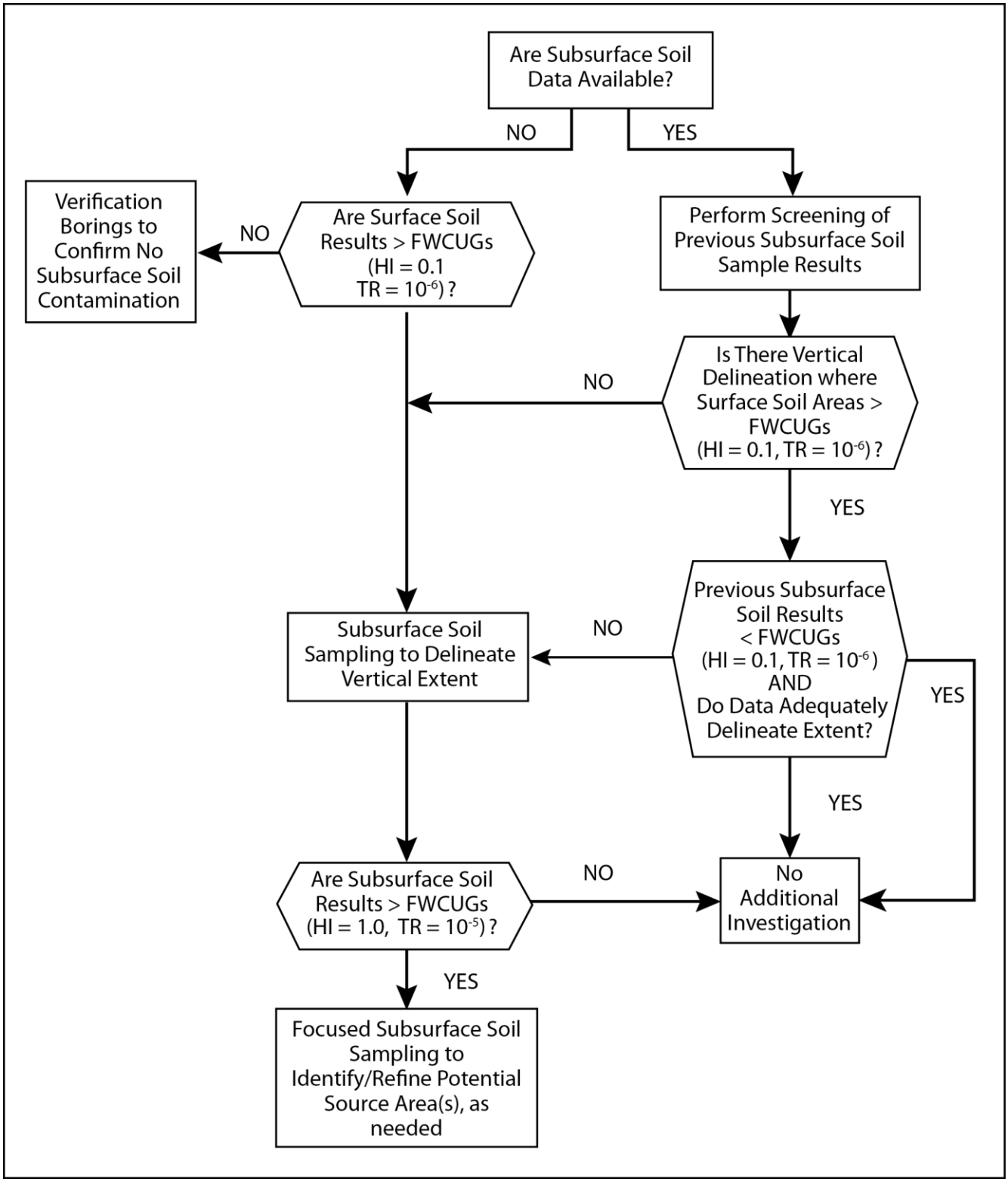

Figure I-2. PBA08 RI Subsurface Soil Sampling Decision Flowchart

Representatives of the Army and the Ohio Environmental Protection Agency (Ohio EPA) reviewed and approved the PBA08 RI sample locations and rationale as part of the approval process for the PBA08 SAP in January 2010.

The PBA08 RI was conducted from February through April 2010 and included the collection of surface water, sediment, surface soil, and subsurface soil using discrete sampling techniques.

No groundwater samples were collected during the PBA08 RI, as the current condition of groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI Report. The following sections describe the rationale and sample collection methods for each component of the PBA08 RI field investigation.

I.1 SOIL CHARACTERIZATION

Soil samples were collected during the PBA08 RI to assess contaminant occurrence and distribution in surface and subsurface soil. The decision-making matrices for the surface soil and subsurface soil sampling plans are presented in Figures I-1 and I-2, respectively.

I.1.1 Surface Soil Sampling Rationale and Methods

The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., at the edges of the ponds). Surface soil sampling to define the lateral extent of contamination was conducted according to the decision rules approved in the PBA08 SAP and as depicted in Figure I-1. All PBA08 RI surface soil samples were collected using discrete sampling techniques.

Eight discrete surface soil samples were collected at Upper and Lower Cobbs Pond during the PBA08 RI in 2010. Five samples were collected along the shoreline and drainage ditches near historical locations where chemical detections were greater than the screening criteria presented in Table I-1. Additionally, three samples were collected in areas not previously investigated at the AOC. These samples were collected to further delineate the lateral extent of surface soil contamination.

Discrete samples were analyzed for target analyte list (TAL) metals, explosives, and polycyclic aromatic hydrocarbons (PAHs). Two discrete surface soil samples (10% of the total number of discrete surface soil samples collected) were analyzed for RVAAP full-suite analytes. References to the "RVAAP full-suite analytes" generally include analyses of TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and pesticides. Nitroglycerin was analyzed under U.S. Environmental Protection Agency (USEPA) Method 8330 and was reported as an explosive chemical. Table I-2 presents the specific rationale for each surface soil sample collected for the PBA08 RI.

Table I-2. PBA08 RI Surface Soil Samples and Rationales

PBA08 RI Location	Targeted Area	Purpose	Analyses Performed				
			Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
CPCss-036	Pond Bank – northeastern bank of Lower Cobbs Pond	Characterize an area not previously sampled.	Y	Y	N	N	Y
CPCss-037	Pond Bank – southeastern bank of Lower Cobbs Pond	Delineate lateral extent of previously identified surface contamination.	Y	Y	N	N	Y
		QA/QC	Y	Y	N	N	Y
			Y	Y	N	N	Y
CPCss-038	Pond Bank –eastern bank of Upper Cobbs Pond	Characterize an area not previously sampled.	Y	Y	N	N	Y
CPCss-039	Pond Bank –southeastern bank of Upper Cobbs Pond	Delineate lateral extent of previously identified surface contamination. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
CPCss-040	Pond Bank – eastern bank south of Track FA	Delineate lateral extent of previously identified surface contamination.	Y	Y	N	N	Y
CPCss-041	Pond Bank – western bank of Upper Cobbs Pond	Delineate lateral extent of previously identified surface contamination.	Y	Y	N	N	Y
CPCss-042	Pond Bank – northwestern bank of Upper Cobbs Pond	Delineate lateral extent of previously identified surface contamination.	Y	Y	N	N	Y
CPCss-043	Pond Bank – south/southwestern bank of Lower Cobbs Pond	Characterize an area not previously sampled.	Y	Y	N	N	Y

FA = Functional area.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

All surface soil samples were collected from 0–1 ft below ground surface (bgs) in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the Facility-Wide Sampling and Analysis Plan (USACE 2001a) (herein referred to as the FWSAP). An updated version of the FWSAP was developed in February 2011 and approved by Ohio EPA; however, the PBA08 RI was implemented prior to approval of this updated version.

Quality control (QC) field duplicate and quality assurance (QA) split samples were collected at a 10% frequency (two samples). The QC field duplicate samples were submitted to the laboratory as "blind" and were used to determine whether the field sampling technique was reproducible and as an indicator of sample heterogeneity. The QA split samples were sent to a U.S. Army Corps of Engineers (USACE) QA laboratory for independent analysis and evaluation of analytical results obtained by the primary laboratory.

After the discrete samples were collected, excess soil was designated as investigation-derived waste (IDW) and placed in lined, labeled 55-gal drums that were sealed after use and staged at Building 1036. IDW management practices for all media are discussed in Appendix F. Hand auger borings were backfilled to ground surface with dry bentonite chips and hydrated with the project-approved potable water.

I.1.2 Subsurface Soil Sampling Rationale and Methods

The PBA08 RI used discrete samples from five soil borings to complete the characterization of subsurface soil. The subsurface soil decision rules are presented in Figure I-2 and were based upon prior surface soil sampling results to define the vertical extent of contamination. Subsurface soil sampling was conducted according to the decision rules approved in the PBA08 SAP. The subsurface soil borings were located based on three objectives:

- Borings at locations where previous surface soil sampling results exceeded screening criteria and vertical delineation was warranted.
- Borings at locations where previous surface soil sampling results only slightly exceeded screening criteria to confirm that contaminant concentrations did not increase with depth.
- Borings at locations not previously sampled to provide full characterization of surface and subsurface soil.

The subsurface soil was characterized by placing borings in various areas, including areas with previous surface soil results greater than the screening criteria, areas with previous results only slightly greater than the screening criteria, and areas not previously sampled. In all cases, subsurface borings were biased toward areas where contamination from historical uses or site drainage was most likely. Soil samples from five soil borings were installed to further delineate the vertical extent of contamination in subsurface soil at the AOC (Figure I-3). Table I-3 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI.

Table I-3. Subsurface Soil Rationale and Analyses

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
CPCsb-030	Confirm absence of contamination in an area not previously sampled. Groundwater encountered at 1 ft bgs.	Discrete	0–1	Y	Y	N	N	Y
		NS	1–4	N	N	N	N	N
		NS	4–7	N	N	N	N	N
		NS	7–13	N	N	N	N	N
CPCsb-031	Delineate vertical extent of previously identified surface contamination. Groundwater encountered at 1.3 ft bgs.	Discrete	0–1	Y	Y	N	N	Y
		NS	1–4	N	N	N	N	N
		NS	4–7	N	N	N	N	N
		NS	7–13	N	N	N	N	N
CPCsb-032	Delineate vertical extent of previously identified surface contamination. Groundwater encountered at 10 ft bgs.	Discrete	0–1	Y	Y	N	N	Y
		Discrete	1–4	Y	Y	N	N	Y
		Discrete	4–7	Y	Y	N	N	Y
		Discrete[a]	7–10	Y	Y	N	N	Y
	QA/QC.	Discrete	1–4	Y	Y	N	N	Y
		Discrete	1–4	Y	Y	N	N	Y
CPCsb-033	Geotechnical.	Discrete	4-5.4	N	N	N	N	N
		Discrete	8-9.7	N	N	N	N	N
CPCsb-034	Delineate vertical extent of previously identified surface contamination. Groundwater encountered at 2 ft bgs.	Discrete	0–1	Y	Y	N	N	Y
		Discrete	1–2	Y	Y	N	N	Y
		NS	4–7	N	N	N	N	N
		NS	7–13	N	N	N	N	N
CPCsb-035	Delineate vertical extent of previously identified surface contamination. Analyzed for RVAAP full-suite analytes.	Discrete	0–1	Y	Y	Y	Y	Y
		Discrete	1–4	Y	Y	Y	Y	Y
		Discrete	4–7	Y	Y	Y	Y	Y
		NA	7–13	N	N	N	N	N
	QA/QC. Analyzed for RVAAP full-suite analytes.	Discrete	4–7	Y	Y	Y	Y	Y
		Discrete	4–7	Y	Y	Y	Y	Y

bgs = Below ground surface.
ft = Feet.
NA = Sample not analyzed by the laboratory based on preliminary screening criteria of the 4-7 ft bgs sample interval.
NS = Not sampled due to refusal.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army and Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

Subsurface soil borings were completed by direct-push technology (DPT) using a Geoprobe® and/or hand auger. DPT soil samples were collected in a single-use acetate liner at discrete sample locations, and hand auger samples were collected in a chemically decontaminated 3-inch-diameter stainless steel auger bucket.

To assess the depths of exposure of the Resident Receptor, each soil boring was sampled at the following intervals: 0–1, 1–4, 4–7, and 7–13 ft bgs. These sample intervals were selected to be able to evaluate surface and subsurface exposure depths for the Resident Receptor (0–1 and 1–13 ft bgs) and National Guard Trainee (0–4 and 4–7 ft bgs). Each interval was composited and homogenized in a stainless steel bowl, with the exception of VOC samples. The deep sample interval was archived onsite, while the 4–7 ft bgs interval sample was analyzed under an expedited five-day turnaround time. As specified in the PBA08 SAP, the deep sample interval (7–13 ft bgs) would be analyzed for the following reasons:

1. One chemical had a concentration that exceeded screening criteria in the 4–7 ft bgs sample; or
2. To ensure at least 10% of all subsurface samples from 7–13 ft bgs were submitted for laboratory analysis for adequate characterization of subsurface soil to 13 ft bgs.

One sample collected from the 7–13 ft bgs sample interval was submitted for laboratory analysis for Upper and Lower Cobbs Pond. No 7–13 ft bgs samples were analyzed due to preliminary screening criteria exceedances within the 4–7 ft bgs sample interval, but one sample (CPCSB-032-5116-SO) was analyzed to ensure adequate characterization of the 7–13 ft bgs interval.

All subsurface soil samples were analyzed for TAL metals, explosives, and PAHs. A minimum of 10% of samples (three) was analyzed for the RVAAP full-suite analytes. Two QC field duplicates and two QA split samples were collected to satisfy the QA/QC sample requirements of 10% frequency for subsurface soil samples. A lithologic soil description was completed for each soil boring and is included in Appendix A.

Two geotechnical samples were collected from one boring location to provide soil data for fate and transport modeling. A pilot boring was installed with a Geoprobe® to a depth of 13 ft bgs to lithologically characterize the soil and determine the appropriate geotechnical sample intervals (Appendix A). The geotechnical sample location was offset from the pilot boring and drilled with hollow-stem auger attachments. Geotechnical samples were collected through the hollow-stem augers directly into Shelby Tubes. Shelby Tubes were collected from 4–5.4 ft bgs and 8–9.7 ft bgs, directly above the saturated zone observed in the pilot boring. Shelby Tubes were sealed with wax, capped, and submitted for laboratory geotechnical analysis for porosity, bulk density, moisture content, total organic carbon, grain size fraction analysis, and permeability. Laboratory analytical results for geotechnical samples are presented in Appendix D. QA/QC samples were not collected for geotechnical samples.

After the discrete samples were collected, excess soil was designated as IDW and placed in lined, labeled 55-gal drums that were sealed after use and staged at Building 1036. IDW management practices for all media are discussed in Appendix F. Hand auger borings were backfilled to ground surface with dry bentonite chips while hydrating with the project-approved potable water.

I.2 SURFACE WATER AND SEDIMENT CHARACTERIZATION

For the purposes of this report, the term "surface soil" includes dry sediment. Dry sediment refers to unconsolidated inorganic and organic material within conveyances, ditches, or low-lying areas that occasionally may be covered with water, usually following a precipitation event or due to snowmelt. Dry sediment is not covered with water for extended periods and typically is dry within seven days of precipitation. Dry sediment does not function as a permanent habitat for aquatic organisms, although it may serve as a natural medium for the growth of terrestrial organisms. Dry sediment is addressed the same as surface soil (0–1 ft bgs) in terms of contaminant nature and extent, fate and transport, and risk exposure models. The term "sediment," as used in this report, refers to wet sediment within conveyances, ditches, wetlands, or water bodies that are inundated for extended periods of time. These definitions and terminology usage are consistent with the FWCUG Report.

Surface water and sediment samples were collected to characterize current conditions and assess potential entrance and exit pathways from the AOC (Figure I-3). Five co-located surface water and sediment samples and ten composite and discrete sediment samples were collected during the PBA08 RI.

I.2.1 Surface Water and Sediment Sampling Methods

The surface water grab samples were collected by the hand-held bottle method in accordance with Section 4.3 of the PBA08 SAP and analyzed for the RVAAP full-suite analytes. Water quality parameters for temperature, pH, conductivity, dissolved oxygen, and turbidity were collected using calibrated water quality meters (Hanna Instrument Models 9828 and 98703). A surface water and sediment sample collection sheet was completed for each sample location and is included in Appendix A.

The sediment samples were collected in accordance with Section 4.2 of the PBA08 SAP. The samples consisted of a multi-aliquot composite with 10 aliquots selected randomly within a 5-ft radius of the identified sample location. Each aliquot was collected by means of a stainless steel push probe or Ponar sediment sampler lowered from the side of a boat to a maximum depth of 0.5 ft bgs. The aliquots were homogenized in a stainless steel bowl and transferred to the appropriate labeled sample container. CPCSD-044-5022-SD was analyzed for TAL metals, explosives, and SVOCs, and CPCSD-049-5032-SD (chromium speciation sample) was analyzed for total and hexavalent chromium. All other composite sediment samples were analyzed for the RVAAP full-suite analytes [i.e., TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), SVOCs, VOCs, PCBs, and pesticides]. For VOC analysis, one discrete sample collected from 0–0.5 ft bgs was collected within the 5-ft sampling radius and placed directly in the appropriate, labeled sample container.

Four discrete subsurface sediment samples were collected at a maximum depth of 2 ft bgs from a stainless steel split core barrel attached to the end of a slide hammer. Sediment from 0.5–2 ft bgs was homogenized in a stainless steel bowl, transferred to the appropriate labeled sample container, and analyzed for the RVAAP full-suite analytes [i.e., TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), SVOCs, VOCs, PCBs, and pesticides]. No QC field duplicate or QA split sediment samples were collected.

I.2.2 Upper and Lower Cobbs Pond Surface Water and Sediment Sampling Rationale

During previous investigations, surface water or sediment samples were collected for characterization purposes at Upper and Lower Cobbs Pond. Five co-located surface water and sediment samples were collected during the PBA08 RI from the Upper and Lower Cobbs Pond. The samples were collected in accordance with the following decision rules approved in the PBA08 SAP: Table I-4 presents the specific rationale for the surface water and sediment samples collected for the PBA08 RI.

Table I-4. PBA08 RI Surface Water and Sediment Samples and Rationales

PBA08 RI Location	Targeted Area	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
					Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
CPCsd-044	Outlet of Lower Cobbs Pond	Characterize off-AOC migration.	Composite	0—0.5	Y	Y	N	N	Y
CPCsw-044			Grab	NA	Y	Y	Y	Y	Y
CPCsd-045	Lower Cobbs Pond	Confirm presence of contamination in previously sampled area.	Composite	0–0.5	Y	Y	Y	Y	Y
			Discrete	0.5–2	Y	Y	Y	Y	Y
CPCsw-045			Grab	NA	Y	Y	Y	Y	Y
CPCsd-046	Upper Cobbs Pond	Confirm presence of contamination in previously sampled area.	Composite	0–0.5	Y	Y	Y	Y	Y
CPCsw-046			Discrete	0.5–2	Y	Y	Y	Y	Y
CPCsd-047	Inlet of Upper Cobbs Pond	Confirm presence of contamination in previously sampled area.	Composite	0–0.5	Y	Y	Y	Y	Y
			Discrete	0.5–2	Y	Y	Y	Y	Y
CPCsw-047			Grab	NA	Y	Y	Y	Y	Y
		QA/QC	Grab	NA	Y	Y	Y	Y	Y
			Grab	NA	Y	Y	Y	Y	Y
CPCsd-048	Backwater Area	Confirm presence of contamination in previously sampled area.	Composite	0–0.5	Y	Y	Y	Y	Y
			Discrete	0.5–2	Y	Y	Y	Y	Y
CPCsw-048			Grab	NA	Y	Y	Y	Y	Y
CPCsd-049	Upper Cobbs Pond	Chromium speciation - Previous Cr result represents maximum Cr concentration	Composite	0–0.5	Cr	N	N	N	N

AOC = Area of concern.
bgs = Below ground surface.
Cr = Chromium.
ft = Feet.
NA = Not applicable.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA = Quality assurance.
QC = Quality control.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.

I.3 CHANGES FROM THE WORK PLAN

Changes to the PBA08 SAP are documented in the field change requests (FCRs) provided in Appendix B. Changes made in the field based on AOC-specific conditions are not documented on FCRs but on the field sampling logs (Appendix A). These changes are presented in the field sampling logs and presented in Table I-5.

Table I-5. Changes from the PBA08 SAP

Location	Affected Sample	Date Sampled	Change/Rationale
CPCsb-032	CPCSB-032-5113-SO	03/24/10	Location moved due to standing water.
	CPCSB-032-5114-SO	03/24/10	
	CPCSB-032-5115-SO	03/24/10	
	CPCSB-032-5116-SO	03/24/10	
	CPCSB-032-6073-FD	03/24/10	
CPCsb-033	CPCSB-033-5117-SO	03/29/10	Location moved due to standing water.
	CPCSB-033-5118-SO	03/29/10	
CPCsb-034	CPCSB-034-5119-SO	03/29/10	Location moved due to standing water.
	CPCSB-034-5120-SO	03/29/10	
CPCsw-048	CPCSW-048-5031-SW	04/01/10	Location moved approximately 30 ft to the south due to access issues.
	CPCSD-048-5786-SD	04/01/10	
	CPCSD-048-5026-FD	04/01/10	

PBA08 SAP = Performance-Based Acquisition 2008 Sampling and Analysis Plan.

I.4 ANALYTICAL PROGRAM OVERVIEW

The following sections describe the analytical program followed during the PBA08 RI.

I.4.1 Data Quality Objectives

Samples were collected and analyzed according to the FWSAP and PBA08 SAP that were prepared in accordance with USACE and USEPA guidance. The FWSAP and PBA08 SAP outline the organization, objectives, intended data uses, and QA/QC activities to perform to achieve the desired DQOs for maintaining the defensibility of the data. Project DQOs were established in accordance with USEPA Region 5 guidance. Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data verification criteria for the RI are consistent with USEPA and U.S. Department of Defense (DoD) requirements. DQOs for this project include analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix C presents an assessment of the analytical program objectives.

I.4.2 Quality Assurance and Quality Control

Samples were properly packaged for shipment and transferred by courier to the laboratory for analysis. A signed chain-of-custody record (included in Appendix D) with sample numbers and locations was enclosed with each shipment. When transferring possession of samples, the individuals relinquishing and receiving the samples signed, dated, and noted the time on the record. All shipments were in

compliance with applicable U.S. Department of Transportation regulations for environmental samples.

QA/QC samples for this project included field blanks, trip blanks, QC field duplicates, QA split samples, laboratory method blanks, laboratory control samples, laboratory duplicates, and matrix spike/matrix spike duplicate samples. Table I-6 presents a summary of QA/QC samples utilized during the PBA08 RI and how each sample type was used to support the quality of the analytical data. Evaluation of QA/QC samples and their contribution to documenting project data quality is provided in Appendix C.

Table I-6. Summary of PBA08 RI QA/QC Samples

Sample Type	Rationale
Field Blank	Analyzed to determine contamination in source material that may contribute to sample contamination.
Trip Blank	Analyzed to assess the potential for cross-contamination of samples due to contaminant interference during sample shipment and storage.
Field Duplicate	Analyzed to determine sample heterogeneity and sampling methodology reproducibility.
Equipment Rinsate	Analyzed to assess the adequacy of the equipment decontamination processes for non-dedicated sampling equipment.
Laboratory Method Blanks	Analyzed to assess the contamination level in the laboratory preparation and analysis process.
Laboratory Duplicate Samples	Analyzed to assist in determining the analytical reproducibility and precision of the analysis for the samples of interest and provide information about the effect of the sample matrix on the measurement methodology.
Matrix Spike/Matrix Spike Duplicate	
Laboratory Control Sample	Analyzed to determine the accuracy and precision of the analytical method implemented by the laboratory and to monitor the laboratory's analytical process control.
QA Split	Analyzed to provide independent verification of the accuracy and precision of the principal analytical laboratory.

QA = Quality assurance.
QC = Quality control.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.

I.4.3 Field Analyses

No field laboratory analyses (i.e., field explosives testing) were conducted for the PBA08 RI. However, water quality parameters were recorded using water quality meters (Hanna Instrument Models 9828 and 98703) that were calibrated daily. Additionally, field screening for organic vapors was not used to guide sampling or analytical efforts. Organic vapors were monitored in the breathing zone during drilling for health and safety purposes at each subsurface soil boring location.

I.4.4 Laboratory Analyses

Samples collected during the PBA08 RI were analyzed by TestAmerica Laboratories, Inc. (herein referred to as TestAmerica) of North Canton, Ohio, and West Sacramento, California, as a subcontractor to White Water Associates, Inc., of Amasa, Michigan. Collected QA split samples were analyzed by USACE's contracted QA laboratory, RTI Laboratories, Inc., of Livonia, Michigan.

TestAmerica and RTI Laboratories, Inc. are accredited by the DoD Environmental Laboratory Accreditation Program.

All analytical procedures were completed in accordance with applicable professional standards; USEPA requirements; government regulations and guidelines; DoD Quality Systems Manual Version 3; USACE Louisville District analytical QA guidelines; and specific project goals and requirements. In addition to these standards, the analytical laboratories were required to strictly adhere to the requirements set forth in the FWSAP and PBA08 SAP so that conditions adverse to data quality would not arise. Project quantitation level goals for analytical methods were listed in the Quality Assurance Project Plan. These levels were achieved or exceeded throughout the analytical process, with the exception of a few pesticide and SVOC analytes in some samples due to required dilutions. These goals and exceptions are further discussed in Appendix C. While some quantitation levels were elevated above FWCUGs, all method detection limits for undetected analytes remained below these levels, with the exception of benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine results in sample CPCss-043-5021-SO. Preparation and analyses for chemical parameters were performed according to the methods listed in Table I-7. Additionally, soil geotechnical analysis for porosity, bulk density, moisture content, grain size fraction, and permeability were performed in compliance with American Society for Testing and Materials test methods.

Table I-7. Summary of PBA08 RI Sample Preparation and Analytical Procedures

Parameter	Soil and Sediment		Surface Water	
	Preparation	Analysis	Preparation	Analysis
Inorganic Chemicals	SW-846 3050B	SW-846 6020	SW-846 3005A	SW-846 6020
Mercury	--	SW-846 7471A	--	SW-846 7470A
Explosives	--	SW-846 8330B	--	SW-846 8330B
SVOCs and PAHs	SW-846 3540C	SW-846 8270C	SW-846 3520C	SW-846 8270C
Propellants: Nitrocellulose Nitroguanidine	 -- SW-846 3550A	 353.2 Modified SW-846 8330M	 -- SW-846 3535	 353.2 Modified SW-846 8330M
VOCs	SW-846 5030B	SW-846 8260B	SW-846 5030B	SW-846 8260B
Pesticides	SW-846 3540C	SW-846 8081A	SW-846 3520C	SW-846 8081A
PCBs	SW-846 3540C	SW-846 8082	SW-846 3520C	SW-846 8082
Hexavalent Chromium	SW-846 3060A	SW-846 7196A	--	SW-846 7196A

PAH = Polycyclic aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
PBA08 = Performance-Based Acquisition 2008 Remedial Investigation.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
-- = Preparation steps included in analytical method.

Leidos is the custodian of project files and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports, correspondence, and sample custody forms. These files will remain in a secure area under the custody of the Leidos project manager until they are transferred to USACE Louisville District and the Army at the end of the Performance-Based Acquisition 2008 project.

Analytical data reports from the project laboratory were forwarded to the USACE Louisville District laboratory data validation contractor for validation, review, and QA comparison. White Water Associates, Inc. and TestAmerica will retain all original raw data (hard copy and electronic copy) in a secure area under the custody of the laboratory project manager for a minimum of seven years.

I.4.5 Data Review, Verification, and Quality Assessment

Data were produced, reviewed, and reported by the laboratory in accordance with specifications in the PBA08 SAP; USACE Louisville District analytical QA guidelines; and the laboratory's QA manual.

TestAmerica performed in-house analytical data reduction under the direction of the laboratory project manager and QA officer. These individuals were responsible for assessing data quality and informing Leidos and USACE of any data considered "unacceptable" or requiring caution by the data user in terms of its reliability.

Final reports were generated by the laboratory project manager. Data were then delivered to Leidos for verification. TestAmerica prepared and retained full analytical and QC documentation for the project in paper copy and electronic storage media (e.g., compact disk), as directed by the analytical methodologies employed. Laboratory reports included documentation verifying analytical holding time compliance.

Leidos performed a systematic process utilizing automated data review (ADR) software for data verification to ensure the precision and accuracy of the analytical data were adequate for their intended use. The ADR outlier reports are included as Attachment 2 to Appendix C. This verification also attempted to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected chemicals). This approach was consistent with the DQOs for the project and with the analytical methods used for determining chemicals of concern and calculating risk. "Definitive Data" were reported consistent with the deliverables identified in the project sampling and analysis plan (SAP). These definitive data were then verified through the review process outlined in the project SAP and presented in Appendix C. A few inorganic chemical, SVOC, and pesticide samples required dilution due to elevated analyte concentrations or difficult matrices. All of the reporting limits and/or method detection limits for undetected analytes remained below FWCUGs, with the exception of dibenz(a,h)anthracene, n-nitrosodi-n-propylamine, and benzo(a)pyrene for soil sample CPCSS-043-5021-SO. During the review process, nine non-detectable antimony concentrations in soils were rejected due to poor matrix spike recoveries. Rejected data constituted 0.2% of the Upper and Lower Cobbs Pond data. Additional results were qualified as estimated, indicating accuracy, precision, or sensitivity was less than desired but adequate for their intended use. The completeness goal for analytical data is 90%, as defined in Tables 3-1 and 3-2 of the FWQAPP. The project achieved this goal by collecting all samples presented in the PBA08 SAP and producing usable results for 99.8% of all sample analyses performed. In addition to the Leidos data review, a 10% validation of all data was performed by USACE to evaluate data usability.

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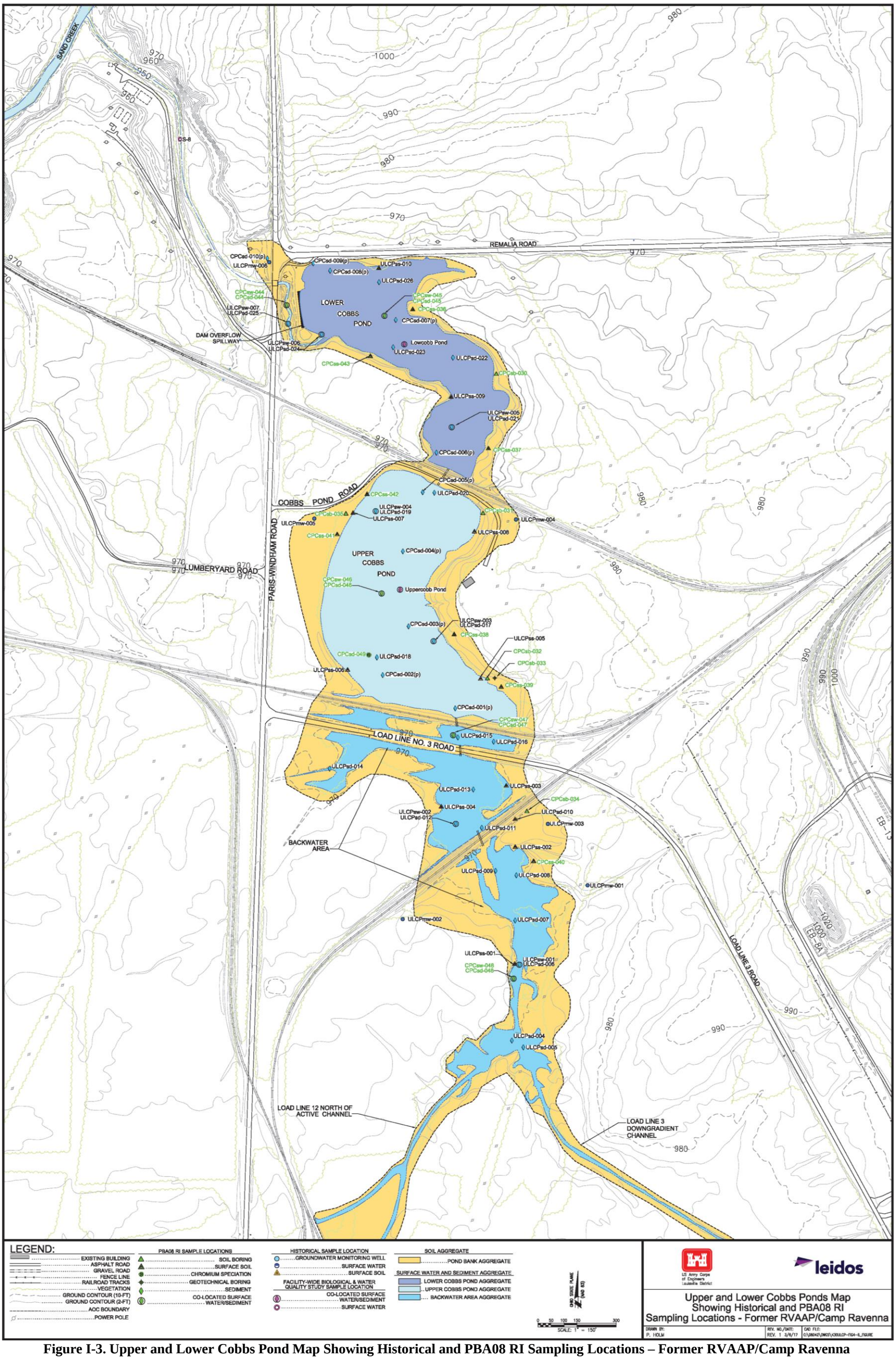

Figure I-3. Upper and Lower Cobbs Pond Map Showing Historical and PBA08 RI Sampling Locations – Former RVAAP/Camp Ravenna

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REFERENCES

USACE 2001. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. March 2001.

USACE 2005. *RVAAP Facility-Wide Human Health Risk Assessors Manual – Amendment 1*. December 2005.

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