Revised Draft

Phase III Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-29 Upper and Lower Cobbs Ponds

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-15-C-0046

Prepared for:

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Louisville District

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None.

14. ABSTRACT

This Phase III Remedial Investigation Report for the Upper and Lower Cobbs Ponds AOC presents physical characteristics, geology, and hydrogeology of the AOC; compiles historical and newly acquired environmental data; summarizes nature and extent of contamination in soil, sediment, and surface water; evaluates contaminant fate and transport; and provides human health and ecological risk assessments. These evaluations indicate there are no chemicals of concern (COCs) that pose unacceptable risk; therefore, this report recommends No Further Action with respect to soil, sediment, and surface water to attain Unrestricted (Residential) Land Use.

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risk assessment, weight of evidence, nature and extent, fate and transport, no further action

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Revised Draft Phase III Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-29 Upper and Lower Cobbs Ponds at the Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing U.S. Army Corps of Engineers (USACE) policy.

	3/17/17
Jed Thomas, P.E. Study/Design Team Leader, Main Author	Date

	3/17/17
Michael Bolen, P.G. Independent Technical Review Team Leader	Date

Significant concerns and the explanation of the resolution are as follows:

Internal Leidos Independent Technical Review comments are recorded on a Document Review Record per Leidos standard operating procedure ESE A3.1 Document Review. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader. As noted above, all concerns resulting from independent technical review of the project have been considered.

	3/17/17
Lisa Jones-Bateman Senior Program Manager	Date

PLACEHOLDER FOR:

Documentation of Ohio EPA Concurrence of Final Document

(Documentation to be provided once concurrence is issued.)

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ARNG = Army National Guard.
CO = Central Office.
DERR = Division of Environmental Response and Revitalization.
IED = Installation and Environment Division.
NEDO = Northeast District Office.
OHARNG = Ohio Army National Guard.
Ohio EPA = Ohio Environmental Protection Agency.
REIMS = Ravenna Environmental Information Management System.
SWDO = Southwest District Office.
USACE = U.S. Army Corps of Engineers.

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ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
AOC	Area of Concern
Army	U.S. Department of the Army
AT123D	Analytical Transient 1-, 2-, 3- Dimensional
bgs	Below Ground Surface
BHC	Hexachlorocyclohexane
BHHRA	Baseline Human Health Risk Assessment
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCOC	Contaminant Migration Chemical of Concern
CMCOPC	Contaminant Migration Chemical of Potential Concern
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSEM	Conceptual Site Exposure Model
CSI	Community Similarity Index
CSM	Conceptual Site Model
CUG	Cleanup Goal
DAF	Dilution Attenuation Factor
DERR	Division of Environmental Response and Revitalization
DFFO	Directors Final Findings and Orders
DNT	Dinitrotoluene
DQO	Data Quality Objective
EcoSSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
ESV	Ecological Screening Value
EU	Exposure Unit
f_{oc}	Mass Fraction of the Organic Carbon Soil Content
FS	Feasibility Study
FWCUG	Facility-wide Cleanup Goal
FWERWP	Facility-wide Ecological Risk Work Plan
FWGWMP	Facility-wide Groundwater Monitoring Plan
FWHHRAM	Facility-wide Human Health Risk Assessors Manual
FWSAP	Facility-wide Sampling and Analysis Plan
gpm	Gallons Per Minute
GSSL	Generic Soil Screening Level
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HLC	Henry’s Law Constant

HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	Hazard Quotient
ILCR	Incremental Lifetime Cancer Risk
INRMP	Integrated Natural Resource Management Plan
IRIS	Integrated Risk Information System
ISM	Incremental Sampling Methodology
K_d	Soil/Water Partitioning Coefficient
K_ds	Distribution Coefficient
K_{oc}	Water/Organic Carbon Partition Coefficient
K_{ow}	Octanol-Water Partition Coefficient
LOAEL	Lowest Observed Adverse Effect Level
L-QHEI	Lake Erie Shoreline Qualitative Habitat Evaluation Index
MCL	Maximum Contaminant Level
MDC	Maximum Detected Concentration
MDL	Method Detection Limit
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	No Observed Adverse Effect Level
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OMZA	Outside Mixing Zone Average
OMZM	Outside Mixing Zone Maximum
ORAM	Ohio Rapid Assessment Method
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
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PEC	Probable Effect Concentration
PP	Proposed Plan
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QC	Quality Control
QHEI	Qualitative Habitat Evaluation Index
R	Retardation Factor
RDA	Recommended Daily Allowance
RDI	Recommended Daily Intake
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
REIMS	Ravenna Environmental Information Management System
RfD	Reference Dose
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level

RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment Model
SMCL	Secondary Maximum Contaminant Level
SOR	Sum of Ratio
SRC	Site-related Contaminant
SRV	Sediment Reference Value
SSL	Soil Screening Level
SSSL	Site-Specific Soil Screening Level
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TEC	Threshold Effect Concentration
TNT	2,4,6-Trinitrotoluene
TR	Target Risk
UCL	Upper Confidence Limit
URF	Unit Risk Factor
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence
WQC	Water Quality Criteria
WQS	Water Quality Standards

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EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND SCOPE

This document has been revised by Leidos under the U.S. Army Corps of Engineers Louisville District Contract Number W912QR-15-C-0046. This Phase III Remedial Investigation (RI) Report addresses soil, sediment, and surface water at the Upper and Lower Cobbs Ponds area of concern (AOC) within the former Ravenna Army Ammunition Plant (RVAAP) [now known as Camp Ravenna Joint Military Training Center (Camp Ravenna)] in Portage and Trumbull counties, Ohio.

This report has been prepared in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) Director's Final Findings and Orders (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and National Contingency Plan to implement an RI to characterize the AOC; develop a feasibility study (FS) (if remediation is necessary); and evaluate remedial alternatives to address contamination presenting unacceptable risk to human health and the environment, present a preferred alternative in a proposed plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a record of decision (ROD). The following sections present the site history, scope of this report, and an explanation of the evaluation of future use.

ES.1.1 Site History

The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of Camp Ravenna. The AOC is located east of Paris-Windham Road and south of Remalia Road, north of Load Line 12, and northwest of Load Line 3. The AOC is approximately 39 acres and is comprised of the Backwater Area (5.2 acres), Upper Cobbs Pond (9.4 acres), Lower Cobbs Pond (6.4 acres), and surrounding pond banks (18 acres). Upper Cobbs Pond ranges from 3–8 ft in depth, and Lower Cobbs Pond ranges from 2–7 ft in depth (MKM 2005). The Backwater Area is located to the south (upstream) of Upper Cobbs Pond and was created through beaver dam construction activity. The Backwater Area is located south of Track 33, while Upper and Lower Cobbs Ponds are located north of Track 33. Cobbs Pond Road separates Upper Cobbs Pond from Lower Cobbs Pond.

Upper Cobbs Pond and Lower Cobbs Pond were constructed in 1940–1941, expanding a natural drainage conveyance to receive effluent discharge and to serve as the unlined sedimentation basins for Load Lines 3 and 12. From 1941–1971, the ponds received effluent from the Load Lines 3 and 12 sawdust filtration units, wash water, storm water runoff, and surface water runoff. Rinsate from demilitarization operations at Load Lines 3 and 12 was initially allowed to flow out of buildings and directly onto the ground or to drainage ditches, which ultimately discharged to Upper Cobbs Pond and Lower Cobbs Pond. Load Line 12 was formerly utilized for producing ammonium nitrate from 1941–1943 and 1946–1950. From 1951–1961, explosive melt-out and demilitarization activities occurred at Load Line 12. Since there were no wash water collection tanks or settling ponds in Load Line 12 during these operations, all residues, dusts, and spills were washed into the drainage system that eventually discharged into Upper Cobbs Pond.

From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 in Load Line 12 for producing aluminum chloride. On November 15, 1966, a fish kill occurred at Lower Cobbs Pond as a result of improper handling of aluminum chloride during manufacturing operations. The bulk of the aluminum chloride was collected and disposed at Ramsdell Quarry Landfill (RVAAP-01). The pond, receiving the contaminating waste from drainage ditches, was settled, drained, and the contaminants were removed to Ramsdell Quarry. Contaminated metals were flashed at a burning ground to a 5X condition (USATHAMA 1978 and 1982, RVAAP 2000). The U.S. Department of the Army (Army) terminated the lease early on December 3, 1967 due to environmental concerns related to air emissions and wastewater discharges to Upper and Lower Cobbs Ponds.

The Upper and Lower Cobbs Ponds AOC is currently utilized for recreational purposes, as it contains abundant fish and wildlife. The Ohio Army National Guard (OHARNG) and facility workers use the ponds for fishing. Currently, due to the fact that the investigative activities are still ongoing at the AOC under the restoration program, fishing in the ponds is catch and release. The pond bank areas are lightly vegetated and covered with grass. A picnic area, pavilion, and playground are located approximately 100 ft from the edge of the eastern bank of Upper Cobbs Pond.

ES.1.2 Scope

The scope of this Phase III RI Report is to perform a CERCLA evaluation of soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. The media of concern associated with the AOC are surface soil [0–1 ft below ground surface (bgs)], subsurface soil (1–13 ft bgs), sediment, and surface water. This report does not include a full evaluation of groundwater; it will be evaluated as an individual AOC for the entire facility. However, the potential for soil and sediment contaminants to leach to and migrate in groundwater is evaluated in this RI Report to determine whether soil remedial actions to protect groundwater may be necessary.

ES.1.3 Evaluation of Future Use

In February 2014, the Army and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the RVAAP Installation Restoration Program* (ARNG 2014) (herein referred to as the Technical Memorandum) identified the three Categorical Land Uses and Representative Receptors below to be considered during the RI phase of the CERCLA process.

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor [U.S. Environmental Protection Agency's (USEPA) Composite Worker].

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Industrial and Military Training), and those other Land Uses do not require evaluation.

ES.2 FINDINGS AND RECOMMENDATIONS OF THE REMEDIAL INVESTIGATION

This section presents the data used in the RI, contaminant nature and extent, fate and transport, human health risk assessment (HHRA), and ecological risk assessment (ERA), followed by the conclusions of the RI.

ES.2.1 Data Use and Sample Selection Process

Quality-assured sample data from the RIs [1996 Phase I RI, 2001 Phase II RI, and 2010 Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI)] and the 2003 Facility-wide Biological and Water Quality Study (FWBWQS) were used to evaluate nature and extent of contamination at the Upper and Lower Cobbs Ponds AOC. All available sample data were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, risk assessment). Evaluating the data's suitability for use in the PBA08 RI involved two primary considerations: (1) whether the data represented current AOC conditions, and (2) sample collection methods [e.g., discrete vs. incremental sampling methodology (ISM)].

Samples from the Phase I and II RIs were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI. Data collected in 2010 as part of the PBA08 RI focused on delineating the extent of contaminants identified in surface soil (0–1 ft bgs), subsurface soil (1–13 ft bgs), sediment, and surface water. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to historical operations areas or within sediment accumulation areas) and analyzed for chemicals identified in historical investigations.

ES.2.2 Summary of Contaminant Nature and Extent

Nature and extent of contamination in surface soil (0–1 ft bgs), subsurface soil (greater than 1 ft bgs), sediment, and surface water was evaluated in the RI. Data from the RIs (1996 Phase I RI, 2001 Phase II RI, and 2010 PBA08 RI) and the 2003 FWBWQS effectively characterized the nature and extent of the contamination at the AOC. Figure ES-1 shows the sample locations used to conduct this RI. To support the evaluation of nature and extent of contamination, site-related contaminant (SRC) concentrations were compared to screening levels (SLs) corresponding to the lowest facility-wide cleanup goal (FWCUG) for the Resident Receptor (Adult and Child) and National Guard Trainee at a target hazard quotient (HQ) of 0.1 or target risk (TR) of 1E-06, as presented in the *Facility-wide Human Health Cleanup Goals* for the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 2010a) (herein referred to as the FWCUG Report). It can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate the AOC.

ES.2.2.1 Surface Soil

The predominant SRCs for surface soil at the Pond Bank were inorganic chemicals and semi-volatile organic compounds (SVOCs); the majority of which were polycyclic aromatic hydrocarbons (PAHs). A total of 18 inorganic chemicals (16 metals, cyanide, and nitrate/nitrite) were identified as SRCs in surface soil. Elevated inorganic chemical concentrations above background concentrations were observed in surface soil throughout the Pond Bank, and only 1 of 24 surface soil samples collected exhibited no inorganic chemicals above background concentrations (ULCPss-009). However, the majority of elevated inorganic chemical concentrations occurred at levels marginally in excess of background concentrations, as all but two concentrations occurred at magnitudes less than twice their respective background concentrations. As such, no apparent spatial trend is evident in the distribution of inorganic chemicals throughout the surface soil in the Pond Bank.

Sixteen SVOCs, predominantly PAHs, were identified as SRCs in surface soil at the Pond Bank. The highest frequency and magnitudes of detection were observed at CPCsb-035, located on the western bank of Upper Cobbs Pond, immediately south of Cobbs Pond Road. The pesticide beta-hexachlorocyclohexane (BHC) and propellant nitrocellulose were also identified as SRCs in surface soil at the Pond Bank. PAH concentrations are an order of magnitude higher in sediment than those observed in the adjacent Pond Bank surface soil.

One propellant (nitrocellulose) and one pesticide (BHC) were identified as SRCs in surface soil at the Pond Bank. Neither exceeded their respective SLs. No explosives, volatile organic compounds (VOCs), or polychlorinated biphenyls (PCBs) were detected or identified as SRCs in Pond Bank surface soil surrounding Upper and Lower Cobbs Pond.

ES.2.2.2 Subsurface Soil

Four inorganic chemicals (cadmium, lead, selenium, and silver) were identified as SRCs in subsurface soil samples at the Pond Bank. Lead and selenium were detected above the background concentrations at only one sample location. Selenium was detected at 1.6 mg/kg, slightly above the background concentration of 1.5 mg/kg, and lead was detected at 23.3 mg/kg above the background concentration of 19.1 mg/kg. As such, no apparent spatial trend in the distribution of inorganic chemicals throughout the subsurface soil in the Pond Bank is evident.

A total of 13 SVOCs, 12 of which were PAHs, were detected and identified as SRCs in subsurface soil at the Pond Bank. Of the 13 SVOCs, 12 were detected from the 1–4 ft bgs interval at CPCsb-035; the majority of which were observed at low, estimated concentrations below laboratory reporting limits. Sample location CPCsb-035 is on the western bank of Upper Cobbs Pond and near Cobbs Pond Road. PAH concentrations in the subsurface soil samples were generally comparable to those observed in the corresponding surface soil sample (i.e., within the same order of magnitude). One propellant (nitrocellulose) was identified as an SRC in subsurface soil at the Pond Bank. No explosives, VOCs, PCBs, or pesticides were detected or identified as SRCs in Pond Bank subsurface soil surrounding Upper and Lower Cobbs Pond.

ES.2.2.3 Sediment

Backwater Area

The Backwater Area was evaluated using 14 surface sediment and 2 subsurface sediment samples. Three explosives [2,4,6-trinitrotoluene (TNT); 2,6-dinitrotoluene (DNT); and tetryl] and one propellant (nitrocellulose) were detected in surface sediment. All of the detected concentrations were below the Resident Receptor (Adult and Child) FWCUG and regional screening level (RSL) at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in subsurface sediment in the Backwater Area. In surface sediment, aluminum, cobalt, and cyanide concentrations exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only the cobalt concentration exceeded a TR of 1E-06, HQ of 0.1 in subsurface sediment in one subsurface soil location, but not at a TR of 1E-05, HQ of 1. Five PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] exceeded their respective SLs in surface sediment. Four of the five PAHs were detected at their maximum concentrations in the Phase II RI sample ULCPsd-015. The detected concentrations in the adjacent PBA08 RI sample CPCsd-047 indicate that concentrations have declined since the 2001 Phase II RI sampling event. Benzo(a)pyrene concentrations at ULCPsd-006, ULCPsd-015, and CPCsd-047 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Only benzo(a)pyrene was detected above its respective SL (0.022 mg/kg) at PBA08 RI sample location CPCsd-047 in the 0.5–2 ft bgs interval. The concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, methylene chloride, and 2-butanone) were detected below their respective SLs in surface and subsurface sediment, respectively. PCB-1254 also was detected in the Phase II RI surface sediment samples ULCPsd-006 and ULCPsd-011; however, it was not detected in the PBA08 RI samples. No pesticides were detected in surface sediment. Pesticides and PCBs were not detected in the Backwater Area subsurface sediment.

Upper Cobbs Pond

Five surface discrete sediment samples, one surface ISM sample, and one subsurface sediment sample were used to evaluate Upper Cobbs Pond. Five explosives [1,3-dinitrobenzene; TNT; 4-amino-2,6-DNT; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); and tetryl] and one propellant (nitrocellulose) were detected in surface sediment at PBA08 RI sample location CPCsd-046. All detected concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in subsurface sediment. In surface sediment, aluminum, hexavalent chromium, and cobalt concentrations exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only the cobalt concentration exceeded a TR of 1E-06, HQ of 0.1 in the subsurface sediment, but not at a TR of 1E-05, HQ of 1. Ten SVOCs were detected in surface and subsurface sediment at the PBA08 RI sample location CPCsd-046. Two additional SVOCs (acenaphthylene and anthracene) were detected in subsurface sediment. The 10 SVOCs occurred at higher concentrations in surface sediment than in the corresponding subsurface sediment sample. Benzo(a)pyrene was detected above its respective SL in surface and subsurface sediment at CPCsd-046; however, the concentrations were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Two VOCs (acetone and 2-butanone) were detected in surface sediment below their respective SLs, both were detected at their maximum concentrations at PBA08 RI location CPCsd-046. These VOCs also were detected at the 2001 Phase II RI sample location ULCPsd-020 at lower concentrations than CPCsd-046. PCB-1254 also was detected in surface sediment at Upper Cobbs Pond in ULCPsd-020 below its respective SL. PCB-1254 was not detected in the PBA08 RI sample. Pesticides were not detected in surface sediment at Upper Cobbs Pond. The VOC 2-butanone was detected in subsurface sediment below the TR of 1E-05, HQ of 1. The pesticide delta-BHC does not have an SL. PCBs were not detected in subsurface sediment.

Lower Cobbs Pond

Lower Cobbs Pond was evaluated using eight discrete surface sediment samples, one surface ISM sample, and one subsurface sediment sample. Two explosives (HMX and tetryl) and one propellant (nitrocellulose) were detected in surface sediment, and the explosive HMX and propellant nitrocellulose were detected in subsurface sediment at Lower Cobbs Pond. The concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. In surface sediment, aluminum, arsenic, hexavalent chromium, cobalt, and cyanide concentrations exceeded a TR of 1E-06, HQ of 0.1, but only arsenic exceeded a TR of 1E-05, HQ of 1. Only the cobalt concentration exceeded a TR of 1E-06, HQ of 0.1 in subsurface sediment, but not at a TR of 1E-05, HQ of 1. A total of 11 SVOCs were detected in surface sediment in Lower Cobbs Pond and 18 SVOCs were detected in subsurface sediment. The 11 SVOC SRCs that were identified for surface sediment also were observed in subsurface sediment and occurred at their highest concentrations in the PBA08 RI subsurface sediment sample CPCsd-045. Benzo(a)pyrene concentrations exceeded its respective SL in surface and subsurface sediment at CPCsd-045; however, only the subsurface sediment concentration exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (2-butanone, acetone, and carbon disulfide) were detected in surface sediment at Lower Cobbs Pond. All three VOCs were detected at PBA08 RI location CPCsd-045, with 2-butanone and carbon disulfide observed at their maximum concentrations in this sample location. 2-Butanone also was detected in subsurface sediment. All of the VOCs detected in surface and subsurface soil were below their respective SLs. No PCBs or pesticides were detected in surface or subsurface sediment in Lower Cobbs Pond.

ES.2.2.4 Surface Water

Backwater Area

Four surface water samples were used to evaluate the Backwater Area. One explosive (4-amino-2,6-DNT) was detected in surface water at a low, estimated concentration below laboratory reporting limits. No propellants were detected in the Backwater Area surface water. Four inorganic chemical concentrations (arsenic, cobalt, manganese, and selenium) exceeded the RSL at a TR of 1E-06, HQ of 0.1. Manganese concentrations at Phase II RI sample locations ULCPsw-001 and ULCPsw-002 and cobalt at ULCPsw-001 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, chloromethane, and toluene) were detected in surface water for the Backwater Area, all of which were detected in ULCPsw-002. No propellants, SVOCs, PCBs, or pesticides were detected in surface water at the Backwater Area. Elevated inorganic chemical concentrations and 4-amino-2,6-DNT are likely attributable to continuing upstream sources as these constituents are observed in the PBA08 RI locations immediately downstream of the confluence of the drainage channels from Load Lines 3 and 12.

Upper Cobbs Pond

Surface water in Upper Cobbs Pond was evaluated using five surface water samples. One explosive (4-amino-2,6-DNT) was detected at a low, estimated concentration in two surface water samples. The concentration was below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No surface water concentrations for inorganic chemicals in Upper Cobbs Pond exceeded the SL at a TR of 1E-06, HQ of 0.1. The SVOCs bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected at low, estimated concentrations below the laboratory reporting limit at PBA08 RI sample location CPCsw-046 and the August 2003 FWBWQS location, respectively. No VOCs, PCBs, or pesticides were detected in surface water at Upper Cobbs Pond.

Lower Cobbs Pond

Lower Cobbs Pond surface water was evaluated using seven surface water samples. The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at Lower Cobbs Pond. 4-Amino-2,6-DNT was detected at a concentration of 0.00029J mg/L in the August 2003 FWBWQS sample at Lower Cobbs Pond. 4-Amino-2,6-DNT was not detected in the subsequent PBA08 RI samples taken at CPCsw-044 and CPCsw-045 in 2010. No propellants were detected. Only manganese was detected at a concentration which exceeded the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1 at one sample location. Two SVOCs (benzenemethanol and butyl benzyl phthalate) were detected at low, estimated concentrations at PBA08 RI location CPCsw-045, located at the center of the aggregate. No VOCs, PCBs, or pesticides were detected in surface water in Lower Cobbs Pond.

ES.2.3 Summary of Contaminant Fate and Transport

All SRCs identified in surface soil, subsurface soil, and sediment at the Upper and Lower Cobbs Ponds AOC were evaluated through the stepwise contaminant fate and transport evaluation. The evaluation included analyzing leaching and migration from soil and sediment to groundwater and determining whether contamination present in soil and sediment may potentially impact groundwater quality at the site.

Maximum SRC concentrations identified in surface and subsurface soil were evaluated using a series of generic screening steps to identify initial contaminant migration chemicals of potential concern (CMCOPCs). Initial CMCOPCs for soil were further evaluated using the Seasonal Soil Compartment model to predict leaching concentrations and identify final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria among USEPA maximum contaminant levels (MCLs), USEPA tap water RSLs, or RVAAP groundwater FWCUGs for the Resident Receptor Adult. These final CMCOPCs were evaluated using the Analytical Transient 1-, 2-, 3-Dimensional model to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., Cobbs Ponds) and identify contaminant migration chemicals of concern (CMCOCs).

A sediment screening analysis was performed for sediment samples at the AOC. Chemical-specific dilution attenuation factors (DAFs) were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. These DAFs were used in the sediment screening analysis to identify the initial CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. The initial CMCOPCs for sediment were further evaluated by comparing their maximum detected surface water concentrations against their respective MCL/RSLs to identify the final sediment CMCOPCs.

The modeling results identified the following CMCOCs for soil and final CMCOPCs for sediment:

- Arsenic, nickel, selenium, and thallium in soil were predicted to exceed the screening criteria in groundwater beneath the source area, and only arsenic was predicted to exceed the screening criteria in groundwater at the downgradient receptor location.
- Hexavalent chromium in Upper and Lower Cobbs Ponds sediment was predicted to exceed the screening criteria in groundwater beneath the source areas.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any soil CMCOCs are present in soil that may impact the groundwater beneath the source or at the downstream receptor location (Cobbs Ponds) or if any CMCOPCs in sediment may impact groundwater beneath Cobbs Ponds. This qualitative assessment concluded that the remaining soil CMCOCs and sediment CMCOPCs are not expected to adversely impact groundwater at the AOC. No further action is required of soil and sediment at the Upper and Lower Cobbs Ponds AOC for the protection of groundwater.

ES.2.4 Summary and Conclusions of the Human Health Risk Assessment

The HHRA identified chemicals of concern (COCs) and conducted risk management analysis to determine if COCs pose unacceptable risk to the Resident Receptor. If there is no unacceptable risk to the Resident Receptor, it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at the Upper and Lower Cobbs Ponds AOC are surface soil, subsurface soil, surface water, and sediment. Soil data were aggregated into surface and subsurface soil. Surface water and sediment data were aggregated into three exposure units (EUs) (Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond).

No COCs were identified in soil. Several PAHs were identified as COCs in sediment at the backwater area. The maximum detected concentration (MDC) of benzo(a)pyrene (0.89 mg/kg) at the Backwater Area exceeds the FWCUG (0.221 mg/kg). The MDC is at ULCPsd-015, which was collected in 2001. Sample ULCPsd-047 was collected at approximately the same location in 2010 and showed a benzo(a)pyrene concentration of 0.39 mg/kg. Detected benzo(a)pyrene concentrations in the other

Backwater Area samples ranged from 0.063–0.23 mg/kg. Three additional PAHs, present below FWCUGs, were identified as COCs based on the sum-of-ratios analysis. Benzo(a)pyrene, and by association the other PAHs, were not identified as COCs to be carried forward for potential remediation because the elevated PAH concentrations are located near a culvert between Load Line 3 Road and Track 33. The source of the PAHs in sediment is most likely runoff from the road and railroad bed. The FWCUGs for exposure to sediment are the same as the FWCUGs for soil (i.e., exposure is assumed to be the same for soil in a residential yard and sediment in a pond). However, the MDC at the backwater area (0.89 mg/kg) is below a more realistic (but still conservative) calculated RSL of 9 mg/kg.

The exposure point concentration (EPC) of arsenic in sediment at Lower Cobbs Pond (26.9 mg/kg) exceeds the FWCUG for the Resident Receptor Adult of 4.25 mg/kg, the facility-wide background concentration of 19.5 mg/kg, and the Ohio EPA sediment reference value (SRV) of 25 mg/kg. The MDC of arsenic (34.3 mg/kg) at ULCPsd-026, collected in 2001, is the only sample concentration greater than the facility-wide background concentration and Ohio EPA SRV. Reported arsenic concentrations in the other Lower Cobbs Pond samples ranged from 5.1–20.2 mg/kg. Arsenic was not identified as a COC for potential remediation because the reported concentrations appear to represent naturally occurring levels in sediment.

The EPC of cobalt (0.01 mg/L) is less than two times the tap water RSL of 0.006 mg/L. The Backwater Area is a shallow pond created through beaver dam construction activity upstream of Upper Cobbs Pond. This limited shallow surface water is not a potential source of residential drinking water; therefore, this low exceedance of the tap water RSL does not warrant potential remediation in this EU.

The EPC of manganese in surface water at the Backwater Area EU exceeds the FWCUG for the Resident Receptor (Adult and Child) of 6.326 mg/L. The EPC is strongly influenced by the elevated concentration reported in a single sample collected in 2001. The manganese concentrations in all samples collected in 2010 are below the facility-wide background concentration of 0.391 mg/L. Because recent sample data indicate manganese is present at naturally occurring background concentrations, manganese does not warrant potential remediation in this EU.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor (Adult and Child) in any of the media of concern at the Upper and Lower Cobbs Pond AOC; therefore, no other receptors were evaluated and no further action is recommended from a human health risk perspective.

ES.2.5 Summary and Conclusions of the Ecological Risk Assessment

The Level I ERA presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in surface soil, sediment, and surface water at Upper and Lower Cobbs Ponds AOC. This contamination was identified using historical and PBA08 RI data and data from the FWBWQS. Although the ponds constitute much of the AOC, red maple successional forest (dominant vegetation type); dry, mid-successional, cold-deciduous shrubland; three types of herbaceous communities; and three additional types of forests were observed on the 39 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, a state-listed threatened species (Least Bittern) and its habitat, wetlands, and surface water (i.e., ponds) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated integrated chemicals of potential ecological concern (COPECs) in soil, sediment, and surface water. Integrated COPECs are identified by screening PBA08 RI, FWBWQS, and historical data sets against ecological screening values. Twelve integrated COPECs were identified for soil. Forty integrated COPECs were identified for sediment. Eight integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA for Upper and Lower Cobbs Ponds AOC concludes with a recommendation that no further action is required to be protective of important ecological resources.

ES.2.6 Recommendation of the Remedial Investigation

Based on the investigation results, the Upper and Lower Cobbs Ponds AOC has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the current nature and extent of impacted media has been sufficiently characterized; (2) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (3) there are no CERCLA-release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or additional remediation; and (4) remedial actions to protect ecological resources are not warranted.

The next step in the CERCLA process is to prepare a PP to solicit public input with respect to no further action for soil, sediment, and surface water. The PP will briefly summarize the history, characteristics, risks, and the basis for no further action. Comments on the PP received from state and federal agencies and the public will be considered in preparing a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.

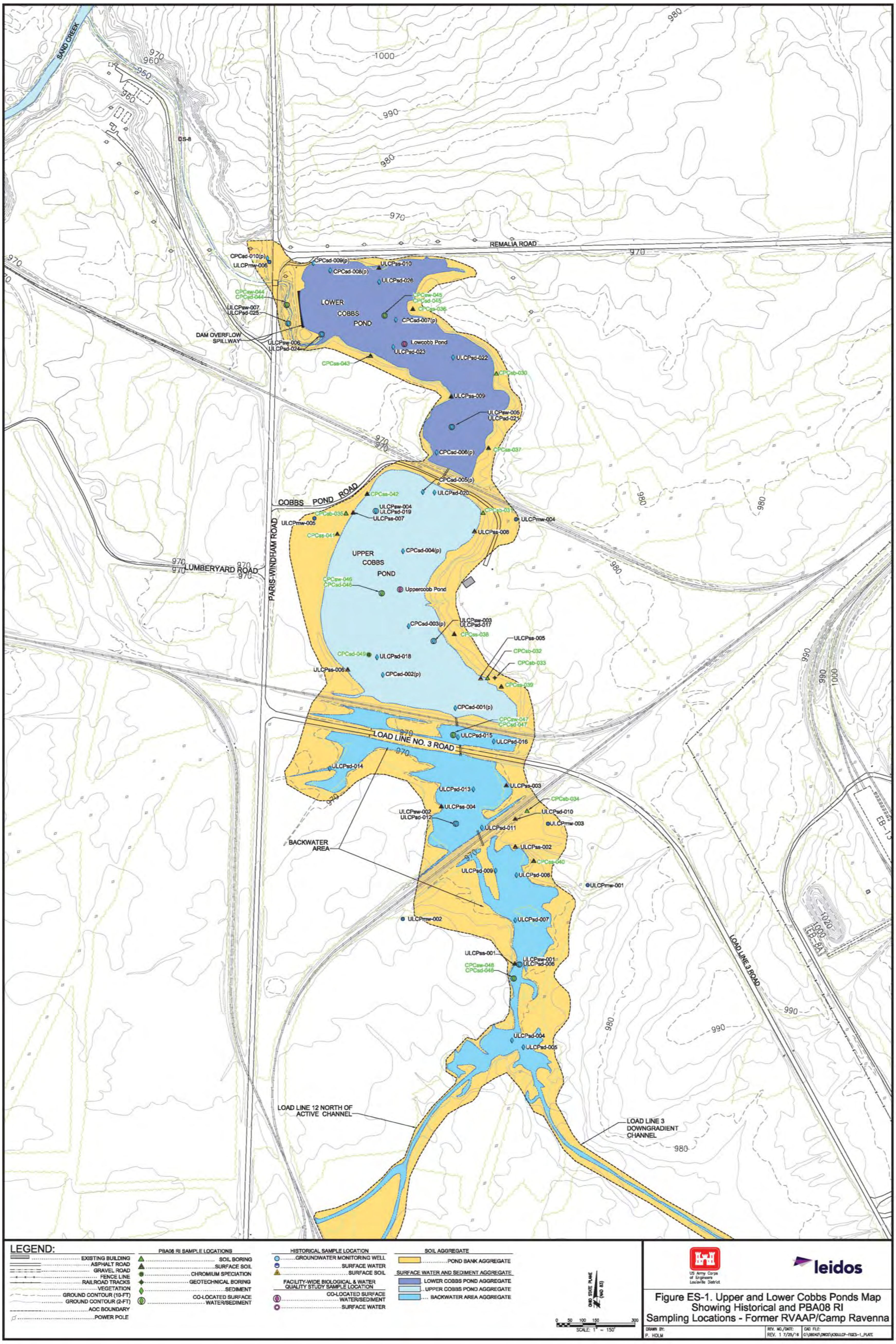

Figure ES–1. Upper and Lower Cobbs Ponds Map Showing Historical and PBA08 RI Sampling Locations - Former RVAAP/Camp Ravenna

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1.0 INTRODUCTION

This document was revised by Leidos under the U.S. Army Corps of Engineers (USACE) Louisville District Contract Number W912QR-15-C-0046. This Phase III Remedial Investigation (RI) Report addresses soil, sediment, and surface water at the Upper and Lower Cobbs Ponds area of concern (AOC) within the former Ravenna Army Ammunition Plant (RVAAP) [now known as Camp Ravenna Joint Military Training Center (Camp Ravenna)] in Portage and Trumbull counties, Ohio (Figures 1-1 and 1-2). The Upper and Lower Cobbs Ponds AOC is designated as AOC RVAAP-29.

This report has been prepared in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) *Director's Final Findings and Orders* (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and National Contingency Plan (NCP) to implement an RI to characterize the AOC, develop a feasibility study (FS) (if remediation is necessary) to evaluate remedial alternatives to address contamination presenting unacceptable risk to human health and the environment, present a preferred remedial alternative in a proposed plan (PP), and document stakeholder selection and acceptance of the preferred final remedy in a record of decision (ROD).

This document includes the following:

- A description of the operational history and environmental setting for the AOC.
- A summary of all historical assessments and investigations at the Upper and Lower Cobbs Ponds AOC.
- A description of the nature and extent of contamination, including the identification of site-related contaminants (SRCs) by screening applicable data against background, essential human nutrients, and frequency of detection/weight-of-evidence (WOE) screening.
- An evaluation of contaminant fate and transport by identifying contaminant migration chemicals of potential concern (CMCOPCs) and contaminant migration chemicals of concern (CMCOCs) that may pose a future threat to groundwater.
- A human health risk assessment (HHRA) to identify chemicals of potential concern (COPCs) and chemicals of concern (COCs).
- An ecological risk assessment (ERA) to identify chemicals of potential ecological concern (COPECs) and chemicals of ecological concern.
- Conclusions of the Phase III RI Report.

1.1 PURPOSE

The purpose of this report is to use available RI data to evaluate the nature and extent of contamination; fate and transport of contaminants in the environment; and risk assessments for surface and subsurface soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. This report also provides a summary of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at the Upper and Lower Cobbs Ponds AOC that was performed to supplement data from previous sampling events. Depending on the results of the evaluations contained in this report, a conclusion of no further action is provided or a recommendation to complete an FS to evaluate potential remedies and future actions will be made.

1.2 SCOPE

The scope of this report to present: (1) the nature and extent of contamination, fate and transport of contaminants in the environment, and risk assessments for surface soil, subsurface soil, sediment, and surface water at the AOC; (2) the results of the evaluation of remedial alternatives for meeting remedial action objectives for any CERCLA-related COCs identified in the media at the AOC; and (3) a conclusion of no further action or a preferred alternative to present to the public in a PP.

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 a precipitation event. 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 below ground surface (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 is inundated for extended periods. This terminology is consistent with the *Facility-wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2010a), herein referred to as the FWCUG Report.

Potential impacts to groundwater from soil (e.g., contaminant leaching) are evaluated in this report, as protectiveness to groundwater is included in the fate and transport analysis and the evaluation of remedial alternatives for these media. Groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI/FS Report.

1.3 REPORT ORGANIZATION

This report is organized in accordance with Ohio EPA and U.S. Environmental Protection Agency (USEPA) CERCLA RI/FS guidance and applicable USACE guidance. The following is a summary of the components of the report and a list of appendices:

- Section 2.0 provides a description and history of the former RVAAP and the AOC, presents potential sources of contamination, presents potential receptors, and summarizes co-located or proximate sites.
- Section 3.0 describes the environmental setting at Camp Ravenna and the Upper and Lower Cobbs Ponds AOC, including the geology, hydrogeology, climate, and receptor population.
- Section 4.0 summarizes previous assessments and investigations at the Upper and Lower Cobbs Ponds AOC, as well as the data used to support the Phase III RI.
- Section 5.0 discusses the occurrence and distribution of contamination at the AOC.

- Section 6.0 presents an evaluation of contaminant fate and transport.
- Section 7.0 includes the methods and results of the HHRA and ERA.
- Section 8.0 provides the conclusions and recommendations of the Phase III RI.
- Section 9.0 summarizes the framework for conducting the necessary agency and public involvement activities.
- Section 10.0 provides a list of references used to develop this report.
- Appendices:
  Appendix A: Field Sampling Logs,
  Appendix B: Project Quality Assurance Summary,
  Appendix C: Data Quality Control Summary Report,
  Appendix D: Laboratory Analytical Results and Chains-of-Custody,
  Appendix E: Fate and Transport Modeling Results,
  Appendix F: Investigation-derived Waste Management Reports,
  Appendix G: Human Health Risk Assessment Tables,
  Appendix H: Ecological Risk Assessment Information and Data, and
  Appendix I: PBA08 Remedial Investigation Summary.

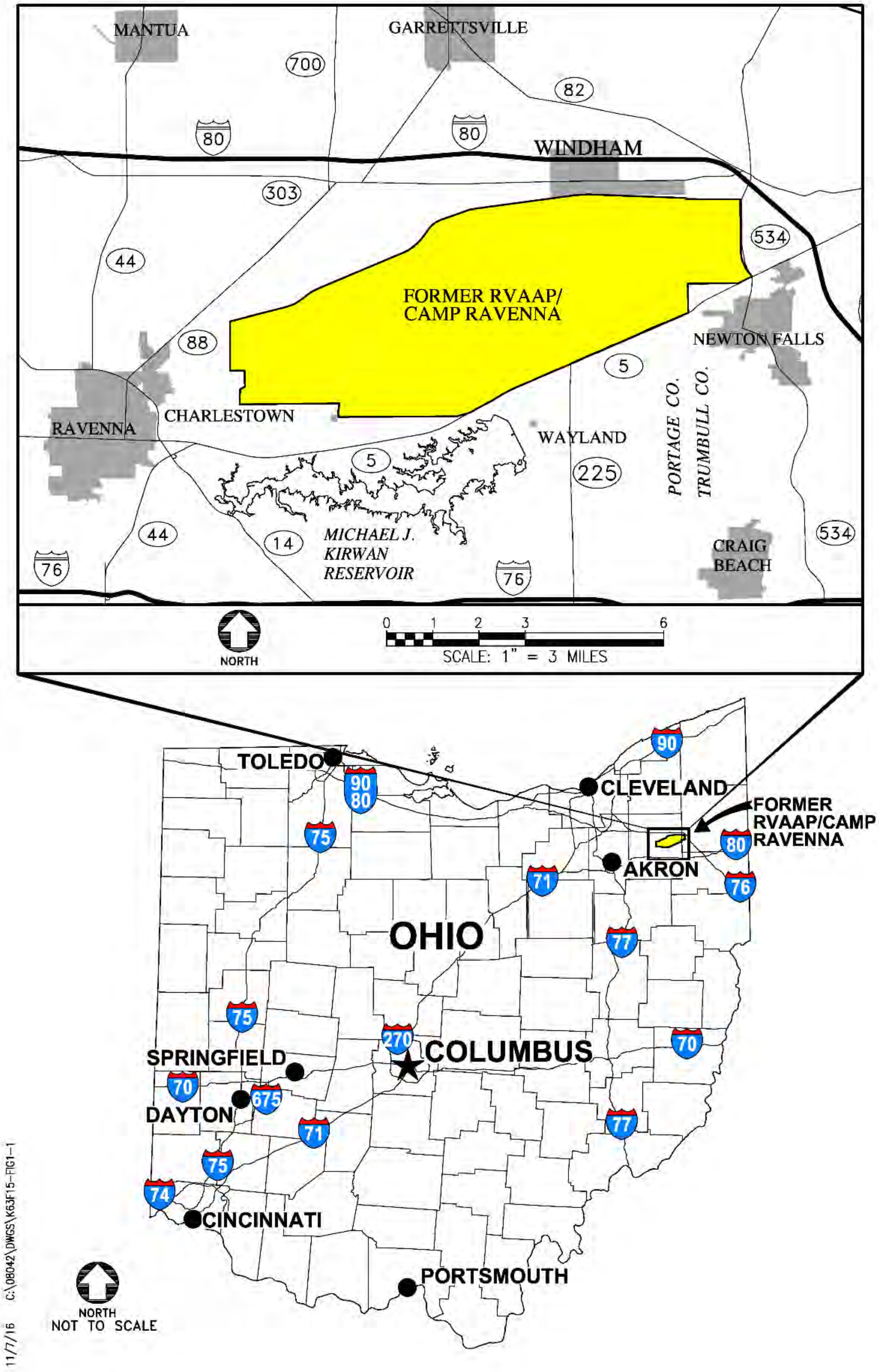

Figure 1–1. General Location and Orientation of Camp Ravenna

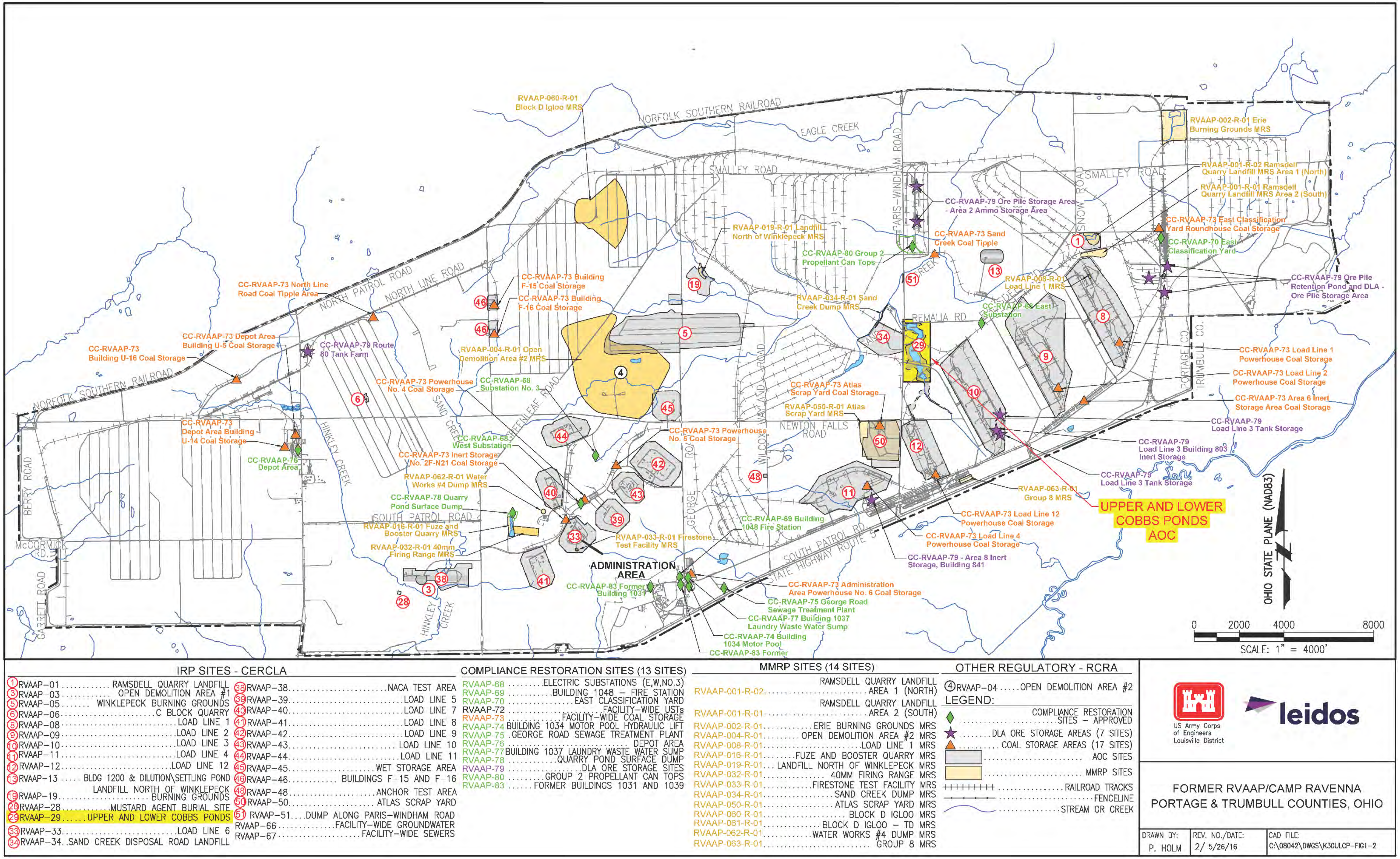

Figure 1–2. Location of AOCs and Munitions Response Sites at Camp Ravenna

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2.0 BACKGROUND

This section provides a description of the facility. In addition, it summarizes the Upper and Lower Cobbs Ponds AOC's operational history, potential sources, potential human health receptors and ecological resources, and co-located or proximate sites.

2.1 FACILITY-WIDE BACKGROUND INFORMATION

2.1.1 General Facility Description

The facility, consisting of 21,683 acres, is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (3 miles) east/northeast of the city of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the city of Newton Falls (Figure 1-1). The facility, previously known as RVAAP, was formerly used as a load, assemble, and pack facility for munitions production. As of September 2013, administrative accountability for the entire acreage of the facility has been transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a military training site (Camp Ravenna). References in this document to RVAAP relate to previous activities at the facility as related to former munitions production activities or to activities being conducted under the restoration/cleanup program.

In 1978, the U.S. Army Toxic and Hazardous Materials Agency conducted an Installation Assessment of RVAAP to review the potential for contaminant releases at multiple former operations areas, as documented in the Installation Assessment of Ravenna Army Ammunition Plant (USATHAMA 1978). The assessment identified that pink water and washout of residue, dusts, and spills at Load Lines 3 and 12 were discharged into Upper Cobbs Pond through surface drainage channels. Load Line 3 was used for 2,4,6-trinitrotoluene (TNT) and composition B a combination of TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)] melt-pour activities, and Load Line 12 was used for ammonium nitrate production. Both load lines were also used for demilitarization activities.

The former RVAAP received bulk TNT product during operational activities and did not manufacture/produce dinitrotoluene (DNT) or TNT. A facility where DNT is manufactured will have the following isomers of DNT in the finished product: 2,4-DNT; 2,6-DNT; 2,5-DNT; 3,4-DNT; 2,3-DNT; and 3,5-DNT. This is not applicable to the former RVAAP. Degradation of TNT to 2,4-DNT occurs in soil; however, 2,4-DNT and 2,6-DNT do not degrade to the lesser isomers. It is the U.S. Department of the Army's (Army) position that testing DNT isomers other than 2,4-DNT and 2,6-DNT is unnecessary and has no additional value of being protective to human health and the environment at the former RVAAP (RVAAP 2013).

2.1.2 Demography and Land Use

Camp Ravenna occupies east-central Portage County and southwestern Trumbull County. Census projections for 2010 indicated the populations of Portage and Trumbull counties are 161,419 and

210,312, respectively. Population centers closest to Camp Ravenna are Ravenna, with a population of 11,724, and Newton Falls, with a population of 4,795.

The facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of Camp Ravenna is located, consists of either woodland or farmland acreage. The closest major recreational area, the Michael J. Kirwan Reservoir (also known as West Branch Reservoir), is located adjacent to the western half of Camp Ravenna, south of State Route 5.

Camp Ravenna is federally owned and is licensed to OHARNG for use as a military training site. Restoration activities at Camp Ravenna are managed by the Army National Guard and OHARNG. Training and related activities at Camp Ravenna include field operations and bivouac training, range firing activities, convoy training, maintaining equipment, C-130 aircraft drop zone operations, helicopter operations, and storing heavy equipment.

2.2 UPPER AND LOWER COBBS PONDS AOC BACKGROUND INFORMATION

2.2.1 Operational History

The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of Camp Ravenna. The AOC is located east of Paris-Windham Road and south of Remalia Road, north of Load Line 12, and northwest of Load Line 3 (Figures 1-2, 2-1, and 2-2). The AOC is approximately 39 acres and is comprised of approximately 18 acres of pond banks and the surface water features presented below from upstream to downstream:

- Backwater Area, 5.2 acres.
- Upper Cobbs Pond, 9.4 acres, ranges from 3–8 ft in depth, and is also called Big Cobbs Pond or South Cobbs Pond.
- Lower Cobbs Pond, 6.4 acres, 2–7 ft in depth, and is also called Little Cobbs Pond or North Cobbs Pond.

Three railroad trackbeds dissect the AOC (the railroad tracks have been removed) and are described below:

- The trackbed for Track 25 separates Lower Cobbs Pond from Upper Cobbs Pond.
- The trackbed for Track 33 is north of Load Line 3 Road and separates Upper Cobbs Pond from the Backwater Area.
- The trackbed for Track FA runs through the Backwater Area.

Upper Cobbs Pond and Lower Cobbs Pond were constructed in 1940–1941, expanding a natural drainage conveyance to receive effluent discharge and to serve as the unlined sedimentation basins for Load Lines 3 and 12. The surface water conveyance is depicted in Figure 2-1. The ponds were utilized as unlined sedimentation basins after improvements, such as flow control structures, were constructed throughout the complex. The Backwater Area did not exist when the facility was operational, rather it is a product of beaver dam construction activity (Jacobs 1989).

Flow between the Backwater Area and Upper Cobbs Pond is controlled through a culvert located under the Track 33 and Load Line 3 Road crossings. Surface water in Lower Cobbs Pond discharges to a dam overflow spillway adjacent to the intersection of Remalia and Paris Windham Roads.

From 1941–1971, the ponds received effluent from the Load Lines 3 and 12 sawdust filtration units, wash water, storm water runoff, and surface water runoff. Rinsate from demilitarization operations at Load Lines 3 and 12 was initially allowed to flow out of buildings and directly onto the ground or to drainage ditches which ultimately discharged to Upper Cobbs Pond and Lower Cobbs Pond. Load Line 12 was formerly utilized for producing ammonium nitrate from 1941–1943 and 1946–1950. From 1951–1961, explosive melt-out and demilitarization activities occurred at Load Line 12. Since there were no wash water collection tanks or settling ponds in Load Line 12 during these operations, all residues, dusts, and spills were washed into the drainage system that eventually discharged into Upper Cobbs Pond.

During Load Line 3's operational history, 6.5 million munitions were produced that generated approximately 79,248 gal of pink water each month when the facility was operating at full capacity (USACE 1996a). The contaminated pink water washout at Load Lines 3 and 12 was collected in concrete settling sumps and treated through sawdust filters before being discharged into Upper Cobbs Pond through surface drainage channels.

From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 in Load Line 12 for producing aluminum chloride. On November 15, 1966, a fish kill occurred at Lower Cobbs Pond as a result of improper handling of aluminum chloride during manufacturing operations. The bulk of the aluminum chloride was collected and disposed at Ramsdell Quarry Landfill (RVAAP-01). The pond, receiving the contaminating waste from drainage ditches, was settled, drained, and the contaminants were removed to Ramsdell Quarry. Contaminated metals were flashed at a burning ground to a 5X condition (USATHAMA 1978 and 1982, RVAAP 2000). The Army terminated the lease early on December 3, 1967 due to environmental concerns related to air emissions and wastewater discharges to Upper and Lower Cobbs Ponds.

2.2.2 Potential Sources

No primary sources are present within the AOC. The existing features include two sedimentation basins (ponds), primary drainage conveyances, and flow control structures (e.g., dam overflow spillway).

The 1978 Installation Assessment identified the pink wastewater and washout of residue, dusts, and spills at Load Lines 3 and 12, which were discharged through surface drainage channels towards Upper Cobbs Pond (USATHAMA 1978), as contaminants. Potential site-specific contaminants include TNT; RDX; octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); nitrate; nitrocellulose; and heavy metals (i.e., lead, chromium, mercury, and arsenic) from the pink water. Other contaminants identified include washout from explosives melt-out and demilitarization activities at Load Lines 3 and 12 and ammonium nitrate and aluminum chloride from Load Line 12.

Many other chemicals were analyzed in the site investigations and are discussed in this report.

2.2.3 AOC Boundary

The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of Camp Ravenna. The AOC is located east of Paris-Windham Road and south of Remalia Road, north of Load Line 12, and northwest of Load Line 3 (Figures 1-2 and 2-1). No fences or perimeter boundaries exist at the AOC; however, the AOC boundary encompasses the limits of investigation of the Phase I and II RIs and PBA08 RI, as presented in Figure 2-2. The AOC is approximately 39 acres and is comprised of the Backwater Area (5.2 acres), Upper Cobbs Pond (9.4 acres), Lower Cobbs Pond (6.4 acres), and surrounding pond banks (18 acres).

2.2.4 Spatial Aggregates

Upper and Lower Cobbs Ponds AOC data were aggregated for evaluating contaminant nature and extent, human health, and the environment. Spatial aggregates established for this evaluation are discussed below and are presented on Figure 2-2.

Surface and subsurface soil within the geographic area of the AOC was evaluated as an AOC-wide spatial aggregate, designated as the Pond Bank aggregate. The Pond Bank aggregate is defined as the perimeter of the natural shorelines surrounding Upper Cobbs Pond and Lower Cobbs Pond. The Pond Bank also extends from the Backwater Area to the south at the confluence of the channels exiting Load Lines 3 and 12 and north to the intersection of Remalia Road and Paris-Windham Road. The areas encompassed within the Pond Bank are dry the majority of the time, although they may be intermittently wet in association with heavy rainfall events when they may receive runoff from the surrounding areas or when water levels within the AOC are elevated.

Sediment and surface water spatial aggregates identified were the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Sediment samples included in the risk assessments are limited to sediment samples collected with a starting depth of 0 ft bgs (e.g., 0–0.5 or 0–1.75 ft bgs). All three of these aggregates are perennially inundated water bodies. The Backwater Area is in the southern (upstream) portion of the complex and extends from the confluence of the drainage channels exiting Load Lines 3 and 12 and reaching north to Track 33. Upper Cobbs Pond is the portion of the water body north of Track 33, extending to Cobbs Pond Road. Lower Cobbs Pond (furthest downstream) is north of the Cobbs Pond Road, bounded by Remalia Road on the north and Paris-Windham Road to the west.

2.2.5 Current Land Use

The Upper and Lower Cobbs Ponds AOC is currently utilized for recreational purposes, as it contains abundant fish and wildlife. OHARNG and facility workers use the ponds for fishing. Currently, due to the fact that the investigative activities are still ongoing at the AOC under the restoration program, fishing in the ponds is catch and release. The pond bank areas are lightly vegetated and covered with grass. A picnic area, pavilion, and playground are located approximately 100 ft from the edge of the eastern bank of Upper Cobbs Pond.

2.3 POTENTIAL HUMAN RECEPTORS AND ECOLOGICAL RESOURCES AT UPPER AND LOWER COBBS PONDS AOC

The following sections discuss potential human receptors and ecological resources at the Upper and Lower Cobbs Ponds AOC.

2.3.1 Human Receptors

The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of the facility and is currently used for recreational purposes (Figure 1-2). Future OHARNG Land Use for the AOC (which includes the ponds and their associated sediment and banks) includes recreational use, dam maintenance, wildlife management activities, and training purposes. Surrounding adjacent areas may be used for recreational activities as well as maneuver and multipurpose military training operations. This RI Report evaluates the Resident Receptor (Adult and Child) (formerly called the Resident Farmer) to assess Unrestricted (Residential) Land Use.

2.3.2 Ecological Resources

Camp Ravenna has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas (OHARNG 2014).

An abundance of wildlife is present on the facility: 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified. The ponds support a variety of aquatic animals (e.g., fish, turtles, and frogs) and semi-aquatic wildlife, such as waterfowl (e.g., ducks and geese) and wading birds (e.g., great blue heron).

The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat occurs (OHARNG 2014). Ohio state-listed plant and animal species have been identified through confirmed sightings and/or biological inventories at the facility and are presented in Table 2-1. Currently, the AOC is surrounded by forest, grassland, and wetland habitat. Additional information specific to ecological resources at the Upper and Lower Cobbs Ponds AOC is included in Section 7.3.

2.4 CO-LOCATED OR PROXIMATE SITES

The following subsections summarize sites that are co-located or proximate to the Upper and Lower Cobbs Ponds AOC, but are addressed separately.

2.4.1 Facility-wide Sewers

There are no facility-wide sewers within or adjacent to the AOC boundary.

2.4.2 Facility-wide Groundwater

As part of the Installation Restoration Program, the Army implements the Facility-wide Groundwater Monitoring Program (FWGWMP) in accordance with previous agreements made with Ohio EPA. The FWGWMP was initiated in 2005 and involves quarterly and semi-annual sampling of selected wells within the former RVAAP. From 2008–2009 for the FWGWMP, groundwater samples were collected from each of the six wells (ULCPmw-001 through ULCPmw-006) associated with the Upper and Lower Cobbs Ponds AOC. These wells are shown on Figure 2-2.

In January 2011, additional groundwater data from the wells presented below were collected under the FWGWMP, as indicated in Attachment B of the *Facility-wide Groundwater Monitoring Program Report on the January 2011 Sampling Event* (EQM 2011):

- ULCPmw-002 – Bis(2-ethylhexyl)phthalate was detected at a concentration above the cleanup goal (CUG),
- ULCPmw-005 – There were indications that barium concentrations were increasing, and
- ULCPmw-006 – Manganese and naphthalene were detected at a concentration above the CUG.

Most chemical concentrations in groundwater were below the maximum contaminant level (MCL) or regional screening level (RSL) [target risk (TR) of 1E-05, hazard quotient (HQ) of 1]. The exceptions were (EQM 2015):

- Arsenic exceeded the MCL of 10 µg/L in each sample collected at ULCPmw-005 with a maximum concentration of 65 µg/L. All samples collected from ULCPmw-006 were below the MCL except the sample collected in October 2009 that had a concentration of 18.7 µg/L.
- Manganese in ULCPmw-006 exceeded the RSL of 1E-05 (430 µg/L) in all samples collected with a maximum concentration of 3,260J µg/L from the January 2009 sample.
- Bis(2-ethylhexyl)phthalate in ULCPmw-002 exceeded the MCL (6 µg/L) in one sample with a concentration of 16 µg/L. The subsequent two samples had concentrations below the MCL and RSL of 1E-05 (5.6 µg/L).
- Naphthalene in ULCPmw-006 exceeded the RSL of 1E-05 (0.17 µg/L) in one sample in the final quarterly sample collected in January 2009; however, the detected concentration was below the reporting limit (J-flagged). All other samples from this well had non-detectable concentrations of naphthalene.
- 2,6-DNT exceeded the RSL (TR of 1E-05, HQ of 1, 0.048 µg/L) in ULCPmw-003 from the first two samples collected in 2008. These samples had detected concentrations below the reporting limit (J-flagged). All subsequent samples from this well did not have detectable concentrations of 2,6-DNT.

Additional groundwater level monitoring was performed in May 2014 at the six monitoring wells at the Upper and Lower Cobbs Ponds AOC; however, no samples were collected (EQM 2015). Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at the Upper and Lower Cobbs Ponds AOC will be addressed as part of that facility-wide AOC.

2.4.3 Munitions Response Sites

There is no munitions response site within or adjacent to the AOC boundary identified as part of the Military Munitions Response Program.

2.4.4 Compliance Restoration Sites

There are no compliance restoration sites, such as former or existing underground storage tanks, within or adjacent to the AOC boundary.

Table 2–1. Federal- and State-listed Species List

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST	
December 2014	
I. Species confirmed to be on Camp Ravenna property by biological inventories and confirmed sightings.	
A. Federal Threatened	
1. Northern long-eared bat, *Myotis septentrionalis*	
B. State Endangered	
1. American bittern, *Botaurus lentiginosus* (migrant) 2. Northern harrier, *Circus cyaneus* 3. Sandhill Crane, *Grus Canadensis* (probable nester) 4. Black bear, *Ursus americanus* 5. Mountain Brook Lamprey, *Ichthyomyzon greeleyi* 6. Brush-tipped emerald, *Somatochlora walshii* 7. Graceful Underwing, *Catocala gracilis*	8. Tufted Moisture-loving Moss, *Philonotis Fontana var. caespitosa* 9. Appalachian quillwort, *Isoetes engelmannii* 10. Handsome sedge, *Carex formosa* 11. Narrow-necked Pohl's Moss, *Pohlia elongata var. elongate* 12. Philadelphia panic-grass, *Panicum philadelphicum* 13. Variegated scouring-rush, *Equisetum variegatum*
C. State Threatened	
1. Barn owl, *Tyto alba* 2. Least Bittern, *Ixobrychus exilis* 3. Trumpeter swan, *Cygnus buccinators* (migrant) 4. Bobcat, *Felis rufus* 5. Caddis fly, *Psilotreta indecisa*	6. Northern long-eared bat, *Myotis septentrionalis* 7. Hobblebush, *Viburnum alnifolium* 8. Simple willow-herb, *Epilobium strictum* 9. Lurking leskea, *Plagiothecium latebricola* 10. Strict blue-eyed grass, *Sisyrinchium montanum*
D. State Potentially Threatened Plants	
1. Arborvitae, *Thuja occidentalis* 2. False hop sedge, *Carex lupiliformis* 3. Greenwhite sedge, *Carex albolutescens* 4. Long Beech Fern, *Phegopteris connectilis* (*Thelypteris phegopteris*) 5. Pale sedge, *Carex pallescens*	6. Sharp-glumed manna-grass, *Glyceria acutifolia* 7. Straw sedge, *Carex straminea* 8. Water avens, *Geum rivale* 9. Woodland Horsetail, *Equisetum sylvaticum* 10. Shining ladies'-tresses, *Spiranthes lucida*

Table 2–1. Federal- and State-listed Species List (continued)

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST

December 2014

E. State Species of Concern

1. Big brown bat, *Eptesicus fuscus*
2. Deer mouse, *Peromyscus maniculatus*
3. Eastern red bat, *Lasiurus borealis*
4. Hoary bat, *Lasiurus cinereus*
5. Little brown bat, *Myotis lucifugus*
6. Pygmy shrew, *Sorex hovi*
7. Southern bog lemming, *Svnaptomys cooperi*
8. Star-nosed mole, *Condylura cristata*
9. Tri-colored bat, *Perimyotis subflavus*
10. Woodland jumping mouse, *Napaeozapus insignis*
11. Sharp-shinned hawk, *Accipiter striatus*
12. Marsh wren, *Cistothorus palustris*
13. Henslow's sparrow, *Ammodramus henslowii*
14. Cerulean warbler, *Dendroica cerulean*
15. Prothonotary warbler, *Protonotaria citrea*
16. Bobolink, *Dolichonyx oryzivorus*
17. Northern bobwhite, *Colinus virginianus*
18. Common moorhen*,* *Gallinula chloropus*
19. Great egret, *Ardea alba* (migrant)
20. Sora, *Porzana carolina*
21. Virginia Rail, *Rallus limicola*
22. Yellow-bellied Sapsucker, *Sphyrapicus varius*
23. Creek heelsplitter, *Lasmigona compressa*
24. Eastern box turtle, *Terrapene carolina*
25. Four-toed Salamander, *Hemidacrylium scutatum*
26. Eastern garter snake, *Thamnophis sirtalis*
27. Smooth green snake, *Opheodrys vernalis*
28. Eastern sand darter, *Ammocrypta pellucida*
29. Mayfly, *Stenonema ithica*
30. Moth, *Apamea mixta*
31. Moth, *Brachylomia algens*
32. Scurfy quaker, *Homorthodes furfurata*
33. Sedge wren, *Cistothorus platensis*

F. State Special Interest

1. American black duck, *Anas rubripes*
2. Canada warbler, *Wilsonia Canadensis*
3. Dark-eyed junco, *Junco hyemalis* (migrant)
4. Hermit thrush, *Catharus guttatus* (migrant)
5. Least flycatcher, *Empidonax minimus*
6. Magnolia warbler, *Dendroica magnolia*
7. Northern waterthrush, *Seiurus noveboracensis*
8. Winter wren, *Troglodytes*
9. Back-throated blue warbler, *Dendroica caerulescens*
10. Brown creeper, *Certhia Americana*
11. Mourning warbler, *Oporornis Philadelphia*
12. Pine siskit, *Carduelis pinus*
13. Purple finch, *Carpodacus purpureus*
14. Red-breasted nuthatch, *Sitta Canadensis*
15. Golden-crowned kinglet, *Regulus satrapa*
16. Blackburnian warbler, *Dendroica fusca*
17. Gadwall, *Anas strepera*
18. Green-winged teal, *Anas crecca*
19. Northern shoveler, *Anas clypeata*
20. Redhead duck, *Aytya Americana*
21. Ruddy duck, *Oxyura jamaicensis*
22. Wilson's snipe, *Gallinago delicata*
23. Subflava sedge borer, *Capsula subflava*

Note: The Integrated Natural Resources Plan (OHARNG 2014) indicated that no federally listed species are known to reside at Camp Ravenna, and no critical habitat occurs. However, Table 2-1 reflects that the northern long-eared bat exists at Camp Ravenna and is federally threatened (USFWS 2016) and state threatened (ODNR 2016).

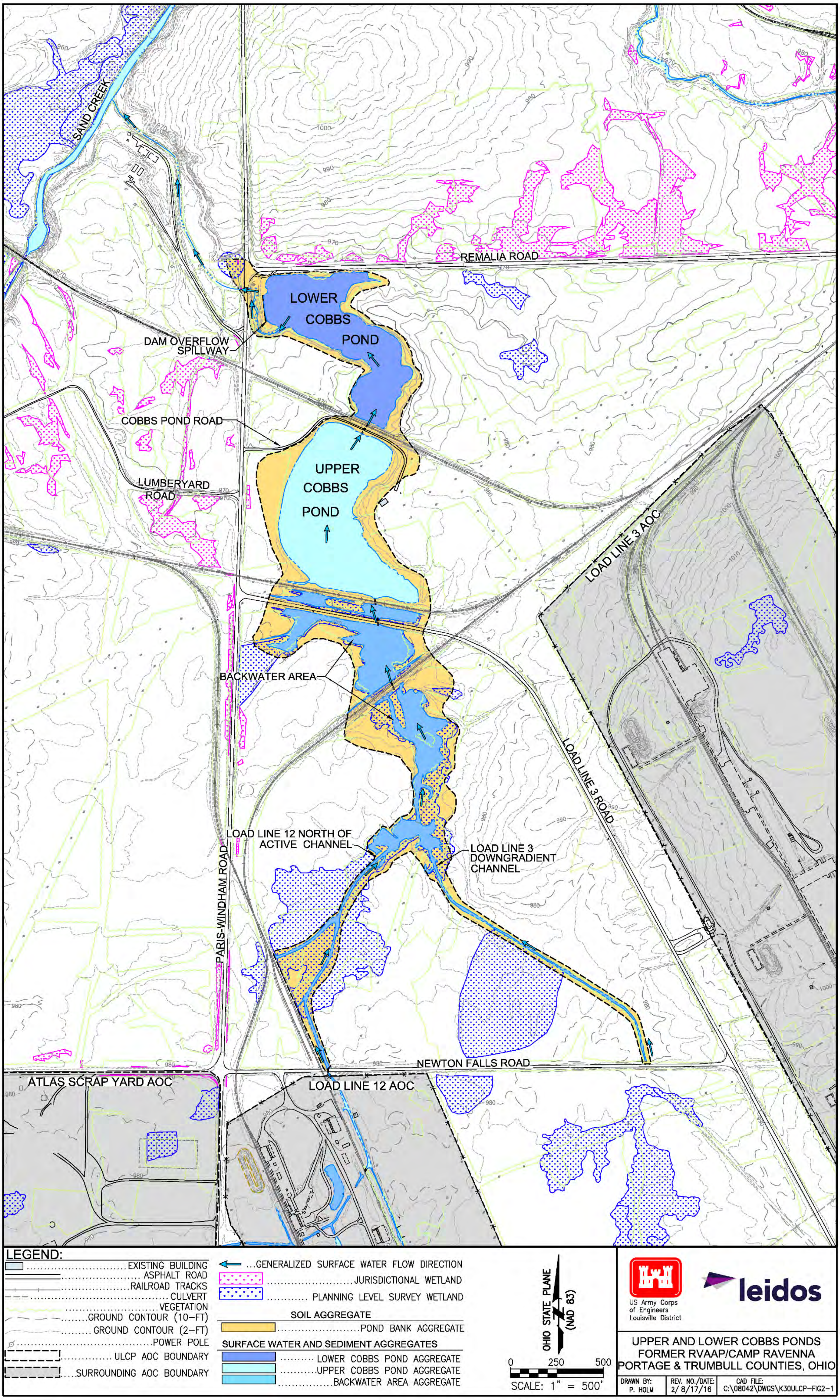

Figure 2–1. Surface Water Conveyance at Upper and Lower Cobbs Ponds

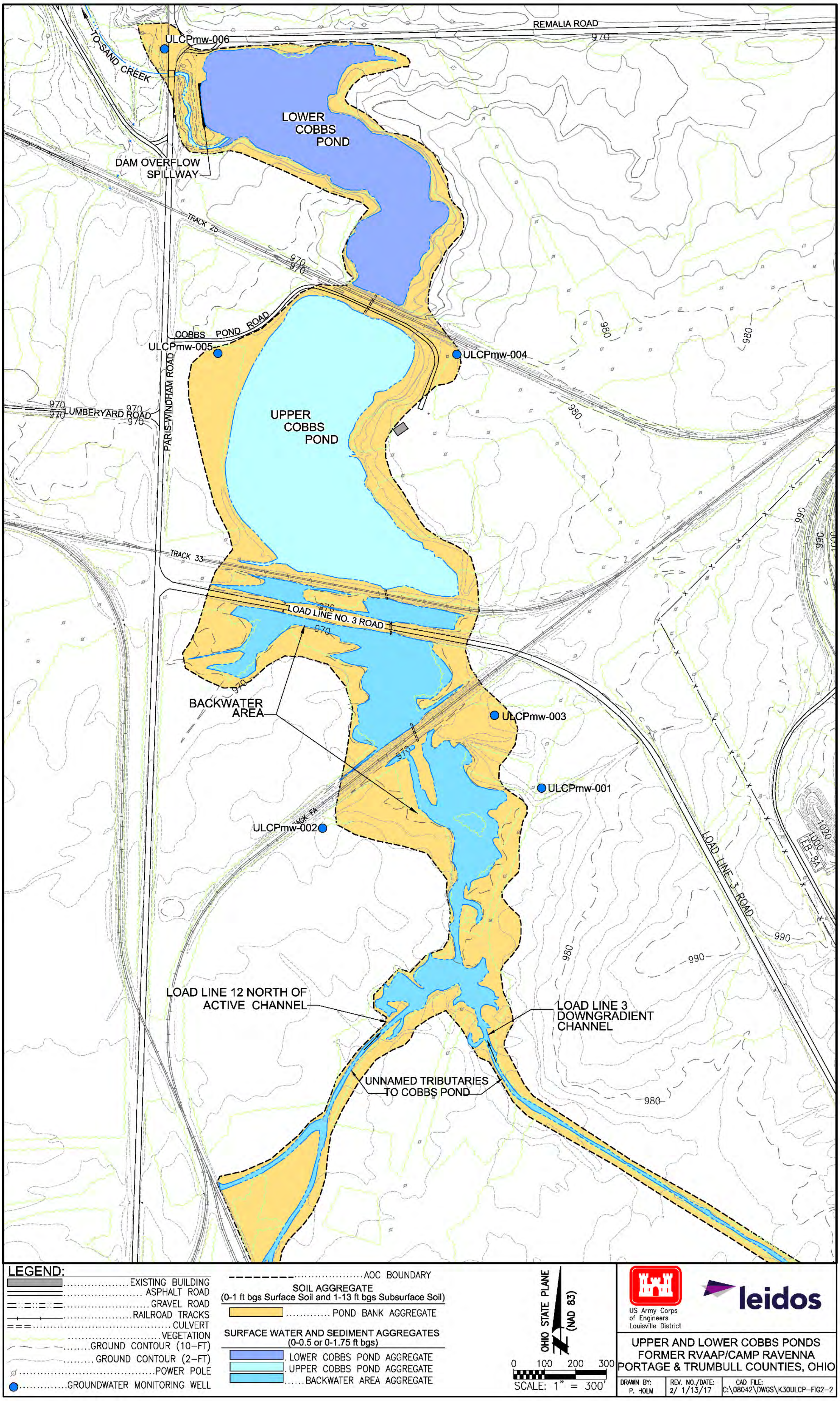

Figure 2–2. Upper and Lower Cobbs Ponds AOC Aggregates

3.0 ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of Camp Ravenna at the Upper and Lower Cobbs Ponds AOC that are factors in identifying the potential contaminant transport pathways, receptor populations, and exposure scenarios to evaluate human health and ecological risk.

3.1 CAMP RAVENNA PHYSIOGRAPHIC SETTING

Camp Ravenna is located within the southern New York Section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian and Pennsylvanian age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography, with incised streams having dendritic drainage patterns. The southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially-derived unconsolidated deposits (e.g., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

3.2 SURFACE FEATURES AND AOC TOPOGRAPHY

The topography of Camp Ravenna is gently undulating, with an overall decrease in ground elevation from a topographic high of approximately 1,220 ft above mean sea level (amsl) in the far western portion of the facility to low areas at approximately 930 ft amsl in the far eastern portion of the facility.

USACE mapped the facility topography in February 1998 using a 2-ft contour interval with an accuracy of 0.02 ft. USACE based the topographic information on aerial photographs taken during the spring of 1997. The USACE survey is the basis for the topographical information illustrated in figures included in this report.

The Upper and Lower Cobbs Ponds AOC is in the east-central portion of Camp Ravenna, east of Paris-Windham Road and south of Remalia Road (Figures 1-2 and 2-1). No fences or perimeter boundaries exist at the AOC. The topography at the AOC is dominated by the ponds and their associated drainage conveyances (Figure 3-1). The pond banks are characterized by mild to steep contours, surrounded by relatively flat land surface. The ground elevation varies from 960–980 ft amsl, with a slight topographic high located near the southeastern portion of the AOC and a topographic low west of the dam overflow spillway in the northwest portion of the AOC. Perennial surface water is present within Upper Cobbs Pond, Lower Cobbs Pond, and the Backwater Area (Figure 3-1). Surface water flows through the Backwater Area to Upper Cobbs Pond then to Lower Cobbs Pond, ultimately exiting the AOC through a dam overflow spillway located near the intersection of Remalia and Paris-Windham Roads. Surface water then enters an unnamed tributary that discharges into Sand Creek, northwest of the AOC.

3.3 SOIL AND GEOLOGY

3.3.1 Regional Geology

The regional geology at Camp Ravenna consists of horizontal to gently dipping bedrock strata of Mississippian and Pennsylvanian age, overlain by varying thicknesses of unconsolidated glacial deposits. The bedrock and unconsolidated geology at Camp Ravenna and the geology specific to the Upper and Lower Cobbs Ponds AOC are presented in the following subsections.

3.3.2 Soil and Glacial Deposits

Bedrock at Camp Ravenna is overlain by deposits of the Wisconsin-age Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern two-thirds of the facility (Figure 3-2). Unconsolidated glacial deposits vary considerably in their character and thickness across Camp Ravenna, from zero in some of the eastern portions of the facility to an estimated 150 ft in the south-central portion.

Thin coverings of glacial material have been completely removed as a consequence of human activities at locations such as Ramsdell Quarry. Bedrock is present at or near the ground surface in locations such as Load Line 1 and the Erie Burning Grounds (USACE 2001a). Where this glacial material is still present, its distribution and character indicate its origin as ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments. Lacustrine sediment from bodies of glacial-age standing water has also been encountered in the form of deposits of uniform light gray silt greater than 50-ft thick in some areas (USACE 2001a).

Soil at Camp Ravenna is generally derived from the Wisconsin-age silty clay glacial till. Distributions of soil types are discussed and mapped in the *Soil Survey of Portage County, Ohio*, which describes soil as nearly level to gently sloping and poor to moderately well drained (USDA 1978). Much of the native soil at Camp Ravenna was disturbed during construction activities in former production and operational areas of the facility.

The Sharon Member of the Pennsylvanian Pottsville Formation is the primary bedrock beneath Camp Ravenna. In the western half of the facility, the upper members of the Pottsville Formation, including the Connoquenessing Sandstone (also known as the Massillon Sandstone), Mercer Shale, and uppermost Homewood Sandstone, have been found. The regional dip of the Pottsville Formation measured in the western portion of Camp Ravenna is between 5–11.5 ft per mile to the south.

3.3.3 Geologic Setting of Upper and Lower Cobbs Ponds

Bedrock was not encountered at the Upper and Lower Cobbs Pond AOC during the PBA08 RI or previous characterization activities. The bedrock formation underlying the unconsolidated deposits at the Upper and Lower Cobbs Pond AOC, is the Pennsylvanian age Pottsville Formation, Sharon Sandstone Member, informally referred to as the Sharon Conglomerate (Figure 3-3) (Winslow et al.

1966). The Sharon Sandstone Member, the lowest unit of the Pottsville Formation, is a highly porous, loosely cemented, permeable, cross-bedded, frequently fractured and weathered orthoquartzite sandstone, which is locally conglomeratic. The Sharon Conglomerate exhibits locally occurring thin shale lenses in the upper portion of the unit. Upper members of the Pottsville Formation are not present at the AOC.

The soil types observed surrounding the ponds and Backwater Area are the Mahoning silt loam (2–6% slopes) and the Trumbull silt loam (0–2% slopes). Mahoning silt loam is a gently sloping, poorly drained soil formed in silty clay loam or clay loam glacial till, generally where bedrock is greater than 6 ft bgs. The Mahoning silt loam has low permeability, with rapid runoff and seasonal wetness and is present primarily around 85% of the water at the AOC (USDA 2010). The Trumbull silt loam covers the remaining 15% of the pond banks at the AOC, primarily in the southeastern portion within the Backwater Area. The Trumbull silt loam is poorly drained soil formed in silty clay till, generally where bedrock is greater than 6 ft bgs. The Trumbull silt loam is typically formed in depressions with a moderate water capacity with groundwater existing near ground surface (USDA 2010).

As observed in PBA08 RI soil borings, the composition of unconsolidated deposits at the AOC generally consist of yellowish-brown to gray, medium dense clay to sand-rich silt tills with interbedded sands scattered throughout. Bedrock was not encountered during PBA08 RI investigation activities at the AOC. Groundwater was observed from 1–10.3 ft bgs in the PBA08 RI soil borings. PBA08 RI boring logs containing geologic descriptions of unconsolidated deposits at the Upper and Lower Cobbs Pond AOC are included in Appendix A. Geologic descriptions and geotechnical analyses of subsurface soil samples collected during the PBA08 RI are generally consistent with the conclusions from the Phase II RI.

Two geotechnical samples were collected from the AOC during the PBA08 RI. Samples collected from CPCsb-033 at 4–5.4 ft bgs and 8–9.7 ft bgs were classified as clayey silts with trace sand. A summary of geotechnical analysis, including porosity, density, and moisture content, is presented in Section 5.3.5.

3.4 HYDROGEOLOGY

3.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County, as described in the *Phase I Remedial Investigation Report for High-Priority Areas of Concern* (USACE 1998) (herein referred to as the Phase I RI Report). Generally, these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies; however, yields are sufficient for residential water supplies. Lateral continuity of these aquifers is unknown. Recharge of these units is derived from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at Camp Ravenna have not been delineated.

The thickness of the unconsolidated interval at Camp Ravenna ranges from thin to absent in the eastern and northeastern portion of Camp Ravenna, to an estimated 150 ft in the central portion of the facility. The groundwater table occurs within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns are difficult to determine with a high degree of accuracy. Vertical recharge from precipitation likely occurs via infiltration along root zones, desiccation cracks, and partings within the soil column. Laterally, most groundwater flow likely follows topographic contours and stream drainage patterns, with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material. Figure 3-4 illustrates facility-wide potentiometric surface data in the unconsolidated interval from the January 2010 contemporaneous measurement event (EQM 2010a).

Within bedrock units at Camp Ravenna, the principle water-bearing aquifer is the Sharon Sandstone/Conglomerate. Depending on the existence and depth of overburden, the Sharon Sandstone/Conglomerate ranges from an unconfined to a leaky artesian aquifer. Water yields from on-site water supply wells completed in the Sharon Sandstone/Conglomerate ranged from 30–400 gallons per minute (gpm) (USATHAMA 1978). Well yields of 5–200 gpm were reported for on-site bedrock wells completed in the Sharon Sandstone/Conglomerate (Kammer 1982). Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquenessing Sandstone. Wells completed in the Connoquenessing Sandstone in Portage County have yields ranging from 5–100 gpm but are typically less productive than the Sharon Sandstone/Conglomerate due to lower permeabilities (Winslow et al. 1966).

Figure 3-5 shows the potentiometric surface within bedrock strata at Camp Ravenna in January 2010 (EQM 2010a). The bedrock potentiometric map shows a more uniform and regional eastward flow direction than the unconsolidated zone that is not as affected by local surface topography. Due to the lack of well data in the western portion of Camp Ravenna, general flow patterns are difficult to discern. For much of the eastern half of Camp Ravenna, bedrock potentiometric elevations are higher than the overlying unconsolidated potentiometric elevations, indicating an upward hydraulic gradient. This evidence suggests there is a confining layer that separates the two aquifers. In the far eastern area, the two potentiometric surfaces are at approximately the same elevation, suggesting hydraulic communication between the two aquifers is occurring.

3.4.2 Upper and Lower Cobbs Ponds Hydrologic/Hydrogeologic Setting

Six groundwater monitoring wells were installed at the Upper and Lower Cobbs Ponds AOC during the Phase II RI (MKM 2005). Initial depths to groundwater encountered during well installation varied from 5.75–39.75 ft bgs. Monitoring wells at the AOC ranged in completion from 18–27 ft bgs. All monitoring wells have groundwater elevations collected under the FWGWMP. All monitoring wells at the Upper and Lower Cobbs Ponds AOC were screened in the unconsolidated overburden.

The potentiometric surface of the AOC from the January 2010 monitoring event is shown in Figure 3-1. The estimated groundwater flow directions reflect the January 2010 facility-wide potentiometric data presented in the *Facility-wide Groundwater Monitoring Program Report on the January 2010 Sampling Event* (EQM 2010a). Water level elevations at the AOC had ranged from 957.38–973.40 ft amsl. The potentiometric surface shows the groundwater flow pattern to the northwest toward Sand Creek. The average hydraulic gradient for the AOC is approximately 0.0046 ft/ft.

Results of rising and falling head slug tests performed at the six monitoring wells during the Phase II RI indicate an average hydraulic conductivity of 5.64E-06 cm/s (MKM 2005). Table 3-1 presents the hydraulic conductivity result for each well at the Upper and Lower Cobbs Ponds AOC.

3.4.3 Surface Water

The following sections describe the regional and AOC-specific surface water.

3.4.3.1 Regional Surface Water

Camp Ravenna resides within the Mahoning River watershed, which is part of the Ohio River basin. The west branch of the Mahoning River is the main surface stream in the area. The west branch flows adjacent to the west end of the facility, generally in a north to south direction, before flowing into the Michael J. Kirwan Reservoir, located to the south of State Route 5 (Figure 1-1). The west branch flows out of the reservoir and parallels the southern Camp Ravenna boundary before joining the Mahoning River east of Camp Ravenna. The western and northern portions of Camp Ravenna display low hills and a dendritic surface drainage pattern. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection of the surface drainage. The facility is marked with marshy areas and flowing and intermittent streams whose headwaters are located in the upland areas of the facility.

The three primary watercourses that drain Camp Ravenna are (Figure 1-2):

- South Fork Eagle Creek,
- Sand Creek, and
- Hinkley Creek.

These watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square miles (36 km^2), generally flows in a northeast direction to its confluence with South Fork Eagle Creek. In turn, South Fork Eagle Creek continues in a northerly direction for 2.7 miles to its confluence with Eagle Creek. The drainage area of South Fork Eagle Creek is 26.2 square miles, including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Routes 88 and 303 to the north of the facility. Hinkley Creek, with a drainage area of 11 square miles, flows in a southerly direction through the facility and converges with the west branch of the Mahoning River (USACE 2001a).

Previous jurisdictional wetland delineations have surveyed approximately 5,680 acres (or 26% of the Camp Ravenna land). Approximately 715 acres of jurisdictional wetlands have been delineated within the 5,680 acres surveyed, which comprises approximately 13% of the total surveyed area. Wetland areas at Camp Ravenna include seasonal wetlands, wet fields, and forested wetlands. Many of the wetland areas are the result of natural drainage or beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas.

Approximately 30 ponds are scattered throughout the facility. Many were constructed within natural drainageways to function as settling ponds or basins for process effluent and runoff. Others are natural in origin, resulting from glacial action or beaver activity. Water bodies at Camp Ravenna support aquatic vegetation and biota as described in Section 2.3.2. Storm water runoff is controlled primarily by natural drainage, except in former operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent while production facilities were operational.

3.4.3.2 Upper and Lower Cobbs Ponds Surface Water

Surface water at the AOC is present perennially within the ponds and Backwater Area (Figure 3-1). The flow of surface water begins with the drainage channels from Load Line 3 and Load Line 12 that enter the AOC from the south and flows through the Backwater Area. Surface water flows north through Upper Cobbs Pond to Lower Cobbs Pond.

Flow from the Backwater Area into Upper Cobbs Pond and, subsequently, into Lower Cobbs Pond is through culverts beneath railroad trackbeds and roads that cross the AOC. Lower Cobbs Pond surface water discharges into a dam overflow spillway adjacent to the intersection of Remalia and Paris-Windham Roads, entering an unnamed tributary to Sand Creek, which is the primary migration pathway for contamination to exit the AOC.

Several large planning wetlands exist within the AOC boundary (OHARNG 2008), generally along the Pond Banks, which may receive overland surface water flow or runoff from ponds when water levels within the AOC are elevated.

3.5 CLIMATE

The general climate of the Camp Ravenna area is continental and is characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. The climate data presented below for the Camp Ravenna area were obtained from available National Weather Service records for the 30-year period of record from 1981–2010 at the Youngstown Regional Airport, Ohio (http://www.weather.gov/climate/xmacis.php?wfo=cle). Wind speed data for Youngstown, Ohio, are from the National Climatic Data Center (http://www1.ncdc.noaa.gov/pub/data/ccd-data/wndspd14.txt) for the available 30-year period of record from 1984–2014.

Average annual rainfall at Camp Ravenna area is 38.86 inches, with the highest monthly average occurring in July (4.31 inches) and the lowest monthly average occurring in February (2.15 inches). Average annual snowfall totals approximately 62.9 inches, with the highest monthly average occurring in January (17.1 inches). Due to the influence of lake-effect snowfall events associated with

Lake Erie (located approximately 35 miles to the northwest of Camp Ravenna), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the Camp Ravenna area is 49.3ºF, with an average daily high temperature of 70.9ºF and an average daily low temperature of 26.1ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at Camp Ravenna is from the southwest, with the highest average wind speed occurring in January (10.3 miles per hour) and the lowest average wind speed occurring in August (6.5 miles per hour). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. Camp Ravenna is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

Table 3–1. Hydraulic Conductivities Measured During the Phase II Remedial Investigation

Monitoring Well ID	Screened Interval (ft bgs)	Geologic Material Adjacent to Screen	Hydraulic Conductivity (cm/s)
ULCPmw-001	5.5–15.5	Silty sand, clayey silt	1.98E-06
ULCPmw-002	5.5–15.5	Clayey silt with silty sand interbeds	6.01E-06
ULCPmw-003	8–18	Clayey silt	1.38E-05
ULCPmw-004	9.5–19.5	Silty sand, clayey silt	8.38E-07
ULCPmw-005	29.5–39.5	Clayey silt; sandy silt	1.16E-06
ULCPmw-006	8–18	Clayey silt	1.01E-05

Source = *Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds* (MKM 2005).
bgs = Below ground surface.
cm/s = Centimeters per second.
ft= Feet.
ID = Identification.

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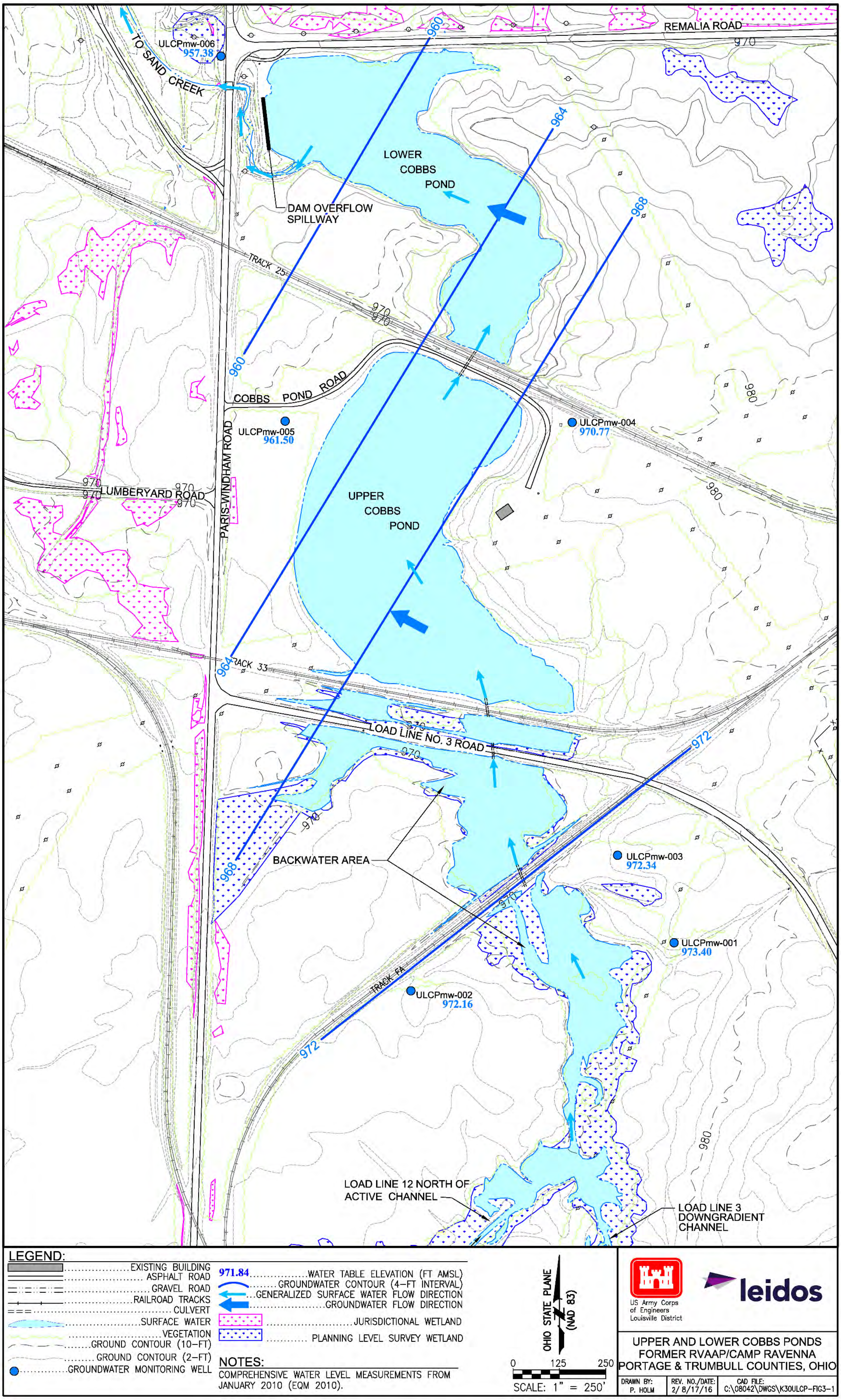
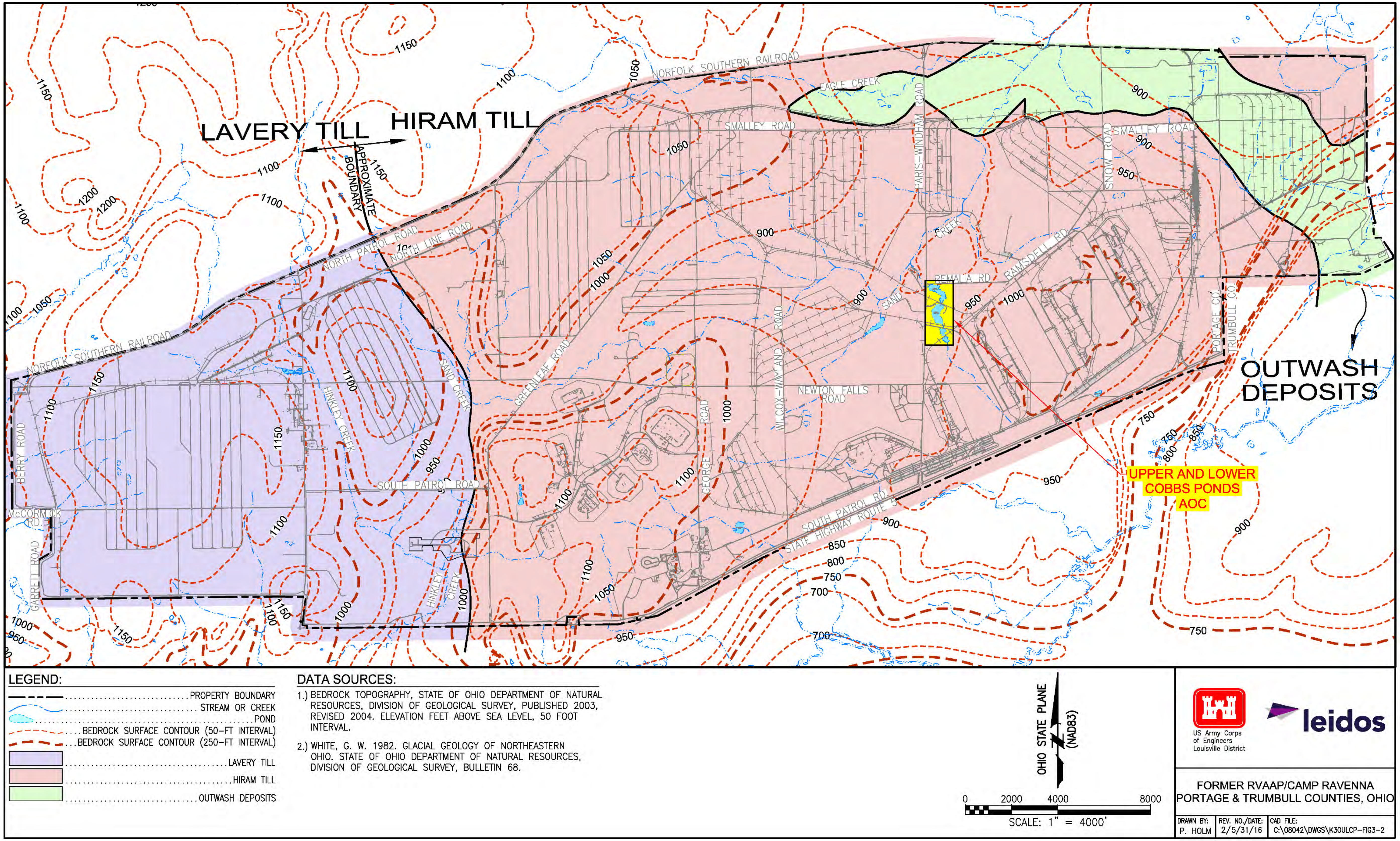


Figure 3–1. Topography, Groundwater Flow, and Surface Water Flow at Upper and Lower Cobbs Ponds AOC



DATA SOURCES:

1.) BEDROCK TOPOGRAPHY, STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, PUBLISHED 2003, REVISED 2004. ELEVATION FEET ABOVE SEA LEVEL, 50 FOOT INTERVAL.

2.) WHITE, G. W. 1982. GLACIAL GEOLOGY OF NORTHEASTERN OHIO. STATE OF OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGICAL SURVEY, BULLETIN 68.

Figure 3–2. Geologic Map of Unconsolidated Deposits on Camp Ravenna

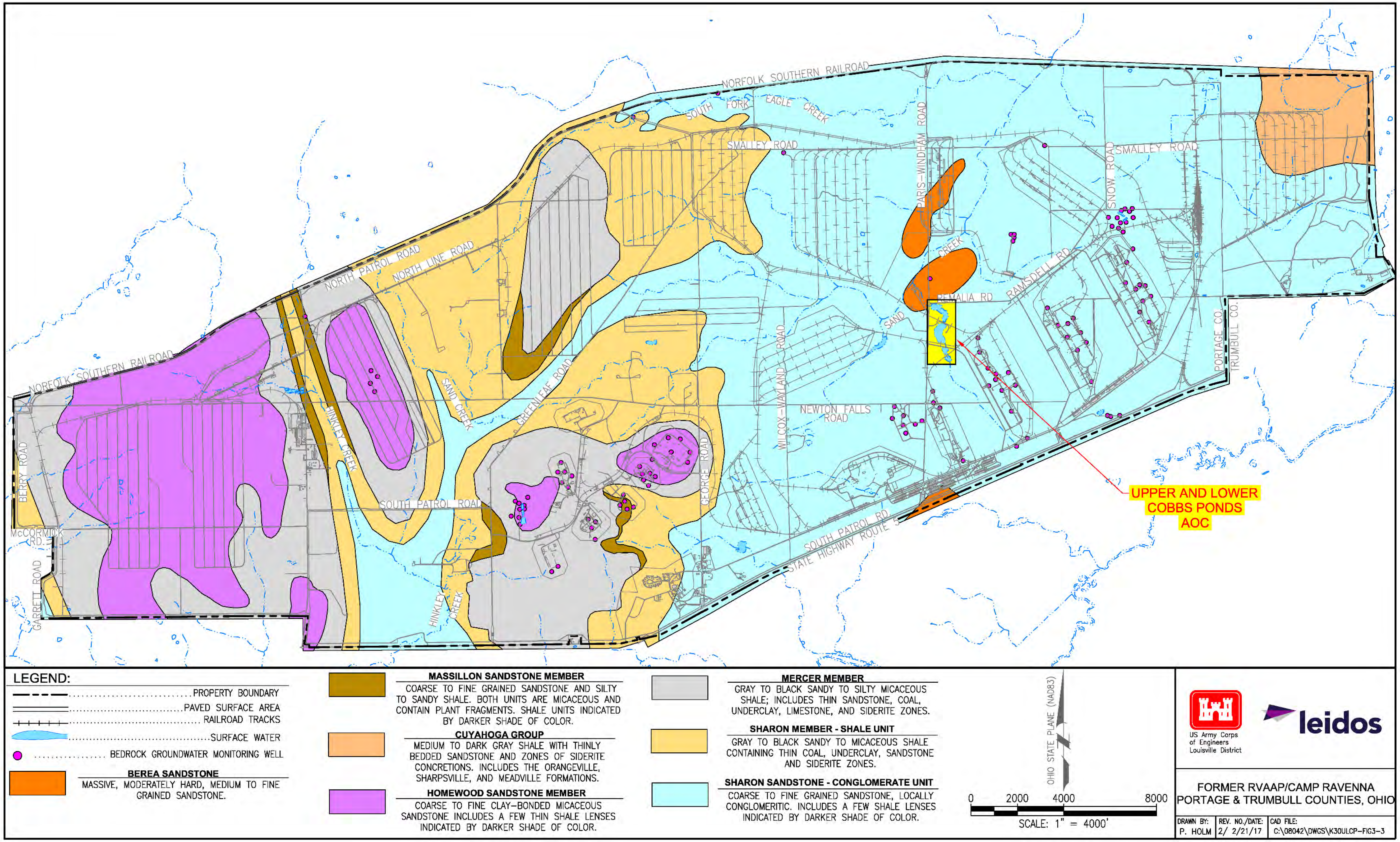


Figure 3–3. Geologic Bedrock Map and Stratigraphic Description of Units on Camp Ravenna

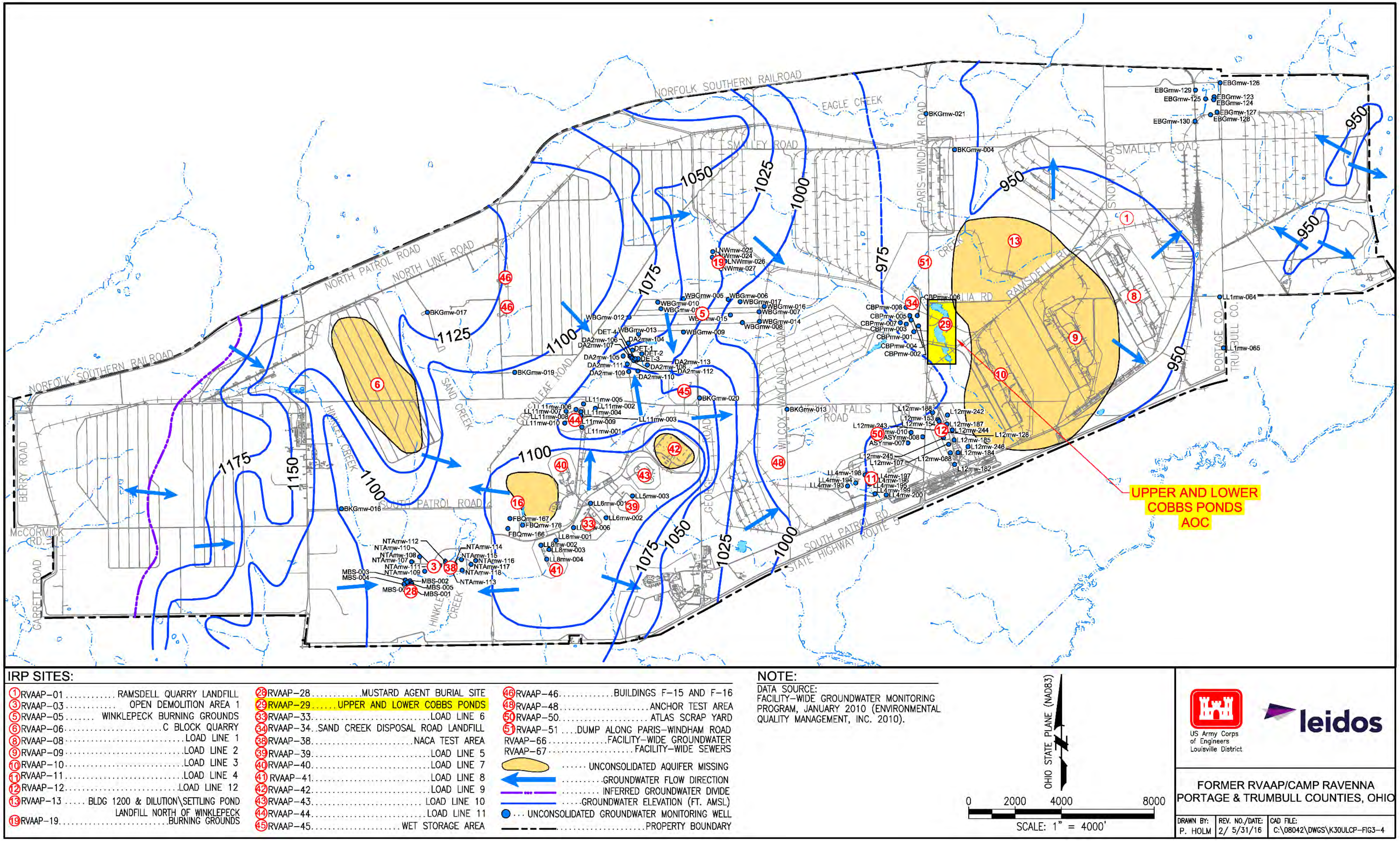
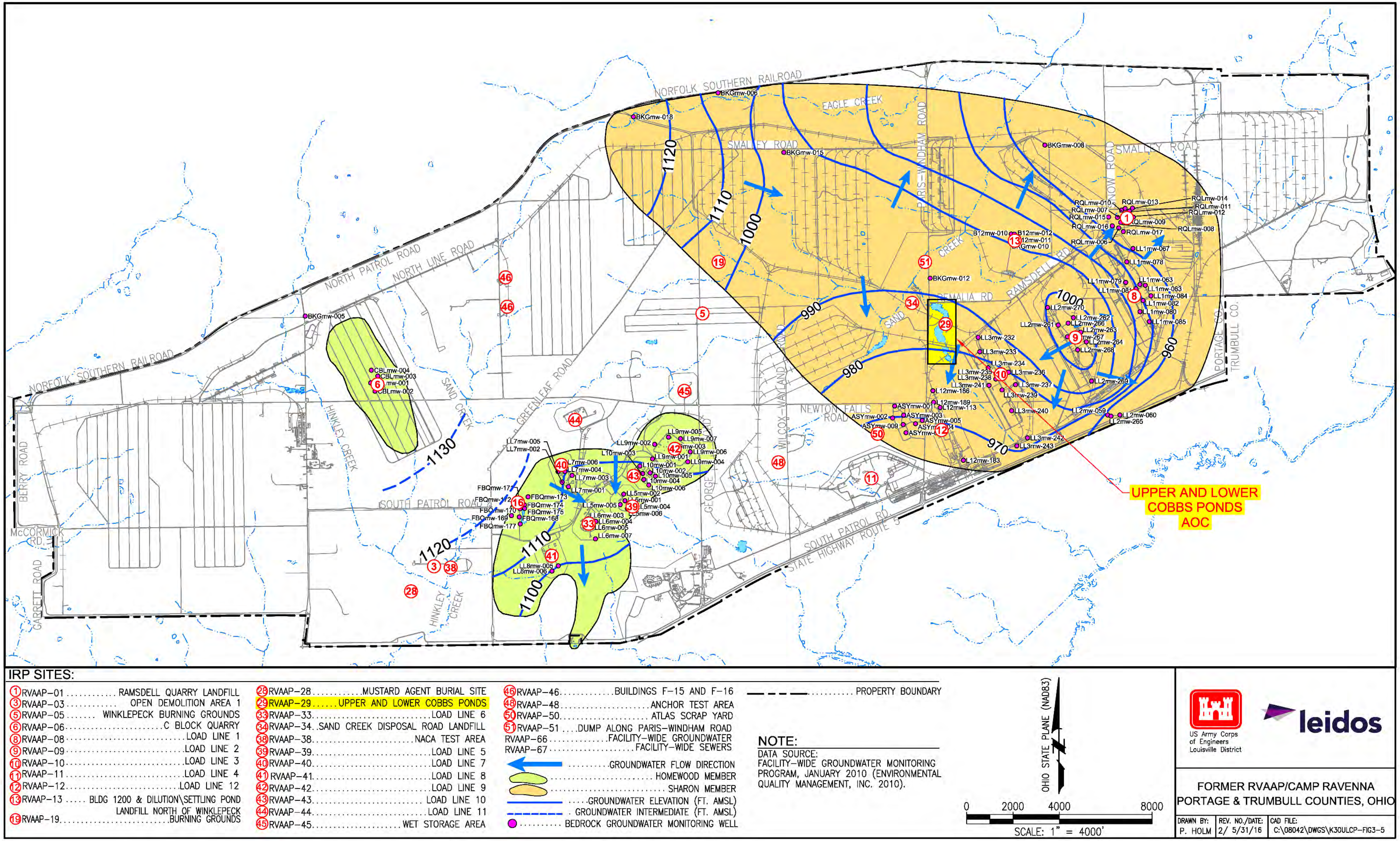


Figure 3–4. Potentiometric Surface of Unconsolidated Aquifer at Camp Ravenna



IRP SITES:

①RVAAP–01 .... RAMSDELL QUARRY LANDFILL
③RVAAP–03 .... OPEN DEMOLITION AREA 1
⑤RVAAP–05 .... WINKLEPECK BURNING GROUNDS
⑥RVAAP–06 .... C BLOCK QUARRY
⑧RVAAP–08 .... LOAD LINE 1
⑨RVAAP–09 .... LOAD LINE 2
⑩RVAAP–10 .... LOAD LINE 3
⑪RVAAP–11 .... LOAD LINE 4
⑫RVAAP–12 .... LOAD LINE 12
⑬RVAAP–13 ..... BLDG 1200 & DILUTION\SETTLING POND
⑲RVAAP–19 .... LANDFILL NORTH OF WINKLEPECK BURNING GROUNDS
㉘RVAAP–28 .... MUSTARD AGENT BURIAL SITE
㉙RVAAP–29 ...... UPPER AND LOWER COBBS PONDS
㉝RVAAP–33 .... LOAD LINE 6
㉞RVAAP–34 .. SAND CREEK DISPOSAL ROAD LANDFILL
㊳RVAAP–38 .... NACA TEST AREA
㊴RVAAP–39 .... LOAD LINE 5
㊵RVAAP–40 .... LOAD LINE 7
㊶RVAAP–41 .... LOAD LINE 8
㊷RVAAP–42 .... LOAD LINE 9
㊸RVAAP–43 .... LOAD LINE 10
㊹RVAAP–44 .... LOAD LINE 11
㊺RVAAP–45 .... WET STORAGE AREA
㊻RVAAP–46 .... BUILDINGS F–15 AND F–16
㊽RVAAP–48 .... ANCHOR TEST AREA
㊿RVAAP–50 .... ATLAS SCRAP YARD
(51)RVAAP–51 .... DUMP ALONG PARIS–WINDHAM ROAD
RVAAP–66 .... FACILITY–WIDE GROUNDWATER
RVAAP–67 .... FACILITY–WIDE SEWERS

➡ .... GROUNDWATER FLOW DIRECTION
🟩 .... HOMEWOOD MEMBER
🟧 .... SHARON MEMBER
— ..... GROUNDWATER ELEVATION (FT. AMSL)
- - - . GROUNDWATER INTERMEDIATE (FT. AMSL)
● .... BEDROCK GROUNDWATER MONITORING WELL
— — — .... PROPERTY BOUNDARY

NOTE:
DATA SOURCE:
FACILITY–WIDE GROUNDWATER MONITORING PROGRAM, JANUARY 2010 (ENVIRONMENTAL QUALITY MANAGEMENT, INC. 2010).

US Army Corps of Engineers Louisville District

leidos

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
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Figure 3–5. Potentiometric Surface of Bedrock Aquifers at Camp Ravenna

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4.0 SITE ASSESSMENTS, INVESTIGATIONS, AND DATA ASSEMBLY

This section summarizes all previous site assessments and investigations conducted at the Upper and Lower Cobbs Ponds AOC. These previous activities included assessments to prioritize the AOC and investigations that collected data used in support of the RI.

4.1 PREVIOUS ASSESSMENTS AND EVALUATIONS

This section summarizes previous assessments and evaluations conducted at the Upper and Lower Cobbs Ponds AOC. These activities were generally performed as an initial evaluation and/or prioritization assessment of the AOC. The data collected as part of these prioritization assessments and evaluations are not used in the nature and extent, fate and transport, HHRA, or ERA due to their age and lack of data quality documentation.

4.1.1 Installation Assessment of Ravenna Army Ammunition Plant

The *Installation Assessment of Ravenna Army Ammunition Plant* incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. No sampling was performed at Upper and Lower Cobbs Ponds as part of the assessment. The assessment identified the following conditions at RVAAP, applicable to Upper and Lower Cobbs Ponds (USATHAMA 1978):

- Load Line 3 was used for TNT and composition B melt-pour activities, and Load Line 12 was used for ammonium nitrate production. Both load lines were also used for demilitarization activities. Pink water and washout of residue, dusts, and spills at Load Lines 3 and 12 were discharged into Upper Cobbs Pond through surface drainage channels.
- From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 in Load Line 12 for producing aluminum chloride. A fish kill occurred on November 15, 1966 at Lower Cobbs Pond as a result of improper handling of aluminum chloride during these manufacturing operations. The bulk of the aluminum chloride at Load Line 12 was removed and disposed in Ramsdell Quarry. The pond was settled and drained, and the contaminants were moved to Ramsdell Quarry. Contaminated metals were flashed at a burning ground to a five times condition (USATHAMA 1978 and 1982, RVAAP 2000). The Army terminated the lease early on December 3, 1967 due to environmental concerns related to air emissions and wastewater discharges to Upper and Lower Cobbs Ponds.
- Surface waters exiting the facility were not required to be monitored for nitrobodies and heavy metals.
- In August 1949, the ammonium nitrate fertilizer operations at Load Line 12 were investigated to determine whether high nitrate concentrations observed in Warren, Ohio were related to Load Line 12 waste disposal procedures. Warren, Ohio used the Mahoning River as a water supply source. The Mahoning River received influent from upgradient waters, including Upper and Lower Cobbs Ponds, which received drainage from Load Line 12. Improvements

in the operations and housekeeping at RVAAP in 1949 reduced nitrate concentrations to an acceptable concentration (less than 10 parts per million) in on-site surface water and downstream.
- Analysis of the well water indicated potable quality.
- No environmental stress was identified at RVAAP.

4.1.2 Soil and Sediment Analysis

The Mogul Corporation performed surface soil and sediment analysis at selected RVAAP ponds and streams for the explosives TNT and RDX in May 1982. A description of field activities and data summary are provided in the *Soil and Sediment Analysis Performed for Ravenna Arsenal* (Mogul 1982). Results relevant to Upper and Lower Cobbs Ponds are as follows:

- One composite sample collected at Upper Cobbs Pond had non-detectable concentrations of TNT. RDX had a concentration of 1.16 µg/mL.
- One composite sample collected from Lower Cobbs Pond had non-detectable concentrations of TNT and RDX.
- One grab sample collected at Load Line 12 Stream #1 had a TNT concentration of 0.17 µg/mL and an RDX concentration of 1.12 µg/mL.
- Samples at upstream locations from Upper Cobbs Pond, including Load Line 12 Stream #2, Load Line 12 Stream #3, and the Load Line 12 pond had non-detectable concentrations of TNT and RDX.

4.1.3 RVAAP Preliminary Assessment

The *Preliminary Assessment for the Characterization of Areas of Contamination* researched RVAAP history, process operations, and historical data to identify AOCs (USACE 1996a). No additional historical documents were available and minimal service history was available for the AOC. The report provided preliminary assessment scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model.

The assessment also recognized the following conditions relevant to the Upper and Lower Cobbs Ponds AOC:

- Upper and Lower Cobbs Ponds consists of two unlined ponds that received pink water effluent and storm water runoff from Load Lines 3 and 12.
- The ponds have been used for recreational purposes and support abundant fish and wildlife.
- A ponded area (Backwater Area) was created by beavers and exists south (upstream) of Upper Cobbs Pond. This area did not exist during plant operations. This Backwater Area supports abundant fish and wildlife.
- A fish kill occurred at Lower Cobbs Pond in 1966 due to improper handling of aluminum chloride at Load Line 12.
- Contaminants of concern at the AOC include TNT, HMX, composition B, lead, mercury, chromium, and aluminum chloride.

- The total volume of wastewater received by Upper and Lower Cobbs Ponds during the AOC's operational period is unknown.
- The greatest potential for release of contaminants to groundwater was identified as wastewater effluent discharge to unlined earthen settling ponds (i.e., Upper and Lower Cobbs Ponds).
- The greatest potential for historical off-site contaminant migration during load line operations was identified as surface water.
- The greatest potential for current off-site contaminant migration was identified as groundwater and surface water.

Based on qualitative assessment of the potential hazards, release mechanisms, and environmental conditions, the Upper and Lower Cobbs Ponds AOC was ranked as a high-priority AOC.

4.2 REMEDIAL INVESTIGATIONS

This section summarizes previous investigations [including the 2003 Facility-wide Biological and Water Quality Study (FWBWQS)] conducted at the Upper and Lower Cobbs Ponds AOC. These investigations collected data of sufficient provenance and quality to be used to support the evaluations in this RI, including the nature and extent, fate and transport, HHRA, and/or ERA.

The previous Phase I RI Report (USACE 1998) and *Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds* (MKM 2005) (herein referred to as the Phase II RI Report) presented SRCs and/or COPCs based on data evaluation protocols in use at the time the investigations were completed. The data and information is used in this report; however, an updated screening process and the addition of new data and information may result in a different list of SRCs and/or COPCs.

References to "RVAAP full-suite analytes" generally include analyses of target analyte list (TAL) metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and pesticides.

4.2.1 Phase I Remedial Investigation

In 1996, sampling was conducted at the Upper and Lower Cobbs Ponds AOC in accordance with the *RVAAP Facility-wide Sampling and Analysis Plan* (FWSAP; USACE 1996b) and *Phase I RI SAP Addendum for High-Priority AOCs* (USACE 1996c). The Phase I RI was performed to accomplish the following tasks:

- Collect environmental samples from potentially impacted media to confirm if contamination is present and is being released to the environment,
- Determine the nature of the COPCs, and
- Provide a human health risk screening evaluation.

Results of this Phase I RI are presented in the Phase I RI Report (USACE 1998) and are summarized in the following subsections.

4.2.1.1 Field Activities

The following field activities were conducted during the Phase I RI in August 1996 at the Upper and Lower Cobbs Ponds AOC to assess the potential impacts from former operations:

- Collected 10 composite sediment samples from the ponds and drainage conveyances (5 samples at Upper Cobbs Pond, 3 samples at Lower Cobbs Pond, and 2 samples downstream of Lower Cobbs Pond);
- Installed, developed, and sampled three temporary well points; and
- Surveyed sampling locations.

Temporary well points were installed, developed, and sampled; however, these activities are pertinent to other co-located AOCs associated with Upper and Lower Cobbs Ponds (e.g., facility-wide groundwater) and are not discussed in this section.

Sediment samples were analyzed for TAL metals and explosives, with one sample submitted for analysis for RVAAP full-suite analytes (10%). All groundwater samples were submitted for analysis of RVAAP full-suite analytes.

Figure 4-1 presents the locations sampled under the Phase I RI. Table 4-1 presents the sample locations, associated operations, and suite of chemicals analyzed as part of the Phase I RI. Table 4-2 presents the results of the analytes detected from samples collected during the Phase I RI.

Analytical laboratory procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Samples were analyzed as specified by the FWSAP current at the time of the investigation and the *Phase I RI SAP Addendum for High-Priority AOCs* (USACE 1996c). The data quality objectives (DQOs) were established for the Phase I RI and complied with USEPA Region 5 guidance. The requisite number of quality assurance (QA)/quality control (QC) samples was obtained during the investigation. The data validation determined that the data met the completeness requirements for the project (100% complete), was usable, and that it satisfied the DQOs for the project.

4.2.1.2 Nature and Extent of Contamination

Five TAL metals were detected in sediment at concentrations exceeding background concentrations and identified as SRCs. Concentrations of inorganic chemicals in drainage sediment tended to be higher towards the center of the ponds. In addition, a single detection of the explosive nitrobenzene was observed in sediment at the outfall of Upper Cobbs Pond (location CPCsd-005) at a concentration of 0.38 mg/kg. Eight non-nutrient TAL metals, cyanide, and the organic compound 4-chloro-3-methyl-phenol were identified as SRCs in groundwater samples.

4.2.1.3 Risk Evaluation

A risk evaluation for the Upper and Lower Cobbs Ponds AOC was included in the Phase I RI. The risk evaluation compared chemical concentrations detected in AOC samples to RVAAP criteria in effect at that time, which included facility-wide background concentrations for inorganic chemicals, USEPA Region 4 sediment criteria, and state of Ohio or federal MCLs for drinking water. The results of the risk evaluation identified chromium in sediment and manganese in groundwater as COPCs.

4.2.1.4 Conclusions and Recommendations

The Phase I RI Report provided the following conclusions applicable to the Upper and Lower Cobbs Ponds AOC:

- The RI objectives were to characterize the nature and extent of potential contamination in sediment at the site. The objectives of the RI were met through the field investigation conducted in 1996. Field investigation included sampling sediment and groundwater.
- The Phase I RI re-categorized the Upper and Lower Cobbs Ponds AOC as a "medium priority" AOC, as there was one detection of explosives and concentrations of inorganic chemicals were slightly above background concentrations (at the time of the investigation) primarily in the center of the ponds.
- The concentrations of inorganic chemicals in the drainage downstream of the AOC were generally below background concentrations (at the time of the investigation), indicating contaminants were not migrating from the ponds.

Recommendations of the Phase I RI include:

- Conduct a Phase II RI to determine extent of soil and sediment contamination at high- and medium-priority AOCs as defined by the Phase I RI.
- Collect site-specific hydrogeologic data to determine the vertical and lateral extent of potential groundwater contamination in the unconsolidated zone.
- Perform chemical fate and transport modeling to identify contaminant migration potential via groundwater and surface water within the Upper and Lower Cobbs Ponds AOC.
- Complete a baseline human health risk assessment (BHHRA) for all environmental media.
- Complete an ERA for all environmental media.

4.2.2 Phase II Remedial Investigation

In July–September 2001, sampling was conducted at the Upper and Lower Cobbs Ponds AOC in accordance with the *Sampling and Analysis Plan Addendum for the Phase II Remedial Investigation at the Upper and Lower Cobbs Pond (AOC 29)* (MKM 2001; herein referred to as the Phase II RI SAP Addendum).

The Phase II RI was performed to accomplish the following:

- Define the vertical and horizontal extent of contamination at Upper and Lower Cobbs Ponds and their surroundings,
- Gather sufficient data to conduct a BHHRA and a screening ecological risk assessment (SERA),
- Define potential transport pathways and receptor populations, and
- Provide sufficient data for selecting remedial action alternatives.

The primary focus of the Phase II RI is to evaluate sediment, surface water, and groundwater. Soil samples were collected from the pond bank soils (0–1 ft bgs) associated with banks on the pond to determine if fluctuations in water levels in the ponds affected the bank soil. The data from the RI sampling was incorporated into an evaluation of risk for the AOC, followed by recommendations for remedial efforts, as necessary. Results of this Phase II RI are presented in the Phase II RI Report (MKM 2005) and are summarized in the following subsections.

4.2.2.1 Field Activities

The following field activities were conducted during the Phase II RI in July–September 2001 at the AOC [as documented in the Phase II RI Report (MKM 2005)] to assess the potential impacts from former operations:

- Conducted unexploded ordnance-avoidance screening before initiating field activities,
- Collected 10 discrete surface soil (0–1 ft bgs) samples from Pond Bank,
- Field-screened Pond Bank soil samples for RDX and TNT,
- Collected 7 surface water samples,
- Collected 29 sediment samples, and
- Surveyed sampling locations.

The following activities also took place; however, these activities are pertinent to other co-located AOCs associated with the Upper and Lower Cobbs Ponds AOC (e.g., facility-wide groundwater) and are not discussed in this section:

- Installed, developed, and sampled six monitoring wells;
- Conducted in-situ permeability testing (slug tests);
- Collected geotechnical samples from three monitoring well borings; and
- Surveyed monitoring well locations.

Soil, sediment, and surface water samples were analyzed for TAL metals and explosives. Additionally, 10% of samples were analyzed for RVAAP full-suite analytes. Groundwater samples were submitted for RVAAP full-suite analysis.

Figure 4-1 presents the locations sampled under the Phase II RI. Table 4-3 presents the sample locations, associated operations, and suite of chemicals analyzed as part of the Phase II RI. Tables 4-4 through 4-6 present the results of the analytes detected from samples collected during the Phase II RI.

Analytical laboratory procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Samples were analyzed as specified by the FWSAP current at the time of the investigation (USACE 2001a) and the Phase II RI SAP Addendum (MKM 2001). DQOs were established for the Phase II RI and complied with USEPA Region 5 guidance. The requisite number of QA/QC samples was obtained during the investigation. The data validation determined that the data met the completeness requirements for the project (100% complete), were usable, and that they satisfied the DQOs for the project.

4.2.2.2 Nature and Extent of Contamination

A summary of the nature and extent of contamination for each medium sampled during the Phase II RI is presented below.

Pond Bank Soil (0–1 ft bgs)

- Arsenic was detected in three samples exceeding the background and preliminary remediation goals (PRGs) and in eight samples exceeding PRGs. Chromium was detected in three samples exceeding background.
- No explosives, VOCs, SVOCs, pesticides, PCBs, or nitrates/nitrites were detected above detection limits.
- Nitrates/nitrites were detected in one sample (ULCPss-001).
- The propellants detected exceed background because the background value for propellants is zero. However, none of the concentrations exceeded PRGs.

Sediment

- Arsenic was detected in 3 samples exceeding the background and PRGs and in 27 samples exceeding PRGs. Chromium was detected in nine samples exceeding background and PRGs.
- No pesticides were detected above detection limits.
- No background values were established for VOCs, SVOCs, PCBs, or total organic carbon in sediment.
- Aroclor-1254 was detected in four samples (ULCPsd-006, ULCPsd-011, ULCPsd-020, and ULCPsd-020 duplicate) but at concentrations below PRGs.
- Sediment samples were analyzed for hexavalent chromium separately (as well as total chromium). Four samples (ULCPsd-010, ULCPsd-018, ULCPsd-021, and ULCPsd-022) contained concentrations of hexavalent chromium below the Region 9 PRG. At each of these locations, the total chromium concentration was also below the Region 9 PRG.

Surface Water

- Arsenic was detected in three samples exceeding PRGs and in three samples exceeding the background and PRGs. Manganese was detected in three samples exceeding background and PRGs and in two samples exceeding the background.
- No explosives, cyanide, SVOCs, pesticides, PCBs, or nitrates were detected above detection limits.
- No background values were established for VOCs, sulfides, or sulfates in surface water.
- Metals and cyanide samples were not filtered; therefore, results represent total concentrations.
- Chloromethane, acetone, and toluene were detected in sample ULCPSW-002 and in duplicate at concentrations below Region 9 PRGs.

Groundwater

- Arsenic was detected in three samples exceeding PRGs and in one sample exceeding the background and PRGs. Manganese was detected in two samples exceeding background and PRGs.
- No explosives, propellants, cyanide, VOCs, PCBs, or nitrates/nitrites were detected above detection limits.
- Bis(2-ethylhexyl)phthalate was detected in the duplicate of sample ULCPGW-006 but not in the original sample. No background values were established for SVOCs in groundwater.
- The pesticide endrin was detected in one sample (ULCPGW-003) at a concentration below the Region 9 PRG. No background values were established for pesticides in groundwater.

Figure 4-4 presents locations that exceed current screening criteria.

4.2.2.3 Baseline Human Health Risk Assessment

A BHHRA was included in the Phase II RI Report (MKM 2005) for the Upper and Lower Cobbs Ponds AOC. The BHHRA utilized the screening process in effect at that time, based on the protocol established in the *RVAAP Facility-wide Human Health Risk Assessor Manual – Amendment 1* (USACE 2005b) (herein referred to as the FWHHRAM), in order to identify potential contaminants of concern. Risks were evaluated for the receptors available at that time [National Guard Trainee (the primary receptor of concern), National Guard Resident/Trainer, National Guard Fire and Dust Control Specialist, Hunter/Trapper/Fisher, Security Guard/Maintenance Worker, and Resident Farmer (Adult and Child)]. COPCs were selected and toxicological and exposure factors were applied to evaluate risk. The COPCs identified in the quantitative BHHRA are summarized in Table 4-10.

The BHHRA indicated that several significant uncertainties associated with the risk assessment were identified and must be considered carefully when making any risk management decisions, including the fact that the nature and extent of the contamination in soil, sediment, surface water, and groundwater at the Upper and Lower Cobbs Ponds AOC had not been completely defined. Therefore, the results of the BHHRA are preliminary and subject to change based on the additional data and information presented in the Phase III RI Report.

4.2.2.4 Screening Ecological Risk Assessment

The SERA compared chemical concentrations detected in Upper and Lower Cobbs Ponds environmental media to RVAAP facility-wide background concentrations for inorganic chemicals and ecological screening values (ESVs). The SERA followed screening methodology guidance presented in the *2003 RVAAP Facility-wide Ecological Risk Work Plan* (USACE 2003a) (herein referred to as the FWERWP) and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). Chemicals were retained if they did not have screening values.

A SERA was performed to assess whether adverse ecological impacts are present at the Upper and Lower Cobbs Ponds AOC as a result of SRCs detected. The SERA concluded no unacceptable ecological risks were identified. No COPCs were retained for direct toxicity to terrestrial plants, soil invertebrates, sediment invertebrates (benthos), and aquatic organisms. Refining conservative assumptions used during food chain modeling led to determining that the risks were acceptable. Refinement included using less conservative bioavailability, less conservative dietary benchmarks [lowest observed adverse effect levels (LOAELs)], and more realistic average exposure scenarios (not maximum) and considering aquatic habitat quality in the ponds, backwater area, and site drainage channels.

4.2.2.5 Conclusions and Recommendations

The Phase II RI Report (MKM 2005) provided the following conclusions applicable to the Upper and Lower Cobbs Ponds AOC.

- The RI objectives were to characterize the nature and extent of potential contamination at the site. The objectives of the RI were met through the field investigations conducted in 2001. Field investigation included sampling the pond bank soil, surface water, groundwater, and sediment. Six soil borings were selected to complete as groundwater monitoring wells. In addition to collecting samples to meet RI objectives, aquifer testing was conducted at each well to characterize subsurface lithologic conditions.
- The results of the Phase II RI defined the lateral and vertical extent of contamination, including explosives, propellants, inorganic chemicals, and SVOCs.
- Collection of additional data was recommended to support human health risk management decisions and future remedial actions, particularly with respect to elevated inorganic chemical concentrations above background levels.
- No additional action was recommended for ecological risk management.

4.2.3 2003 Facility-wide Biological and Water Quality Study

The FWBWQS collected samples at locations throughout the former RVAAP to evaluate sediment and surface water from ponds and streams with potential repositories of contamination (USACE 2005a).

This evaluation included the following specific objectives.

- Establish biological conditions in select streams on the former RVAAP by evaluating fish and macroinvertebrate communities, and assessing physical habitat conditions.
- Measure and evaluate surface water and sediment chemical quality in select streams within the former RVAAP. General COCs included munitions and explosives of concern, semi-volatile organic compounds (SVOCs), and inorganic constituents.
- Determine the aquatic life use attainment status of streams with regard to warmwater habitat or other applicable aquatic life use designations codified in the Ohio Water Quality Standards (WQS).
- Determine if chemical contamination within the streams is adversely affecting biological communities.
- Complete an ecological assessment report summarizing the sediment, surface water, and aquatic biological results.

The data most relevant to the Upper and Lower Cobbs Ponds AOC were collected from two stations within the Upper and Lower Cobbs Ponds (i.e., stations Lowcobb Pond and Uppercobb Pond), and a sampling station (S-8) along a tributary to Sand Creek, which is fed by drainage from Upper and Lower Cobbs Ponds, which in turn have drainages from Load Lines 3 and 12 (Figure 4-1). Station S-8 is adjacent to the former Sand Creek Sewage Treatment Plant. All surface water that exits the Upper and Lower Cobbs Ponds AOC enters the tributary to Sand Creek and passes through the sampling station S-8. One multi-increment sediment sample in each pond, one sample at downstream location S-8, and two surface water samples from each location were collected for the FWBWQS (USACE 2005a) in June and August/September 2003. Sediment and surface water samples were analyzed for TAL metals, explosives, pesticides, PCBs, SVOCs, ammonia, and phosphorus. Sediment collected from Lower Cobbs Pond reflected slightly contaminated conditions. Three metals (cadmium, copper, zinc) were reported at levels above the threshold effect concentration (TEC) [and above the sediment reference values (SRVs)]. In addition, chromium (121 mg/kg) was measured above the probable effect concentration (PEC), a level above which harmful effects potentially could occur to aquatic biota.

4.2.4 PBA08 Remedial Investigation – February to April 2010

In November 2008, Science Applications International Corporation (SAIC) scientists performed a site walk of the Upper and Lower Cobbs Ponds AOC. The site walk was conducted to develop the *Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (USACE 2009) (herein referred to as the PBA08 SAP), which supplemented the Phase I and II RIs and completed the RI phase of the CERCLA process. No significant physical changes occurred at the Upper and Lower Cobbs Ponds AOC between the 1996 Phase I RI sampling and the development of the PBA08 SAP. The PBA08 SAP considered prior investigations and changes in AOC conditions during development of the DQOs and sampling scheme for completing the Upper and Lower Cobbs Ponds AOC RI. Section 4.4.4 discusses the suitability and use of samples collected to support the RI, with respect to changes in AOC conditions. The PBA08 SAP was reviewed and approved by representatives of the Army and Ohio EPA in January 2010.

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). Decision flowcharts for PBA08 RI surface and subsurface sampling are presented in Figures 4-2 and 4-3, respectively. The screening approach presented in the PBA08 SAP compared sample results from previous investigations at the Upper and Lower Cobbs Ponds AOC to chemical-specific facility-wide cleanup goals (FWCUGs) at the 1E-06 cancer risk level and non-carcinogenic risk HQ of 0.1, as presented in the FWHHRAM (USACE 2005b). The most protective FWCUGs for the three potential receptors are referred to as "screening criteria." Previous results were also compared to FWCUGs at the higher TR of 1E-05, HQ of 1 to facilitate identifying potential source areas that may require additional sampling to refine the extent of contamination. Table 4-11 lists the chemicals with detected concentrations that exceeded screening criteria at the time of the PBA08 SAP in historical soil samples.

In February–April 2010, the PBA08 RI was implemented by collecting surface and subsurface soil and surface water using discrete sampling techniques, and sediment using the multi-aliquot composite and discrete sampling techniques. The results of the PBA08 RI sampling, combined with the results of the Phase I and II RIs were used to evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct HHRAs and ERAs, and evaluate the need for remedial alternatives.

No groundwater samples were collected during the PBA08 RI, as the current conditions of groundwater will be evaluated as an individual AOC for the entire facility (designated as RVAAP-66) and addressed in a separate RI/FS Report.

A sample log for each sample and lithologic soil description for each soil boring collected during the PBA08 RI is included in Appendix A. The DQOs, field activities, sampling methodologies, QA/QC, and management of analytical data for the PBA08 RI are further expanded upon in Appendix I.

4.2.4.1 Surface Soil Sampling Rationale

Soil samples were collected during the PBA08 RI to assess contaminant occurrence and distribution in surface soil. The PBA08 RI samples were designed to delineate the extent of areas previously identified as having the greatest likelihood of contamination (e.g., along the shoreline/pond banks and drainage ditches). Table 4-12 presents the specific rationale for each surface soil sample collected during the PBA08 RI. Table 4-13 presents the results of the analytes detected from surface soil samples collected during the PBA08 RI. All PBA08 RI sample locations are presented on Figure 4-4.

Eight surface soil samples were collected at the Upper and Lower Cobbs Ponds AOC during the PBA08 RI to further delineate surface soil above screening criteria, as presented in Table 4-12, and to completely characterize the AOC (Figure 4-4). Of the eight surface soil samples collected, five surface soil samples were collected to delineate contamination along the shoreline and in drainage ditches where historical screening criteria exceedances were observed. Three discrete 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. All surface soil samples collected during the PBA08 RI were collected from 0–1 ft bgs in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the FWSAP (USACE 2001a). 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. Discrete surface soil samples were analyzed for TAL metals, explosives, and SVOCs. One sample (10% of the total number of samples collected) was analyzed for RVAAP full-suite analytes. One QC field duplicate and one QA split sample were collected to satisfy the QA/QC requirement of 10% of the total samples collected.

4.2.4.2 Subsurface Soil Sampling Rationale and Methods

The PBA08 RI used discrete samples from soil borings to characterize subsurface soil. 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:

1. Borings at locations where previous surface soil sampling results exceeded screening criteria and vertical delineation was warranted.
2. Borings at locations where previous surface soil sampling results only slightly exceeded screening criteria to confirm that contaminant concentrations did not increase with depth.
3. Borings at locations not previously sampled to fully characterize surface and subsurface soil.

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. Four locations were near five historical locations where chemicals exceeded the screening criteria. One location was near Lower Cobbs Pond in an area not previously investigated to verify the absence of subsurface soil contamination. In all cases, soil samples were collected from the subsurface borings to further define the vertical extent of contamination in subsurface soil at the AOC (Figure 4-4). Table 4-14 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI. Results of detected analytes are presented in Table 4-15.

To assess the depths of exposure of the Resident Receptor, each soil boring was sampled at 0–1, 1–4, 4–7, and 7–13 ft bgs. The deep sample interval was archived on site, while the 4–7 ft bgs sample was analyzed under an expedited five-day turnaround time. As specified in the PBA08 SAP, the deep sample interval would be analyzed for the following reasons:

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

Each interval was composited and homogenized in a stainless steel bowl, with the exception of VOC samples. The sample collected from 7–13 ft bgs (where achievable) was archived on site, while the 4–7 ft bgs sample was analyzed under an expedited five day turnaround time. 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 7–13 ft bgs. All samples were analyzed for TAL metals, explosives, and SVOCs; three samples were analyzed for RVAAP full-suite analytes to satisfy the PBA08 SAP sample requirements of a minimum of 10% frequency for full-suite analysis.

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.

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 Section 5.3.5 and Appendix D.

4.2.4.3 Surface Water and Sediment Rationale and Methods

Surface water and sediment samples were collected to characterize current conditions and assess potential exit pathways from the AOC (Figure 4-4). Five co-located surface water and sediment samples were collected during the PBA08 RI.

The surface water grab samples were collected by the handheld bottle method in accordance with Section 4.3 of the PBA08 SAP and analyzed for RVAAP full-suite analytes. Additionally, water quality parameters for temperature, pH, conductivity, dissolved oxygen, and turbidity were collected using calibrated water quality meters (Hanna Instrument Models 9828 and 98703). Ten composite and discrete sediment samples were collected during the PBA08 RI. Six composite samples were collected as multi-aliquot composite sediment samples in accordance with Section 4.2 of the PBA08 SAP. Each sample 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 RVAAP full-suite analytes (and their associated QA/QC samples). For the sample location designated for VOC analysis, one discrete sample collected from 0.5 ft bgs was collected within the 5-ft sampling radius of the discrete sample location 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 in accordance with Section 4.2 of the PBA08 SAP. Sediment from 0.5-2 ft bgs was homogenized in a stainless steel bowl, transferred to the appropriate, labeled sample container, and analyzed for RVAAP full-suite analytes. No QC field duplicate or QA split sediment samples were collected. Table 4-16 presents the specific rationale for the surface water and sediment samples collected for the PBA08 RI. The locations of these samples are presented in Figure 4-4 and the results are presented in Tables 4-17 and 4-18 for surface water and sediment, respectively.

4.2.4.4 Changes from the Work Plan

Significant changes to the work plan are documented in field change requests (Appendix B). Changes made in the field based on site conditions are not documented on field change requests but on the field sampling logs (Appendix A). These changes are presented on Table 4-19. New coordinates for all station locations can be found on the field sampling logs.

4.3 FACILITY-WIDE BACKGROUND EVALUATION

Facility-wide background values for inorganic constituents in soil, sediment, surface water, and groundwater were developed in 1998, as documented in the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds* (USACE 2001b). These background values are currently being reassessed, but the background valued developed in 1998 are used throughout this report.

These facility-wide background values developed in 1998 were employed in the data reduction and screening process described in Section 4.4.2 and the remainder of the evaluations in this RI (e.g., nature and extent, fate and transport). Background locations were selected using aerial photographs and site visits from areas believed to be unaffected by RVAAP activities. Soil, sediment, surface water, and groundwater samples were collected from those locations to determine the range of background concentrations that could be expected in these media. Results from the site-specific background data collection were used to determine if detected metals and potential anthropogenic compounds [such as polycyclic aromatic hydrocarbons (PAHs)] are site-related, naturally occurring, or from non-RVAAP-related anthropogenic sources.

A total of 14 wells were installed in established background locations to collect filtered and unfiltered samples from the bedrock and unconsolidated zones. These samples were analyzed for TAL metals and cyanide for determining background concentrations.

Soil samples were collected from each of the background monitoring well locations from three intervals: 0–1, 1–3, and greater than 3 ft bgs. Because boring locations were changed during sampling based on the lithological requirements for well screen intervals, all depth intervals for soil were not sampled for each boring. Background surface soil samples were analyzed for TAL metals, cyanide, SVOCs, pesticides, PCBs, and VOCs. Surface water samples were analyzed for TAL metals and cyanide.

Seven stream locations upstream of RVAAP activities along Hinkley, Sand, and Eagle Creeks were sampled for sediment and surface water to characterize background conditions. Background sediment samples were analyzed for TAL metals, cyanide, SVOCs, pesticides, PCBs, and VOCs. Surface water samples were analyzed for TAL metals and cyanide.

Using the sampling results, an evaluation of outliers, data assessment, and statistical analyses were performed to determine background concentrations for each medium. For surface soil samples, PAHs, in addition to metals, were elevated in four samples. PAHs are related to combustion products and could indicate human disturbance at the locations where they were detected. Visits to the sampling locations and a review of aerial photography showing the area prior to the establishment of RVAAP indicated that these sampling locations were near homes or farms and could have been influenced by activities associated with those structures. During the finalization of background concentrations at the former RVAAP, the Army and Ohio EPA agreed that formal background concentrations would only be applicable for inorganics. All organic analytes (e.g., PAHs, VOCs, explosives) were classified as anthropogenic and potentially related to RVAAP operations; therefore, no background values were established for these classes of compounds. The final, approved facility-wide background concentrations for inorganics are presented in Table 4-20.

4.4 DATA EVALUATION METHOD

Data evaluation methods for the Upper and Lower Cobbs Ponds AOC are consistent with those established in the FWCUG Report. These methods were specified in the PBA08 SAP (USACE 2009). The processes used to evaluate the analytical data involved three general steps: (1) defining data aggregates; (2) conducting data verification, reduction, and screening; and (3) presenting data.

4.4.1 Definition of Aggregates

The Upper and Lower Cobbs Ponds AOC data were aggregated in three ways for evaluating contaminant nature and extent and completing the HHRA and ERA. The initial basic aggregation of data was by environmental medium: surface soil, subsurface soil, sediment, and surface water. For each medium-specific aggregate, an evaluation was conducted to determine if further aggregation was warranted with respect to AOC characteristics, ecological habitat, and potential future remedial strategy and Land Use (e.g., spatial aggregates). Data for soil were further aggregated based on depth and sample type for consistency with guidance established in the FWHHRAM and FWCUG Report.

Data aggregates for evaluating the nature and extent of contamination at the Upper and Lower Cobbs Ponds AOC are as follows:

- **Surface Soil (0–1 ft bgs)**. Using the above data aggregation criteria, surface soil within the geographic area of Upper Cobbs Pond, Lower Cobbs Pond, and the Backwater Area were evaluated as an AOC-wide spatial aggregate, designated as the Pond Bank aggregate. The Pond Bank is defined as the perimeter of the natural shorelines throughout the entirety of the AOC. It extends from the Backwater Area to the south at the confluence of the channels exiting Load Lines 3 and 12 and north to the intersection of Remalia Road and Paris-

Windham Road. The areas encompassed within the Pond Bank are dry the majority of the time, although they may be intermittently wet in association with heavy rainfall events when they may receive runoff from the surrounding areas or when water levels within the AOC are elevated.

- **Subsurface Soil (greater than 1 ft bgs)**. This medium was classified as an AOC-wide spatial aggregate on the same basis as surface soil (i.e., Pond Bank).
- **Sediment.** Sediment samples were divided into three spatial aggregates for this report: Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. All three of these aggregates are perennially inundated water bodies. The Backwater Area is in the southern portion of the complex, extending from the confluence of the drainage channels exiting Load Lines 3 and 12 and reaching north to Track 33. Upper Cobbs Pond is the portion of the water body north of Track 33 to Cobbs Pond Road. Lower Cobbs Pond is the portion north of the Cobbs Pond Road, bounded by Remalia Road on the north and Paris-Windham Road to the west.
- **Surface Water.** This medium is subdivided into the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond spatial aggregates on the same basis as sediment. Similar to sediment, surface water was divided into three spatial aggregates for this report: Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. The direction of flow within the AOC is from the south (Backwater Area) towards the dam overflow spillway at the north (Lower Cobbs Pond).

4.4.2 Data Verification, Reduction, and Screening

4.4.2.1 Data Verification

Data verification was performed on 38 surface soil, subsurface soil, sediment, and surface water samples (including QC duplicates) collected during the PBA08 RI in February–April 2010. Historical data were verified and completed as presented in the historical reports. Analytical results were reported by the laboratory in electronic format and loaded into the Ravenna Environmental Information Management System (REIMS) database. Data verification was performed to ensure all requested data were received and complete. Data qualifiers were assigned to each result based on the laboratory QA review and verification criteria.

Results were qualified as follows:

- "U" not detected;
- "UJ" not detected, reporting limit estimated;
- "J" indicates the analyte was positively identified, but the associated numerical value is an approximate concentration of the analyte in the sample; and
- "R" result not usable.

In addition to assigning qualifiers, the verification process also selected the appropriate result to use when re-analyses or dilutions were performed. Where laboratory surrogate recovery data or laboratory QC samples were outside of analytical method specifications, the verification chemist determined whether laboratory re-analysis should be used in place of an original reported result. If the laboratory reported results for both diluted and undiluted samples, diluted sample results were used for those analytes that exceeded the calibration range of the undiluted sample. A complete discussion of verification process results is contained in the data QC summary report (Appendix C). The data QC summary report also includes a summary table of the assigned data qualifiers and an accompanying rationale. Independent, third-party validation of 10% of the RI data, and 100% of the USACE QA laboratory data, was performed by a subcontractor to the USACE Louisville District.

4.4.2.2 Data Reduction

Calculating data summary statistics was the initial step in the data reduction process to identify SRCs. Eligible historic and current AOC data were extracted from the database. Results from QC splits and field duplicates, as well as rejected results, were excluded from the data screening process. All analytes having at least one detected value were included in the data reduction process. As stated in Section 5.4.7 of the FWSAP, "The duplicate is submitted as 'blind' to the laboratory and is used to determine whether the field sampling technique is reproducible and to check the accuracy of reported laboratory results." Therefore, duplicates are not used in the data screening process. All analytes having at least one detected value were included in the data reduction process.

Summary statistics calculated for each data aggregate included the minimum, maximum, and average (mean) values and the proportion of detected results to the total number of samples collected. For calculating mean values, non-detected results were addressed by using one-half of the reported detection limit as a surrogate value when calculating the mean result for each compound (USEPA 1989). Non-detected results with elevated detection limits (i.e., more than five times the contract-required detection limit) were excluded from the summary statistics in order to avoid skewing the mean value calculations.

4.4.2.3 Data Screening

After reduction, the data were screened to identify SRCs using the processes outlined below. Additional screening of identified SRCs against applicable criteria (e.g., USEPA RSLs, FWCUGs, and ESVs) was conducted (1) in the fate and transport evaluation (Section 6.0) to identify CMCOPCs, (2) in the HHRA to identify human health COPCs and COCs (Section 7.2), and (3) in the ERA to evaluate COPECs (Section 7.3). Figure 4-5 illustrates the screening process to identify SRCs and COPCs at the Upper and Lower Cobbs Ponds AOC in accordance with the FWCUG Report. All chemicals that were not eliminated during the screening steps were retained as SRCs. The steps involved in the SRC screening are summarized below:

- **Data quality assessment**. Review the usability of the RI data set with respect to established DQOs as discussed in Section I.4.5 of Appendix I.
- **Background screening.** Compare the maximum detected concentrations (MDCs) of inorganic chemicals to background concentrations. If background concentrations are exceeded, the respective inorganic chemicals are retained as SRCs. No background concentrations were established for organic chemicals at the Upper and Lower Cobbs Ponds AOC. As such, all detected organic chemicals were retained as SRCs.

- **Screening of essential human nutrients**. Evaluate chemicals that are considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) that are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated unless they are grossly elevated relative to background concentrations or would exhibit toxicity at the observed concentrations at an AOC (USEPA 1989). Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for all of these chemicals (Table 4-21). Screening values are calculated for receptors ingesting 100 mg of soil per day or 1 L of groundwater per day to meet their RDA/RDI. In the case of calcium, magnesium, phosphorous, potassium, and sodium, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI value, even if the soil consisted of the pure mineral (i.e., soil concentrations at 1,000,000 mg/kg). Essential nutrients detected at or below their RDA/RDI-based SLs are eliminated as SRCs.
- **Frequency of detection/WOE screening:** The FWCUG Report and the *Final (Revised) USACE RVAAP Position Paper for the Application and Use of Facility-wide Human Health Cleanup Goals* (USACE 2012a) (hereafter referred to as the FWCUG Position Paper) establish the protocol for frequency of detection and WOE screening. These guidance documents denote that analytes (with exception of explosives and propellants) detected in less than 5% of the discrete samples are screened out from further consideration, if the sample population is 20 or more samples and evidence exists that the analyte is not AOC-related. Chemicals that were never detected in a given medium are eliminated as SRCs. For chemicals with at least 20 samples and a frequency of detection of less than 5%, a WOE approach is used to determine if the chemical is AOC-related. The WOE evaluates magnitude and location (clustering) of detected results and if the distribution of detected results indicates a potential source of the chemical. If the detected results for a chemical show (1) no clustering, (2) concentrations were not substantially elevated relative to detection limit, and (3) the chemical did not have an evident source, the results are considered spurious, and the chemical is eliminated from further consideration. This screen is applied to all organic chemicals and inorganic chemicals (with the exception of explosives and propellants); all detected explosives and propellants are considered SRCs regardless of frequency of detection. Frequency of detection/WOE screening only applied to the Pond Bank surface soil data set, as it was comprised of 20 or more samples.

4.4.3 Data Presentation

Data summary statistics and screening results for SRCs in surface soil, subsurface soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC are presented below for each media and spatial aggregate. Analytical results for SRCs are presented in Table 4-22 for surface soil, Table 4-23 for subsurface soil, Tables 4-24 through 4-31 for sediment, and Tables 4-32 through 4-34 for surface water.

The complete laboratory analytical data packages are included in Appendix D. In order to maximize efficiency for laboratory reporting and data management activities, all of the samples received at the laboratory on a given day were reported in a single data package. Therefore, results may be present in the data packages in Appendix D that are associated with different AOCs. All samples for the Upper and Lower Cobbs Ponds AOC have sample identifications beginning with "CPC." Each table in Appendix D presents the results for each sampling location for a specific medium aggregate (i.e., surface soil, subsurface soil, sediment, and surface water), spatial aggregate (i.e., Pond Bank, Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond), and class of analyte (e.g., explosives, inorganic chemicals, SVOCs, and VOCs).

The tables in Appendix D present the analytical results for samples collected during the 1996 Phase I RI, 2001 Phase II RI, 2003 FWBWQS, and PBA08 RI. Sample locations from these investigations are presented on Figure 4-6. Analytical results are grouped by media (e.g., surface soil, subsurface soil) and class of analyte (e.g., explosives, inorganic chemicals) for ease of reference.

4.4.4 Data Evaluation

All quality-assured sample data were further evaluated to determine suitability for use in the various key RI data screens and evaluations (i.e., nature and extent, fate and transport, risk assessment). Evaluating data suitability for use in the PBA08 RI involved considering representativeness with respect to current AOC conditions. Table 4-35 presents the designated use for all available Upper and Lower Cobbs Ponds samples.

4.4.4.1 Soil

Surface and subsurface soil samples at the Upper and Lower Cobbs Ponds AOC were collected using discrete sample methods during the 2001 Phase II RI and the PBA08 RI. Samples from 2001 (Phase II RI) were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the PBA08 RI activities. No AOC disturbance activities occurred at the Upper and Lower Cobbs Ponds AOC between the Phase I RI sampling in 1996 and the PBA08 RI sampling in 2010. However, since more recent sample data were available from the PBA08 RI, the Phase II samples were utilized for nature and extent purposes only. The full Phase II RI and PBA08 RI data sets were incorporated into the SRC screening process, and more recent sample data were carried forward into the risk assessment.

4.4.4.2 Sediment and Surface Water

The only medium sampled in the 1996 Phase I RI was sediment. Sediment throughout the AOC was resampled in the 2001 Phase II RI and also under the 2010 PBA08 RI activities. The Phase II RI, in addition to sediment, also incorporated surface water sample collection. PBA08 RI activities consisted of sediment and surface water sampling. Under the PBA08 RI sampling activities, sediment samples were collected from 0-0.5 ft bgs and 0.5-2 ft bgs at a subset of locations in order to characterize vertical extent. The PBA08 RI samples collected from 0.5-2 ft bgs were screened as subsurface sediment. The surface sediment screening data set includes both the PBA08 RI samples from 0-0.5 ft bgs and historical sediment samples.

Samples from the 1996 Phase I RI and 2001 Phase II RI data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI activities. No disturbance activities have occurred at the AOC between Phase I RI and PBA08 RI activities. For sediment and surface water data, if a PBA08 RI sample was obtained from a historical (1996 Phase I RI or 2001 Phase II RI) sample location, the PBA08 RI result was considered to represent current conditions and was screened for SRCs. All historical sediment and surface water samples superseded in the SRC screen by PBA08 RI data were used only for evaluating contaminant nature and extent (e.g., temporal trends) and contaminant transport.

Off AOC sediment and surface water samples collected at location S-8 (FSW-012 and FSW-052) during the 2003 FWBWQS were used for nature and extent comparison only. Samples collected at locations Uppercobb Pond (FSW-030) and Lowcobb Pond (FSW-031) were used in the risk assessments included in this Phase III RI.

Table 4–1. Phase I RI Sampling Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation
CPCsd-001(P)	0–1	Metals, Explosives	Upper Cobbs Pond – southern portion near culvert draining Backwater Area
CPCsd-002(P)	0–1	Metals, Explosives	Upper Cobbs Pond – southwestern portion
CPCsd-003(P)	0–1	Metals, Explosives	Upper Cobbs Pond – south-central
CPCsd-004(P)	0–1	Metals, Explosives	Upper Cobbs Pond – north-central
CPCsd-005(P)	0–1	Metals, Explosives	Upper Cobbs Pond – northern portion near culvert draining to Lower Cobbs Pond
CPCsd-006(P)	0–1	Metals, Explosives	Lower Cobbs Pond – southwestern portion near culvert draining Upper Cobbs Pond
CPCsd-007(P)	0–1	Metals, Explosives	Lower Cobbs Pond – north-central portion
	0–1	Metals, Explosives (QA/QC sample collected)	
CPCsd-008(P)	0–1	Metals, Explosives	Lower Cobbs Pond – northwestern portion
CPCsd-009(P)	0–0.5	Metals, Explosives	Lower Cobbs Pond – northwestern portion adjacent to access road
CPCsd-010(P)	0–0.5	Metals, Explosives	Drainage Ditch West of Lower Cobbs Pond (near ULCPmw-006)

bgs = Below ground surface.
Comp B = Composition B (a combination of TNT and RDX).
DNT = Dinitrotoluene.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
QA = Quality assurance.
QC = Quality control.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RI = Remedial investigation.
TNT = 2,4,6-Trinitrotoluene.

Table 4–2. Analytes Detected in Phase I RI Sediment Samples

Area		**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**CPCsd-006(p)**	**CPCsd-007(p)**	**CPCsd-007(p)**	**CPCsd-008(p)**	**CPCsd-009(p)**	**CPCsd-010(p)**	**CPCsd-001(p)**	**CPCsd-002(p)**	**CPCsd-003(p)**	**CPCsd-004(p)**	**CPCsd-005(p)**
Sample ID		**CPCsd-006(P)-0655-SD**	**CPCsd-007(P)-0657-FD**	**CPCsd-007(P)-0656-SD**	**CPCsd-008(P)-0659-SD**	**CPCsd-009(P)-0660-SD**	**CPCsd-010(P)-0661-SD**	**CPCsd-001(P)-0650-SD**	**CPCsd-002(P)-0651-SD**	**CPCsd-003(P)-0652-SD**	**CPCsd-004(P)-0653-SD**	**CPCsd-005(P)-0654-SD**
Date		**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**
Metals (mg/kg)												
Aluminum	13900	12500	9930	8500	9610	4470	4310	5830	12000	9040	10300	9520
Antimony	0	NR	**1.3J***	**1.9***	NR	NR	NR	NR	NR	NR	NR	NR
Arsenic	19.5	16.4	10.5	14.4	8.5	8.2	9.4	4.9	**23.4***	5.9	5	7.7
Barium	123	100	82	79.1	77.3	40.8	41.4	43.4	66.1	52.3	46.7	71.1
Beryllium	0.38	NR	**0.74***	**0.73***	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium	0	**1J***	**1.2J***	**1.4***	**1.4***	<0.2U	<0.13U	**0.54J***	**0.75J***	**0.54J***	<0.29U	**0.54J***
Calcium	5510	NR	2110	2320	NR	NR	NR	NR	NR	NR	NR	NR
Chromium	18.1	**86.2***	**147***	**329***	**63.2***	8.3	16.2	7.9	**40.9***	**54.3***	**30.8***	**38.9***
Cobalt	9.1	NR	**10.9***	**11.1***	NR	NR	NR	NR	NR	NR	NR	NR
Copper	27.6	NR	**143***	**316***	NR	NR	NR	NR	NR	NR	NR	NR
Iron	28200	NR	19400	19600	NR	NR	NR	NR	NR	NR	NR	NR
Lead	27.4	**37.8***	**31.3***	**34.2***	**33.3***	10.1	8.8	12.6	**31.6***	17.9	14.8	19.1
Magnesium	2760	NR	1960	1640	NR	NR	NR	NR	NR	NR	NR	NR
Manganese	1950	407	354	345	517	425	816	312J	483J	239J	171J	375J
Mercury	0.059	**0.15***	**0.09***	**0.11***	<0.09U	<0.05U	<0.05U	<0.06U	**0.12***	**0.08***	**0.23***	**0.11***
Nickel	17.7	NR	**22.4***	**20.9***	NR	NR	NR	NR	NR	NR	NR	NR
Potassium	1950	NR	842J	683J	NR	NR	NR	NR	NR	NR	NR	NR
Selenium	1.7	**2.1***	**2.2***	**2.2***	**2.4***	1.2	1.3	1.1	**2.9***	**1.8***	1.4	1.7
Silver	0	<0.42U	**1.1J***	**1.7J***	**1.4J***	<0.27U	<0.27U	<0.31U	**1.3J***	**1.4J***	**0.38J***	**0.98J***
Sodium	112	NR	**482J***	**458J***	NR	NR	NR	NR	NR	NR	NR	NR
Thallium	0.89	NR	**2.4***	**2.3***	NR	NR	NR	NR	NR	NR	NR	NR
Vanadium	26.1	NR	16.3	15.1	NR	NR	NR	NR	NR	NR	NR	NR
Zinc	532	222	202	254	182	46.2	49.5	68.3	167	133	90.8	127
Explosives (mg/kg)												
Nitrobenzene	None	<0.26U	**0.38***	<0.26U	<0.26U	<0.26U	<0.26U	<0.26U	<0.26U	<0.26U	<0.26U	**0.38J***
SVOCs (mg/kg)												
Benz(a)anthracene	None	NR	**0.22J***	**0.21J***	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(a)pyrene	None	NR	**0.26J***	**0.26J***	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(b)fluoranthene	None	NR	**0.37J***	**0.56J***	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(ghi)perylene	None	NR	**0.23J***	**0.2J***	NR	NR	NR	NR	NR	NR	NR	NR
Benzo(k)fluoranthene	None	NR	**0.32J***	<1.9U	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	NR	**0.29J***	**0.27J***	NR	NR	NR	NR	NR	NR	NR	NR
Fluoranthene	None	NR	**0.43J***	**0.38J***	NR	NR	NR	NR	NR	NR	NR	NR
Indeno(1,2,3-cd)pyrene	None	NR	**0.22J***	**0.19J***	NR	NR	NR	NR	NR	NR	NR	NR
Pyrene	None	NR	**0.29J***	**0.27J***	NR	NR	NR	NR	NR	NR	NR	NR

Table 4–2. Analytes Detected in Phase I RI Sediment Samples (continued)

Area	Background Criteria	Lower Cobbs Pond	Lower Cobbs Pond	Lower Cobbs Pond	Lower Cobbs Pond	Lower Cobbs Pond	Lower Cobbs Pond	Upper Cobbs Pond	Upper Cobbs Pond	Upper Cobbs Pond	Upper Cobbs Pond	Upper Cobbs Pond
Station		**CPCsd-006(p)**	**CPCsd-007(p)**	**CPCsd-007(p)**	**CPCsd-008(p)**	**CPCsd-009(p)**	**CPCsd-010(p)**	**CPCsd-001(p)**	**CPCsd-002(p)**	**CPCsd-003(p)**	**CPCsd-004(p)**	**CPCsd-005(p)**
Sample ID		**CPCsd-006(P)-0655-SD**	**CPCsd-007(P)-0657-FD**	**CPCsd-007(P)-0656-SD**	**CPCsd-008(P)-0659-SD**	**CPCsd-009(P)-0660-SD**	**CPCsd-010(P)-0661-SD**	**CPCsd-001(P)-0650-SD**	**CPCsd-002(P)-0651-SD**	**CPCsd-003(P)-0652-SD**	**CPCsd-004(P)-0653-SD**	**CPCsd-005(P)-0654-SD**
Date		**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**	**08/19/96**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**	**TAL Metals, Explosives**
Analyte												
						VOCs (mg/kg)						
Acetone	None	NR	**0.28J***	**0.33J***	NR	NR	NR	NR	NR	NR	NR	NR
Methylene chloride	None	NR	**0.035***	<0.029U	NR	NR	NR	NR	NR	NR	NR	NR

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
TAL = Target analyte list.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–3. Phase II RI Sampling Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation
ULCPss-001	0–1	Metals, Explosives, Anions	Pond Bank – Backwater Area
ULCPss-002	0–1	Metals, Explosives, Anions	Pond Bank –Backwater Area near Track FA
ULCPss-003	0–1	Metals, Explosives, Anions	Pond Bank – Northeastern bank of Backwater Area
ULCPss-004	0–1	Metals, Explosives, Anions	Pond Bank – Northwestern bank of Backwater Area
ULCPss-005	0–1	Metals, Explosives, Anions	Pond Bank – Southeastern bank of Upper Cobbs Pond
ULCPss-006	0–1	Metals, Explosives, Anions	Pond Bank – Southwestern bank of Upper Cobbs Pond
ULCPss-007	0–1	Full suite	Pond Bank – Northwestern bank of Upper Cobbs Pond
	0–1	Full suite (QA/QC sample collected)	
ULCPss-008	0–1	Metals, Explosives, Anions	Pond Bank – Northeastern bank of Upper Cobbs Pond
ULCPss-009	0–1	Metals, Explosives, Anions	Pond Bank – Southwestern bank of Lower Cobbs Pond
ULCPss-010	0–1	Metals, Explosives, Anions	Pond Bank – Northern bank of Lower Cobbs Pond
ULCPsd-010	0–0.5	Metals, Explosives, Anions	Pond Bank –Backwater Area along Track FA
ULCPsd-004	0–1	Metals, Explosives, Anions	Backwater Area at Confluence of Southern Tributaries from Load Lines 3 and 12
	0–1	Metals, Explosives, Anions (QA/QC sample collected)	
ULCPsd-005	0–1	Metals, Explosives, Anions	Backwater Area Downgradient of Southern Tributaries from Load Lines 3 and 12
ULCPsd-006	0–1	Full suite	Backwater Area Downgradient of Southern Tributaries from Load Lines 3 and 12
ULCPsd-007	0–0.8	Metals, Explosives, Anions	Backwater Area – South-central portion, South of Track FA
ULCPsd-008	0–0.5	Metals, Explosives, Anions	Backwater Area – Northeastern Portion, South of Track FA
ULCPsd-009	0–0.9	Metals, Explosives, Anions	Backwater Area – Northwestern Portion, Just South of Track FA Culvert
ULCPsd-011	0–0.8	Full suite	Backwater Area Adjacent to Track FA culvert
ULCPsd-012	0–1.8	Metals, Explosives, Anions	Backwater Area Northwest of Track FA Culvert
ULCPsd-013	0–1.8	Metals, Explosives, Anions	Backwater Area – Northern Portion South of Load Line 3 Road
	0–1.8	Metals, Explosives, Anions (QA/QC sample collected)	
ULCPsd-014	0–0.5	Metals, Explosives, Anions	Backwater Area – Northwestern Portion, South of Load Line 3 Road
ULCPsd-015	0–0.5	Metals, Explosives, Anions	Backwater Area between Load Line 3 Road and Track 33 culverts
ULCPsd-015	0–1	VOCs, SVOCs	
ULCPsd-016	0–1.5	Metals, Explosives, Anions	Backwater Area between Load Line 3 Road and Track 33, East of Culverts
ULCPsd-017	0–1	Metals, Explosives, Anions	Upper Cobbs Pond – Eastern Portion

Table 4–3. Phase II RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation
ULCPsd-018	0–0.5	Metals, Explosives, Anions	Upper Cobbs Pond – Southwestern Portion
ULCPsd-019	0–0.5	Metals, Explosives, Anions	Upper Cobbs Pond – Northwestern Portion
ULCPsd-020	0–0.8	Full suite	Upper Cobbs Pond – Northern Portion near Track 25 Culvert
ULCPsd-020	0–0.8	Full suite (QA/QC sample collected)	
ULCPsd-021	0–1	Metals, Explosives, Anions	Lower Cobbs Pond – Southern Portion
ULCPsd-021	0–1	VOCs, SVOCs	
ULCPsd-022	0–0.8	Metals, Explosives, Anions	Lower Cobbs Pond – East-central Portion
ULCPsd-023	0–0.8	Metals, Explosives, Anions	Lower Cobbs Pond – West-central Portion
ULCPsd-024	0–0.5	Metals, Explosives, Anions	Lower Cobbs Pond – outlet channel
ULCPsd-025	0–0.5	Metals, Explosives, Anions	Downstream of Lower Cobbs Pond, near Dam Overflow Spillway
ULCPsd-026	0–1	Metals, Explosives, Anions	Lower Cobbs Pond – Northern Portion
ULCPsd-027	0–0.5	Metals, Explosives, Anions	Headwaters of the Load Line 3 Tributary
ULCPsw-001	NA	Metals, Explosives, Anions	Backwater Area Downgradient of Southern Tributaries from Load Lines 3 and 12
ULCPsw-002	NA	Metals, Explosives, Anions	Backwater Area Northwest of Track FA Culvert
ULCPsw-002	NA	Metals, Explosives, Anions (QA/QC sample collected)	
ULCPsw-003	NA	Metals, Explosives, Anions	Upper Cobbs Pond – Eastern Portion
ULCPsw-004	NA	Metals, Explosives, Anions	Upper Cobbs Pond – Northwestern Portion
ULCPsw-005	NA	Metals, Explosives, Anions	Lower Cobbs Pond – Southern Portion
ULCPsw-006	NA	Metals, Explosives, Anions	Lower Cobbs Pond – Outlet Channel
ULCPsw-007	NA	Metals, Explosives, Anions	Downstream of Lower Cobbs Pond, near Dam Overflow Spillway

Full suite = Target analyte list metals, explosives, propellants, VOCs, SVOCs, polychlorinated biphenyls, pesticides and cyanide.
bgs = Below ground surface.
Comp B = Composition B (a combination of TNT and RDX).
DNT = Dinitrotoluene.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = Not applicable.
QA = Quality assurance.
QC= Quality control.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RI = Remedial investigation.
SVOC = Semi-volatile organic compound.
TNT = 2,4,6-Trinitrotoluene.
VOC = Volatile organic compound.

Table 4–4. Analytes Detected in Phase II RI Surface Soil Samples

Area	**Background Criteria**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**
Station		**ULCPsd-010**	**ULCPss-001**	**ULCPss-002**	**ULCPss-003**	**ULCPss-004**	**ULCPss-005**	**ULCPss-006**	**ULCPss-007**	**ULCPss-007**	**ULCPss-008**	**ULCPss-009**	**ULCPss-010**
Sample ID		**ULCPsd-010-0001-SD**	**ULCPss-001-0001-SO**	**ULCPss-002-0001-SO**	**ULCPss-003-0001-SO**	**ULCPss-004-0001-SO**	**ULCPss-005-0001-SO**	**ULCPss-006-0001-SO**	**ULCPss-007-0001-FD**	**ULCPss-007-0001-SO**	**ULCPss-008-0001-SO**	**ULCPss-009-0001-SO**	**ULCPss-010-0001-SO**
Date		**08/21/01**	**07/17/01**	**07/17/01**	**07/18/01**	**07/17/01**	**07/18/01**	**07/19/01**	**07/18/01**	**07/18/01**	**07/18/01**	**07/19/01**	**07/19/01**
Depth (ft)		**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**
Analyte (mg/kg)													
Metals (mg/kg)													
Aluminum	17700	6450	11000	11100	10200	**18000***	**19200***	10700	12300	12900	13300	11200	16200
Antimony	0.96	0.25J	<0.19U	<0.22U	0.34	0.46	0.3	0.28	<0.21U	<0.19U	<0.23U	<0.18U	0.39
Arsenic	15.4	**28.4***	8.5	**16.9***	5.3	4.2	**16.3***	5.2	**16.7***	13.7	13.5	9.3	11.2
Barium	88.4	65	**90.4***	60.9	75.9	64.8	61.7	61.6	52.1	49.3	74.4	35.2	57.9
Beryllium	0.88	0.6	0.56	0.58	0.48	0.4	0.86	0.39	0.43	0.43	0.7	0.39	0.61
Cadmium	0	**0.49***	<0.1U	**0.15***	**0.16***	**0.11***	<0.11U	**0.11***	<0.11U	<0.1U	**0.13***	<0.093U	<0.12U
Calcium	15800	1530	1190	4040	538	512	1050	876	1290	1320	1870	195	572
Chromium	17.4	9.6	13.6	17.3	11.3	14.2	**24.8***	11.6	15.7	16	**22.3***	12.4	**23.7 ***
Chromium, hexavalent		**1***	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt	10.4	9.2	**10.7***	**10.6***	6.2	6.7	**11.6***	6.1	6.2	6.1	**12***	5.6	8.4
Copper	17.7	12.2	9.5	**18.7***	4.2	6.4	**23.9***	8.3	13.6	13.8	**22.9***	11.3	**21 ***
Cyanide	0	**1.2***	<0.28U	**0.45***	<0.24U	**0.31***	<0.16U	**0.42***	<0.27U	<0.22U	<0.27U	<0.23U	<0.26U
Iron	23100	21800	15300	**24000***	13800	16900	**44000***	13400	22200	**24400***	**30800***	18400	**34100 ***
Lead	26.1	**30.8***	22.6	18.1	19.1	25	19.6	18.6	12.3	20.4	22.5	14.5	20.1
Magnesium	3030	1340	1880	**3630***	1600	2540	**4310***	1550	2300	2380	**4080***	1770	**4080 ***
Manganese	1450	453	241	397	186	107	231	125	115	129	267	126	208
Mercury	0.036	0.025J	**0.066***	0.029	**0.041***	**0.046***	0.03	0.035	0.032	0.032	0.029	0.033	0.027
Nickel	21.1	14.8	12.9	**24.7***	9.7	10.7	**26.6***	8.6	13.9	13.9	**27.2***	13.9	**23.9 ***
Potassium	927	704	**959***	**1490***	727	**1290***	**2220***	568	**1550***	**1510***	**1750***	696	**1610 ***
Selenium	1.4	<0.18U	0.83	<0.59U	0.85	0.48	1.2	0.86	<0.52U	**1.4***	0.72	0.67	<0.57U
Silver	0	<0.19U	**0.45***	**0.41***	<0.14U	**0.32***	<0.22U	<0.18U	<0.21U	<0.19U	<0.24U	<0.18U	<0.24U
Sodium	123	42.9	**136***	83.4	104	63.5	**143***	95.1	123	116	**159***	55.6	84.5
Thallium	0	<0.22U	**0.25***	<0.22U	<0.21U	<0.22U	<0.2U	<0.44U	<1.1U	<0.19U	<1.1U	<0.36U	<0.52U
Vanadium	31.1	14.4	18.9	20.5	17.8	**35.3***	28.3	21	22.7	23.1	22.4	17.7	27
Zinc	61.8	**121***	**81.1***	**72.1***	**63.1***	50.9	**72.7***	52.3	50.4	47.7	**77***	53	**68.3 ***
Anions (mg/kg)													
Nitrate/Nitrite (NO_3/NO_2-N)	None	<0.96U	**1.4***	<0.97U	<0.9U	<0.92U	<0.89U	<0.96U	<0.9U	<0.89U	<1U	<0.75U	<0.96U
Explosives (mg/kg)													
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	**0.66***	**1.5***	NR	NR	NR

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
TAL = Target analyte list.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–5. Analytes Detected in Phase II RI Sediment Samples

Area		**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**
Station		**ULCPsd-004**	**ULCPsd-004**	**ULCPsd-005**	**ULCPsd-006**	**ULCPsd-007**	**ULCPsd-008**	**ULCPsd-009**	**ULCPsd-011**	**ULCPsd-012**
Sample ID		**ULCPsd-004-0001-FD**	**ULCPsd-004-0001-SD**	**ULCPsd-005-0001-SD**	**ULCPsd-006-0001-SD**	**ULCPsd-007-0001-SD**	**ULCPsd-008-0001-SD**	**ULCPsd-009-0001-SD**	**ULCPsd-011-0001-SD**	**ULCPsd-012-0001-SD**
Date		**08/22/01**	**08/22/01**	**08/22/01**	**08/22/01**	**08/21/01**	**08/21/01**	**08/21/01**	**08/20/01**	**08/20/01**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.8**	**0.0 - 0.5**	**0.0 - 0.9**	**0.0 - 0.8**	**0.0 - 1.8**
Parameters Analyzed **Analyte (mg/kg)**	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**
Metals (mg/kg)										
Aluminum	13900	**14700***	**15900***	13000	12800	13200	9010	**16200***	12200	10000
Antimony	0	**0.47J***	<0.38U	**0.85***	**0.65***	**0.76***	<0.28U	**1.4***	**0.24J***	**0.66***
Arsenic	19.5	15.5	11.6	6.5	10.5	14.9	4.4	13.9	13.8	6.7
Barium	123	122	**132***	**147***	103	113	101	104	69.6	95.4
Beryllium	0.38	**0.97***	**1.1***	**0.96***	**0.81***	**1***	**0.61J***	**1***	**0.63***	**0.63***
Cadmium	0	**2***	**1.4***	**1.9***	**1.2***	**2.2***	**0.57***	**0.97***	**0.11J***	**0.52***
Calcium	5510	3290	2880	2420	3540	3830	1350	2490	1180	1450
Chromium	18.1	**24.1***	**25.1***	**19.3***	**21.1***	**41.4***	12.6	**56.5***	**30.4***	13.9
Chromium, hexavalent	None	<1U	<1U	<1U	<1U	<1U	<1U	<1U	<1U	<1U
Cobalt	9.1	**23.3***	**17.8***	**13.9***	**17.1***	**20.1***	**10.8***	**20.7***	**11.5***	**12***
Copper	27.6	**36.1***	**36.7***	24.6	21.9	**61.1***	11.7	**50.5***	23.7	14
Cyanide	0	<0.46U	<0.49U	<0.49U	<0.38U	**0.12***	**0.1***	**0.55***	<0.36U	<0.45U
Iron	28200	27300	27100	24800	23600	25400	14400	26700	23500	15600
Lead	27.4	**40.8***	**35***	**42.6***	**32.5***	**40***	19.2	**57.9***	21.7	19.7
Magnesium	2760	2290	2400	2090	2240	2030	1530	2570	2560	1700
Manganese	1950	516	462	348	711	964	343	721	296	570
Mercury	0.059	**0.098***	**0.1***	**0.11***	**0.068J***	**0.089J***	0.042J	**0.085J***	0.04J	**0.068***
Nickel	17.7	**26.3***	**24.9***	**24.4***	**21.6***	**29.4***	15.8	**24.8***	**21.8***	16.3
Potassium	1950	1590	1640	1230	1430	1150	846	1290	1370	731
Selenium	1.7	0.47	0.39	0.35J	<0.34U	0.44J	<0.24U	<0.34U	<0.18U	0.26J
Silver	0	**10.9***	**10.9***	**1.4***	**5.6***	**23***	**1.1***	**21.7***	<0.21U	**1.8***
Sodium	112	**156J***	**145J***	98.8J	**228***	**139***	107	**239***	91.4J	87.1J
Thallium	0.89	<0.4U	<0.38U	<0.39U	<0.4U	<0.46U	<0.28U	<0.4U	<0.21U	<0.28U
Vanadium	26.1	22.9	24.8	21.8	19.2	15.9	15.2	25.7	20.4	15.4
Zinc	532	298	234	222	199	418	114	212	79.1	101
Anions (mg/kg)										
Nitrate/Nitrite (NO_3/NO_2-N)	None	<1.5U	<1.4U	<1.5U	<1.5U	<1.8U	<1.1U	<1.8U	<1U	<1.2U
Explosives (mg/kg)										
2,4,6-Trinitrotoluene	None	<0.033U	<0.034U	**0.32***	**0.18***	<0.033U	<0.034U	**0.17***	**0.049J***	<0.034U
2,6-Dinitrotoluene	None	<0.047U	<0.047U	**0.16J***	<0.047U	<0.047U	<0.048U	<0.048U	<0.047U	<0.048U
Nitrocellulose	None	NR	NR	NR	**3***	NR	NR	NR	**2.5***	NR
Anthracene	None	NR	NR	NR	<0.17U	NR	NR	NR	<0.11U	NR
Benz(a)anthracene	None	NR	NR	NR	<0.13U	NR	NR	NR	<0.077U	NR
Benzo(a)pyrene	None	NR	NR	NR	**0.23J***	NR	NR	NR	<0.084U	NR
Benzo(b)fluoranthene	None	NR	NR	NR	<0.26U	NR	NR	NR	<0.16U	NR
Benzo(ghi)perylene	None	NR	NR	NR	<0.36U	NR	NR	NR	<0.22U	NR
Benzo(k)fluoranthene	None	NR	NR	NR	<0.27U	NR	NR	NR	<0.17U	NR
Chrysene	None	NR	NR	NR	**0.24J***	NR	NR	NR	<0.058U	NR
Fluoranthene	None	NR	NR	NR	<0.22U	NR	NR	NR	<0.14U	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	<0.26U	NR	NR	NR	<0.16U	NR
Phenanthrene	None	NR	NR	NR	<0.16U	NR	NR	NR	<0.1U	NR
Pyrene	None	NR	NR	NR	<0.34U	NR	NR	NR	<0.21U	NR

Table 4–5. Analytes Detected in Phase II RI Sediment Samples (continued)

Area		**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**
Station		**ULCPsd-004**	**ULCPsd-004**	**ULCPsd-005**	**ULCPsd-006**	**ULCPsd-007**	**ULCPsd-008**	**ULCPsd-009**	**ULCPsd-011**	**ULCPsd-012**
Sample ID		**ULCPsd-004-0001-FD**	**ULCPsd-004-0001-SD**	**ULCPsd-005-0001-SD**	**ULCPsd-006-0001-SD**	**ULCPsd-007-0001-SD**	**ULCPsd-008-0001-SD**	**ULCPsd-009-0001-SD**	**ULCPsd-011-0001-SD**	**ULCPsd-012-0001-SD**
Date		**08/22/01**	**08/22/01**	**08/22/01**	**08/22/01**	**08/21/01**	**08/21/01**	**08/21/01**	**08/20/01**	**08/20/01**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.8**	**0.0 - 0.5**	**0.0 - 0.9**	**0.0 - 0.8**	**0.0 - 1.8**
Parameters Analyzed **Analyte (mg/kg)**	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**Misc., TAL Metals, Explosives**
Pesticides/PCBs										
PCB-1254	None	NR	NR	NR	**0.047***	NR	NR	NR	**0.046***	NR
VOCs										
2-Butanone	None	NR	NR	NR	<0.01U	NR	NR	NR	<0.006U	NR
Acetone	None	NR	NR	NR	**0.13***	NR	NR	NR	**0.02***	NR
Methylene chloride	None	NR	NR	NR	**0.048***	NR	NR	NR	<0.003U	NR

Table 4–5. Analytes Detected in Phase II RI Sediment Samples (continued)

Area	**Background Criteria**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**
Station		**ULCPsd-013**	**ULCPsd-013**	**ULCPsd-014**	**ULCPsd-015**	**ULCPsd-015**	**ULCPsd-016**	**ULCPsd-021**	**ULCPsd-021**	**ULCPsd-022**
Sample ID		**ULCPsd-013-0001-FD**	**ULCPsd-013-0001-SD**	**ULCPsd-014-0001-SD**	**ULCPsd-015-0001-SD**	**ULCPsd-015-0002-SD**	**ULCPsd-016-0001-SD**	**ULCPsd-021-0001-SD**	**ULCPsd-021-0002-SD**	**ULCPsd-022-0001-SD**
Date		**08/20/01**	**08/20/01**	**07/25/01**	**08/17/01**	**09/27/01**	**08/17/01**	**08/15/01**	**09/27/01**	**08/15/01**
Depth (ft)		**0.0 - 1.8**	**0.0 - 1.8**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.8**
Parameters Analyzed		**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**SVOCs, VOCs**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**SVOCs, VOCs**	**Misc., TAL Metals, Explosives**
Analyte (mg/kg)										
					Metals					
Aluminum	13900	13900	**18600***	11500	10300	NR	8000	11900	NR	**14800***
Antimony	0	<0.3U	<0.4U	**0.25J***	**0.31J***	NR	**0.3J***	<0.37U	NR	<0.31U
Arsenic	19.5	4.8	12.3	3.5	11.3	NR	11.1	**20.2***	NR	5.1
Barium	123	105	**142***	58.3	57.3	NR	53.8	77.3	NR	96.7
Beryllium	0.38	**0.72***	**1***	**0.41J***	**0.94***	NR	0.34J	**0.81***	NR	**0.66***
Cadmium	0	**0.45***	**0.67***	**0.57***	**0.36***	NR	**0.23J***	**1***	NR	**0.43***
Calcium	5510	1940	3000	2130	**15400***	NR	1620	2470	NR	1480
Chromium	18.1	**21***	**27***	15	**19.3***	NR	10.1	**122***	NR	**33.6***
Chromium, hexavalent	None	<1U	<1U	<1U	<1U	NR	<1U	**5.7***	NR	**5***
Cobalt	9.1	**12.2***	**14.2***	5.4	7.3	NR	6.1	**10.6***	NR	**10.7***
Copper	27.6	19.6	26.9	12.7	25.2	NR	10.9	**115***	NR	**31.8***
Cyanide	0	<0.46U	<0.59U	<0.28U	<0.38U	NR	<0.42U	<0.48U	NR	<0.31U
Iron	28200	21000	27100	12700	15000	NR	12800	22200	NR	20000
Lead	27.4	20.1	**32.7***	21	14.2	NR	20.5	**35.4***	NR	18.7
Magnesium	2760	2180	**2870***	1710	**3830***	NR	1170	2220	NR	2590
Manganese	1950	383	480	179	563	NR	197	367	NR	307
Mercury	0.059	0.046J	**0.073J***	0.045J	0.035J	NR	0.031J	**0.093***	NR	0.041J
Nickel	17.7	**19.1***	**24.8***	12.8	12.2	NR	9.4	**22***	NR	**19.6***
Potassium	1950	1250	1460	1080	767	NR	682	1190	NR	1520
Selenium	1.7	0.29J	0.37J	0.95	<0.18U	NR	<0.21U	0.45	NR	<0.27U
Silver	0	**2.3***	**3.1***	**0.54J***	**2***	NR	**0.51J***	**2.4***	NR	<0.27U
Sodium	112	**119J***	**173J***	55.2	**237***	NR	**114J***	**148J***	NR	**190***
Thallium	0.89	<0.3U	<0.4U	<0.21U	<0.21U	NR	<0.25U	<0.37U	NR	<0.31U
Vanadium	26.1	23.7	**30***	23	11.7	NR	15.8	18.9	NR	**26.6***
Zinc	532	121	170	74.8	117	NR	79.2	275	NR	108
					Anions					
Nitrate/Nitrite (NO_3/NO_2-N)	None	<1.2U	<1.5U	<1U	<1.1U	NR	**2.2***	<1.7U	NR	<1.1U
					Explosives					
2,4,6-Trinitrotoluene	None	<0.034U	**0.086J***	<0.033U	<0.034U	NR	<0.034U	<0.034U	NR	<0.034U
2,6-Dinitrotoluene	None	<0.047U	<0.048U	<0.047U	<0.048U	NR	<0.047U	<0.047U	NR	<0.047U
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
Anthracene	None	NR	NR	NR	NR	**0.22J***	NR	NR	<0.18U	NR
Benz(a)anthracene	None	NR	NR	NR	NR	**0.83J***	NR	NR	<0.13U	NR
Benzo(a)pyrene	None	NR	NR	NR	NR	**0.89J***	NR	NR	<0.14U	NR
Benzo(b)fluoranthene	None	NR	NR	NR	NR	**0.86J***	NR	NR	<0.26U	NR
Benzo(ghi)perylene	None	NR	NR	NR	NR	**0.49J***	NR	NR	<0.37U	NR
Benzo(k)fluoranthene	None	NR	NR	NR	NR	**0.8J***	NR	NR	<0.28U	NR
Chrysene	None	NR	NR	NR	NR	**0.93J***	NR	NR	<0.096U	NR
Fluoranthene	None	NR	NR	NR	NR	**1.8***	NR	NR	<0.23U	NR
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	**0.48J***	NR	NR	<0.27U	NR
Phenanthrene	None	NR	NR	NR	NR	**0.91J***	NR	NR	<0.17U	NR
Pyrene	None	NR	NR	NR	NR	**1.9***	NR	NR	<0.34U	NR

Table 4–5. Analytes Detected in Phase II RI Sediment Samples (continued)

Area		**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**
Station		**ULCPsd-013**	**ULCPsd-013**	**ULCPsd-014**	**ULCPsd-015**	**ULCPsd-015**	**ULCPsd-016**	**ULCPsd-021**	**ULCPsd-021**	**ULCPsd-022**
Sample ID		**ULCPsd-013-0001-FD**	**ULCPsd-013-0001-SD**	**ULCPsd-014-0001-SD**	**ULCPsd-015-0001-SD**	**ULCPsd-015-0002-SD**	**ULCPsd-016-0001-SD**	**ULCPsd-021-0001-SD**	**ULCPsd-021-0002-SD**	**ULCPsd-022-0001-SD**
Date		**08/20/01**	**08/20/01**	**07/25/01**	**08/17/01**	**09/27/01**	**08/17/01**	**08/15/01**	**09/27/01**	**08/15/01**
Depth (ft)		**0.0 - 1.8**	**0.0 - 1.8**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.8**
Parameters Analyzed	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**SVOCs, VOCs**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**SVOCs, VOCs**	**Misc., TAL Metals, Explosives**
Analyte (mg/kg)										
Pesticides/PCBs										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	NR	NR
VOCs										
2-Butanone	None	NR	NR	NR	NR	**0.035***	NR	NR	**0.025***	NR
Acetone	None	NR	NR	NR	NR	**0.14***	NR	NR	**0.076***	NR
Methylene chloride	None	NR	NR	NR	NR	<0.005U	NR	NR	<0.004U	NR

Table 4–5. Analytes Detected in Phase II RI Sediment Samples (continued)

Area		**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**ULCPsd-023**	**ULCPsd-024**	**ULCPsd-025**	**ULCPsd-026**	**ULCPsd-017**	**ULCPsd-018**	**ULCPsd-019**	**ULCPsd-020**	**ULCPsd-020**
Sample ID		**ULCPsd-023-0001-SD**	**ULCPsd-024-0001-SD**	**ULCPsd-025-0001-SD**	**ULCPsd-026-0001-SD**	**ULCPsd-017-0001-SD**	**ULCPsd-018-0001-SD**	**ULCPsd-019-0001-SD**	**ULCPsd-020-0001-FD**	**ULCPsd-020-0001-SD**
Date		**08/15/01**	**08/14/01**	**07/25/01**	**08/14/01**	**08/17/01**	**08/16/01**	**08/16/01**	**08/16/01**	**08/16/01**
Depth (ft)		**0.0 - 0.8**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.8**	**0.0 - 0.8**
Parameters Analyzed	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte (mg/kg)										
Metals										
Aluminum	13900	12900	11600	10000	**16400***	**21400***	**15100***	**14000***	13000	13400
Antimony	0	<0.46U	<0.22U	<0.22U	<0.2U	**1.3***	**0.21J***	**0.26***	<0.2U	**0.23J***
Arsenic	19.5	10.9	8.5	17.6	**34.3***	17.5	5.1	8.8	11	11.2
Barium	123	80.2	79.4	70.8	51.3	**147***	58.7	84	102	83.2
Beryllium	0.38	**0.76***	**0.63***	**0.67***	**0.55***	**1.3***	**0.44***	**0.8***	**0.69***	**0.67***
Cadmium	0	**0.98***	<0.1U	**0.18***	<0.1U	**2.2***	<0.094U	<0.11U	**0.22J***	**0.15J***
Calcium	5510	2370	**7360***	2050	699	5440	771	1290	2310	1950
Chromium	18.1	**150***	15.8	11.9	**20***	**87.5***	**19.9***	**27.8***	**50***	**43.6***
Chromium, hexavalent	None	<1U	<1U	<1U	<1U	<1U	**10.6***	<1U	<1U	<1U
Cobalt	9.1	**12.1***	**9.3***	**21.3***	**9.3***	**19.3***	5.9	**12***	**11***	**10.9***
Copper	27.6	**149***	14.2	12.4	14.5	**106***	14.1	**29.6***	**36***	**31.7***
Cyanide	0	<0.67U	**0.4***	<0.21U	<0.23U	<1.2U	<0.23U	<0.26U	<0.27U	<0.28U
Iron	28200	24500	22700	**32200***	24600	**36400***	18300	**30600***	23200	24400
Lead	27.4	**43.8***	**60.4***	12.6	16.3	**40.9***	13.1	14.5	16.9	17.5
Magnesium	2760	2520	2510	**3240***	**2790***	**3550***	2370	**3690***	**2820***	**3040***
Manganese	1950	423	711	966	217	705	138	310	358	326
Mercury	0.059	**0.078J***	0.033J	0.016J	0.022J	**0.11J***	0.029J	0.014J	0.023J	0.028J
Nickel	17.7	**24.4***	15.6	**19.3***	16.6	**35.4***	13.1	**30.7***	**22.6***	**23.1***
Potassium	1950	1320	1490	1650	1860	**2100***	1060	**2070***	1640	1750
Selenium	1.7	<0.39U	<0.19U	1.5	<0.17U	0.91	0.22	<0.15U	<0.17U	<0.18U
Silver	0	**2.1***	<0.2U	**0.23J***	<0.2U	**11***	<0.18U	<0.21U	**0.77***	**0.55***
Sodium	112	**138J***	87J	57.4	**146***	**340***	101	82.7J	94.1J	**114***
Thallium	0.89	<0.46U	<0.22U	<0.22U	<0.2U	<0.73U	<0.2U	0.24	<0.2U	<0.22U
Vanadium	26.1	21.8	22.8	19.4	**32.2***	**31.2***	**33.4***	23.4	24	23.3
Zinc	532	251	73.9	44.6	58.3	479	71.3	89.7	115	99.9
Anions										
Nitrate/Nitrite (NO3/NO2-N)	None	<1.9U	<0.93U	<0.87U	<0.91U	<3.2U	<0.86U	<0.9U	<1.2U	<1.1U
Explosives										
2,4,6-Trinitrotoluene	None	<0.034U	<0.033U	<0.034U	<0.034U	**0.087J***	<0.034U	<0.034U	<0.033U	<0.033U
2,6-Dinitrotoluene	None	<0.047U	<0.046U	<0.047U	<0.048U	<0.048U	<0.048U	<0.047U	<0.047U	<0.047U
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	**2.1***	**2***
SVOCs										
Anthracene	None	NR	NR	NR	NR	NR	NR	NR	<0.13U	<0.12U
Benz(a)anthracene	None	NR	NR	NR	NR	NR	NR	NR	<0.096U	<0.09U
Benzo(a)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.11U	<0.098U
Benzo(b)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.2U	<0.18U
Benzo(ghi)perylene	None	NR	NR	NR	NR	NR	NR	NR	<0.28U	<0.26U
Benzo(k)fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.21U	<0.19U
Chrysene	None	NR	NR	NR	NR	NR	NR	NR	<0.073U	<0.068U
Fluoranthene	None	NR	NR	NR	NR	NR	NR	NR	<0.17U	<0.16U
Indeno(1,2,3-cd)pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.2U	<0.19U
Phenanthrene	None	NR	NR	NR	NR	NR	NR	NR	<0.13U	**<0.12U**
Pyrene	None	NR	NR	NR	NR	NR	NR	NR	<0.26U	<0.24U

Table 4–5. Analytes Detected in Phase II RI Sediment Samples (continued)

Area		**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**ULCPsd-023**	**ULCPsd-024**	**ULCPsd-025**	**ULCPsd-026**	**ULCPsd-017**	**ULCPsd-018**	**ULCPsd-019**	**ULCPsd-020**	**ULCPsd-020**
Sample ID		**ULCPsd-023-0001-SD**	**ULCPsd-024-0001-SD**	**ULCPsd-025-0001-SD**	**ULCPsd-026-0001-SD**	**ULCPsd-017-0001-SD**	**ULCPsd-018-0001-SD**	**ULCPsd-019-0001-SD**	**ULCPsd-020-0001-FD**	**ULCPsd-020-0001-SD**
Date		**08/15/01**	**08/14/01**	**07/25/01**	**08/14/01**	**08/17/01**	**08/16/01**	**08/16/01**	**08/16/01**	**08/16/01**
Depth (ft)		**0.0 - 0.8**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.8**	**0.0 - 0.8**
Parameters Analyzed **Analyte (mg/kg)**	**Background Criteria**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**Misc., TAL Metals, Explosives**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Pesticides/PCBs										
PCB-1254	None	NR	NR	NR	NR	NR	NR	NR	**0.031***	**0.032***
VOCs										
2-Butanone	None	NR	NR	NR	NR	NR	NR	NR	<0.008U	**0.022***
Acetone	None	NR	NR	NR	NR	NR	NR	NR	**0.011***	**0.088***
Methylene chloride	None	NR	NR	NR	NR	NR	NR	NR	<0.003U	<0.003U

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PCB = Polychlorinated biphenyl.
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
VOC = Volatile organic compound.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–6. Analytes Detected in Phase II RI Surface Water Samples

Area		**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**ULCPsw-001**	**ULCPsw-002**	**ULCPsw-002**	**ULCPsw-005**	**ULCPsw-006**	**ULCPsw-007**	**ULCPsw-003**	**ULCPsw-004**
Sample ID		**ULCPsw-001-0001-SW**	**ULCPsw-002-0001-FD**	**ULCPsw-002-0001-SW**	**ULCPsw-005-0001-SW**	**ULCPsw-006-0001-SW**	**ULCPsw-007-0001-SW**	**ULCPsw-003-0001-SW**	**ULCPsw-004-0001-SW**
Date		**07/26/01**	**07/25/01**	**07/25/01**	**07/24/01**	**07/24/01**	**07/24/01**	**07/24/01**	**07/24/01**
Parameters Analyzed		**TAL Metals, Explosives, Sulfate, Sulfide**	**RVAAP Full-suite analytes + Sulfate and Sulfide**	**RVAAP Full-suite analytes + Sulfate and Sulfide**	**TAL Metals, Explosives, Sulfate, Sulfide**	**TAL Metals, Explosives, Sulfate, Sulfide**	**TAL Metals, Explosives, Sulfate, Sulfide**	**TAL Metals, Explosives, Sulfate, Sulfide**	**TAL Metals, Explosives, Sulfate, Sulfide**
Filtered?	**Background Criteria**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Analyte (mg/L)									
Metals (mg/L)									
Aluminum	3.37	1.45	0.456	2.52	0.114J	0.161J	0.377	0.276	0.107J
Arsenic	0.0032	**0.0104***	**0.0038***	**0.0043***	<0.0018U	0.0024	0.002	<0.0018U	0.0025
Barium	0.0475	**0.141***	**0.159***	**0.382***	0.0138	0.0118	0.0228	0.0226	0.0148
Calcium	41.4	38.3	**44.2***	**67.7***	19.8	20.6	38.7	22.3	21.8
Chromium	0	**0.004J***	**0.0031J***	**0.0067J***	<0.003U	<0.003U	<0.003U	<0.003U	<0.003U
Cobalt	0	**0.0107***	<0.002U	**0.0054***	<0.002U	<0.002U	<0.002U	<0.002U	<0.002U
Copper	0.0079	<0.0028U	<0.0028U	**0.0088J***	<0.0028U	<0.0028U	<0.0028U	<0.0028U	<0.0028U
Iron	2.56	**12.4***	**4.53***	**16.3***	0.348	0.294	0.443	1.18	0.419
Magnesium	10.8	6.67	8.97	**11.2***	4.05	3.98	6.71	4.41	4.21
Manganese	0.391	**8.59***	**7.36***	**15.8***	0.157	0.124	**0.654***	**0.528***	0.171
Nickel	0	**0.0042J***	<0.0026U	**0.0067J***	<0.0026U	<0.0026U	<0.0026U	<0.0026U	<0.0026U
Potassium	3.17	**5.82***	**10.1***	**15.7***	0.497J	0.751	1.51	0.894	0.921
Selenium	0	<0.0049U	**0.0075***	**0.0104***	<0.0049U	<0.0049U	<0.0049U	<0.0049U	<0.0049U
Silver	0	<0.0013U	<0.0013U	**0.0017J***	<0.0013U	<0.0013U	<0.0013U	<0.0013U	<0.0013U
Sodium	21.3	7.55	9.99	12.9	3.61	3.28	4.4	3.68	3.46
Vanadium	0	**0.005***	<0.0023U	**0.0049J***	<0.0023U	**0.003J***	**0.0024J***	<0.0023U	<0.0023U
Zinc	0.042	0.0312	0.0329	**0.109***	0.0027J	0.0139	0.0125	0.0115	0.0056J
Anions (mg/L)									
Sulfate	None	**29***	<2.5U	<2.5U	**14***	**16***	**19***	**13***	**13***
Sulfide	None	<0.5U	**1.3***	**2.3***	<0.5U	<0.5U	**0.7***	**0.7***	**0.7***
VOCs (mg/L)									
Acetone	None	NR	**0.005***	**0.003***	NR	NR	NR	NR	NR
Chloromethane	None	NR	**0.001***	**0.0007***	NR	NR	NR	NR	NR
Toluene	None	NR	**0.001***	**0.001***	NR	NR	NR	NR	NR

[a] Only detected site-related contaminants are presented in the table.
[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
ID = Identification.
J = Estimated value less than reporting limits.
mg/L = Milligrams per liter.
NR = Not reported/not analyzed.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
TAL = Target analyte list.
U = Not detected.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–7. Facility-wide Biological and Water Quality Study Sampling Locations

FWBWQS Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
S-8/FSW-SD-012	0–0.5	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus	Tributary to Sand Creek, downstream from Lower Cobbs Pond outlet	Station S-8 is adjacent to the former Sand Creek Sewage Treatment Plant. Station S-8 is along a tributary to Sand Creek, which is fed by drainage from Upper and Lower Cobbs Ponds, which in turn have drainages from Load Lines 3 and 12 (1941–1971). All surface water that exits the Upper and Lower Cobbs Ponds AOC enters the tributary to Sand Creek and passes through the sampling station S-8.	Fish kill from mishandling aluminum chloride at Load Line 12.	TNT, RDX, Comp B, HMX, DNT, nitrocellulose, nitrate, aluminum chloride, arsenic, cadmium, chromium, lead, mercury
S-8/FSW-SW-012	NA	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus				
S-8/FSW-SW-052	NA	Metals, Explosives, SVOCs, Ammonia, and Phosphorus				
Uppercobb Pond/ FSW-SD-030	0–0.3	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus	Upper Cobbs Pond	1941–1971 - Upper and Lower Cobbs Ponds received effluent from Load Lines 3 and 12 sawdust filtration units, wash water, storm water runoff, and surface water runoff. Rinsate from demilitarization operations at Load Lines 3 and 12 was initially allowed to flow out of buildings and directly onto the ground or to drainage ditches which ultimately discharged to Upper Cobbs Pond and Lower Cobbs Pond. From 1951–1961, explosives melt-out and demilitarization activities occurred at Load Line 12. On November 15, 1966, a fish kill occurred at Lower Cobbs Pond as a result of improper handling of aluminum chloride during these manufacturing operations at Load Line 12.		
Uppercobb Pond/ FSW-SW-030	NA	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus				
Uppercobb Pond/ FSW-SW-070	NA	Metals, Explosives, SVOCs, Ammonia, and Phosphorus				
Lowcobb Pond/ FSW-SD-031	0–0.3	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus	Lower Cobbs Pond	1941–1971 - Upper and Lower Cobbs Ponds received effluent from Load Lines 3 and 12 sawdust filtration units, wash water, storm water runoff, and surface water runoff. Rinsate from demilitarization operations at Load Lines 3 and 12 was initially allowed to flow out of buildings and directly onto the ground or to drainage ditches which ultimately discharged to Upper Cobbs Pond and Lower Cobbs Pond. From 1951–1961, explosives melt-out and demilitarization activities occurred at Load Line 12. On November 15, 1966, a fish kill occurred at Lower Cobbs Pond as a result of improper handling of aluminum chloride during these manufacturing operations at Load Line 12.		
Lowcobb Pond/ FSW-SW-031	NA	Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus				
Lowcobb Pond/ FSW-SW-071	NA	Metals, Explosives, SVOCs, Ammonia, and Phosphorus				

AOC = Area of concern.
bgs = Below ground surface.
Comp B = Composition B (a combination of TNT and RDX).
DNT = Dinitrotoluene.
ft = Feet.
FWBWQS = Facility-wide Biological and Water Quality Study
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = Not applicable.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RI = Remedial investigation.
TNT = 2,4,6-Trinitrotoluene.
SVOC = Semi-volatile organic compound.

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Table 4–8. Analytes Detected in Facility-wide Biological and Water Quality Study Sediment Samples

Area		**Lower Cobbs Pond**	**Off AOC**	**Upper Cobbs Pond**
Station		**Lowcobb Pond**	**S-8**	**Uppercobb Pond**
Sample ID		**FSW-SD-031-0000**	**FSW-SD-012-0000**	**FSW-SD-030-0000**
Date		**06/23/03**	**06/24/03**	**06/23/03**
Depth (ft)		**0.0 - 0.3**	**0.0 - 0.5**	**0.0 - 0.3**
Parameters Analyzed		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**
Analyte	**Background Criteria**			
Metals (mg/kg)				
Aluminum	13900	**15400J***	6110J	9030J
Antimony	0	**1.3J***	**0.51J***	**1J***
Arsenic	19.5	10.2J	12.6	6.5J
Barium	123	116	50.6	78.9
Beryllium	0.38	**0.83***	**0.53***	**0.48***
Cadmium	0	**1.2***	**0.12J***	**0.6***
Calcium	5510	2550	1430J	1960
Chromium	18.1	**121***	15.1	**18.6***
Cobalt	9.1	**12***	**9.5J***	7.7
Copper	27.6	120R	13.3J	23R
Iron	28200	26000R	19800	16200J
Lead	27.4	**34.2***	12.2J	17.8
Magnesium	2760	2600	1580J	1530
Manganese	1950	602	1090	383
Mercury	0.059	**0.1J***	0.046J	0.048J
Nickel	17.7	**24.6J***	**24.2***	14.4J
Potassium	1950	1640J	1260R	858J
Selenium	1.7	1.6J	1.1	1.1J
Silver	0	**1.5***	**0.19***	**1.1***
Sodium	112	**203***	85.6	106
Thallium	0.89	<3.6U	0.69J	<2.8U
Vanadium	26.1	24.5	11.5	15.6
Zinc	532	259	97.3	153
Anions (mg/kg)				
Nitrate/Nitrite (NO_3/ NO_2-N)	None	**8.5***	<1.8U	**5.3***
Miscellaneous (mg/kg)				
Ammonia	None	**61***	**10***	**69***
Total Phosphorus as P	None	**360***	**500***	**270***

Table 4–8. Analytes Detected in Facility-wide Biological and Water Quality Study Sediment Samples (continued)

Area		Lower Cobbs Pond	Off AOC	Upper Cobbs Pond
Station		**Lowcobb Pond**	**S-8**	**Uppercobb Pond**
Sample ID		**FSW-SD-031-0000**	**FSW-SD-012-0000**	**FSW-SD-030-0000**
Date		**06/23/03**	**06/24/03**	**06/23/03**
Depth (ft)		**0.0 - 0.3**	**0.0 - 0.5**	**0.0 - 0.3**
Parameters Analyzed		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, Phosphorus**
Analyte	**Background Criteria**			
SVOCs (mg/kg)				
Bis(2-ethylhexyl)phthalate	None	<1.3U	<0.42U	**0.84J***
Butyl benzyl phthalate	None	<1.3U	<0.42U	**0.16J***
Di-n-butyl phthalate	None	**1.035J***	<0.42U	**2.7***

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

AOC = Area of concern.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
R = Rejected result.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

Table 4–9. Analytes Detected in Facility-wide Biological and Water Quality Study Surface Water Samples

Area		**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Off AOC**	**Off AOC**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**Lowcobb Pond**	**Lowcobb Pond**	**S-8**	**S-8**	**Uppercobb Pond**	**Uppercobb Pond**
Sample ID		**FSW-SW-031-0000**	**FSW-SW-071-0000**	**FSW-SW-012-0000**	**FSW-SW-052-0000**	**FSW-SW-030-0000**	**FSW-SW-070-0000**
Date		**06/23/03**	**08/05/03**	**06/24/03**	**09/16/03**	**06/23/03**	**08/05/03**
Parameters Analyzed		**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus**	**TAL Metals, Explosives, SVOCs, Ammonia, and Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus**	**TAL Metals, Explosives, SVOCs, Ammonia, and Phosphorus**	**TAL Metals, Explosives, Pesticides/PCBs, SVOCs, Ammonia, and Phosphorus**	**TAL Metals, Explosives, SVOCs, Ammonia, and Phosphorus**
Filtered?							
Analyte (mg/L)	**Background Criteria**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Metals (mg/kg)							
Aluminum	3.37	0.226	0.125	0.311	0.0678J	0.119	0.0916
Antimony	0	**0.0034J***	**0.0022J***	<0.0019UJ	<0.007UJ	<0.007UJ	<0.007U
Barium	0.0475	0.0135	0.013	0.0163	0.0156	0.0162	0.0138
Calcium	41.4	20.1	10.9	22.8	22.3	24.3	13.2
Chromium	0	**0.0011J***	**0.00053J***	**0.001J***	**0.0018***	**0.001J***	<0.0016U
Cobalt	0	<0.0016U	<0.0016U	**0.00052J***	<0.0016U	<0.0016U	<0.0016U
Copper	0.0079	0.0029J	0.0023J	0.00098J	<0.0032U	0.0051	0.0026J
Iron	2.56	1.35	0.899	1.38	0.303	1.3	0.873
Lead	0	<0.008UJ	**0.0029J***	<0.0022U	<0.008U	**0.0033J***	**0.0022J***
Magnesium	10.8	3.3	1.55	3.95	3.67	3.6	1.75
Manganese	0.391	0.19	0.182	0.216	0.03	0.188	0.0772
Nickel	0	<0.0044U	<0.0044U	**0.002J***	<0.0044U	<0.0044U	<0.0044U
Potassium	3.17	1.58	1.61	1.78	1.75	1.57	1.44
Selenium	0	<0.007UJ	<0.007U	**0.0043J***	<0.007U	<0.007UJ	<0.007U
Sodium	21.3	2.04	1.37	2.71J	2.11	2.07	1.46
Vanadium	0	**0.00082J***	**0.00071J***	**0.00086J***	**0.00054J***	<0.002U	<0.002U
Zinc	0.042	0.0042J	0.0044J	0.0063J	<0.012UJ	0.008J	0.0041J
Anions (mg/kg)							
Nitrate/Nitrite (NO_3/NO_2-N)	None	**0.13***	**0.1***	**0.17***	**0.07***	**0.1***	**0.18***
Miscellaneous (mg/kg)							
Total Phosphorus as P	None	**0.12***	**0.1***	**0.2***	**0.17***	**0.24***	**0.06***
Explosives (mg/kg)							
4-Amino-2,6-Dinitrotoluene	None	<0.00026U	**0.00029J***	<0.00026UJ	<0.00026UJ	<0.00026U	**0.00024J***
SVOCs (mg/kg)							
Bis(2-ethylhexyl)phthalate	None	**0.0029J***	**0.0022J***	**0.0017J***	<0.011UJ	<0.011U	**0.002J***
Di-n-butyl phthalate	None	**0.012***	**0.0023J***	<0.011U	**0.00445J***	**0.0046J***	**0.0018J***

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

AOC = Area of concern.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
PCB = Polychlorinated biphenyl.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
UJ = Non-detectable concentration and reporting limit estimated.
VOC = Volatile organic compound.
*** = Result exceeds background criteria or no background criteria was available.**
< = Less than.

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Table 4–10. Human Health COPCs per the Phase II RI

Pond Bank Soil	Sediment	Surface Water	Groundwater
Aluminum Arsenic Chromium Vanadium	Aluminum Arsenic Cadmium Silver Vanadium Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene	Arsenic Barium Manganese Vanadium	Arsenic Manganese Bis(2–ethylhexyl)phthalate 4,4'-DDD

Source: *Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds* (MKM 2005).
COPC = Chemical of potential concern.
DDD = Dichlorodiphenyldichloroethane
RI = Remedial investigation.

Table 4–11. Chemicals Detected at Concentrations above Screening Criteria in Previous Investigations

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

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).
This table was generated using data from the following sources:
Screening criteria are the smaller of the FWCUGs for the Resident Farmer Adult, Resident Farmer Child, and National Guard Trainee based on hazard quotient =0.1 or target risk =1E-06
RI = Remedial investigation.

Table 4–12. 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

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.

Table 4–13. Analytes Detected in PBA08 RI Surface Soil Samples

Area		**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**
Station		**CPCsb-030**	**CPCsb-031**	**CPCsb-032**	**CPCsb-034**	**CPCsb-035**	**CPCss-036**	**CPCss-037**	**CPCss-037**	**CPCss-038**	**CPCss-039**
Sample ID		**CPCsb-030-5105-SO**	**CPCsb-031-5109-SO**	**CPCsb-032-5113-SO**	**CPCsb-034-5119-SO**	**CPCsb-035-5123-SO**	**CPCss-036-5014-SO**	**CPCss-037-6041-FD**	**CPCss-037-5015-SO**	**CPCss-038-5016-SO**	**CPCss-039-5017-SO**
Date		**03/29/10**	**03/24/10**	**03/24/10**	**03/29/10**	**03/29/10**	**02/23/10**	**02/23/10**	**02/23/10**	**02/23/10**	**02/23/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed	**Background**	**TAL Metals,**	**TAL Metals,**	**TAL Metals,**	**TAL Metals,**	**RVAAP Full-suite**	**TAL Metals,**	**TAL Metals,**	**TAL Metals,**	**TAL Metals,**	**RVAAP Full-suite**
Analyte	**Criteria**	**Explosives, SVOCs**	**Explosives, SVOCs**	**Explosives, SVOCs**	**Explosives, SVOCs**	**analytes**	**Explosives, SVOCs**	**Explosives, SVOCs**	**Explosives, SVOCs**	**Explosives, SVOCs**	**analytes**
						Metals (mg/kg)					
Aluminum	17700	9230	13400J	12200J	9920	10500	14200	10800	11900	13200	8790
Antimony	0.96	<0.67UJ	0.12J	0.086J	<0.72UJ	0.088J	<0.66R	<0.74R	<0.76R	<0.65R	<0.63R
Arsenic	15.4	6.5	15.1J	13.1J	**19.7***	8.7	6.8J	6J	6.7J	11.2J	11J
Barium	88.4	75.7	80.7	52.4	67.7	62.9	61.8J	64.5J	57.6J	43.3J	38.7J
Beryllium	0.88	0.57	0.65	0.58	0.65	0.52	0.36	0.51	0.58	0.41	0.58
Cadmium	0	**0.053J***	**0.17J***	**0.095J***	**0.19J***	**0.2J***	**0.058J***	**0.2J***	**0.26J***	**0.058J***	**0.1J***
Calcium	15800	1130J	1680J	1360J	2400J	3810J	804J	689J	725J	279J	1500J
Chromium	17.4	10.8	**20.8***	**17.4***	13.9	12.5	15.9J	12.6J	14.6J	17.2J	11.7J
Cobalt	10.4	8.1	**13.3***	**16.4***	**12.1***	6.5	4.5	8.8	8.1	7.6	**10.9***
Copper	17.7	8.7	**20***	**21.3***	**17.9***	10.4	12.3J	10.2J	14J	14.4J	**19.9J***
Iron	23100	15200	**31200***	**30200***	**31700***	21000	20600	18000	19300	**25700***	18700
Lead	26.1	10.6	19.9J	15.7J	15.9	**30.1***	11.1	12.7	14.2	12	11.8
Magnesium	3030	1880	**3540J***	**3290J***	2520	2200	2200J	2080J	2370J	2930J	1980J
Manganese	1450	80.7	330	237	667	506	78.6	238	242	200	186
Mercury	0.036	0.023J	0.021J	<0.12U	<0.14U	0.034J	<0.13U	**0.063J***	**0.045J***	**0.052J***	0.023J
Nickel	21.1	12.8	**24.6J***	**25.7J***	20.5	11.9	12.3J	14.3J	16.5J	18J	17.6J
Potassium	927	508	**1040J***	**1090J***	877	**1190***	571J	560J	788J	785J	612J
Selenium	1.4	0.79J	**1.4***	1.2	1.2J	1J	0.72	0.76	0.92	0.63J	0.89
Silver	0	**0.046J***	**0.032J***	<0.022UJ	<0.014UJ	**0.038J***	<0.028UJ	<0.043UJ	**0.062J***	<0.034UJ	<0.021UJ
Sodium	123	38.4J	43.3J	47J	108J	40.7J	42.7J	66.8J	62.8J	51J	48.8J
Thallium	0	**0.12J***	**0.18J***	**0.18J***	**0.14J***	**0.14J***	**0.19J***	**0.18J***	**0.17J***	**0.18J***	**0.11J***
Vanadium	31.1	15.2	26.5	20.3	19	20	26.3J	18.4J	18.7J	21.5J	14.1J
Zinc	61.8	49.7J	61.3	61.3	**96.4J***	**61.9J***	54.1J	48.3J	60.8J	49.1J	54.6J
						Explosives (mg/kg)					
Nitrocellulose	None	NR	NR	NR	NR	**1.5J***	NR	NR	NR	NR	**1.2J***
						SVOCs (mg/kg)					
2-Methylnaphthalene	None	<0.44U	<0.44U	<0.41U	<0.48U	**0.0091J***	<0.43U	<0.49U	<0.5U	<0.43U	<0.41U
Acenaphthylene	None	<0.067U	<0.067U	<0.062U	<0.072U	**0.012J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benz(a)anthracene	None	<0.067U	<0.067U	<0.062U	**0.017J***	**0.035J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benzenemethanol	None	<0.44U	<0.44U	<0.41U	<0.48U	<0.43U	<0.43U	<0.49U	<0.5U	**0.44***	<0.41U
Benzo(a)pyrene	None	<0.067U	<0.067U	<0.062U	**0.014J***	**0.042J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benzo(b)fluoranthene	None	<0.067U	<0.067U	<0.062U	**0.021J***	**0.059J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benzo(ghi)perylene	None	<0.067U	<0.067U	<0.062U	<0.072U	**0.031J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benzo(k)fluoranthene	None	<0.067U	<0.067U	<0.062U	<0.072U	**0.028J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Benzoic acid	None	<1.1U	<1.1U	<0.99U	<1.2U	<1.1U	<1.1U	<1.2U	<1.2U	**17***	<1U
Bis(2-ethylhexyl)phthalate	None	<0.44U	<0.44U	<0.41U	<0.48U	<0.43U	<0.43U	<0.49U	<0.5U	<0.43U	**0.23J***
Chrysene	None	<0.067U	<0.067U	<0.062U	**0.014J***	**0.048J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Di-n-butyl phthalate	None	**0.021J***	<0.44U	<0.41U	**0.027J***	<0.43U	<0.43U	<0.49U	<0.5U	<0.43U	<0.41U
Fluoranthene	None	<0.067U	<0.067U	<0.062U	**0.032J***	**0.093***	**0.012J***	**0.021J***	**0.023J***	<0.065U	<0.063U
Indeno(1,2,3-cd)pyrene	None	<0.067U	<0.067U	<0.062U	<0.072U	**0.026J***	<0.066U	<0.074U	<0.076U	<0.065U	<0.063U
Phenanthrene	None	<0.067U	<0.067U	<0.062U	<0.072U	**0.05J***	<0.066U	**0.01J***	<0.076U	<0.065U	<0.063U
Pyrene	None	<0.067U	<0.067U	<0.062U	**0.025J***	**0.072***	**0.011J***	**0.016J***	**0.016J***	<0.065U	<0.063U
						PCBs (mg/kg)					
beta-BHC	None	NR	NR	NR	NR	**0.0035J***	NR	NR	NR	NR	<0.0044U

Table 4–13. Analytes Detected in PBA08 RI Surface Soil Samples (continued)

Area	**Background Criteria**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**
Station		**CPCss-040**	**CPCss-041**	**CPCss-042**	**CPCss-043**
Sample ID		**CPCss-040-5018-SO**	**CPCss-041-5019-SO**	**CPCss-042-5020-SO**	**CPCss-043-5021-SO**
Date		**02/23/10**	**02/23/10**	**02/23/10**	**02/23/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte					
Metals (mg/kg)					
Aluminum	17700	10900	12400	9340	9890
Antimony	0.96	<0.67R	<0.66R	<0.69R	0.23J
Arsenic	15.4	6.2J	11.3J	7.1J	10.8J
Barium	88.4	62.9J	47.3J	57.3J	59.6J
Beryllium	0.88	0.37	0.45	0.37	0.48J
Cadmium	0	**0.1J***	**0.18J***	**0.17J***	**0.2J***
Calcium	15800	290J	975J	737J	2090J
Chromium	17.4	12.2J	15.3J	12.5J	**18.7J***
Cobalt	10.4	8.1	7.9	6.5	10.4
Copper	17.7	5.4J	11.9J	9.6J	**20.2J***
Iron	23100	16700	**23800***	16900	**24100***
Lead	26.1	13.8	17.4	**31.3***	14.5
Magnesium	3030	1810J	2350J	1970J	**3230J***
Manganese	1450	567	468	326	374
Mercury	0.036	**0.052J***	**0.047J***	**0.072J***	**0.074J***
Nickel	21.1	10.8J	13.9J	12.4J	**23.2J***
Potassium	927	671J	**1090J***	786J	840J
Selenium	1.4	0.68	0.78	0.67J	0.96J
Silver	0	<0.04UJ	<0.04UJ	**0.057J***	**0.085J***
Sodium	123	47.6J	44.9J	46.5J	70.7J
Thallium	0	**0.2J***	**0.16J***	**0.16J***	**0.13J***
Vanadium	31.1	17.6J	21.6J	18.4J	17J
Zinc	61.8	51.8J	57.8J	52.8J	**63.5J***
Explosives (mg/kg)					
Nitrocellulose	None	NR	NR	NR	NR
SVOCs (mg/kg)					
2-Methylnaphthalene	None	<0.44U	<0.44U	<0.45U	<3UJ
Acenaphthylene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Benz(a)anthracene	None	<0.067U	<0.066U	**0.066J***	<0.45UJ
Benzenemethanol	None	<0.44U	<0.44U	<0.45U	<3UJ
Benzo(a)pyrene	None	<0.067U	<0.066U	**0.057J***	<0.45UJ
Benzo(b)fluoranthene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Benzo(ghi)perylene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Benzo(k)fluoranthene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Benzoic acid	None	<1.1U	<1.1U	<1.1U	<7.2U
Bis(2-ethylhexyl)phthalate	None	<0.44U	<0.44U	<0.45U	<3UJ
Chrysene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Di-n-butyl phthalate	None	<0.44U	<0.44U	<0.45U	<3UJ
Fluoranthene	None	**0.018J***	**0.033J***	**0.11***	<0.45UJ
Indeno(1,2,3-cd)pyrene	None	<0.067U	<0.066U	<0.069U	<0.45UJ
Phenanthrene	None	**0.0095J***	**0.017J***	**0.093***	<0.45UJ
Pyrene	None	**0.016J***	**0.028J***	**0.079***	<0.45UJ

Table 4–13. Analytes Detected in PBA08 RI Surface Soil Samples (continued)

Area		**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**
Station		**CPCss-040**	**CPCss-041**	**CPCss-042**	**CPCss-043**
Sample ID		**CPCss-040-5018-SO**	**CPCss-041-5019-SO**	**CPCss-042-5020-SO**	**CPCss-043-5021-SO**
Date		**02/23/10**	**02/23/10**	**02/23/10**	**02/23/10**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
		PCBs (mg/kg)			
beta-BHC	None	NR	NR	NR	NR

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

BHC = Hexachlorocyclohexane.

ft = Feet.

ID = Identification.

J = Estimated value less than reporting limits.

mg/kg = Milligrams per kilogram.

PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.

PCB = Polychlorinated biphenyl.

R = Rejected result.

RI = Remedial investigation.

RVAAP = Ravenna Army Ammunition Plant.

SVOC = Semi-volatile organic compound.

TAL = Target analyte list.

U = Not detected.

UJ = Non-detectable concentration and reporting limit estimated.

*** = Result exceeds background criteria or no background criteria was available.**

< = Less than.

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Table 4–14. PBA08 RI 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.

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Table 4–15. Analytes Detected in PBA08 RI Subsurface Soil Samples

Area	**Background Criteria**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**	**Pond Bank**
Station		**CPCsb-032**	**CPCsb-032**	**CPCsb-032**	**CPCsb-032**	**CPCsb-034**	**CPCsb-035**	**CPCsb-035**	**CPCsb-035**
Sample ID		**CPCsb-032-6073-FD**	**CPCsb-032-5114-SO**	**CPCsb-032-5115-SO**	**CPCsb-032-5116-SO**	**CPCsb-034-5120-SO**	**CPCsb-035-5124-SO**	**CPCsb-035-6072-FD**	**CPCsb-035-5125-SO**
Date		**03/24/10**	**03/24/10**	**03/24/10**	**03/24/10**	**03/29/10**	**03/29/10**	**03/29/10**	**03/29/10**
Depth (ft)		**1.0 - 4.0**	**1.0 - 4.0**	**4.0 - 7.0**	**7.0 - 10.0**	**1.0 - 4.0**	**1.0 - 4.0**	**4.0 - 7.0**	**4.0 - 7.0**
Parameters Analyzed		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte									
Metals (mg/kg)									
Aluminum	19500	8690J	9420J	11000	11000J	7120	10100	14800	10900
Antimony	0.96	<0.6UJ	0.13J	<0.6R	<0.58UJ	<0.64UJ	0.084J	0.079J	0.086J
Arsenic	19.8	11.1J	17.9J	14.3	15.9J	14.2	9.7	18.6	15.4
Barium	124	68.8	63.2	49.1J	38.1	40.7	62.7	77.5	61
Beryllium	0.88	0.58J	0.57	0.61	0.49	0.41	0.47	0.87	0.58
Cadmium	0	**0.069J***	**0.046J***	**0.035J***	**0.032J***	**0.068J***	**0.18J***	**0.078J***	**0.053J***
Calcium	35500	1850J	1530J	5820	8240J	1080J	6870J	3420J	2340J
Chromium	27.2	13.6	15.9	17.5	18.5	10.5	12.8	22.4	15.5
Cobalt	23.2	6.3	9.4	12.4	13.3	9.7	6.6	16.5	14.1
Copper	32.3	19.4	22.4	17.1	20	20.4	12.8	27.5	23
Iron	35200	22000	29900	29600	33600	25600	21300	**37600***	27300
Lead	19.1	11.3J	11.9J	11.8	11.2J	10.9	**23.3***	15.5	13.4
Magnesium	8790	2650J	2830J	5460J	7120J	2110	2640	5250	3570
Manganese	3030	131	181	307	343	243	426	438	541
Mercury	0.044	<0.12U	<0.12U	<0.12U	<0.12U	<0.13U	0.022J	<0.12U	<0.12U
Nickel	60.7	21.5J	26.5J	27.7J	31.7J	19.8	14.6	35.9	26.1
Potassium	3350	959J	1050J	1890J	2190J	856	1210	2050	1420
Selenium	1.5	**1.6***	**1.6***	0.88J	1.1	1.2J	1J	1.5J	1.1J
Silver	0	<0.016UJ	<0.0078UJ	**0.029J***	<0.024UJ	<0.0098UJ	<0.026UJ	**0.033J***	**0.013J***
Sodium	145	46.6J	46.6J	78.4J	110J	40.8J	44.5J	58.8J	46.9J
Thallium	0.91	0.12J	0.14J	0.17J	0.16J	0.093J	0.13J	0.19J	0.17J
Vanadium	37.6	16.3	17.3	16.3	17.2	12.1	17.8	24.9	17.9
Zinc	93.3	55.1	59.7	61.1	62.5	57.2J	61.9J	86J	65.4J
Explosives (mg/kg)									
Nitrocellulose	None	NR	NR	NR	NR	NR	**1.6J***	<6.2U	<6.2U
SVOCs (mg/kg)									
2-Methylnaphthalene	None	<0.4U	<0.38U	<0.4U	**0.014J***	<0.42U	**0.0091J***	<0.41U	<0.41U
Benz(a)anthracene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.047J***	<0.062U	<0.062U
Benzo(a)pyrene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.066***	<0.062U	<0.062U
Benzo(b)fluoranthene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.08***	<0.062U	<0.062U
Benzo(ghi)perylene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.06J***	<0.062U	<0.062U
Benzo(k)fluoranthene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.03J***	<0.062U	<0.062U
Bis(2-ethylhexyl)phthalate	None	<0.4U	<0.38U	<0.4U	<0.38U	<0.42U	<0.41U	**0.024J***	<0.41U
Chrysene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.063***	<0.062U	<0.062U
Di-n-butyl phthalate	None	<0.4U	<0.38U	**0.019J***	<0.38U	<0.42U	<0.41U	**0.025J***	<0.41UJ
Dibenz(a,h)anthracene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.021J***	<0.062U	<0.062U
Fluoranthene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.11***	<0.062U	<0.062U
Indeno(1,2,3-cd)pyrene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.037J***	<0.062U	<0.062U
Phenanthrene	None	<0.06U	<0.058U	<0.06U	**0.014J***	<0.064U	**0.051J***	<0.062U	<0.062U
Pyrene	None	<0.06U	<0.058U	<0.06U	<0.058U	<0.064U	**0.088***	<0.062U	<0.062U

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
R = Rejected result.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
TAL = Target analyte list.
U = Non-detectable concentration.
UJ = Non-detectable concentration and reporting limit estimated.
*** = Result exceeds background concentration.**
< = Less than.

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Table 4–16. 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.

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Table 4–17. Analytes Detected in PBA08 RI Surface Water Samples

Area	**Background Criteria**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**
Station		**CPCsw-047**	**CPCsw-047**	**CPCsw-048**	**CPCsw-044**	**CPCsw-045**	**CPCsw-046**
Sample ID		**CPCsw-047-6045-FD**	**CPCsw-047-5030-SW**	**CPCsw-048-5031-SW**	**CPCsw-044-5027-SW**	**CPCsw-045-5028-SW**	**CPCsw-046-5029-SW**
Date		**04/01/10**	**04/01/10**	**04/01/10**	**03/29/10**	**04/01/10**	**03/25/10**
Parameters Analyzed		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Filtered?							
Analyte (mg/L)		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
Metals (mg/kg)							
Aluminum	3.37	0.254	0.357	0.26	0.285	0.236	0.332
Antimony	0	**0.00095J***	**0.00096J***	**0.001J***	**0.00073J***	**0.00088J***	**0.00094J***
Arsenic	0.0032	0.00086J	0.001J	0.0009J	0.00078J	0.00092J	0.00078J
Barium	0.0475	0.0161	0.0216	0.0198	0.0121	0.0117	0.0168
Beryllium	0	**0.00008J***	**0.00006J***	**0.00005J***	<0.001U	**0.00003J***	<0.001U
Cadmium	0	**0.00004J***	**0.00006J***	**0.00006J***	<0.002U	**0.00004J***	<0.002U
Calcium	41.4	22.3	21.6	22.1	14.7	18	16.2
Chromium	0	<0.005U	**0.00062J***	**0.00056J***	<0.00072UJ	<0.005U	**0.00059J***
Cobalt	0	**0.00027J***	**0.00039J***	**0.00041J***	<0.00018UJ	**0.00015J***	<0.00024UJ
Copper	0.0079	0.0018J	0.0021J	0.0019J	0.0016J	0.0016J	0.0019J
Iron	2.56	0.814	0.995	0.846	0.814	0.683	0.818
Lead	0	**0.0003J***	**0.00047J***	**0.00032J***	**0.00032J***	**0.00029J***	**0.00039J***
Magnesium	10.8	3.34	3.27	3.25	2.71	2.88	2.85
Manganese	0.391	0.102	0.136	0.132	0.0915	0.107	0.115
Nickel	0	**0.0017J***	**0.0019J***	**0.002J***	**0.0016J***	**0.0014J***	**0.0019J***
Potassium	3.17	1.42	1.49	1.39	1.26	1.39	1.49
Selenium	0	**0.0002J***	**0.00023J***	**0.00031J***	<0.005U	**0.00032J***	**0.00024J***
Sodium	21.3	1.66	1.6	1.68	1.44	1.49	1.41
Thallium	0	<0.002U	**0.00046J***	<0.002U	<0.002U	**0.00035J***	<0.002U
Vanadium	0	**0.00054J***	**0.00051J***	<0.01U	**0.00063J***	<0.01U	**0.00089J***
Zinc	0.042	<0.04U	0.0109J	0.0101J	<0.04U	<0.04U	<0.04U
Explosives (mg/kg)							
4-Amino-2,6-Dinitrotoluene	None	**0.00004J***	**0.00004J***	**0.00007J***	<0.00015U	<0.00015U	**0.00007J***
SVOCs (mg/kg)							
Benzenemethanol	None	<0.01U	<0.01U	<0.01U	<0.01U	**0.0049J***	<0.01U
Bis(2-ethylhexyl)phthalate	None	<0.01U	<0.01UJ	<0.01UJ	<0.01U	<0.01UJ	**0.0019J***
Butyl benzyl phthalate	None	<0.01U	<0.01U	<0.01U	<0.01U	**0.0018J***	<0.01U
PCBs (mg/kg)							
beta-BHC	None	**0.00002J***	<0.0001U	<0.00005U	<0.00005UJ	<0.00005U	<0.00005U

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

ID = Identification.

J = Estimated value less than reporting limits.

mg/kg = Milligrams per kilogram.

PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.

RVAAP = Ravenna Army Ammunition Plant.

SVOC = Semi-volatile organic compound.

U = Non-detectable concentration.

UJ = Non-detectable concentration and reporting limit estimated.

*** = Result exceeds background concentration.**

< = Less than.

Table 4–18. Analytes Detected in PBA08 RI Sediment Samples

Area		**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**CPCsd-047**	**CPCsd-047**	**CPCsd-048**	**CPCsd-048**	**CPCsd-044**	**CPCsd-045**	**CPCsd-045**	**CPCsd-046**	**CPCsd-046**	**CPCsd-049**
Sample ID		**CPCsd-047-5025-SD**	**CPCsd-047-5785-SD**	**CPCsd-048-5026-SD**	**CPCsd-048-5786-SD**	**CPCsd-044-5022-SD**	**CPCsd-045-5023-SD**	**CPCsd-045-5783-SD**	**CPCsd-046-5024-SD**	**CPCsd-046-5784-SD**	**CPCsd-049-5032-SD**
Date		**04/01/10**	**04/01/10**	**04/01/10**	**04/01/10**	**03/29/10**	**04/01/10**	**04/01/10**	**03/25/10**	**03/25/10**	**03/25/10**
Depth (ft)		**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**
Metals (mg/kg)											
Aluminum	13900	**17300J***	9150J	6620J	9120J	8920	**16200J***	13400J	**18400J***	8500J	NR
Antimony	0	**2.1J***	**0.15J***	**0.45J***	**0.17J***	<0.66UJ	**1.4J***	**0.15J***	**1.9J***	**0.19J***	NR
Arsenic	19.5	16.7	6.4	5.8	4.9	8.8	14	7.7	18.8J	5.5J	NR
Barium	123	**151***	73.9	65.8	84.2	73.5	**149***	114	**157***	82.3	NR
Beryllium	0.38	**1***	**0.59***	**0.52***	**0.58***	**0.42***	**0.93***	**0.68***	**1***	**0.45***	NR
Cadmium	0	**2.3***	**0.24J***	**0.61***	**0.28J***	**0.1J***	**1.5***	**0.44***	**2.3***	**0.28***	NR
Calcium	5510	**10100***	1010	1720	3550	1260J	3660	2110	4440J	1650J	NR
Chromium	18.1	**24.3J***	16.6J	9.9J	13.1J	16	**103J***	**21.3J***	**91.6***	15.5	**34.3***
Cobalt	9.1	**22.8***	8.9	**10.6***	**10.4***	8.6	**13.9***	**10.5***	**18.3***	**10.1***	NR
Copper	27.6	**62.3J***	14J	11.9J	12.1J	12.8	**103J***	18J	**104***	12.6	NR
Iron	28200	**36100***	16600	15400	16500	15800	28100	22500	**41800***	17200	NR
Lead	27.4	**40.8***	14.3	15.9	14.2	12.3	**35.9***	16.8	**52.4J***	13.5J	NR
Magnesium	2760	**3200***	1710	1340	1950	2140	**2840***	**2780***	**3090J***	1770J	NR
Manganese	1950	999	279	445	332	287	734	596	712	916	NR
Mercury	0.059	<0.64U	<0.14U	0.036J	0.031J	<0.13U	**0.082J***	0.054J	**0.15J***	<0.14U	NR
Nickel	17.7	**35.5***	13.6	12.7	15.3	15.3	**30.2***	**21.4***	**41.1J***	14.8J	NR
Potassium	1950	1740	655	541	724	673	1440	989	1680J	534J	NR
Selenium	1.7	**2.7J***	0.77J	0.79J	0.86J	1.1J	**2.2J***	1J	**2.9J***	0.97	NR
Silver	0	**6.2***	**0.25J***	**1.8***	**0.71J***	**0.052J***	**1.7J***	**0.075J***	**7.3***	**0.09J***	NR
Sodium	112	**178J***	56.9J	73J	85.5J	47.3J	**142J***	86.9J	**142J***	58.4J	NR
Thallium	0.89	<1.3U	0.15J	0.16J	0.15J	0.13J	0.41J	0.21J	0.37J	0.13J	NR
Vanadium	26.1	26.1	16.4	12.9	16.7	15.3	23	21	**27.6***	15	NR
Zinc	532	384	65.5	104	73.7	53.1J	267	91.8	458	63.9	NR
Explosives (mg/kg)											
1,3-Dinitrobenzene	None	<0.25U	<0.25U	<0.26U	<0.25U	<0.25U	<0.26U	<0.24U	**0.036J***	<0.25U	NR
2,4,6-Trinitrotoluene	None	<0.25U	<0.25U	**0.088J***	<0.25U	<0.25U	<0.26U	<0.24U	**0.15J***	<0.25U	NR
4-Amino-2,6-Dinitrotoluene	None	<0.25U	<0.25U	<0.26U	<0.25U	<0.25U	<0.26U	<0.24U	**0.12J***	<0.25U	NR
HMX	None	<0.25U	<0.25U	<0.26U	<0.25U	**0.017J***	<0.26U	**0.015J***	**0.083J***	<0.25U	NR
Nitrocellulose	None	**10.4J***	<7.2U	**3.1J***	<7.6U	NR	**7.8J***	**1.9J***	**5.7J***	<7.1U	NR
Tetryl	None	**0.024J***	<0.25U	<0.26U	<0.25U	<0.25U	**0.022J***	<0.24U	**0.019J***	<0.25U	NR
SVOCs (mg/kg)											
2-Methylnaphthalene	None	<2.1U	<0.48U	<0.58U	<0.5U	<0.44U	<1.9U	**0.025J***	<2.1UJ	<0.47U	NR
Acenaphthene	None	<0.32U	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.0099J***	<0.32U	<0.071U	NR
Acenaphthylene	None	<0.32U	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.091***	<0.32U	**0.02J***	NR
Anthracene	None	**0.074J***	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.07J***	<0.32U	**0.01J***	NR
Benz(a)anthracene	None	**0.38***	**0.027J***	**0.058J***	**0.015J***	**0.021J***	**0.045J***	**0.34***	**0.078J***	**0.05J***	NR
Benzo(a)pyrene	None	**0.39***	**0.032J***	**0.063J***	**0.012J***	**0.02J***	**0.052J***	**0.47***	**0.12J***	**0.063J***	NR
Benzo(b)fluoranthene	None	**0.52***	**0.064J***	**0.1***	**0.025J***	**0.038J***	**0.075J***	**0.8***	**0.19J***	**0.11***	NR
Benzo(ghi)perylene	None	**0.27J***	**0.029J***	**0.05J***	**0.011J***	**0.014J***	**0.045J***	**0.47***	**0.11J***	**0.061J***	NR
Benzo(k)fluoranthene	None	**0.26J***	**0.027J***	**0.044J***	<0.076U	**0.013J***	<0.29U	**0.21***	**0.067J***	**0.036J***	NR
Bis(2-ethylhexyl)phthalate	None	**0.16J***	<0.48U	<0.58U	<0.5U	<0.44U	<1.9U	<0.48U	<2.1UJ	<0.47U	NR
Chrysene	None	**0.43***	**0.048J***	**0.06J***	**0.014J***	**0.027J***	**0.052J***	**0.4***	**0.11J***	**0.062J***	NR

Table 4–18. Analytes Detected in PBA08 RI Sediment Samples (continued)

Area	**Background Criteria**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Backwater Area**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Lower Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**	**Upper Cobbs Pond**
Station		**CPCsd-047**	**CPCsd-047**	**CPCsd-048**	**CPCsd-048**	**CPCsd-044**	**CPCsd-045**	**CPCsd-045**	**CPCsd-046**	**CPCsd-046**	**CPCsd-049**
Sample ID		**CPCsd-047-5025-SD**	**CPCsd-047-5785-SD**	**CPCsd-048-5026-SD**	**CPCsd-048-5786-SD**	**CPCsd-044-5022-SD**	**CPCsd-045-5023-SD**	**CPCsd-045-5783-SD**	**CPCsd-046-5024-SD**	**CPCsd-046-5784-SD**	**CPCsd-049-5032-SD**
Date		**04/01/10**	**04/01/10**	**04/01/10**	**04/01/10**	**03/29/10**	**04/01/10**	**04/01/10**	**03/25/10**	**03/25/10**	**03/25/10**
Depth (ft)		**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**	**0.5 - 2.0**	**0.0 - 0.5**
Parameters Analyzed		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals**
Analyte											
Di-n-butyl phthalate	None	<2.1U	<0.48U	<0.58U	**0.034J***	**0.022J***	<1.9U	**0.023J***	<2.1UJ	<0.47U	NR
Dibenz(a,h)anthracene	None	**0.066J***	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.12***	<0.32U	<0.071U	NR
Fluoranthene	None	**0.96***	**0.07J***	**0.11***	**0.022J***	**0.042J***	**0.095J***	**0.48***	**0.22J***	**0.087***	NR
Fluorene	None	**0.053J***	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.02J***	<0.32U	<0.071U	NR
Indeno(1,2,3-cd)pyrene	None	**0.23J***	**0.026J***	**0.04J***	<0.076U	**0.014J***	**0.042J***	**0.43***	**0.09J***	**0.054J***	NR
Naphthalene	None	<0.32U	<0.072U	<0.088U	<0.076U	<0.066U	<0.29U	**0.038J***	<0.32U	<0.071U	NR
Phenanthrene	None	**0.35***	**0.027J***	**0.034J***	**0.01J***	**0.014J***	<0.29U	**0.15***	**0.07J***	**0.024J***	NR
Pyrene	None	**0.76***	**0.053J***	**0.084J***	**0.019J***	**0.032J***	**0.083J***	**0.41***	**0.18J***	**0.069J***	NR
PCBs (mg/kg)											
delta-BHC	None	<0.13UJ	<0.029U	<0.035U	<0.03UJ	NR	<0.12U	<0.029U	<0.13UJ	**0.0018J***	NR
VOCs (mg/kg)											
2-Butanone	None	**0.055J***	**0.013J***	**0.03J***	**0.01J***	NR	**0.047J***	**0.012J***	**0.033J***	**0.0072J***	NR
Acetone	None	**0.19***	<0.055U	**0.12***	<0.051U	NR	**0.17***	<0.052U	**0.091J***	<0.028UJ	NR
Carbon disulfide	None	<0.032U	<0.0072U	<0.0088U	<0.0076U	NR	**0.0033J***	<0.0072U	<0.032UJ	<0.0071UJ	NR

[a] Only detected site-related contaminants are presented in the table.

[b] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

BHC = Hexachlorocyclohexane.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC= Semi-volatile organic compound.
TAL = Target analyte list.
U = Not detected.
UJ = Not detected, reporting limit estimated.
VOC = Volatile organic compound.
* = Result exceeds background criteria or no background criteria was available.
< = Less than.

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Table 4–19. Changes from the PBA08 SAP

Location	Affected Sample	Date Sampled	Change/Rationale
CPCsb-032	CPCSB-032-5113-SO	3/24/2010	Location moved due to standing water.
	CPCSB-032-5114-SO	3/24/2010	
	CPCSB-032-5115-SO	3/24/2010	
	CPCSB-032-5116-SO	3/24/2010	
	CPCSB-032-6073-FD	3/24/2010	
CPCsb-033	CPCSB-033-5117-SO	3/29/2010	Location moved due to standing water.
	CPCSB-033-5118-SO	3/29/2010	
CPCsb-034	CPCSB-034-5119-SO	3/29/2010	Location moved due to standing water.
	CPCSB-034-5120-SO	3/29/2010	
CPCsw-048	CPCSW-048-5031-SW	4/1/2010	Location moved approximately 30 ft to the south due to access issues.
	CPCSD-048-5786-SD	4/1/2010	
	CPCSD-048-5026-FD	4/1/2010	

ft = Feet.

PBA08 SAP = Performance-Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1 (USACE 2009).

Table 4–20. RVAAP Background Concentrations

Chemical	Surface Soil (mg/kg)	Subsurface soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)	Groundwater-Unconsolidated (mg/L)		Groundwater-Bedrock (mg/L)	
					Filtered	Unfiltered	Filtered	Unfiltered
Aluminum	17700	19500	13900	3.37	NA	48	NA	9.41
Antimony	0.96	0.96	0	0	0	0.0043	0	0
Arsenic	15.4	19.8	19.5	0.0032	0.0117	0.215	0	0.0191
Barium	88.4	124	123	0.0475	0.0821	0.327	0.256	0.241
Beryllium	0.88	0.88	0.38	0	0	0	0	0
Cadmium	0	0	0	0	0	0	0	0
Calcium	15800	35500	5510	41.4	115	194	53.1	48.2
Chromium	17.4	27.2	18.1	0	0.0073	0.0852	0	0.0195
Cobalt	10.4	23.2	9.1	0	0	0.0463	0	0
Copper	17.7	32.3	27.6	0.0079	0	0.289	0	0.017
Cyanide	0	0	0	0	0	0	0	0
Iron	23100	35200	28200	2.56	0.279	195	1.43	21.5
Lead	26.1	19.1	27.4	0	0	0.183	0	0.023
Magnesium	3030	8790	2760	10.8	43.3	58.4	15	13.7
Manganese	1450	3030	1950	0.391	1.02	2.86	1.34	1.26
Mercury	0.036	0.044	0.059	0	0	0.00025	0	0
Nickel	21.1	60.7	17.7	0	0	0.117	0.0834	0.0853
Potassium	927	3350	1950	3.17	2.89	7.48	5.77	6.06
Selenium	1.4	1.5	1.7	0	0	0.0057	0	0
Silver	0	0	0	0	0	0	0	0
Sodium	123	145	112	21.3	45.7	44.7	51.4	49.7
Thallium	0	0.91	0.89	0	0	0.0024	0	0
Vanadium	31.1	37.6	26.1	0	0	0.0981	0	0.0155
Zinc	61.8	93.3	532	0.042	0.0609	0.888	0.0523	0.193

Background concentrations were developed in 1998 and published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b). These background values are currently being reassessed, but the background valued developed in 1998 are used throughout this report.

mg/kg = Milligrams per kilogram.

mg/L = Milligrams per liter.

NA = Not available. Aluminum results were rejected in validation.

RVAAP = Ravenna Army Ammunition Plant.

Table 4–21. Recommended Dietary Allowances/Reference Daily Intake Values

Essential Human Nutrient	USDA RDA/RDI[a] Value
Calcium	1000 mg/d
Chloride[b]	3400 mg/d
Iodine	150 µg/d
Iron	8 mg/d
Magnesium	400 mg/d
Potassium[b]	4700 mg/d
Phosphorous	700 mg/d
Sodium[b]	2300 mg/d

Source= Values were obtained from http://fnic.nal.usda.gov charts.

[a] Dietary reference intakes vary by gender and age, values present are for life stage group: Males 19-30 years.

[b] Adequate intake value.

µg/d = Micrograms per day.

mg/d = Milligram per day.

RDA= Recommended dietary allowance.

RDI= Reference daily intake.

USDA = U.S. Department of Agriculture.

Table 4–22. SRC Screening for Discrete Shallow Surface Soil (0-1 ft bgs) Samples at Cobbs Ponds

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
				Metals				
Aluminum	**7429-90-5**	**24/ 24**	**6450**	**19200**	**11900**	**17700**	**Yes**	**Exceeds background**
Antimony	7440-36-0	10/ 17	0.086	0.46	0.22	0.96	No	Below background
Arsenic	**7440-38-2**	**24/ 24**	**4.2**	**28.4**	**11.1**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**24/ 24**	**35.2**	**90.4**	**61**	**88.4**	**Yes**	**Exceeds background**
Beryllium	7440-41-7	24/ 24	0.36	0.86	0.524	0.88	No	Below background
Cadmium	**7440-43-9**	**19/ 24**	**0.053**	**0.49**	**0.135**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	24/ 24	195	4040	1310	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**24/ 24**	**9.6**	**24.8**	**15.4**	**17.4**	**Yes**	**Exceeds background**
Chromium, hexavalent	**18540-29-9**	**1/ 1**	**1**	**1**	**1**		**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**24/ 24**	**4.5**	**16.4**	**8.9**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**24/ 24**	**4.2**	**23.9**	**14.1**	**17.7**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**4/ 11**	**0.31**	**1.2**	**0.292**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	24/ 24	13400	44000	23000	23100	No	Essential Nutrient
Lead	**7439-92-1**	**24/ 24**	**10.6**	**31.3**	**18.7**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	24/ 24	1340	4310	2560	3030	No	Essential Nutrient
Manganese	7439-96-5	24/ 24	78.6	667	281	1450	No	Below background
Mercury	**7439-97-6**	**21/ 24**	**0.021**	**0.074**	**0.043**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**24/ 24**	**8.6**	**27.2**	**17**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	24/ 24	508	2220	1020	927	No	Essential Nutrient
Selenium	**7782-49-2**	**21/ 24**	**0.48**	**1.4**	**0.813**	**1.4**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**9/ 24**	**0.032**	**0.45**	**0.0996**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	24/ 24	38.4	159	74	123	No	Essential Nutrient
Thallium	**7440-28-0**	**14/ 24**	**0.11**	**0.25**	**0.173**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**24/ 24**	**14.1**	**35.3**	**20.9**	**31.1**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**24/ 24**	**47.7**	**121**	**63.9**	**61.8**	**Yes**	**Exceeds background**
				Anions				
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**1/ 11**	**1.4**	**1.4**	**0.545**	**None**	**Yes**	**Exceeds background**
				Explosives				
Nitrocellulose	**9004-70-0**	**3/ 3**	**1.2**	**1.5**	**1.4**	**None**	**Yes**	**Detected organic**

Table 4–22. SRC Screening for Discrete Shallow Surface Soil (0-1 ft bgs) Samples at Cobbs Ponds (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
2-Methylnaphthalene	91-57-6	1/ 14	0.0091	0.0091	0.293	None	Yes	Detected organic
Acenaphthylene	208-96-8	1/ 14	0.012	0.012	0.0459	None	Yes	Detected organic
Benz(a)anthracene	56-55-3	3/ 14	0.017	0.066	0.0484	None	Yes	Detected organic
Benzenemethanol	100-51-6	1/ 13	0.44	0.44	0.337	None	Yes	Detected organic
Benzo(a)pyrene	50-32-8	3/ 14	0.014	0.057	0.0482	None	Yes	Detected organic
Benzo(b)fluoranthene	205-99-2	2/ 14	0.021	0.059	0.0506	None	Yes	Detected organic
Benzo(ghi)perylene	191-24-2	1/ 14	0.031	0.031	0.0519	None	Yes	Detected organic
Benzo(k)fluoranthene	207-08-9	1/ 14	0.028	0.028	0.0499	None	Yes	Detected organic
Benzoic acid	65-85-0	1/ 13	17	17	2.05	None	Yes	Detected organic
Bis(2-ethylhexyl)phthalate	117-81-7	1/ 14	0.23	0.23	0.304	None	Yes	Detected organic
Chrysene	218-01-9	2/ 14	0.014	0.048	0.0462	None	Yes	Detected organic
Di-n-butyl phthalate	84-74-2	2/ 14	0.021	0.027	0.27	None	Yes	Detected organic
Fluoranthene	206-44-0	7/ 14	0.012	0.11	0.0549	None	Yes	Detected organic
Indeno(1,2,3-cd)pyrene	193-39-5	1/ 14	0.026	0.026	0.0494	None	Yes	Detected organic
Phenanthrene	85-01-8	4/ 14	0.0095	0.093	0.0506	None	Yes	Detected organic
Pyrene	129-00-0	7/ 14	0.011	0.079	0.0517	None	Yes	Detected organic
Pesticides/PCBs								
beta-BHC	319-85-7	1/ 3	0.0035	0.0035	0.00193	None	Yes	Detected organic

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b). Site-related contaminant screening tables include all available and appropriate data as presented in Section 4.4.4.

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
CAS = Chemical Abstract Service.
ft = Feet.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.
SVOC= Semi-volatile organic compound
Bold indicates analyte identified as an SRC.

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Table 4–23. SRC Screening for Discrete Subsurface Soil (1-13 ft bgs) Samples at Cobbs Ponds

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	6/ 6	7120	11000	9920	19500	No	Below background
Antimony	7440-36-0	3/ 5	0.084	0.13	0.182	0.96	No	Below background
Arsenic	7440-38-2	6/ 6	9.7	17.9	14.6	19.8	No	Below background
Barium	7440-39-3	6/ 6	38.1	63.2	52.5	124	No	Below background
Beryllium	7440-41-7	6/ 6	0.41	0.61	0.522	0.88	No	Below background
Cadmium	**7440-43-9**	**6/ 6**	**0.032**	**0.18**	**0.069**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	6/ 6	1080	8240	4310	35500	No	Essential Nutrient
Chromium	7440-47-3	6/ 6	10.5	18.5	15.1	27.2	No	Below background
Cobalt	7440-48-4	6/ 6	6.6	14.1	10.9	23.2	No	Below background
Copper	7440-50-8	6/ 6	12.8	23	19.3	32.3	No	Below background
Iron	7439-89-6	6/ 6	21300	33600	27900	35200	No	Essential Nutrient
Lead	**7439-92-1**	**6/ 6**	**10.9**	**23.3**	**13.8**	**19.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	6/ 6	2110	7120	3960	8790	No	Essential Nutrient
Manganese	7439-96-5	6/ 6	181	541	340	3030	No	Below background
Mercury	7439-97-6	1/ 6	0.022	0.022	0.0545	0.044	No	Below background
Nickel	7440-02-0	6/ 6	14.6	31.7	24.4	60.7	No	Below background
Potassium	7440-09-7	6/ 6	856	2190	1440	3350	No	Essential Nutrient
Selenium	**7782-49-2**	**6/ 6**	**0.88**	**1.6**	**1.15**	**1.5**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**2/ 6**	**0.013**	**0.029**	**0.0126**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	6/ 6	40.8	110	61.2	145	No	Essential Nutrient
Thallium	7440-28-0	6/ 6	0.093	0.17	0.144	0.91	No	Below background
Vanadium	7440-62-2	6/ 6	12.1	17.9	16.4	37.6	No	Below background
Zinc	7440-66-6	6/ 6	57.2	65.4	61.3	93.3	No	Below background
Explosives/Propellants								
Nitrocellulose	**9004-70-0**	**1/ 2**	**1.6**	**1.6**	**2.35**	**None**	**Yes**	**Detected organic**

Table 4–23. SRC Screening for Discrete Subsurface Soil (1-13 ft bgs) Samples at Cobbs Ponds (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
				SVOCs				
2-Methylnaphthalene	**91-57-6**	**2/ 6**	**0.0091**	**0.014**	**0.138**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**1/ 6**	**0.047**	**0.047**	**0.033**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 6**	**0.066**	**0.066**	**0.0362**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/ 6**	**0.08**	**0.08**	**0.0385**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/ 6**	**0.06**	**0.06**	**0.0352**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 6**	**0.03**	**0.03**	**0.0302**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/ 6**	**0.063**	**0.063**	**0.0357**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**1/ 6**	**0.019**	**0.019**	**0.17**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 6**	**0.021**	**0.021**	**0.0287**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 6**	**0.11**	**0.11**	**0.0435**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 6**	**0.037**	**0.037**	**0.0313**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**2/ 6**	**0.014**	**0.051**	**0.0312**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/ 6**	**0.088**	**0.088**	**0.0398**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

bgs = Below ground surface.

CAS = Chemical Abstract Service.

ft = Feet.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC = Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–24. SRC Screening for Discrete Sediment Samples at the Backwater Area

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	**7429-90-5**	**14/ 14**	**6620**	**18600**	**12500**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**11/ 14**	**0.24**	**2.1**	**0.607**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	14/ 14	3.5	16.7	10.2	19.5	No	Below background
Barium	**7440-39-3**	**14/ 14**	**53.8**	**151**	**99.5**	**123**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**14/ 14**	**0.34**	**1.1**	**0.782**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**14/ 14**	**0.11**	**2.3**	**0.972**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	14/ 14	1180	15400	3790	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**14/ 14**	**9.9**	**56.5**	**23.3**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**14/ 14**	**5.4**	**22.8**	**13.6**	**9.1**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**14/ 14**	**10.9**	**62.3**	**28.2**	**27.6**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**3/ 12**	**0.1**	**0.55**	**0.224**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	14/ 14	12700	36100	21400	28200	No	Essential Nutrient
Lead	**7439-92-1**	**14/ 14**	**14.2**	**57.9**	**29.6**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	14/ 14	1170	3830	2230	2760	No	Essential Nutrient
Manganese	7439-96-5	14/ 14	179	999	520	1950	No	Below background
Mercury	**7439-97-6**	**13/ 14**	**0.031**	**0.11**	**0.0816**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**14/ 14**	**9.4**	**35.5**	**20.5**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	14/ 14	541	1740	1140	1950	No	Essential Nutrient
Selenium	**7782-49-2**	**8/ 14**	**0.26**	**2.7**	**0.5**	**1.7**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**13/ 14**	**0.51**	**23**	**5.7**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	14/ 14	55.2	239	140	112	No	Essential Nutrient
Thallium	7440-28-0	1/ 14	0.16	0.16	0.196	0.89	No	Below background
Vanadium	**7440-62-2**	**14/ 14**	**11.7**	**30**	**19.9**	**26.1**	**Yes**	**Exceeds background**
Zinc	7440-66-6	14/ 14	74.8	418	179	532	No	Below background
Anions								
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**1/ 12**	**2.2**	**2.2**	**0.804**	**None**	**Yes**	**Exceeds background**
Explosives								
2,4,6-Trinitrotoluene	**118-96-7**	**6/ 14**	**0.049**	**0.32**	**0.0811**	**None**	**Yes**	**Detected organic**
2,6-Dinitrotoluene	**606-20-2**	**1/ 14**	**0.16**	**0.16**	**0.0483**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**4/ 4**	**2.5**	**10.4**	**4.75**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**1/ 14**	**0.024**	**0.024**	**0.0294**	**None**	**Yes**	**Detected organic**

Table 4–24. SRC Screening for Discrete Sediment Samples at the Backwater Area (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Anthracene	**120-12-7**	**2/ 5**	**0.074**	**0.22**	**0.0956**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**3/ 5**	**0.058**	**0.83**	**0.274**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**4/ 5**	**0.063**	**0.89**	**0.323**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**3/ 5**	**0.1**	**0.86**	**0.338**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**3/ 5**	**0.05**	**0.49**	**0.22**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**3/ 5**	**0.044**	**0.8**	**0.265**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**1/ 5**	**0.16**	**0.16**	**0.165**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**4/ 5**	**0.06**	**0.93**	**0.338**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 5**	**0.066**	**0.066**	**0.095**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**3/ 5**	**0.11**	**1.8**	**0.61**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/ 5**	**0.053**	**0.053**	**0.0844**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**3/ 5**	**0.04**	**0.48**	**0.192**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**3/ 5**	**0.034**	**0.91**	**0.285**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**3/ 5**	**0.084**	**1.9**	**0.604**	**None**	**Yes**	**Detected organic**
Pesticides/PCBs								
PCB-1254	**11097-69-1**	**2/ 4**	**0.046**	**0.047**	**0.0568**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**3/ 5**	**0.03**	**0.055**	**0.0256**	**None**	**Yes**	**Detected organic**
Acetone	**67-64-1**	**5/ 5**	**0.02**	**0.19**	**0.12**	**None**	**Yes**	**Detected organic**
Methylene chloride	**75-09-2**	**1/ 5**	**0.048**	**0.048**	**0.0145**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

PCB = Polychlorinated biphenyl.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–25. SRC Screening for Discrete Subsurface Sediment Samples at the Backwater Area

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	2/ 2	9120	9150	9140	13900	No	Below background
Antimony	**7440-36-0**	**2/ 2**	**0.15**	**0.17**	**0.16**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	2/ 2	4.9	6.4	5.65	19.5	No	Below background
Barium	7440-39-3	2/ 2	73.9	84.2	79.1	123	No	Below background
Beryllium	**7440-41-7**	**2/ 2**	**0.58**	**0.59**	**0.585**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**2/ 2**	**0.24**	**0.28**	**0.26**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	2/ 2	1010	3550	2280	5510	No	Essential Nutrient
Chromium	7440-47-3	2/ 2	13.1	16.6	14.9	18.1	No	Below background
Cobalt	**7440-48-4**	**2/ 2**	**8.9**	**10.4**	**9.65**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	2/ 2	12.1	14	13.1	27.6	No	Below background
Iron	7439-89-6	2/ 2	16500	16600	16600	28200	No	Essential Nutrient
Lead	7439-92-1	2/ 2	14.2	14.3	14.3	27.4	No	Below background
Magnesium	7439-95-4	2/ 2	1710	1950	1830	2760	No	Essential Nutrient
Manganese	7439-96-5	2/ 2	279	332	306	1950	No	Below background
Mercury	7439-97-6	1/ 2	0.031	0.031	0.0505	0.059	No	Below background
Nickel	7440-02-0	2/ 2	13.6	15.3	14.5	17.7	No	Below background
Potassium	7440-09-7	2/ 2	655	724	690	1950	No	Essential Nutrient
Selenium	7782-49-2	2/ 2	0.77	0.86	0.815	1.7	No	Below background
Silver	**7440-22-4**	**2/ 2**	**0.25**	**0.71**	**0.48**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	2/ 2	56.9	85.5	71.2	112	No	Essential Nutrient
Thallium	7440-28-0	2/ 2	0.15	0.15	0.15	0.89	No	Below background
Vanadium	7440-62-2	2/ 2	16.4	16.7	16.6	26.1	No	Below background
Zinc	7440-66-6	2/ 2	65.5	73.7	69.6	532	No	Below background

Table 4–25. SRC Screening for Discrete Subsurface Sediment Samples at the Backwater Area (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Benz(a)anthracene	56-55-3	2/2	0.015	0.027	0.021	None	Yes	Detected organic
Benzo(a)pyrene	50-32-8	2/2	0.012	0.032	0.022	None	Yes	Detected organic
Benzo(b)fluoranthene	205-99-2	2/2	0.025	0.064	0.0445	None	Yes	Detected organic
Benzo(ghi)perylene	191-24-2	2/2	0.011	0.029	0.02	None	Yes	Detected organic
Benzo(k)fluoranthene	207-08-9	1/2	0.027	0.027	0.0325	None	Yes	Detected organic
Chrysene	218-01-9	2/2	0.014	0.048	0.031	None	Yes	Detected organic
Di-n-butyl phthalate	84-74-2	1/2	0.034	0.034	0.137	None	Yes	Detected organic
Fluoranthene	206-44-0	2/2	0.022	0.07	0.046	None	Yes	Detected organic
Indeno(1,2,3-cd)pyrene	193-39-5	1/2	0.026	0.026	0.032	None	Yes	Detected organic
Phenanthrene	85-01-8	2/2	0.01	0.027	0.0185	None	Yes	Detected organic
Pyrene	129-00-0	2/2	0.019	0.053	0.036	None	Yes	Detected organic
VOCs								
2-Butanone	78-93-3	2/2	0.01	0.013	0.0115	None	Yes	Detected organic

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

PCB = Polychlorinated biphenyl.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–26. SRC Screening for ISM Sediment Samples at the Upper Cobbs Pond

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/kg)	Maximum Detect (mg/kg)	Average Result (mg/kg)	Background Criteria[a] (mg/kg)	SRC? (yes/no)	SRC Justification
Metals								
Aluminum	7429-90-5	1/ 1	9030	9030	9030	13900	No	Below background
Antimony	**7440-36-0**	**1/ 1**	**1**	**1**	**1**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/ 1	6.5	6.5	6.5	19.5	No	Below background
Barium	7440-39-3	1/ 1	78.9	78.9	78.9	123	No	Below background
Beryllium	**7440-41-7**	**1/ 1**	**0.48**	**0.48**	**0.48**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**0.6**	**0.6**	**0.6**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	1960	1960	1960	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**18.6**	**18.6**	**18.6**	**18.1**	**Yes**	**Exceeds background**
Cobalt	7440-48-4	1/ 1	7.7	7.7	7.7	9.1	No	Below background
Iron	7439-89-6	1/ 1	16200	16200	16200	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	17.8	17.8	17.8	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	1530	1530	1530	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	383	383	383	1950	No	Below background
Mercury	7439-97-6	1/ 1	0.048	0.048	0.048	0.059	No	Below background
Nickel	7440-02-0	1/ 1	14.4	14.4	14.4	17.7	No	Below background
Potassium	7440-09-7	1/ 1	858	858	858	1950	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	1.1	1.1	1.1	1.7	No	Below background
Silver	**7440-22-4**	**1/ 1**	**1.1**	**1.1**	**1.1**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	106	106	106	112	No	Essential Nutrient
Vanadium	7440-62-2	1/ 1	15.6	15.6	15.6	26.1	No	Below background
Zinc	7440-66-6	1/ 1	153	153	153	532	No	Below background
Anions								
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**1/ 1**	**5.3**	**5.3**	**5.3**	**None**	**Yes**	**Exceeds background**
Miscellaneous								
Ammonia	**7664-41-7**	**1/ 1**	**69**	**69**	**69**	**None**	**Yes**	**Exceeds background**
Total Phosphorus as P	**7723-14-0**	**1/ 1**	**270**	**270**	**270**	**None**	**Yes**	**Exceeds background**
SVOCs								
Bis(2-ethylhexyl)phthalate	**117-81-7**	**1/ 1**	**0.84**	**0.84**	**0.84**	**None**	**Yes**	**Detected organic**
Butyl benzyl phthalate	**85-68-7**	**1/ 1**	**0.16**	**0.16**	**0.16**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**1/ 1**	**2.7**	**2.7**	**2.7**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

ISM = Incremental sampling methodology.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–27. SRC Screening for Discrete Sediment Samples at the Upper Cobbs Pond

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	**7429-90-5**	**5/ 5**	**13400**	**21400**	**16500**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**5/ 5**	**0.21**	**1.9**	**0.78**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	5/ 5	5.1	18.8	12.3	19.5	No	Below background
Barium	**7440-39-3**	**5/ 5**	**58.7**	**157**	**106**	**123**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**5/ 5**	**0.44**	**1.3**	**0.842**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**3/ 5**	**0.15**	**2.3**	**0.95**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	5/ 5	771	5440	2780	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**6/ 6**	**19.9**	**91.6**	**50.8**	**18.1**	**Yes**	**Exceeds background**
Chromium, hexavalent	**18540-29-9**	**1/ 5**	**10.6**	**10.6**	**2.73**		**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**5/ 5**	**5.9**	**19.3**	**13.3**	**9.1**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**5/ 5**	**14.1**	**106**	**57.1**	**27.6**	**Yes**	**Exceeds background**
Iron	7439-89-6	5/ 5	18300	41800	30300	28200	No	Essential Nutrient
Lead	**7439-92-1**	**5/ 5**	**13.1**	**52.4**	**27.7**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	5/ 5	2370	3690	3150	2760	No	Essential Nutrient
Manganese	7439-96-5	5/ 5	138	712	438	1950	No	Below background
Mercury	**7439-97-6**	**5/ 5**	**0.014**	**0.15**	**0.0662**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**5/ 5**	**13.1**	**41.1**	**28.7**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	5/ 5	1060	2100	1730	1950	No	Essential Nutrient
Selenium	**7782-49-2**	**3/ 5**	**0.22**	**2.9**	**0.839**	**1.7**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**3/ 5**	**0.55**	**11**	**3.81**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	5/ 5	82.7	340	156	112	No	Essential Nutrient
Thallium	7440-28-0	2/ 5	0.24	0.37	0.237	0.89	No	Below background
Vanadium	**7440-62-2**	**5/ 5**	**23.3**	**33.4**	**27.8**	**26.1**	**Yes**	**Exceeds background**
Zinc	7440-66-6	5/ 5	71.3	479	240	532	No	Below background
Explosives								
1,3-Dinitrobenzene	**99-65-0**	**1/ 5**	**0.036**	**0.036**	**0.0144**	**None**	**Yes**	**Detected organic**
2,4,6-Trinitrotoluene	**118-96-7**	**2/ 5**	**0.087**	**0.15**	**0.0575**	**None**	**Yes**	**Detected organic**
4-Amino-2,6-Dinitrotoluene	**19406-51-0**	**1/ 1**	**0.12**	**0.12**	**0.12**	**None**	**Yes**	**Detected organic**
HMX	**2691-41-0**	**1/ 5**	**0.083**	**0.083**	**0.0606**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**2/ 2**	**2**	**5.7**	**3.85**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**1/ 5**	**0.019**	**0.019**	**0.021**	**None**	**Yes**	**Detected organic**

Table 4–27. SRC Screening for Discrete Sediment Samples at the Upper Cobbs Pond (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Benz(a)anthracene	**56-55-3**	**1/ 2**	**0.078**	**0.078**	**0.0615**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 2**	**0.12**	**0.12**	**0.0845**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/ 2**	**0.19**	**0.19**	**0.14**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/ 2**	**0.11**	**0.11**	**0.12**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 2**	**0.067**	**0.067**	**0.081**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/ 2**	**0.11**	**0.11**	**0.072**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 2**	**0.22**	**0.22**	**0.15**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 2**	**0.09**	**0.09**	**0.0925**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 2**	**0.07**	**0.07**	**0.065**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/ 2**	**0.18**	**0.18**	**0.15**	**None**	**Yes**	**Detected organic**
Pesticides/PCBs								
PCB-1254	**11097-69-1**	**1/ 2**	**0.032**	**0.032**	**0.0685**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**2/ 2**	**0.022**	**0.033**	**0.0275**	**None**	**Yes**	**Detected organic**
Acetone	**67-64-1**	**2/ 2**	**0.088**	**0.091**	**0.0895**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

mg/kg = Milligrams per kilogram.

PCB = Polychlorinated biphenyl.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–28. SRC Screening for Discrete Subsurface Sediment Samples at the Upper Cobbs Pond

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	1/ 1	8500	8500	8500	13900	No	Below background
Antimony	**7440-36-0**	**1/ 1**	**0.19**	**0.19**	**0.19**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/ 1	5.5	5.5	5.5	19.5	No	Below background
Barium	7440-39-3	1/ 1	82.3	82.3	82.3	123	No	Below background
Beryllium	**7440-41-7**	**1/ 1**	**0.45**	**0.45**	**0.45**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**0.28**	**0.28**	**0.28**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	1650	1650	1650	5510	No	Essential Nutrient
Chromium	7440-47-3	1/ 1	15.5	15.5	15.5	18.1	No	Below background
Cobalt	**7440-48-4**	**1/ 1**	**10.1**	**10.1**	**10.1**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/ 1	12.6	12.6	12.6	27.6	No	Below background
Iron	7439-89-6	1/ 1	17200	17200	17200	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	13.5	13.5	13.5	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	1770	1770	1770	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	916	916	916	1950	No	Below background
Nickel	7440-02-0	1/ 1	14.8	14.8	14.8	17.7	No	Below background
Potassium	7440-09-7	1/ 1	534	534	534	1950	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	0.97	0.97	0.97	1.7	No	Below background
Silver	**7440-22-4**	**1/ 1**	**0.09**	**0.09**	**0.09**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	58.4	58.4	58.4	112	No	Essential Nutrient
Thallium	7440-28-0	1/ 1	0.13	0.13	0.13	0.89	No	Below background
Vanadium	7440-62-2	1/ 1	15	15	15	26.1	No	Below background
Zinc	7440-66-6	1/ 1	63.9	63.9	63.9	532	No	Below background

Table 4–28. SRC Screening for Discrete Subsurface Sediment Samples at the Upper Cobbs Pond (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Acenaphthylene	208-96-8	1/ 1	0.02	0.02	0.02	None	Yes	Detected organic
Anthracene	120-12-7	1/ 1	0.01	0.01	0.01	None	Yes	Detected organic
Benz(a)anthracene	56-55-3	1/ 1	0.05	0.05	0.05	None	Yes	Detected organic
Benzo(a)pyrene	50-32-8	1/ 1	0.063	0.063	0.063	None	Yes	Detected organic
Benzo(b)fluoranthene	205-99-2	1/ 1	0.11	0.11	0.11	None	Yes	Detected organic
Benzo(ghi)perylene	191-24-2	1/ 1	0.061	0.061	0.061	None	Yes	Detected organic
Benzo(k)fluoranthene	207-08-9	1/ 1	0.036	0.036	0.036	None	Yes	Detected organic
Chrysene	218-01-9	1/ 1	0.062	0.062	0.062	None	Yes	Detected organic
Fluoranthene	206-44-0	1/ 1	0.087	0.087	0.087	None	Yes	Detected organic
Indeno(1,2,3-cd)pyrene	193-39-5	1/ 1	0.054	0.054	0.054	None	Yes	Detected organic
Phenanthrene	85-01-8	1/ 1	0.024	0.024	0.024	None	Yes	Detected organic
Pyrene	129-00-0	1/ 1	0.069	0.069	0.069	None	Yes	Detected organic
Pesticides/PCBs								
delta-BHC	319-86-8	1/ 1	0.0018	0.0018	0.0018	None	Yes	Detected organic
VOCs								
2-Butanone	78-93-3	1/ 1	0.0072	0.0072	0.0072	None	Yes	Detected organic

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
SRC screening tables include all available and appropriate data as presented in Section 4.4.4.
BHC = Hexachlorocyclohexane.
CAS = Chemical Abstract Service.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4–29. SRC Screening for ISM Sediment Samples at Lower Cobbs Pond

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
				Metals				
Aluminum	**7429-90-5**	**1/ 1**	**15400**	**15400**	**15400**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**1/ 1**	**1.3**	**1.3**	**1.3**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/ 1	10.2	10.2	10.2	19.5	No	Below background
Barium	7440-39-3	1/ 1	116	116	116	123	No	Below background
Beryllium	**7440-41-7**	**1/ 1**	**0.83**	**0.83**	**0.83**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**1.2**	**1.2**	**1.2**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	2550	2550	2550	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**121**	**121**	**121**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**1/ 1**	**12**	**12**	**12**	**9.1**	**Yes**	**Exceeds background**
Lead	**7439-92-1**	**1/ 1**	**34.2**	**34.2**	**34.2**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/ 1	2600	2600	2600	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	602	602	602	1950	No	Below background
Mercury	**7439-97-6**	**1/ 1**	**0.1**	**0.1**	**0.1**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**1/ 1**	**24.6**	**24.6**	**24.6**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	1640	1640	1640	1950	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	1.6	1.6	1.6	1.7	No	Below background
Silver	**7440-22-4**	**1/ 1**	**1.5**	**1.5**	**1.5**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	203	203	203	112	No	Essential Nutrient
Vanadium	7440-62-2	1/ 1	24.5	24.5	24.5	26.1	No	Below background
Zinc	7440-66-6	1/ 1	259	259	259	532	No	Below background
				Anions				
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**1/ 1**	**8.5**	**8.5**	**8.5**	**None**	**Yes**	**Exceeds background**
				Miscellaneous				
Ammonia	**7664-41-7**	**1/ 1**	**61**	**61**	**61**	**None**	**Yes**	**Exceeds background**
Total Phosphorus as P	**7723-14-0**	**1/ 1**	**360**	**360**	**360**	**None**	**Yes**	**Exceeds background**
				SVOCs				
Di-n-butyl phthalate	**84-74-2**	**1/ 1**	**1.035**	**1.035**	**1.04**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

ISM = Incremental sampling methodology.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–30. SRC Screening for Discrete Sediment Samples at Lower Cobbs Pond

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	**7429-90-5**	**8/ 8**	**8920**	**16400**	**12800**	**13900**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**1/ 8**	**1.4**	**1.4**	**0.328**	**0**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**8/ 8**	**5.1**	**34.3**	**14.9**	**19.5**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**8/ 8**	**51.3**	**149**	**84.8**	**123**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**8/ 8**	**0.42**	**0.93**	**0.679**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**6/ 8**	**0.1**	**1.5**	**0.536**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	8/ 8	699	7360	2670	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**8/ 8**	**11.9**	**150**	**59**	**18.1**	**Yes**	**Exceeds background**
Chromium, hexavalent	**18540-29-9**	**2/ 6**	**5**	**5.7**	**2.12**		**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**8/ 8**	**8.6**	**21.3**	**12**	**9.1**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**8/ 8**	**12.4**	**149**	**56.6**	**27.6**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**1/ 6**	**0.4**	**0.4**	**0.225**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	8/ 8	15800	32200	23800	28200	No	Essential Nutrient
Lead	**7439-92-1**	**8/ 8**	**12.3**	**60.4**	**29.4**	**27.4**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	8/ 8	2140	3240	2610	2760	No	Essential Nutrient
Manganese	7439-96-5	8/ 8	217	966	502	1950	No	Below background
Mercury	**7439-97-6**	**7/ 8**	**0.016**	**0.093**	**0.0538**	**0.059**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**8/ 8**	**15.3**	**30.2**	**20.4**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	8/ 8	673	1860	1390	1950	No	Essential Nutrient
Selenium	**7782-49-2**	**4/ 8**	**0.45**	**2.2**	**0.72**	**1.7**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**5/ 8**	**0.052**	**2.4**	**0.852**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	8/ 8	47.3	190	119	112	No	Essential Nutrient
Thallium	7440-28-0	2/ 8	0.13	0.41	0.179	0.89	No	Below background
Vanadium	**7440-62-2**	**8/ 8**	**15.3**	**32.2**	**22.5**	**26.1**	**Yes**	**Exceeds background**
Zinc	7440-66-6	8/ 8	44.6	275	141	532	No	Below background
Explosives								
HMX	**2691-41-0**	**1/ 8**	**0.017**	**0.017**	**0.0596**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**1/ 1**	**7.8**	**7.8**	**7.8**	**None**	**Yes**	**Detected organic**
Tetryl	**479-45-8**	**1/ 8**	**0.022**	**0.022**	**0.0344**	**None**	**Yes**	**Detected organic**

Table 4–30. SRC Screening for Discrete Sediment Samples at Lower Cobbs Pond (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Benz(a)anthracene	**56-55-3**	**2/ 3**	**0.021**	**0.045**	**0.0437**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**2/ 3**	**0.02**	**0.052**	**0.0473**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**2/ 3**	**0.038**	**0.075**	**0.081**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**2/ 3**	**0.014**	**0.045**	**0.0813**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 3**	**0.013**	**0.013**	**0.0993**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**2/ 3**	**0.027**	**0.052**	**0.0423**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**1/ 3**	**0.022**	**0.022**	**0.352**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**2/ 3**	**0.042**	**0.095**	**0.084**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**2/ 3**	**0.014**	**0.042**	**0.0637**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 3**	**0.014**	**0.014**	**0.0813**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/ 3**	**0.032**	**0.083**	**0.095**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**2/ 2**	**0.025**	**0.047**	**0.036**	**None**	**Yes**	**Detected organic**
Acetone	**67-64-1**	**2/ 2**	**0.076**	**0.17**	**0.123**	**None**	**Yes**	**Detected organic**
Carbon disulfide	**75-15-0**	**1/ 2**	**0.0033**	**0.0033**	**0.0029**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–31. SRC Screening for Discrete Subsurface Sediment Samples at the Lower Cobbs Pond

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	1/ 1	13400	13400	13400	13900	No	Below background
Antimony	**7440-36-0**	**1/ 1**	**0.15**	**0.15**	**0.15**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	1/ 1	7.7	7.7	7.7	19.5	No	Below background
Barium	7440-39-3	1/ 1	114	114	114	123	No	Below background
Beryllium	**7440-41-7**	**1/ 1**	**0.68**	**0.68**	**0.68**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**0.44**	**0.44**	**0.44**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	2110	2110	2110	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**21.3**	**21.3**	**21.3**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**1/ 1**	**10.5**	**10.5**	**10.5**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/ 1	18	18	18	27.6	No	Below background
Iron	7439-89-6	1/ 1	22500	22500	22500	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	16.8	16.8	16.8	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	2780	2780	2780	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	596	596	596	1950	No	Below background
Mercury	7439-97-6	1/ 1	0.054	0.054	0.054	0.059	No	Below background
Nickel	**7440-02-0**	**1/ 1**	**21.4**	**21.4**	**21.4**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	989	989	989	1950	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	1	1	1	1.7	No	Below background
Silver	**7440-22-4**	**1/ 1**	**0.075**	**0.075**	**0.075**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 1	86.9	86.9	86.9	112	No	Essential Nutrient
Thallium	7440-28-0	1/ 1	0.21	0.21	0.21	0.89	No	Below background
Vanadium	7440-62-2	1/ 1	21	21	21	26.1	No	Below background
Zinc	7440-66-6	1/ 1	91.8	91.8	91.8	532	No	Below background
Explosives								
HMX	**2691-41-0**	**1/ 1**	**0.015**	**0.015**	**0.015**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**1/ 1**	**1.9**	**1.9**	**1.9**	**None**	**Yes**	**Detected organic**

Table 4–31. SRC Screening for Discrete Subsurface Sediment Samples at the Lower Cobbs Pond (continued)

Analyte (mg/kg)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
2-Methylnaphthalene	**91-57-6**	**1/ 1**	**0.025**	**0.025**	**0.025**	**None**	**Yes**	**Detected organic**
Acenaphthene	**83-32-9**	**1/ 1**	**0.0099**	**0.0099**	**0.0099**	**None**	**Yes**	**Detected organic**
Acenaphthylene	**208-96-8**	**1/ 1**	**0.091**	**0.091**	**0.091**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/ 1**	**0.07**	**0.07**	**0.07**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**1/ 1**	**0.34**	**0.34**	**0.34**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 1**	**0.47**	**0.47**	**0.47**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**1/ 1**	**0.8**	**0.8**	**0.8**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**1/ 1**	**0.47**	**0.47**	**0.47**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 1**	**0.21**	**0.21**	**0.21**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**1/ 1**	**0.4**	**0.4**	**0.4**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**1/ 1**	**0.023**	**0.023**	**0.023**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 1**	**0.12**	**0.12**	**0.12**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 1**	**0.48**	**0.48**	**0.48**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/ 1**	**0.02**	**0.02**	**0.02**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 1**	**0.43**	**0.43**	**0.43**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**1/ 1**	**0.038**	**0.038**	**0.038**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 1**	**0.15**	**0.15**	**0.15**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**1/ 1**	**0.41**	**0.41**	**0.41**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**1/ 1**	**0.012**	**0.012**	**0.012**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

SRC screening tables include all available and appropriate data as presented in Section 4.4.4.

CAS = Chemical Abstract Service.

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

SVOC= Semi-volatile organic compound.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–32. SRC Screening for Surface Water at the Backwater Area

Analyte (mg/L)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	4/ 4	0.26	2.52	1.15	3.37	No	Below background
Antimony	**7440-36-0**	**2/ 4**	**0.00096**	**0.001**	**0.00119**	**0**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**4/ 4**	**0.0009**	**0.0104**	**0.00415**	**0.0032**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**4/ 4**	**0.0198**	**0.382**	**0.141**	**0.0475**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**2/ 4**	**0.000053**	**0.000064**	**0.000102**	**0**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**2/ 4**	**0.000057**	**0.000062**	**0.00011**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	4/ 4	21.6	67.7	37.4	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**4/ 4**	**0.00056**	**0.0067**	**0.00297**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**4/ 4**	**0.00039**	**0.0107**	**0.00423**	**0**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**3/ 4**	**0.0019**	**0.0088**	**0.00355**	**0.0079**	**Yes**	**Exceeds background**
Iron	7439-89-6	4/ 4	0.846	16.3	7.64	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**2/ 4**	**0.00032**	**0.00047**	**0.000698**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	4/ 4	3.25	11.2	6.1	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**4/ 4**	**0.132**	**15.8**	**6.16**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**4/ 4**	**0.0019**	**0.0067**	**0.0037**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	4/ 4	1.39	15.7	6.1	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**3/ 4**	**0.00023**	**0.0104**	**0.00335**	**0**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**1/ 4**	**0.0017**	**0.0017**	**0.000603**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	4/ 4	1.6	12.9	5.93	21.3	No	Essential Nutrient
Thallium	**7440-28-0**	**1/ 4**	**0.00046**	**0.00046**	**0.000865**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**3/ 4**	**0.00051**	**0.005**	**0.00385**	**0**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**4/ 4**	**0.0101**	**0.109**	**0.0403**	**0.042**	**Yes**	**Exceeds background**
Anions								
Sulfate	**14808-79-8**	**1/ 2**	**29**	**29**	**15.1**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**1/ 2**	**2.3**	**2.3**	**1.28**	**None**	**Yes**	**Exceeds background**
Explosives								
4-Amino-2,6-Dinitrotoluene	**19406-51-0**	**2/ 2**	**0.000043**	**0.00007**	**0.0000565**	**None+**	**Yes**	**Detected organic**

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Table 4–32. SRC Screening for Surface Water at the Backwater Area (continued)

Analyte (mg/L)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
VOCs								
Acetone	**67-64-1**	**1/ 3**	**0.003**	**0.003**	**0.00433**	**None**	**Yes**	**Detected organic**
Chloromethane	**74-87-3**	**1/ 3**	**0.0007**	**0.0007**	**0.000567**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**1/ 3**	**0.001**	**0.001**	**0.000667**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

CAS = Chemical Abstract Service.

mg/L = Milligrams per liter.

SRC = Site-related contaminant.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–33. SRC Screening for Surface Water at Upper Cobbs Pond

Analyte (mg/L)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	5/ 5	0.0916	0.332	0.185	3.37	No	Below background
Antimony	**7440-36-0**	**1/ 5**	**0.00094**	**0.00094**	**0.00215**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	2/ 5	0.00078	0.0025	0.00464	0.0032	No	Below background
Barium	7440-39-3	5/ 5	0.0138	0.0226	0.0168	0.0475	No	Below background
Calcium	7440-70-2	5/ 5	13.2	24.3	19.6	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**2/ 5**	**0.00059**	**0.001**	**0.00108**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	3/ 5	0.0019	0.0051	0.00248	0.0079	No	Below background
Iron	7439-89-6	5/ 5	0.419	1.3	0.918	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**3/ 5**	**0.00039**	**0.0033**	**0.00158**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	5/ 5	1.75	4.41	3.36	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**5/ 5**	**0.0772**	**0.528**	**0.216**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**1/ 5**	**0.0019**	**0.0019**	**0.00178**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	5/ 5	0.894	1.57	1.26	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**1/ 5**	**0.00024**	**0.00024**	**0.00243**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	5/ 5	1.41	3.68	2.42	21.3	No	Essential Nutrient
Vanadium	**7440-62-2**	**1/ 5**	**0.00089**	**0.00089**	**0.00104**	**0**	**Yes**	**Exceeds background**
Zinc	7440-66-6	4/ 5	0.0041	0.0115	0.00984	0.042	No	Below background
Anions								
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**2/ 4**	**0.1**	**0.18**	**0.087**	**None**	**Yes**	**Exceeds background**
Sulfate	**14808-79-8**	**2/ 2**	**13**	**13**	**13**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**2/ 2**	**0.7**	**0.7**	**0.7**	**None**	**Yes**	**Exceeds background**
Miscellaneous								
Total Phosphorus as P	7723-14-0	2/ 2	0.06	0.24	0.15	None	No	Essential Nutrient
Explosives								
4-Amino-2,6-Dinitrotoluene	**19406-51-0**	**2/ 3**	**0.000072**	**0.00024**	**0.000147**	**None**	**Yes**	**Detected organic**
SVOCs								
Bis(2-ethylhexyl)phthalate	**117-81-7**	**2/ 3**	**0.0019**	**0.002**	**0.00313**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**2/ 3**	**0.0018**	**0.0046**	**0.0038**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).

CAS = Chemical Abstract Service.

Bold indicates analyte identified as an SRC.

mg/L = Milligrams per liter.

SRC = Site-related contaminant.

SVOC = Semi-volatile organic compound.

Table 4–34. SRC Screening for Surface Water at Lower Cobbs Pond

Analyte (mg/L)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
Metals								
Aluminum	7429-90-5	7/ 7	0.114	0.377	0.218	3.37	No	Below background
Antimony	**7440-36-0**	**4/ 7**	**0.00073**	**0.0034**	**0.00163**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	4/ 7	0.00078	0.0024	0.00371	0.0032	No	Below background
Barium	7440-39-3	7/ 7	0.0117	0.0228	0.0141	0.0475	No	Below background
Beryllium	**7440-41-7**	**1/ 7**	**0.000034**	**0.000034**	**0.000196**	**0**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 7**	**0.000043**	**0.000043**	**0.000389**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	7/ 7	10.9	38.7	20.4	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**2/ 7**	**0.00053**	**0.0011**	**0.00128**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**1/ 7**	**0.00015**	**0.00015**	**0.000691**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	4/ 7	0.0016	0.0029	0.0018	0.0079	No	Below background
Iron	7439-89-6	7/ 7	0.294	1.35	0.69	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**3/ 7**	**0.00029**	**0.0029**	**0.0015**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	7/ 7	1.55	6.71	3.6	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**7/ 7**	**0.0915**	**0.654**	**0.215**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**2/ 7**	**0.0014**	**0.0016**	**0.00161**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	7/ 7	0.497	1.61	1.23	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**1/ 7**	**0.00032**	**0.00032**	**0.00245**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	7/ 7	1.37	4.4	2.52	21.3	No	Essential Nutrient
Thallium	**7440-28-0**	**1/ 7**	**0.00035**	**0.00035**	**0.00348**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**5/ 7**	**0.00063**	**0.003**	**0.00196**	**0**	**Yes**	**Exceeds background**
Zinc	7440-66-6	5/ 7	0.0027	0.0139	0.0111	0.042	No	Below background
Anions								
Nitrate/Nitrite (NO_3/NO_2-N)	**14797-55-8**	**2/ 5**	**0.1**	**0.13**	**0.0664**	**None**	**Yes**	**Exceeds background**
Sulfate	**14808-79-8**	**3/ 3**	**14**	**19**	**16.3**	**None**	**Yes**	**Exceeds background**
Sulfide	**18496-25-8**	**1/ 3**	**0.7**	**0.7**	**0.4**	**None**	**Yes**	**Exceeds background**
Miscellaneous								
Total Phosphorus as P	7723-14-0	2/ 2	0.1	0.12	0.11	None	No	Essential Nutrient
Explosives								
4-Amino-2,6-Dinitrotoluene	**19406-51-0**	**1/ 4**	**0.00029**	**0.00029**	**0.000143**	**None**	**Yes**	**Detected organic**

Table 4–34. SRC Screening for Surface Water at Lower Cobbs Pond (continued)

Analyte (mg/L)	CAS Number	Freq of Detect	Minimum Detect	Maximum Detect	Average Result	Background Criteria[a]	SRC?	SRC Justification
SVOCs								
Benzenemethanol	**100-51-6**	**1/ 2**	**0.0049**	**0.0049**	**0.00495**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**2/ 4**	**0.0022**	**0.0029**	**0.00378**	**None**	**Yes**	**Detected organic**
Butyl benzyl phthalate	**85-68-7**	**1/ 4**	**0.0018**	**0.0018**	**0.00433**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**2/ 4**	**0.0023**	**0.012**	**0.00608**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001b).
CAS = Chemical Abstract Service.
mg/L = Milligrams per liter.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
Bold indicates analyte identified as an SRC.

Table 4–35. Data Summary and Designated Use for RI

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
Sediment										
CPCsd-001(P)-0650-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-002(P)-0651-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-003(P)-0652-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-004(P)-0653-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-005(P)-0654-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-006(P)-0655-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-007(P)-0656-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-007(P)-0657-FD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-008(P)-0659-SD	D	08/19/96	0–1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-009(P)-0660-SD	D	08/19/96	0–0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-010(P)-0661-SD	D	08/19/96	0–0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was used.
CPCsd-044-5022-SD	D	03/29/10	0–0.5	PBA08 RI	--	X	X	X	X	
CPCsd-045-5023-SD	D	04/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
CPCsd-045-5783-SD	D	04/01/10	0.5–2	PBA08 RI	--	X	X	X	--	
CPCsd-046-5024-SD	D	03/25/10	0–0.5	PBA08 RI	--	X	X	X	X	
CPCsd-046-5784-SD	D	03/25/10	0.5–2	PBA08 RI	--	X	X	X	--	
CPCsd-047-5025-SD	D	04/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
CPCsd-047-5785-SD	D	04/01/10	0.5–2	PBA08 RI	--	X	X	X	--	
CPCsd-048-5026-SD	D	04/01/10	0–0.5	PBA08 RI	--	X	X	X	X	
CPCsd-048-5786-SD	D	04/01/10	0.5–2	PBA08 RI	--	X	X	X	--	
CPCsd-049-5032-SD	D	03/25/10	0–0.5	PBA08 RI	--	X	X	X	X	
FSW-SD-012-0000	ISM	06/24/03	0–0.5	FWBWQS 2003	--	X	--	--	--	Off AOC sample used for nature and extent comparison only.

Table 4–35. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
FSW-SD-030-0000	ISM	06/23/03	0–0.3	FWBWQS 2003	--	X	X	X	X	
FSW-SD-031-0000	ISM	06/23/03	0–0.3	FWBWQS 2003	--	X	X	X	X	
ULCPsd-001-0001-SD	D	08/23/01	0–0.5	Phase II RI	--	--	--	--	--	Do not use sample because it was included in the Load Line 12 evaluation.
ULCPsd-002-0001-SD	D	08/23/01	0.3–1	Phase II RI	--	--	--	--	--	Do not use sample because it was included in the Load Line 12 evaluation.
ULCPsd-003-0001-SD	D	08/22/01	0–0.8	Phase II RI	--	--	--	--	--	Do not use sample because it was included in the Load Line 12 evaluation.
ULCPsd-004-0001-FD	D	08/22/01	0–1	Phase II RI	X	--	--	--	--	Field duplicate.
ULCPsd-004-0001-SD	D	08/22/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-005-0001-SD	D	08/22/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-006-0001-SD	D	08/22/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-007-0001-SD	D	08/21/01	0–0.8	Phase II RI	--	X	X	X	X	
ULCPsd-008-0001-SD	D	08/21/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-009-0001-SD	D	08/21/01	0–0.9	Phase II RI	--	X	X	X	X	
ULCPsd-011-0001-SD	D	08/20/01	0–0.8	Phase II RI	--	X	X	X	X	
ULCPsd-012-0001-SD	D	08/20/01	0–1.8	Phase II RI	--	X	X	X	X	
ULCPsd-013-0001-FD	D	08/20/01	0–1.8	Phase II RI	X	--	--	--	--	Field duplicate.
ULCPsd-013-0001-SD	D	08/20/01	0–1.8	Phase II RI	--	X	X	X	X	
ULCPsd-014-0001-SD	D	07/25/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-015-0001-SD	D	08/17/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-015-0002-SD	D	09/27/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-016-0001-SD	D	08/17/01	0–1.5	Phase II RI	--	X	X	X	X	
ULCPsd-017-0001-SD	D	08/17/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-018-0001-SD	D	08/16/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-019-0001-SD	D	08/16/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-020-0001-FD	D	08/16/01	0–0.8	Phase II RI	X	--	--	--	--	Field duplicate.
ULCPsd-020-0001-SD	D	08/16/01	0–0.8	Phase II RI	--	X	X	X	X	
ULCPsd-021-0001-SD	D	08/15/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-021-0002-SD	D	09/27/01	0–1	Phase II RI	--	X	X	X	X	
ULCPsd-022-0001-SD	D	08/15/01	0–0.8	Phase II RI	--	X	X	X	X	
ULCPsd-023-0001-SD	D	08/15/01	0–0.8	Phase II RI	--	X	X	X	X	
ULCPsd-024-0001-SD	D	08/14/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-025-0001-SD	D	07/25/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPsd-026-0001-SD	D	08/14/01	0–1	Phase II RI	--	X	X	X	X	

Table 4–35. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
ULCPsd-027-0001-SD	D	07/26/01	0–0.5	Phase II RI	--	--	--	--	--	Do not use sample because location was included in the Load Line 3 evaluation.
Soil										
CPCsb-030-5105-SO	D	03/29/10	0–1	PBA08 RI	--	X	X	X	X	
CPCsb-031-5109-SO	D	03/24/10	0–1	PBA08 RI	--	X	X	X	X	
CPCsb-032-5113-SO	D	03/24/10	0–1	PBA08 RI	--	X	X	X	X	
CPCsb-032-5114-SO	D	03/24/10	1–4	PBA08 RI	--	X	X	X	--	
CPCsb-032-5115-SO	D	03/24/10	4–7	PBA08 RI	--	X	X	X	--	
CPCsb-032-5116-SO	D	03/24/10	7–10	PBA08 RI	--	X	X	X	--	
CPCsb-032-6073-FD	D	03/24/10	1–4	PBA08 RI	X	--	--	--	--	Field duplicate.
CPCsb-034-5119-SO	D	03/29/10	0–1	PBA08 RI	--	X	X	X	X	
CPCsb-034-5120-SO	D	03/29/10	1–4	PBA08 RI	--	X	X	X	--	
CPCsb-035-5123-SO	D	03/29/10	0–1	PBA08 RI	--	X	X	X	X	
CPCsb-035-5124-SO	D	03/29/10	1–4	PBA08 RI	--	X	X	X	--	
CPCsb-035-5125-SO	D	03/29/10	4–7	PBA08 RI	--	X	X	X	--	
CPCsb-035-6072-FD	D	03/29/10	4–7	PBA08 RI	X	--	--	--	--	Field duplicate.
CPCss-036-5014-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-037-5015-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-037-6041-FD	D	02/23/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
CPCss-038-5016-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-039-5017-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-040-5018-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-041-5019-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-042-5020-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
CPCss-043-5021-SO	D	02/23/10	0–1	PBA08 RI	--	X	X	X	X	
ULCPsd-010-0001-SD	D	08/21/01	0–0.5	Phase II RI	--	X	X	X	X	
ULCPss-001-0001-SO	D	07/17/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-002-0001-SO	D	07/17/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-003-0001-SO	D	07/18/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-004-0001-SO	D	07/17/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-005-0001-SO	D	07/18/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-006-0001-SO	D	07/19/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-007-0001-FD	D	07/18/01	0–1	Phase II RI	X	--	--	--	--	Field duplicate.
ULCPss-007-0001-SO	D	07/18/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-008-0001-SO	D	07/18/01	0–1	Phase II RI	--	X	X	X	X	

Table 4–35. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
ULCPss-009-0001-SO	D	07/19/01	0–1	Phase II RI	--	X	X	X	X	
ULCPss-010-0001-SO	D	07/19/01	0–1	Phase II RI	--	X	X	X	X	
Surface Water										
CPCsw-044-5027-SW	D	03/29/10		PBA08 RI	--	X	X	X	X	
CPCsw-045-5028-SW	D	04/01/10		PBA08 RI	--	X	X	X	X	
CPCsw-046-5029-SW	D	03/25/10		PBA08 RI	--	X	X	X	X	
CPCsw-047-5030-SW	D	04/01/10		PBA08 RI	--	X	X	X	X	
CPCsw-047-6045-FD	D	04/01/10		PBA08 RI	X	--	--	--	--	Field duplicate.
CPCsw-048-5031-SW	D	04/01/10		PBA08 RI	--	X	X	X	X	
FSW-SW-012-0000	D	06/24/03	0–1	FWBWQS 2003	--	X	--	--	--	Off-AOC sample used for nature and extent comparison only.
FSW-SW-030-0000	D	06/23/03	0–1	FWBWQS 2003	--	X	X	X	X	
FSW-SW-031-0000	D	06/23/03	0–1	FWBWQS 2003	--	X	X	X	X	
FSW-SW-052-0000	D	09/16/03	0–1	FWBWQS 2003	--	X	--	--	--	Off-AOC sample used for nature and extent comparison only.
FSW-SW-070-0000	D	08/05/03	0–1	FWBWQS 2003	--	X	X	X	X	
FSW-SW-071-0000	D	08/05/03	0–1	FWBWQS 2003	--	X	X	X	X	
ULCPsw-001-0001-SW	D	07/26/01		Phase II RI	--	X	X	X	X	
ULCPsw-002-0001-FD	D	07/25/01		Phase II RI	X	--	--	--	--	Field duplicate.
ULCPsw-002-0001-SW	D	07/25/01		Phase II RI	--	X	X	X	X	
ULCPsw-003-0001-SW	D	07/24/01		Phase II RI	--	X	X	X	X	
ULCPsw-004-0001-SW	D	07/24/01		Phase II RI	--	X	X	X	X	
ULCPsw-005-0001-SW	D	07/24/01		Phase II RI	--	X	X	X	X	
ULCPsw-006-0001-SW	D	07/24/01		Phase II RI	--	X	X	X	X	
ULCPsw-007-0001-SW	D	07/24/01		Phase II RI	--	X	X	X	X	

AOC = Area of concern.
D = Discrete.
ERA = Ecological risk assessment.
ft = Feet.
F&T = Fate and transport.
FWBWQS = Facility-wide Biological Water Quality Study.
HHRA = Human health risk assessment.
ID = Identification.
N&E = Nature and extent.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
QC = Quality control.
RI = Remedial investigation.

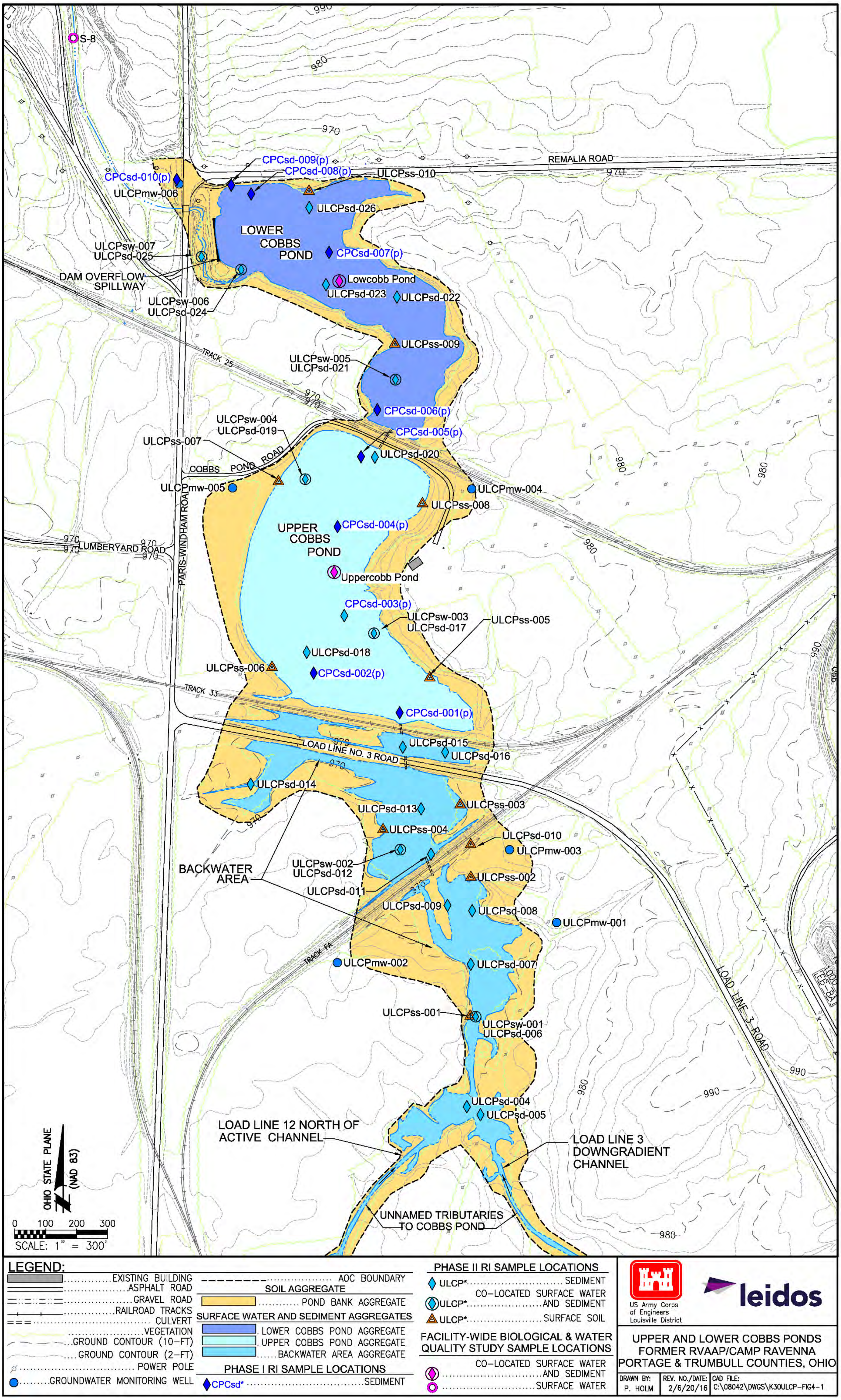

Figure 4–1. Historical Sample Locations at Upper and Lower Cobbs Ponds

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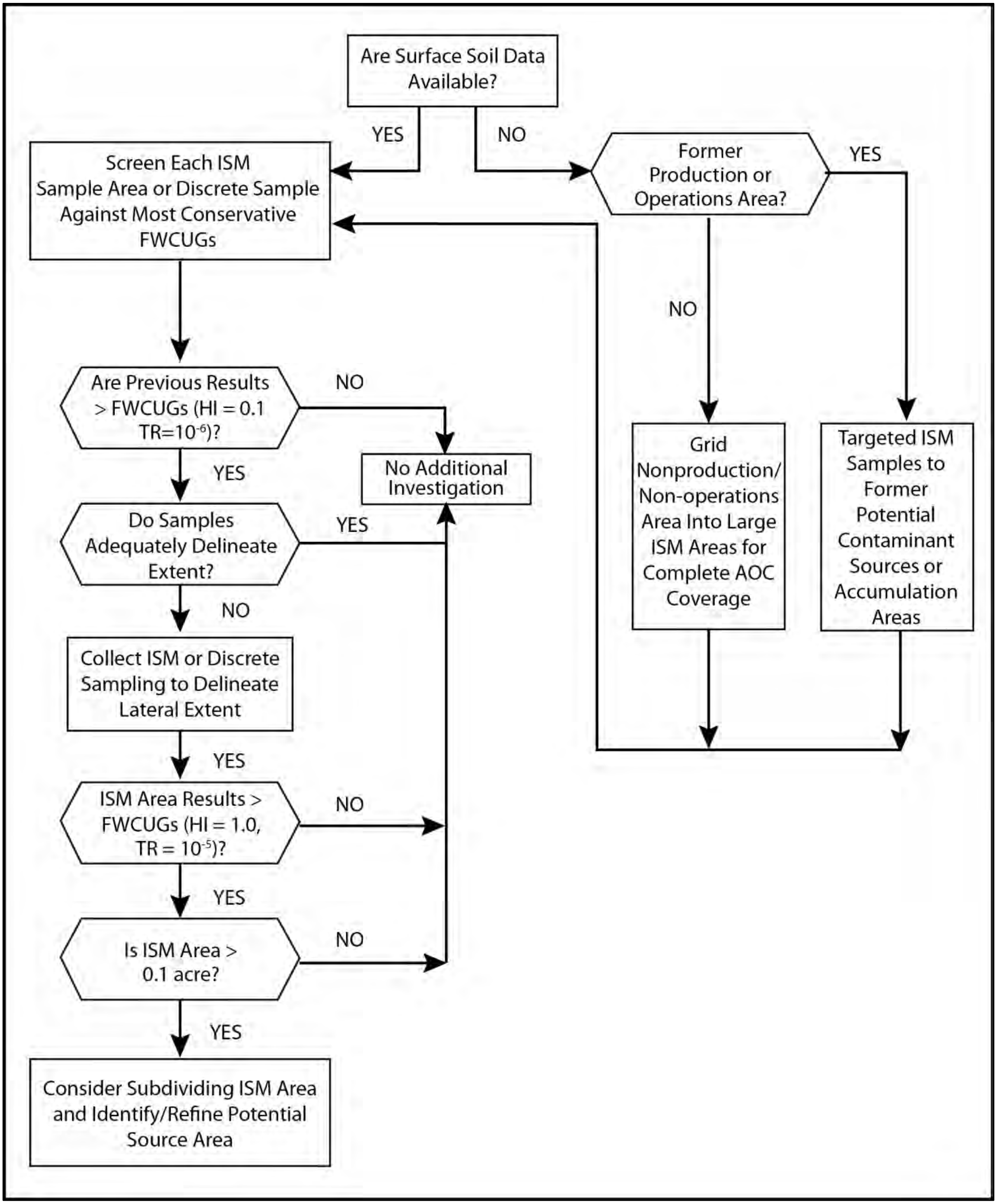

Figure 4–2. PBA08 RI Surface Soil Sampling

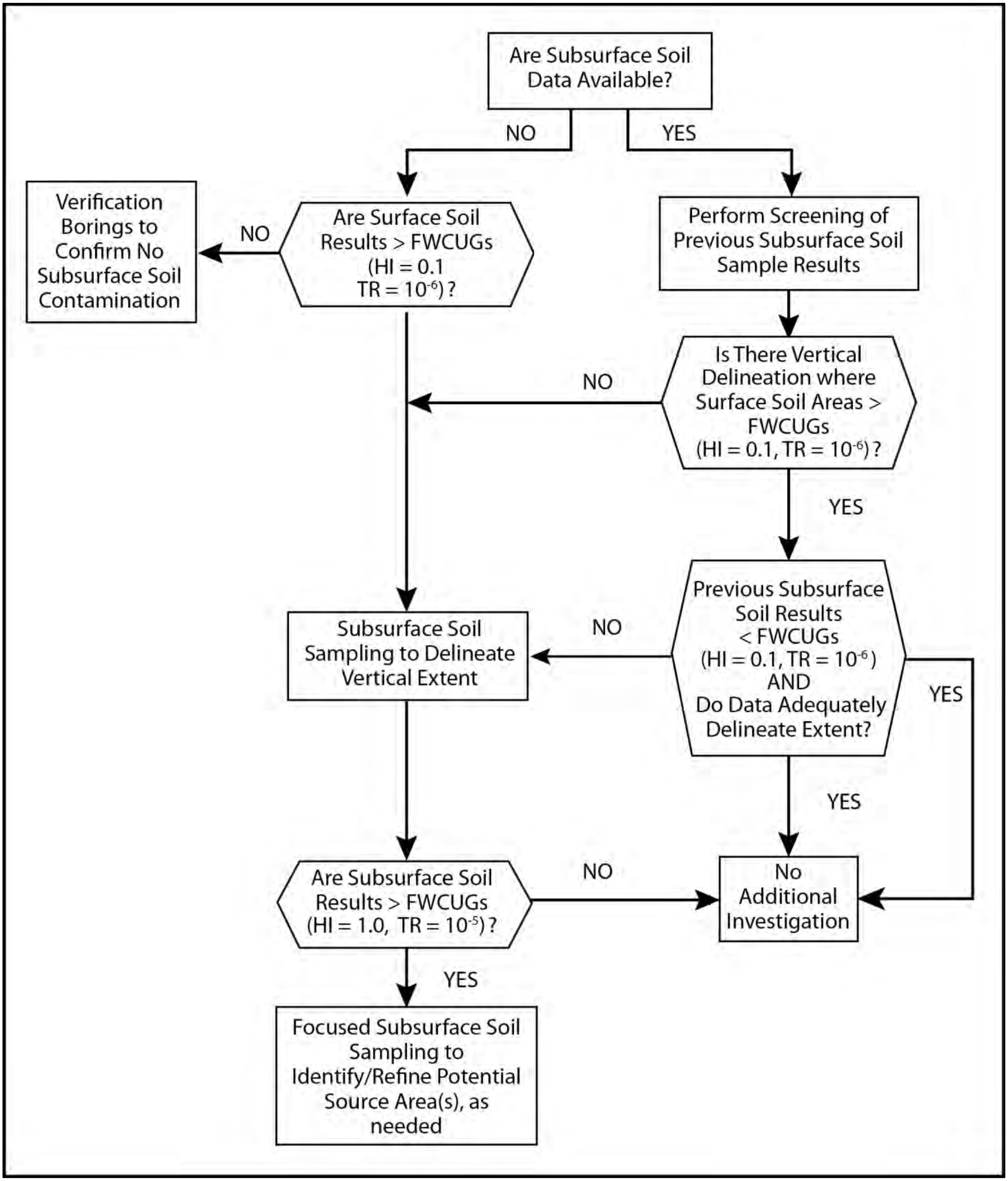

Figure 4–3. PBA08 RI Subsurface Soil Sampling

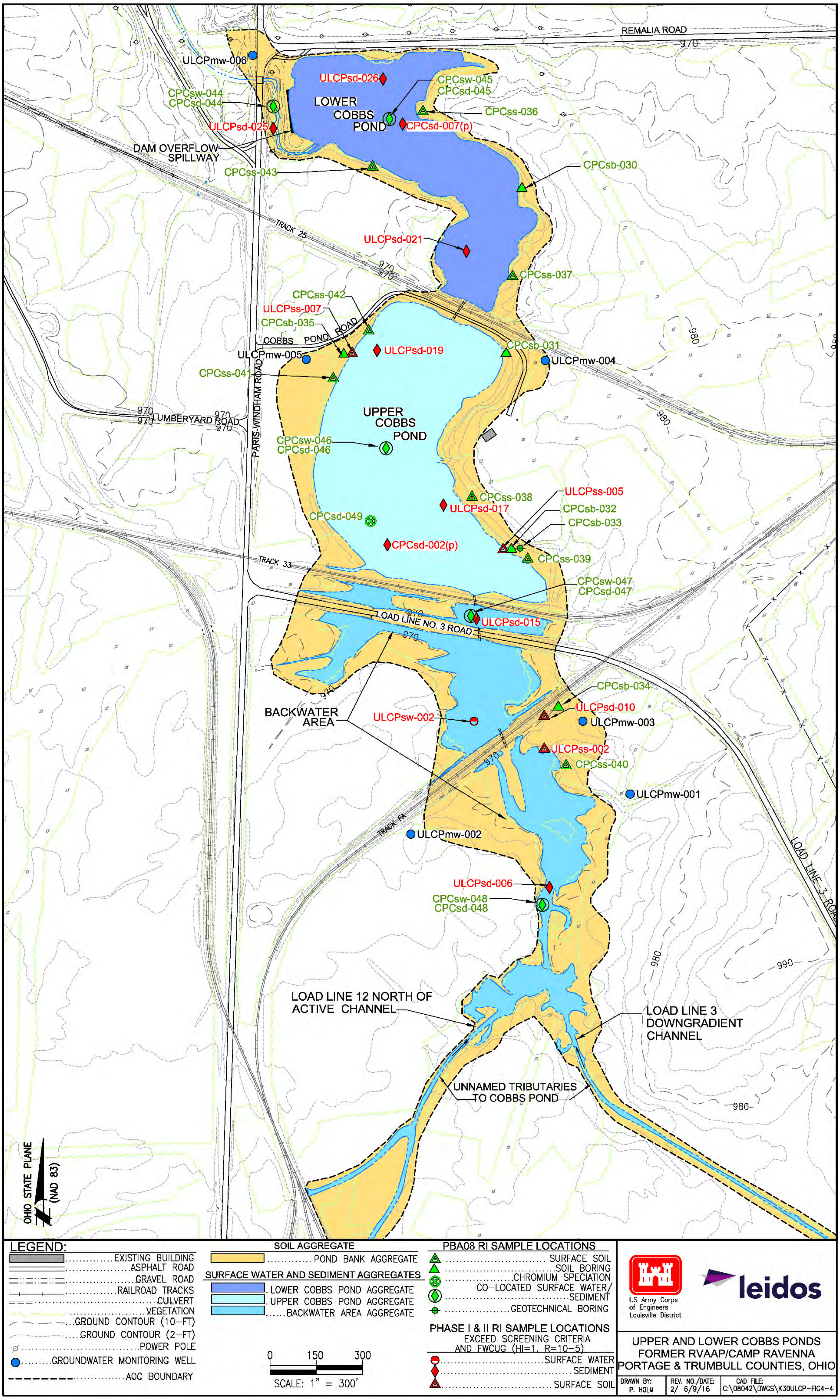

Figure 4–4. PBA08 RI Sample Locations at Upper and Lower Cobbs Ponds

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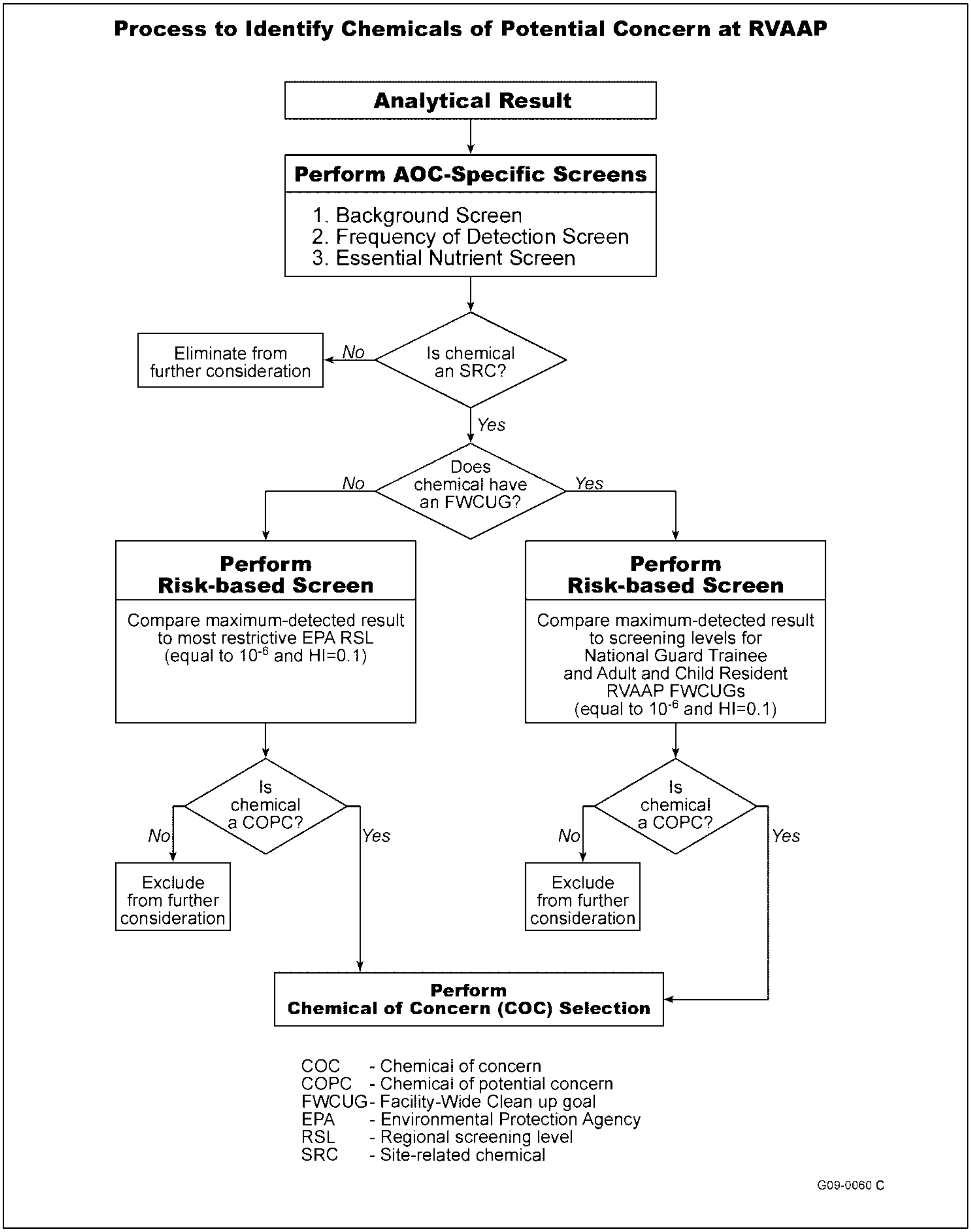

Figure 4–5. Process to Identify RVAAP COPCs in the HHRA (USACE 2010a)

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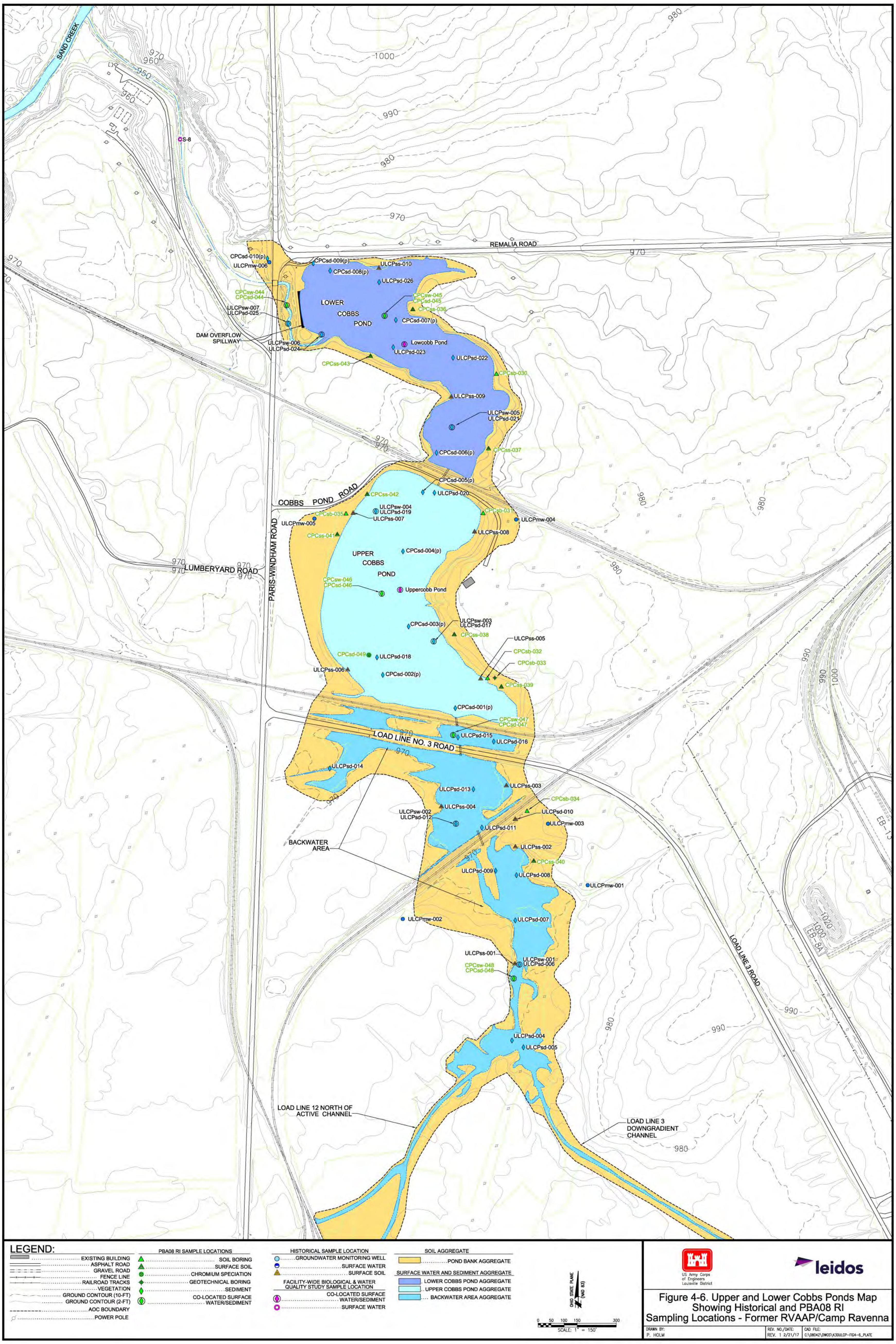

Figure 4–6. All Upper and Lower Cobbs Ponds RI Sample Locations

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section evaluates the nature and extent of contamination at the Upper and Lower Cobbs Ponds AOC and presents results of the analytical data obtained during the 1996 Phase I RI, 2001 Phase II RI, 2003 FWBWQS, and 2010 PBA08 RI. To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. If a chemical did not have a FWCUG, the SL was the lower of the USEPA Residential RSL for HQ of 0.1 or TR of 1E-06. The following figures illustrate the concentration and distribution of SRCs that exceed SLs:

- Figure 5-1 – Data Aggregates and Sample Locations at Upper and Lower Cobbs Ponds.
- Figure 5-2 – Detected Concentrations of Explosives and Propellants in Soil (Discrete Soil Borings).
- Figure 5-3 – Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Aluminum, Arsenic, Cobalt, and Cyanide in Soil (Discrete Soil Borings).
- Figure 5-4 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Soil (Discrete Soil Borings).
- Figure 5-5 – Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (Discrete Soil Borings).
- Figure 5-6 – Detected Concentrations of Explosives and Propellants in Surface Water and Sediment.
- Figure 5-7 – Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Aluminum, Arsenic, Hexavalent Chromium, Cobalt, Cyanide, Manganese, and Selenium in Surface Water and Sediment.
- Figure 5-8 – PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Surface Water and Sediment.
- Figure 5-9 – Detected Concentrations of VOCs, Pesticides, and PCBs in in Surface Water and Sediment.

As discussed in Section 4.0, data from all eligible samples were combined and screened to identify SRCs representing current conditions at the Upper and Lower Cobbs Ponds AOC. All validated Upper and Lower Cobbs Ponds AOC data from the RIs (1996 Phase I RI, 2001 Phase II RI, and 2010 PBA08 RI) and the 2003 FWBWQS are included in Appendix D. Complete analytical data packages from the PBA08 RI are also included in Appendix D.

5.1 DATA AGGREGATES AND EVALUATION

Data were grouped (aggregated) in three ways for evaluation of contaminant nature and extent and the HHRA and ERA. The initial basic aggregation of data was by environmental medium: surface soil, subsurface soil, sediment, and surface water. For each medium-specific aggregate, an evaluation was conducted to determine if further aggregation was warranted with respect to AOC characteristics, historical operations, ecological habitat, and potential future remedial strategy and land use (e.g., spatial aggregates). Data for soil were further aggregated based on depth and sample type for consistency with guidance established in the FWHHRAM and FWCUG Report. Data aggregates for evaluating the nature and extent of contamination at the Upper and Lower Cobbs Ponds AOC are as follows:

- **Surface Soil (0-1 ft bgs):** Using the above data aggregation criteria, surface soil within the geographic area of Upper Cobbs Pond, Lower Cobbs Pond, and the Backwater Area were evaluated as an AOC-wide spatial aggregate, designated as the Pond Bank aggregate. The Pond Bank is defined as the perimeter of the natural shorelines throughout the entirety of the AOC. It extends from the Backwater Area to the south at the confluence of the channels exiting Load Lines 3 and 12 and north to the intersection of Remalia Road and Paris-Windham Road. The areas encompassed within the Pond Bank are dry the majority of the time, although they may be intermittently wet in association with heavy rainfall events when they may receive runoff from the surrounding areas or when water levels within the AOC are elevated.
- **Subsurface Soil (less than 1 ft bgs):** This medium was classified as an AOC-wide spatial aggregate on the same basis as surface soil (i.e., Pond Bank).
- **Sediment:** Sediment samples were divided into three spatial aggregates: Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. These three aggregates are perennially inundated water bodies. The Backwater Area is in the southern portion of the complex, extending from the confluence of the drainage channels exiting Load Line 3 and Load Line 12 north to Track 33. Upper Cobbs Pond is the portion of the water body north of Track 33 to Cobbs Pond Road. Lower Cobbs Pond is the portion north of the Cobbs Pond Road, bounded by Remalia Road on the north and Paris-Windham Road to the west.
- **Surface Water:** This medium is subdivided into the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond spatial aggregates on the same basis as sediment. The direction of flow within the AOC is from the south (Backwater Area) towards the dam overflow spillway at the north (Lower Cobbs Pond).

Surface soil, surface water, and sediment samples were collected during prior investigations such as the 1996 Phase I RI (USACE 1998), 2003 FWBWQS (USACE 2005a), 2001 Phase II RI (MKM 2005), and 2010 PBA08 RI. All media, with the exception of sediment during the 2003 FWBWQS, were sampled using discrete methods.

The media sampled during each of these events are summarized below.

- 1996 Phase I RI
    - The only medium sampled in the 1996 Phase I RI was sediment.
    - Since more recent sample data were available, the Phase I samples were utilized for nature and extent purposes only.

- 2001 Phase II RI
    - Media sampled were surface soil, sediment, and surface water.
- 2003 FWBWQS
    - Media sampled were sediment and surface water.
    - Each pond bottom sediment sample was an incremental sampling methodology (ISM) sample.
    - Pond water samples were discrete grab samples.
- 2010 PBA08 RI
    - Media sampled were surface soil, subsurface soil, sediment (0–0.5 ft bgs), subsurface sediment (0.5–2 ft bgs) and surface water.
    - The PBA08 RI samples collected within the 0.5–2 ft bgs interval were screened as subsurface sediment.

All available sample data were evaluated to determine suitability for use in the various key RI data screens and evaluations (nature and extent, fate and transport, risk assessment). Evaluation of data suitability for use involved two primary considerations: (1) representativeness with respect to current AOC conditions; and (2) sample collection methods (e.g., discrete vs. ISM).

Samples from the 1996 Phase I RI and 2001 Phase II RI data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI activities. No disturbance activities have occurred at the AOC between 1996 Phase I RI and 2010 PBA08 RI activities. For soil, all data collected during these RI data sets were utilized in screening for SRCs and COPCs and were carried forward into the risk assessment. The full Phase II RI and PBA08 RI data sets were incorporated into the sediment and surface water SRC screening process. Since more recent sample data were available, the Phase I samples were utilized for nature and extent purposes only.

The surface sediment screening data set includes both the PBA08 RI samples from the 0–0.5 ft bgs interval and historical sediment samples. ISM sediment samples were screened separately from discrete samples.

5.2 SURFACE SOIL SAMPLE RESULTS FOR CHROMIUM SPECIATION

During the PBA08 RI, a sediment sample was collected from one discrete sample location (CPCsd-049) and analyzed for hexavalent chromium and total chromium. The result is presented in Table 5-1. Since historical samples at the AOC also incorporated hexavalent chromium analysis, this speciation sample was also utilized in the SRC screening data set. This sampling was conducted to determine the contribution of hexavalent chromium to total chromium in soil at the AOC for use in the HHRA (Section 7.2).

5.3 CONTAMINANT NATURE AND EXTENT IN SOIL

The Pond Bank SRC screening data set included 10 discrete surface soil samples collected in 2001 under the Phase II RI and 13 discrete surface soil samples collected during the PBA08 RI. Eleven of the PBA08 RI samples were analyzed for TAL metals, explosives, and SVOCs; two samples were analyzed for RVAAP full-suite analytes. Table 4-22 presents the results of the SRC screening for surface soil samples for the Pond Bank.

Subsurface soil samples were not collected during historical investigations at the AOC. The Pond Bank SRC screening data set for subsurface soil was comprised of six discrete subsurface soil samples collected during the PBA08 RI. Four of the samples were analyzed for TAL metals, explosives, and SVOCs; two samples collected from one boring location were analyzed for RVAAP full-suite analytes. Table 4-23 presents the results of the SRC screening for subsurface soil samples for the Pond Bank.

Tables 4-13 and 4-15 summarize the analytical results for all detected analytes in the Phase II RI surface samples and the PBA08 RI surface and subsurface soil samples at the Pond Bank. Complete copies of all the laboratory analytical data packages are presented in Appendix D.

5.3.1 Explosives and Propellants

Surface and Subsurface Soil

The propellant nitrocellulose was identified as an SRC in surface and subsurface soil at the Pond Bank. Nitrocellulose was detected in all three surface soil samples where analyzed: PBA08 RI locations CPCsb-035 (1.5J mg/kg), CPCss-039 (1.2J mg/kg), and Phase II RI sample ULCPss-007 (1.5 mg/kg). Nitrocellulose was detected in the 1–4 ft bgs interval at the PBA08 RI location CPCsb-035 but was not detected in the sample collected from the 4–7 ft bgs interval. As shown on Figure 5-2, these soil sample locations were located on the perimeter of the Upper Cobbs Pond. All detected concentrations of nitrocellulose were below the RSL for HQ of 0.1 or TR 1E-06 and were not considered COPCs. No explosives were detected in surface and subsurface soil at the Pond Bank.

5.3.2 Inorganic Chemicals

Surface Soil

Eighteen inorganic chemicals (16 metals, cyanide, and nitrate/nitrite) were identified as SRCs in surface soil at the Pond Bank.

Of these eighteen inorganic chemicals, four (aluminum, arsenic, cobalt, and cyanide) were above the background concentration and exceeded their respective SLs in order to be identified as COPCs as described below.

- Aluminum was detected above the background concentration of 17,700 mg/kg and its respective SL of 3,496 mg/kg at two surface soil sample locations (ULCPss-004 and ULCPss-005). The maximum concentration of 19,200 mg/kg was observed at Phase II RI sample location ULCPss-005.

- Arsenic was detected above the background concentration of 15.4 mg/kg and its respective SL of 0.425 mg/kg at four surface soil sample locations, ranging from 16.3 mg/kg (CPCsb-005) to 28.4 mg/kg (ULCPsd-010). The maximum concentration was detected at the Phase II RI sample location in the drainage ditch alongside Track FA that crosses the Backwater Area. The PBA08 RI sample collected at this same location also exceeds the background concentration, but at a lower concentration (CPCsb-034).
- Cobalt was detected above the background concentration of 10.4 mg/kg and its respective SL of 7.03 mg/kg at eight surface soil sample locations, ranging from 10.6 mg/kg (ULCPss-002) to 16.4 mg/kg (CPCsb-032). The Phase II RI sample collected at this same location (Figure 5-3) also exceeds the background concentration and SL, but at a lower concentration (ULCPss-005).
- Cyanide was analyzed in 11 of the Phase II RI samples and was detected in 4 samples above its respective SL of 0.27 mg/kg, ranging from 0.31 mg/kg (ULCPss-004) to 1.2 mg/kg (ULCPsd-010). The maximum concentration was detected in the drainage ditch alongside Track FA that crosses the Backwater Area.

Figure 5-3 presents the locations with concentrations that were above the background concentration and exceeded their respective SLs for these chemicals. Concentrations of chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg).

Subsurface Soil

Four inorganic chemicals (cadmium, lead, selenium, and silver) were identified as SRCs in subsurface soil samples at the Pond Bank. Background concentrations are not established for cadmium and silver. Cadmium was detected in all six subsurface soil samples, with concentrations ranging from 0.032J (CPCsb-032) to 0.18J mg/kg (CPCsb-035). Silver was detected in two subsurface soil samples, with concentrations of 0.029J mg/kg (CPCsb-032) and 0.013J mg/kg (CPCsb-035) from the 4-7 ft bgs interval at both locations. Lead was detected in all six subsurface soil samples but was detected above the background concentration of 19.1 mg/kg at one location (CPCsb-035 from the 1-4 ft bgs interval) with a concentration of 23.3 mg/kg. Selenium also was detected in all subsurface soil samples; however, one concentration was detected above the background concentration of 1.5 mg/kg in one location (CPCsb-032 from the 1–4 ft bgs interval) with a concentration of 1.6 mg/kg. At the two soil borings where multiple intervals were analyzed, the higher concentrations were generally observed in the shallowest interval. No concentrations detected in the subsurface soil at the Pond Bank exceeded their respective SLs and were not considered COPCs.

5.3.3 Semi-volatile Organic Compounds

Surface Soil

SVOCs do not have background concentrations for comparison to chemical results; consequently a large number of SVOCs were identified as SRCs in the surface soil. Sixteen SVOCs were identified as SRCs in surface soil at the Pond Bank. Twelve of the SVOC SRCs were PAHs. As shown on Figure 5-4, benzo(a)pyrene was detected at two sample locations (CPCsb-035 and CPCss-042) with concentrations that exceeded its respective SL of 0.022 mg/kg, and benzo(a)pyrene was identified as a COPC. PBA08 RI sample locations CPCsb-035 and CPCss-042 are located on the western bank of the Upper Cobbs Pond and immediately south of Cobbs Pond Road (Figure 5-4). The benzo(a)pyrene concentrations were detected below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. All other SVOC detections in surface soil were observed throughout the Pond Bank and the majority of detections occurred at low, estimated concentrations below laboratory reporting limits.

Subsurface Soil

Thirteen SVOCs, 12 of which were PAHs, were identified as SRCs in the subsurface soil at the Pond Bank. Twelve of the 13 SVOCs were detected from the 1-4 ft bgs interval at PBA08 RI sample location CPCsb-035, and the majority of detections were observed at low, estimated concentrations below laboratory reporting limits. However, benzo(a)pyrene was detected at CPCsb-035 from the 1-4 ft bgs interval at a concentration of 0.066 mg/kg that exceeded its respective SL of 0.022 mg/kg. The concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 and was not detected in the 4-7 ft bgs interval at CPCsb-035 (Figure 5-4).

5.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Surface and Subsurface Soil

The pesticide beta-hexachlorocyclohexane (BHC) was identified as an SRC in surface soil at the Pond Bank, as shown in Figure 5-5. Beta-BHC was detected in only one surface soil sample, PBA08 RI location CPCsb-035, at a concentration of 0.0035J mg/kg. The concentration was detected below its respective SL and was not detected in the two subsurface intervals collected at CPCsb-035. VOCs and PCBs were not detected in surface soil at the Pond Bank. No VOCs, PCBs, or pesticides were detected in subsurface soil at the Pond Bank.

5.3.5 Geotechnical Subsurface Soil Samples

One soil boring was completed at the Upper and Lower Cobbs Ponds AOC for the purposes of obtaining geotechnical parameters to perform vadose zone soil leaching and groundwater transport modeling. Two samples were collected from this soil boring, from the 4-5.4 ft bgs and 8-9.7 ft bgs intervals. Soil boring CPCsb-033 was advanced to a depth of 13 ft bgs, with groundwater encountered at 10 ft bgs. Bedrock was not encountered at this boring location. Table 5-2 summarizes the results of the geotechnical characteristics of soil at the Upper and Lower Cobbs Ponds. Laboratory analytical data package results are presented in Appendix D.

5.4 CONTAMINANT NATURE AND EXTENT IN SEDIMENT AND SURFACE WATER

Nine discrete sediment samples (0-0.5 ft bgs and 0.5-2 ft bgs) were collected at the at the Upper and Lower Cobbs Ponds AOC during the PBA08 RI; four were located within the Backwater Area (two surface and two subsurface), two were located within the Upper Cobbs Pond (one surface and one subsurface), and three were located within the Lower Cobbs Pond (two surface and one subsurface). Eight sediment samples were analyzed for RVAAP full-suite analytes. Tables 4-24 through 4-31 present the results of the SRC screening for sediment at the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond aggregates, respectively. The 2003 FWBWQS sediment samples were evaluated separately from the other studies because they were ISM samples and the other studies took discrete samples. The results of the detected analytes for the PBA08 RI sediment samples are summarized in Table 4-18 for the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond aggregates, respectively. Complete copies of the laboratory analytical packages are presented in Appendix D.

Under the PBA08 RI sampling activities, samples were collected at the 0–0.5 and 0.5–2 ft bgs intervals at a subset of locations in order to provide characterization of vertical extent. The PBA08 RI samples collected within the 0.5–2 ft bgs interval were screened as subsurface sediment. The surface sediment screening data set includes both the PBA08 RI samples from the 0–0.5 ft bgs interval and historical sediment samples. In each of the SRC screening tables, the results for surface sediment and subsurface sediment are presented. Historical sediment samples from the 1996 Phase I RI are retained in the discussion of nature and extent, but were omitted from the SRC screening process since more recent data from the 2001 Phase II RI and the 2010 PBA08 RI activities are available.

Surface water is present perennially within the AOC, which receives drainage from the Load Line 3 and Load Line 12 channels and conveys the flow north through the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Five surface water locations were sampled during the PBA08 RI; two at the Backwater Area, one at Upper Cobbs Pond, and two at Lower Cobbs Pond. The 2010 PBA08 RI, the 2001 Phase II RI, and 2003 FWBWQS surface water samples were utilized in the SRC screening data set. Tables 4-32 through 4-34 summarize the results of the surface water SRC screening for the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond, respectively. The results of the detected analytes for the PBA08 RI surface water samples are summarized in Table 4-17 for the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Water quality parameters measured at the time of surface water sample collection are presented in Table 5-3. Complete copies of laboratory analytical packages are presented in Appendix D.

5.4.1 Explosives and Propellants

Backwater Area

Three explosives (TNT; 2,6-DNT; and tetryl) and one propellant (nitrocellulose) were identified as SRCs in surface sediment samples at the Backwater Area. The maximum detections of TNT and 2,6-DNT were observed at Phase II RI sample location ULCPsd-005 at the mouth of the channel draining from Load Line 3 into the Backwater Area (Figure 5-6). Nitrocellulose and tetryl were detected at their maximum concentrations at PBA08 RI location CPCsd-047 in surface sediment but not in the subsurface interval. The detected concentrations were below their respective SLs and were not considered to be COPCs. No explosives or propellants were detected in the subsurface sediment samples at the Backwater Area.

The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at the Backwater Area. 4-amino-2,6-DNT was detected in both PBA08 RI sample locations for this aggregate at low, estimated concentrations below laboratory reporting limits. No propellants were detected in the Backwater Area surface water.

Upper Cobbs Pond

Five explosives (1,3-dinitrobenzene; TNT; 4-amino-DNT; HMX; and tetryl) and one propellant (nitrocellulose) were identified as SRCs in surface sediment at Upper Cobbs Pond. All of the SRCs were detected at PBA08 RI sample location CPCsd-046, but were not detected in the subsurface sediment sample collected at the same location. Sample location CPCsd-046 was collected from the center of the Upper Cobbs Pond (Figure 5-6). The detected concentrations were below their respective SLs and were not considered to be COPCs. No explosives or propellants were detected in the subsurface sediment at the Upper Cobbs Pond.

The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at Upper Cobbs Pond. 4-Amino-2,6-DNT was detected in the PBA08 RI sample CPCsw-046 at a low, estimated concentration below the laboratory reporting limit (0.00007J mg/L) and in the June 2003 sample from the FWBWQS Upper Cobbs Pond station (0.00024J mg/L). No propellants were detected in the Upper Cobbs Pond surface water.

Lower Cobbs Pond

Two explosives (HMX and tetryl) and one propellant (nitrocellulose) were identified as SRCs in surface sediment at Lower Cobbs Pond. HMX was detected only at PBA08 RI location CPCsd-044, and nitrocellulose and tetryl were only detected at PBA08 RI location CPCsd-045. The detected concentrations were below their respective SLs and were not considered to be COPCs.

HMX and propellant nitrocellulose also were identified as SRCs in subsurface sediment at Lower Cobbs Pond. Nitrocellulose was detected at a higher concentration in the corresponding surface sediment sample at location CPCsd-045, at 7.8J mg/kg versus 1.9J mg/kg. HMX was not detected in the corresponding surface sediment sample.

The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at Lower Cobbs Pond. 4-Amino-2,6-DNT was detected at a concentration of 0.00029J mg/L in the August 2003 FWBWQS sample at Lower Cobbs Pond. 4-Amino-2,6-DNT was not detected in the subsequent PBA08 RI samples taken at CPCsw-044 and CPCsw-045 in 2010. No propellants were detected in surface water at the Lower Cobbs Pond.

5.4.2 Inorganic Chemicals

Backwater Area

Sixteen inorganic chemicals (14 metals, cyanide, and nitrate/nitrite) were identified as SRCs in surface sediment samples in the Backwater Area.

Of the sixteen inorganic chemicals, three (aluminum, cobalt, and cyanide) were detected above the background concentration and/or exceeded their respective SLs in order to be identified as COPCs as described below.

- Aluminum was detected above the background concentration of 13,900 mg/kg and its respective SL of 3,496 mg/kg at four surface sediment sample locations. The maximum concentration of 18,600 mg/kg was observed at Phase II RI sample location ULCPsd-013.
- Cobalt was detected above the background concentration of 9.1 mg/kg and its respective SL of 2.3 mg/kg at eleven surface sediment sample locations, ranging from 10.6 mg/kg (CPCsd-048) to 22.8 mg/kg (CPCsd-047). Cobalt was detected below the background concentration at the Phase II RI sample collected at a nearby location (ULCPsd-015) (See Figure 5-7).
- Cyanide was analyzed in 12 of the surface sediment samples and was detected in 3 samples; however, only one sample exceeded its respective SL of 0.27 mg/kg. The concentration of 0.55 mg/kg was detected in in the Phase II RI sample UCLPsd-009.

Figure 5-7 presents the locations with concentrations that were above the background concentration and exceeded their respective SLs for these chemicals. Concentrations of chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg).

In the subsurface sediment in the Backwater Area, five inorganic chemicals (antimony, beryllium, cadmium, cobalt, and silver) were identified as SRCs. Overall concentrations of the inorganic SRCs were generally lower in the subsurface interval than their corresponding surface sample. Only one of the five inorganic chemicals identified as SOCs were determined to be a COPC. Cobalt was detected above the background concentration (9.1 mg/kg) and its respective SL (2.3 mg/kg) in one subsurface sediment location (CPCsd-048) in the interval from 0.5-2 ft bgs.

Eighteen inorganic chemicals (16 metals, sulfate, and sulfide) were identified as SRCs in surface water in the Backwater Area.

Of the eighteen inorganic chemicals, four (arsenic, cobalt, manganese, selenium) were detected above the background concentration and/or exceeded their respective SLs in order to be identified as COPCs as described below.

- Arsenic was detected above the background concentration of 0.0032 mg/L and its respective SL of 0.0011 mg/L at two surface water sample locations. The maximum concentration of 0.0104 mg/L was observed at Phase II RI sample location ULCPsw-001.

- Cobalt exceeded its respective SL of 0.0006 mg/L at two surface water sample locations. The maximum concentration of 0.0107 mg/L was observed at Phase II RI sample location ULCPsw-001.
- Manganese was detected above the background concentration of 0.391 mg/L and its respective SL of 0.633 mg/L at two surface water sample locations. The maximum concentration of 15.8 was observed at Phase II RI sample location ULCPsw-002.
- Selenium exceeded its respective SL of 0.01 mg/L at one surface water sample location (ULCPsw-001) with a concentration of 0.0104 mg/L.

As shown on Figure 5-7, concentrations of manganese at ULCPsw-001 and ULCPsw-002 and cobalt at ULCPsw-001 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

Upper Cobbs Pond

Fifteen inorganic chemicals were identified as SRCs in the surface sediment in the Upper Cobbs Pond. Of the fifteen inorganic chemicals, three [aluminum, chromium (hexavalent), and cobalt] were detected above the background concentration and/or exceeded their respective SLs in order to be identified as COPCs as described below.

- Aluminum was detected above the background concentration of 13,900 mg/kg and its respective SL of 3,496 mg/kg at four surface sediment sample locations. The maximum concentration of 21,400 mg/kg was observed at Phase II RI sample location ULCPsd-017.
- Hexavalent chromium exceeded its respective SL of 1.64 mg/kg at one surface sediment location (ULCPsd-018) with a concentration of 10.6 mg/kg.
- Cobalt was detected above the background concentration of 9.1 mg/kg and its respective SL of 2.3 mg/kg at four surface sediment sample locations, ranging from 10.9 mg/kg (CPCsd-020) to 19.3 mg/kg (ULCPsd-017).

Figure 5-7 presents the locations with concentrations that were above the background concentration and exceeded their respective SLs for these chemicals. Concentrations of total chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg).

In subsurface sediment in the Upper Cobbs Pond, five inorganic chemicals (antimony, beryllium, cadmium, cobalt, and silver) were identified as SRCs. These also were identified as SRCs in surface sediment. Overall concentrations were lower in the subsurface interval than their corresponding surface sample, as fourteen inorganic chemicals were detected above background concentrations in the 0–0.5 ft bgs interval at location CPCsd-046. The concentration of cobalt in the 0.5-2 ft bgs interval (10.1 mg/kg) was detected above the background concentration of 9.1 mg/kg and exceeded its respective SL of 2.3 mg/kg. Cobalt was the only subsurface sediment SRC to be identified as a COPC.

Seven metals, nitrate/nitrite, sulfate, and sulfide were identified as SRCs in surface water in the Upper Cobbs Pond. All detections in PBA08 RI sample CPCsw-046 were at low, estimated concentrations below laboratory reporting limits. Although manganese was detected above the background concentration of 0.391 mg/L in historical sample ULCPsw-003 (0.528 mg/L), manganese was not detected above the background concentration in the samples from the 2003 FWBWQS or PBA08 RI. No inorganic chemicals exceeded their respective SLs and were considered to be COPCs. Nitrate/nitrite, sulfate, and sulfide were detected but do not have respective SLs.

Lower Cobbs Pond

Seventeen inorganic chemicals were identified as SRCs in the surface sediment in the Lower Cobbs Pond. Of the seventeen inorganic chemicals, five [aluminum, arsenic, chromium (hexavalent), cobalt, and cyanide] were detected above the background concentration and/or exceeded their respective SLs in order to be considered COPCs as described below.

- Aluminum was detected above the background concentration of 13,900 mg/kg and its respective SL of 3,496 mg/kg at four surface sediment sample locations. The maximum concentration of 16,400 mg/kg was observed at Phase II RI sample location ULCPsd-026.
- Arsenic was detected above the background concentration of 19.5 mg/kg and its respective SL of 0.425 mg/kg at two surface sediment sample locations. The maximum concentration of 34.3 mg/kg was observed at Phase II RI sample location ULCPsd-026.
- Hexavalent chromium exceeded its respective SL of 2.3 mg/kg at two surface sediment location (ULCPsd-021 and ULCPsd-022) with concentrations of 5.7 and 5 mg/kg.
- Cobalt was detected above the background concentration of 9.1 mg/kg and its respective SL of 2.3 mg/kg at eight surface sediment sample locations, ranging from 9.3 mg/kg (ULCPsd-024 and ULCOsd-026) to 21.3 mg/kg (ULCPsd-025).
- Cyanide was analyzed in 6 surface sediment samples and was detected in 1 sample (ULCPsd-024) with a concentration of 0.4 mg/kg that exceeded its respective SL of 0.27 mg/kg.

Figure 5-7 presents the locations with concentrations that were above the background concentration and exceeded their respective SLs for these chemicals. Concentrations of total chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg).

Seven inorganic chemicals were identified as SRCs in subsurface sediment (Table 4-31). These also were identified as SRCs in surface sediment at Lower Cobbs Pond. Overall concentrations were lower in the subsurface interval than their corresponding surface sample, as 15 inorganic chemicals were detected above the background concentrations in the 0–0.5 ft bgs interval at location CPCsd-045, but only 8 were above background from the 0.5-2 ft bgs interval. Concentrations of cobalt in the 0.5-2 ft bgs interval were detected above the background concentration of 9.1 mg/kg and exceeded its respective SL of 2.3 mg/kg. Cobalt was the only subsurface sediment SRC that was considered to be a COPC.

Eleven metals, nitrate/nitrite, sulfate, and sulfide were identified as SRCs in surface water in the Lower Cobbs Pond. Of these inorganic chemicals, only manganese was considered a COPC. Manganese was detected above the background concentration of 0.391 mg/L at Phase II RI sample location ULCPsw-007 (0.654 mg/L) but was not detected above the background concentration in the two samples from the 2003 FWBWQS or the two PBA08 RI samples collected for this aggregate. Nitrate/nitrite, sulfate, and sulfide were detected but do not have respective SLs.

5.4.3 Semi-volatile Organic Compounds

Backwater Area

Fourteen SVOCs were identified as SRCs in surface sediment samples in the Backwater Area. Of the fourteen SVOCs, 5 PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] exceeded their respective SLs. Four of the five PAHs were detected at their maximum concentrations in the Phase II RI sample ULCPsd-015. PBA08 RI sample CPCsd-047 was collected adjacent to ULCPsd-015, and although all 14 SRCs were detected at CPCsd-047, only 3 of these SVOCs were observed at their maximum concentrations, indicating concentrations have declined since the 2001 Phase II RI sampling event. Concentrations of benzo(a)pyrene at ULCPsd-006, ULCPsd-015, and CPCsd-047 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. The distribution of SVOCs in sediment in the Backwater Area is shown in Figure 5-8.

Eleven SVOC SRCs were identified in subsurface sediment in the Backwater Area. These also were identified as SRCs for surface sediment. Only benzo(a)pyrene was detected above its respective SL (0.022 mg/kg) at PBA08 RI sample location CPCsd-047 in the 0.5-2 ft bgs interval and was considered to be a COPC in the subsurface sediment in the Backwater Area. The concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

No SVOCs were detected in surface water in the Backwater Area.

Upper Cobbs Pond

Ten SVOCs were identified as SRCs in the surface and subsurface sediment in the Upper Cobbs Pond at the PBA08 RI sample location CPCsd-046. Two additional SVOCs (acenaphthylene and anthracene) were identified in the subsurface sediment. The ten SVOCs occurred at higher concentrations in surface sediment than in the corresponding subsurface sediment sample. Benzo(a)pyrene was detected above its respective SL in both the surface and subsurface sediment at CPCsd-046; however, the concentrations were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. SVOCs were not detected in the Phase II RI sediment sample ULCPsd-020. PAHs were not detected in the ISM sample from the 2003 FWBWQS; however, three phthalates [bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, and di-n-butyl phthalate] were detected at low concentrations.

SVOCs bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were identified as SRCs in surface water in the Upper Cobbs Pond. The detected concentrations were below their respective SLs; therefore, they were not considered to be COPCs. Bis(2-ethylhexyl)phthalate was detected at low, estimated concentrations below the laboratory reporting limit at PBA08 RI sample location CPCsw-046 and at the 2003 FWBWQS sample from August 2003. Di-n-butyl phthalate was detected at low, estimated concentrations below the laboratory reporting limit in the 2003 FWBWQS samples from June and August 2003.

Lower Cobbs Pond

Eleven SVOCs were identified as SRCs in the surface sediment in the Lower Cobbs Pond and eighteen SVOCs were identified as SRCs in the subsurface sediment (Table 4-31). The 11 SVOC SRCs that were identified for surface sediment also were observed in subsurface sediment and occurred at their highest concentrations in the PBA08 RI subsurface sediment sample CPCsd-045 (Table 4-31). Concentrations of benzo(a)pyrene exceeded its respective SL in the surface and subsurface sediment at CPCsd-045; however, only the subsurface sediment concentration exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. There were no SVOCs detected above their SLs in the ISM sediment sample taken in 2003.

Four SVOCs [benzenemethanol, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, and di-n-butyl phthalate] were identified as SRCs in surface water in the Lower Cobbs Pond. Benzenemethanol and butyl benzyl phthalate were detected at low, estimated concentrations at PBA08 RI location CPCsw-045 at the center of the aggregate. No SVOCs were detected at CPCsw-044, located at the dam overflow spillway from Lower Cobbs Pond. Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected in both samples taken in the 2003 FWBWQS samples from June and August 2003. There were no SVOCs detected above their respective SLs in surface water at Lower Cobbs Pond.

5.4.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Backwater Area

Three VOCs (acetone, methylene chloride, and 2-butanone) were identified as SRCs in the surface sediment samples in the Backwater Area. As shown on Figure 5-9, 2-butanone also was identified as the only VOC SRC in subsurface sediment. The maximum concentration of 2-butanone and acetone was observed at the PBA08 RI sample location CPCsd-047. PCB-1254 was identified as an SRC in surface sediment, and it was detected in the Phase II RI sample locations ULCPsd-006 and ULCPsd-011. No PCBs were detected in any of the PBA08 RI surface or subsurface sediment samples. No pesticides were detected in the surface or subsurface sediment samples collected in the Backwater Area. No VOCs, pesticides, or PCBs exceeded their respective SLs in sediment at the Backwater Area.

Three VOCs (acetone, chloromethane, and toluene) were identified as SRCs in surface water in the Backwater Area. All three of the VOCs were detected in the Phase II RI sample ULCPsw-002. No VOCs were detected in the two PBA08 RI surface water samples at this aggregate. No VOCs, detected exceeded their respective SLs in surface water at the Backwater Area. No PCBs or pesticides were detected in surface water at the Backwater Area.

Upper Cobbs Pond

Two VOCs (acetone and 2-butanone) were identified as SRCs in the surface sediment in the Upper Cobbs Pond. The maximum concentrations were detected at the PBA08 RI sample location CPCsd-046. These VOCs also were detected at the 2001 Phase II RI sample location ULCPsd-020 at lower concentrations. PCB-1254 also was identified as an SRC in the surface sediment in the Upper Cobbs Pond and it was detected in ULCPsd-020. However, PCB-1254 was not detected in CPCsd-046. Pesticides were not detected in surface sediment. One pesticide (delta-BHC) and one VOC (2-butanone) were identified as SRCs in subsurface sediment at Upper Cobbs Pond. PCBs were not detected in the subsurface sediment. No VOCs, pesticides, or PCBs exceeded their respective SLs in sediment at Upper Cobbs Pond (although delta-BHC has no SL).

No VOCs, PCBs, or pesticides were detected in surface water in the Upper Cobbs Pond.

Lower Cobbs Pond

Three VOCs (2-butanone, acetone, and carbon disulfide) were detected in the surface sediment in the Lower Cobbs Pond. All three of the VOCs were detected at the PBA08 RI sample location CPCsd-045 at their maximum concentrations. Acetone was detected at 0.33J mg/L adjacent to CPCsd-045 (0.17 mg/L) in the 1996 sample CPCsd-007(p) which was not used in the screening process because more recent data was available. VOCs were also detected in the Phase II RI sample location ULCPsd-021. The VOC 2-butanone was identified as an SRC in the subsurface sediment the Lower Cobbs Pond. 2-Butanone was detected in the corresponding surface sediment sample at location CPCsd-045 at a higher concentration than observed in the subsurface interval. No PCBs or pesticides were detected in either surface or subsurface sediment at Lower Cobbs Pond.

No VOCs, PCBs, or pesticides were detected in surface water in the Lower Cobbs Pond.

5.5 SUMMARY OF CONTAMINANT NATURE AND EXTENT

From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 in Load Line 12 for producing aluminum chloride. On November 15, 1966, a fish kill occurred at Lower Cobbs Pond as a result of improper handling of aluminum chloride during manufacturing operations. The bulk of the aluminum chloride was collected and disposed at Ramsdell Quarry Landfill (RVAAP-01). The pond, receiving the contaminating waste from drainage ditches, was settled, drained, and the contaminants were removed to Ramsdell Quarry.

Data from the 2001 Phase II RI, the 2003 FWBWQS, and the 2010 PBA08 RI, collected after contaminant removal response from the 1966 fish kill, were used to identify remaining SRCs at the Upper and Lower Cobbs Ponds AOC. This data set effectively characterizes the nature and extent of contamination at the AOC. To support the evaluation of the nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and the National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. If there was no FWCUG for a chemical, the USEPA RSL was used as the SL. Based on the information provided earlier in this section and the summary below, it can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate the Upper and Lower Cobbs Ponds.

5.5.1 Soil

5.5.1.1 Surface Soil

The predominant SRCs for surface soil at the Pond Bank at the AOC were inorganic chemicals and SVOCs; the majority of which were PAHs. Eighteen inorganic chemicals (16 metals, cyanide, and nitrate/nitrite) were identified as SRCs in surface soil. Elevated inorganic chemical concentrations above background concentrations are observed in surface soil throughout the Pond Bank, and only 1 of 24 surface soil samples collected exhibited no inorganic chemicals above background concentrations (ULCPss-009). However, the majority of elevated inorganic chemical concentrations occurred at levels marginally in excess of background concentrations, as all but two concentrations occurred at magnitudes less than twice their respective background concentrations. As such, no apparent spatial trend in the distribution of inorganic chemicals throughout the surface soil in the Pond Bank is evident.

Sixteen SVOCs, predominantly PAHs, were identified as SRCs in surface soil at the Pond Bank. The highest frequency and magnitudes of detection were observed at CPCsb-035, located on the western bank of the Upper Cobbs Pond, immediately south of Cobbs Pond Road. The pesticide beta-BHC and propellant nitrocellulose were also identified as SRCs in surface soil at the Pond Bank. PAH concentrations are an order of magnitude higher in sediment than those observed in the adjacent Pond Bank surface soil.

One propellant (nitrocellulose) and one pesticide (BHC) were identified as SRCs in the surface soil at the Pond Bank. Neither exceeded their respective SLs. No explosives, VOCs, or PCBs were detected or identified as SRCs in Pond Bank surface soil surrounding Upper Cobbs Pond and Lower Cobbs Pond.

5.5.1.2 Subsurface Soil

Four inorganic chemicals (cadmium, lead, selenium, and silver) were identified as SRCs in subsurface soil samples at the Pond Bank. Lead and selenium were detected above the background concentrations at only one sample location. Selenium was detected at 1.6 mg/kg versus the background concentration of 1.5 mg/kg, and lead was detected at 23.3 mg/kg versus the background concentration of 19.1 mg/kg. As such, no apparent spatial trend in the distribution of inorganic chemicals throughout the subsurface soil in the Pond Bank is evident.

Thirteen SVOCs, 12 of which were PAHs, were detected and identified as SRCs in subsurface soil at the Pond Bank. Twelve of the 13 SVOCs were detected from the 1-4 ft bgs interval at CPCsb-035; the majority of which were observed at low, estimated concentrations below laboratory reporting limits. Sample location CPCsb-035 is on the western bank of Upper Cobbs Pond and near Cobbs Pond Road. Concentrations of PAHs in the subsurface soil samples were generally comparable to those observed in the corresponding surface soil sample (i.e., within the same order of magnitude). One propellant (nitrocellulose) was identified as an SRC in subsurface soil at the Pond Bank. No explosives, VOCs, PCBs, or pesticides were detected or identified as SRCs in Pond Bank subsurface soil surrounding Upper Cobbs Pond and Lower Cobbs Pond.

5.5.2 Sediment

5.5.2.1 Backwater Area

The Backwater Area was evaluated using fourteen surface sediment and two subsurface sediment samples. Three explosives (TNT; 2,6-DNT; and tetryl) and one propellant (nitrocellulose) were detected in the surface sediment. All of the detected concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in the subsurface sediment in the Backwater Area. In surface sediment, concentrations of aluminum, cobalt, and cyanide exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only concentrations of cobalt exceeded a TR of 1E-06, HQ of 0.1 in the subsurface sediment in one subsurface soil location, but not at a TR of 1E-05, HQ of 1. Five PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) exceeded their respective SLs in the surface sediment. Four of the five PAHs were detected at their maximum concentrations in the Phase II RI sample ULCPsd-015. The detected concentrations in the adjacent PBA08 RI sample CPCsd-047 indicates that concentrations have declined since the 2001 Phase II RI sampling event. Concentrations of benzo(a)pyrene at ULCPsd-006, ULCPsd-015, and CPCsd-047 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Only benzo(a)pyrene was detected above its respective SL (0.022 mg/kg) at PBA08 RI sample location CPCsd-047 in the 0.5-2 ft bgs interval. The concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, methylene chloride, and 2-butanone) and one VOC (2-butanone) were detected below their respective SLs in the surface and subsurface sediment, respectively. PCB-1254 also was detected in the Phase II RI surface sediment samples ULCPsd-006 and ULCPsd-011; however, it was not detected in the PBA08 RI samples. No pesticides were detected in surface sediment. Pesticides and PCBs were not detected in the Backwater Area subsurface sediment.

5.5.2.2 Upper Cobbs Pond

Five surface discrete sediment, one surface ISM, and one subsurface sediment samples were used to evaluate the Upper Cobbs Pond. Five explosives (1,3-dinitrobenzene; TNT; 4-amino-2,6-DNT; HMX; and tetryl) and one propellant (nitrocellulose) were detected in the surface sediment at PBA08 RI sample location CPCsd-046. All the detected concentrations were below Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in the subsurface sediment. In surface sediment, concentrations of aluminum, hexavalent chromium, and cobalt exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only concentrations of cobalt exceeded a TR of 1E-06, HQ of 0.1 in the subsurface sediment, but not at a TR of 1E-05, HQ of 1. Ten SVOCs were detected in the surface and subsurface sediment at the PBA08 RI sample location CPCsd-046. Two additional SVOCs (acenaphthylene and anthracene) were detected in the subsurface sediment. The ten SVOCs occurred at higher concentrations in surface sediment than in the corresponding subsurface sediment sample. Benzo(a)pyrene was detected above its respective SL in both the surface and subsurface sediment at CPCsd-046; however, the concentrations were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Two VOCs (acetone and 2-butanone) were detected in surface sediment below their respective SLs, both of which were detected at their maximum concentrations at PBA08 RI location CPCsd-046. These VOCs also were detected at the 2001 Phase II RI sample location ULCPsd-020 at lower concentrations than CPCsd-046. PCB-1254 also was detected in the surface sediment at Upper Cobbs Pond in ULCPsd-020 below its respective SL. PCB-1254 was not detected in the PBA08 RI sample. Pesticides were not detected in surface sediment at Upper Cobbs Pond. The VOC 2-butanone was detected in the subsurface sediment below the TR of 1E-05, HQ of 1. The pesticide delta-BHC does not have an SL. PCBs were not detected in subsurface sediment.

5.5.2.3 Lower Cobbs Pond

The Lower Cobbs Pond was evaluated using eight discrete surface sediment, one surface ISM, and one subsurface sediment samples. Two explosives (HMX and tetryl) and one propellant (nitrocellulose) were detected in the surface sediment, and the explosive HMX and propellant nitrocellulose were detected in the subsurface sediment at Lower Cobbs Pond. The concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. In surface sediment, concentrations of aluminum, arsenic, hexavalent chromium, cobalt, and cyanide exceeded a TR of 1E-06, HQ of 0.1, but only arsenic exceeded a TR of 1E-05, HQ of 1. Only concentrations of cobalt exceeded a TR of 1E-06, HQ of 0.1 in the subsurface sediment, but not at a TR of 1E-05, HQ of 1. Eleven SVOCs were detected in the surface sediment in the Lower Cobbs Pond and eighteen SVOCs were detected in the subsurface sediment. The 11 SVOC SRCs that were identified for surface sediment also were observed in subsurface sediment and occurred at their highest concentrations in the PBA08 RI subsurface sediment sample CPCsd-045. Concentrations of benzo(a)pyrene exceeded its respective SL in the surface subsurface sediment at CPCsd-045; however, only the subsurface sediment concentration exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (2-butanone, acetone, and carbon disulfide) were detected in surface sediment at Lower Cobbs Pond. All three of these VOCs were detected at PBA08 RI location CPCsd-045, with 2-butanone and carbon disulfide observed at their maximum concentrations in this sample location. 2-Butanone also was detected in the subsurface sediment. All the VOCs detected in surface and subsurface soil were below their respective SLs. No PCBs or pesticides were detected in either the surface or subsurface sediment in the Lower Cobbs Pond.

5.5.3 Surface Water

5.5.3.1 Backwater Area

Four surface water samples were used to evaluate the Backwater Area. One explosive (4-amino-2,6-DNT) was detected in surface water at low, estimated concentrations below laboratory reporting limits. No propellants were detected in the Backwater Area surface water. Concentrations of four inorganic chemicals (arsenic, cobalt, manganese, and selenium) exceeded the exceeded the RSL at a TR of 1E-06, HQ of 0.1. Concentrations of manganese at Phase II RI sample locations ULCPsw-001 and ULCPsw-002 and cobalt at ULCPsw-001 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, chloromethane, and toluene) were detected in surface water for the Backwater Area, all of which were detected in ULCPsw-002. No propellants, SVOCs, PCBs, or pesticides were detected in surface water at the Backwater Area. Elevated inorganic chemical concentrations and 4-amino-2,6-DNT are likely attributable to continuing upstream sources as these constituents are observed in the PBA08 RI locations immediately downstream of the confluence of the drainage channels from Load Line 3 and Load Line 12.

5.5.3.2 Upper Cobbs Pond

Surface water in the Upper Cobbs Pond was evaluated using five surface water samples. One explosive (4-amino-2,6-DNT) was detected at a low, estimated concentration in two surface water samples. The concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No surface water concentrations for inorganic chemicals in the Upper Cobbs Pond exceeded the SL at a TR of 1E-06, HQ of 0.1. The SVOCs bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected at a low, estimated concentration below the laboratory reporting limit at PBA08 RI sample location CPCsw-046 and the August 2003 FWBWQS location respectively. No VOCs, PCBs, or pesticides were detected in surface water at Upper Cobbs Pond.

5.5.3.3 Lower Cobbs Pond

Lower Cobbs Pond surface water was evaluated using seven surface water samples. The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at Lower Cobbs Pond. 4-Amino-2,6-DNT was detected at a concentration of 0.00029J mg/L in the August 2003 FWBWQS sample at Lower Cobbs Pond. 4-Amino-2,6-DNT was not detected in the subsequent PBA08 RI samples taken at CPCsw-044 and CPCsw-045 in 2010. No propellants were detected. Only manganese was detected at a concentration which exceeded the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1 at one sample location. Two SVOCs (benzenemethanol and butyl benzyl phthalate) were detected at low, estimated concentrations at PBA08 RI location CPCsw-045, located at the center of the aggregate. No VOCs, PCBs, or pesticides were detected in surface water in the Lower Cobbs Pond.

Table 5–1. Chromium Speciation Results

Sample Location	Hexavalent Chromium Concentration (mg/kg)	Total Chromium Concentration[a] (mg/kg)	Percent Hexavalent Chromium (%)
Sediment – Upper Cobbs Pond			
CPCsd-049	<3.1 U	34.3	NA

[a] Background concentration for total chromium = 18.1 mg/kg. No background concentration is available for hexavalent chromium.

mg/kg = Milligrams per kilogram.

NA = Not applicable; hexavalent chromium not detected in sample.

U = Not detected.

Table 5–2. Summary of Geotechnical Parameters

Sample ID: Parameters	CPCsb-033-5117-SO	CPCsb-033-5118-SO
Depth	4–5.4 ft bgs	8–9.7 ft bgs
Porosity	37.3 %	39.8 %
Density	1.75 g/cm^3	1.67 g/cm^3
Moisture content	19.2 %	21.4 %
Total organic carbon	2,700 mg/kg	5,400 mg/kg
Size fraction analysis	1.2 % gravel, 10.3 % sand, 51.3 % silt, 37.2% clay	0.7 % gravel, 0.6 % sand, 63.9 % silt, 34.8 % clay
Permeability (K)	2.1E-07 cm/sec	7.5E-07 cm/sec

bgs = Below ground surface.

ID = Identification.

Table 5-3. Surface Water Field Measurements

Location	Temperature (°C)	pH (S.U.)	Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
CPCsw-044	9.13	7.10	0.128	9.32	6.92
CPCsw-045	10.92	7.87	0.116	12.86	5.48
CPCsw-046	10.19	7.00	0.118	9.96	6.53
CPCsw-047	12.94	9.61	0.140	12.25	6.17
CPCsw-048	15.79	8.23	0.147	10.95	4.98

°C = degrees Celsius

mg/L = milligrams per Liter

mS/cm =milli-Siemens per centimeter

NTU = nephelometric turbidity units

S.U. = standard unit

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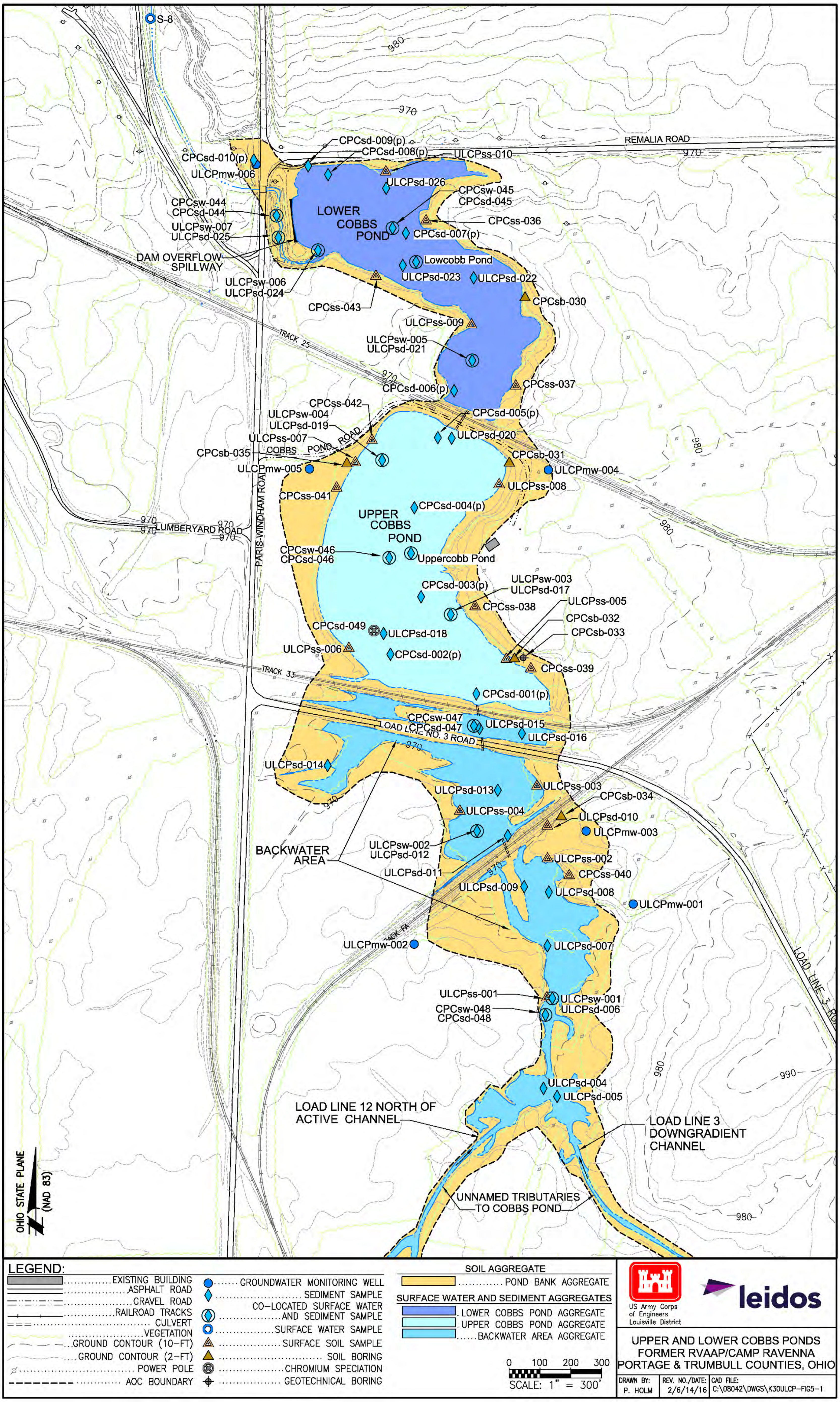
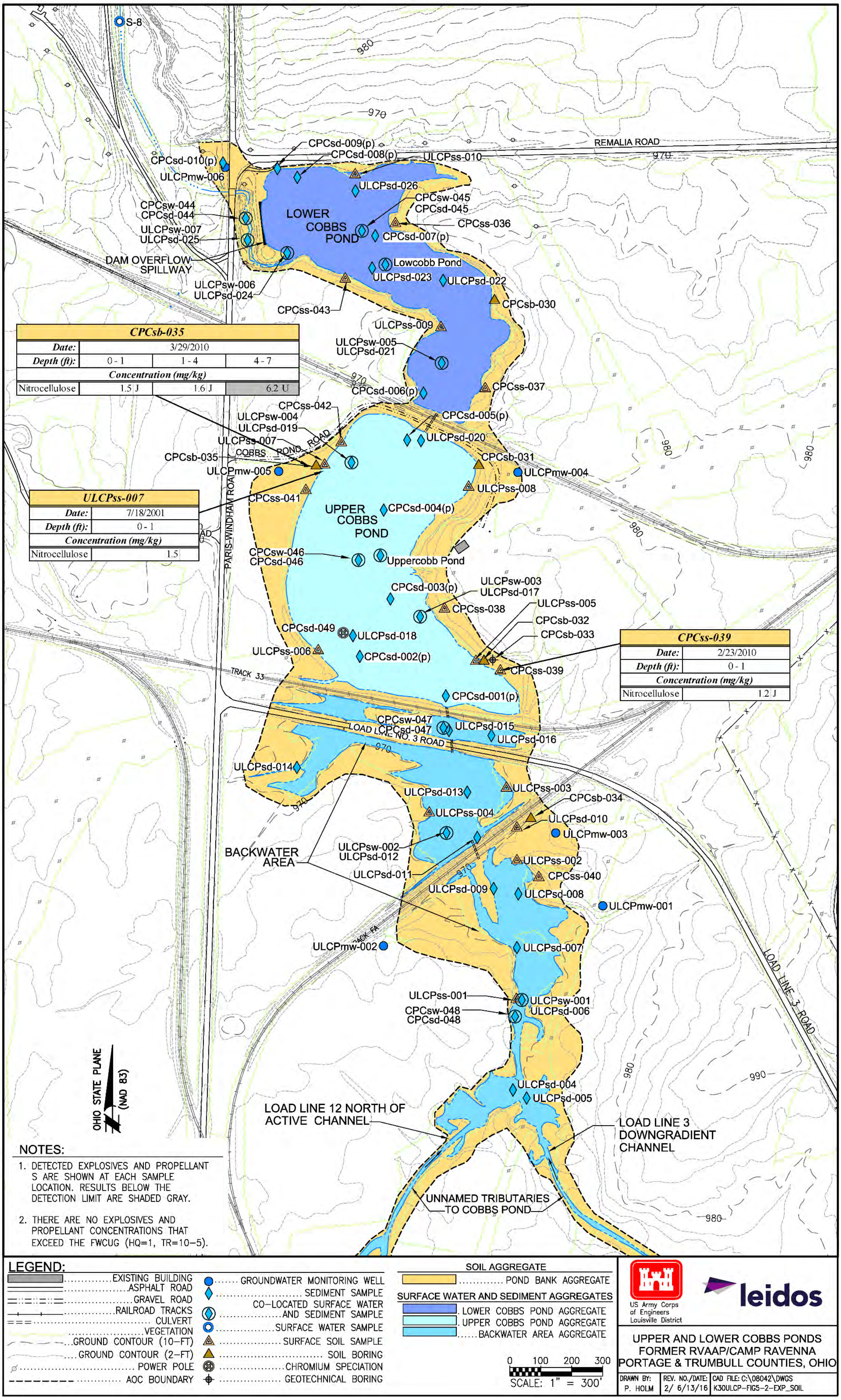


Figure 5–1. Data Aggregates and Sample Locations at Upper and Lower Cobbs Ponds



CPCsb-035			
Date:	3/29/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Nitrocellulose	1.5 J	1.6 J	6.2 U

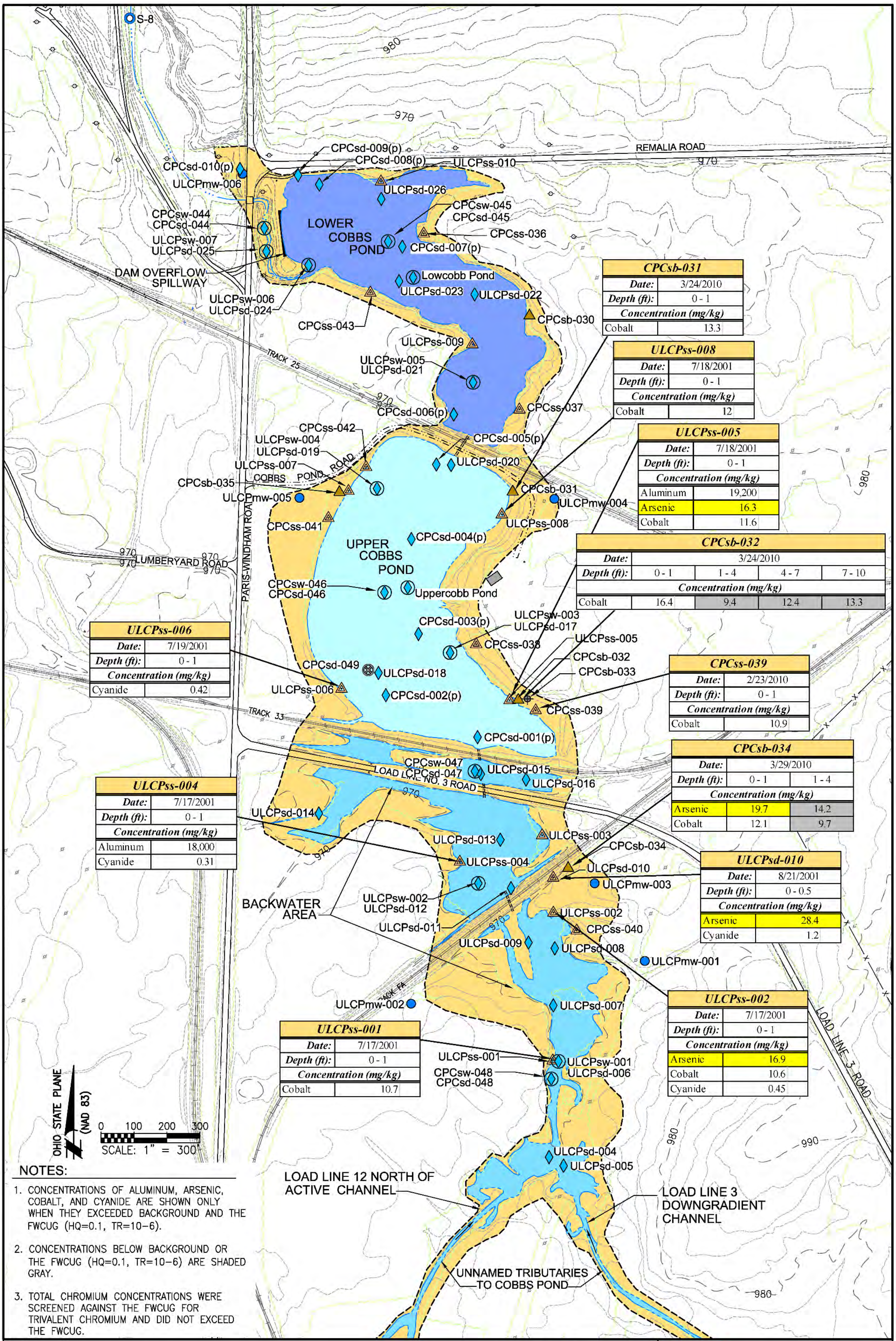
ULCPss-007	
Date:	7/18/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.5

CPCss-039	
Date:	2/23/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.2 J

NOTES:

1. DETECTED EXPLOSIVES AND PROPELLANTS ARE SHOWN AT EACH SAMPLE LOCATION. RESULTS BELOW THE DETECTION LIMIT ARE SHADED GRAY.
2. THERE ARE NO EXPLOSIVES AND PROPELLANT CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10-5).

Figure 5–2. Detected Concentrations of Explosives and Propellants in Soil (Discrete Soil Borings)



CPCsb-031	
Date:	3/24/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	13.3

ULCPss-008	
Date:	7/18/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	12

ULCPss-005	
Date:	7/18/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	19,200
Arsenic	16.3
Cobalt	11.6

CPCsb-032				
Date:	3/24/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 10
Concentration (mg/kg)				
Cobalt	16.4	9.4	12.4	13.3

ULCPss-006	
Date:	7/19/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cyanide	0.42

CPCss-039	
Date:	2/23/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.9

CPCsb-034		
Date:	3/29/2010	
Depth (ft):	0 - 1	1 - 4
Concentration (mg/kg)		
Arsenic	19.7	14.2
Cobalt	12.1	9.7

ULCPss-004	
Date:	7/17/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	18,000
Cyanide	0.31

ULCPsd-010	
Date:	8/21/2001
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Arsenic	28.4
Cyanide	1.2

ULCPss-002	
Date:	7/17/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	16.9
Cobalt	10.6
Cyanide	0.45

ULCPss-001	
Date:	7/17/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.7

NOTES:

1. CONCENTRATIONS OF ALUMINUM, ARSENIC, COBALT, AND CYANIDE ARE SHOWN ONLY WHEN THEY EXCEEDED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10−6).
2. CONCENTRATIONS BELOW BACKGROUND OR THE FWCUG (HQ=0.1, TR=10−6) ARE SHADED GRAY.
3. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM AND DID NOT EXCEED THE FWCUG.

LEGEND:

▬	EXISTING BUILDING
═	ASPHALT ROAD
═	GRAVEL ROAD
┼	RAILROAD TRACKS
═	CULVERT
⌒	VEGETATION
—	GROUND CONTOUR (10-FT)
—	GROUND CONTOUR (2-FT)
ø	POWER POLE
‒ ‒ ‒	AOC BOUNDARY
●	GROUNDWATER MONITORING WELL
◆	SEDIMENT
◈	CO-LOCATED SURFACE WATER AND SEDIMENT
○	SURFACE WATER SAMPLE
△	SURFACE SOIL
▲	SOIL BORING
⊗	CHROMIUM SPECIATION
⊕	GEOTECHNICAL BORING

SOIL AGGREGATE

🟧	POND BANK AGGREGATE

SURFACE WATER AND SEDIMENT AGGREGATES

🟦	LOWER COBBS POND AGGREGATE
🟦	UPPER COBBS POND AGGREGATE
🟦	BACKWATER AREA AGGREGATE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10−5)

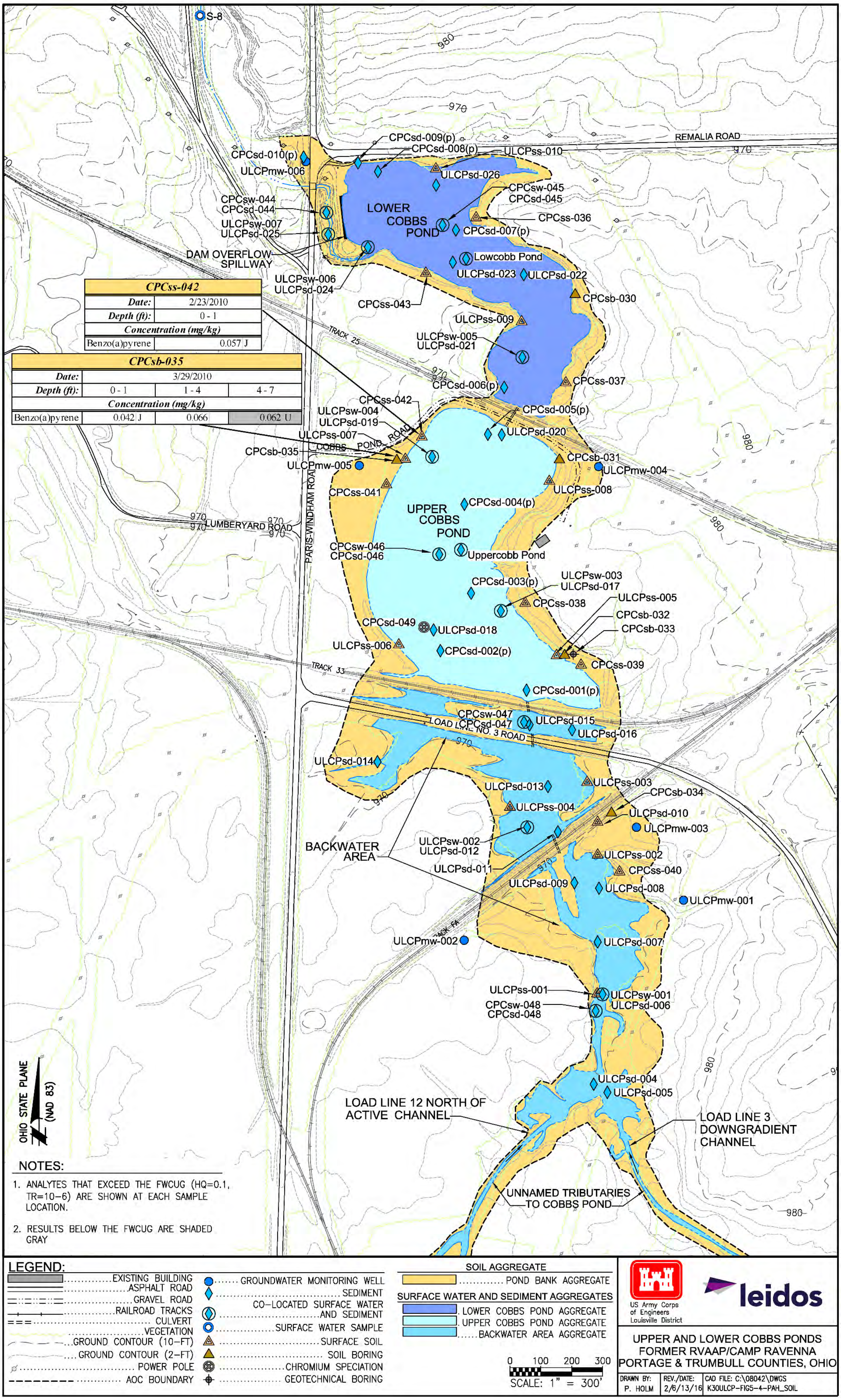
US Army Corps of Engineers Louisville District

leidos

UPPER AND LOWER COBBS PONDS
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE: C:\08042\DWGS
P. HOLM	2/ 6/15/16	K30ULCP-FIG5-3-MET_SOIL

1 **Figure 5–3. Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Aluminum, Arsenic, Cobalt, and Cyanide in Soil (Discrete Soil Borings)**



CPCss-042	
Date:	2/23/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.057 J

CPCsb-035			
Date:	3/29/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.042 J	0.066	0.062 U

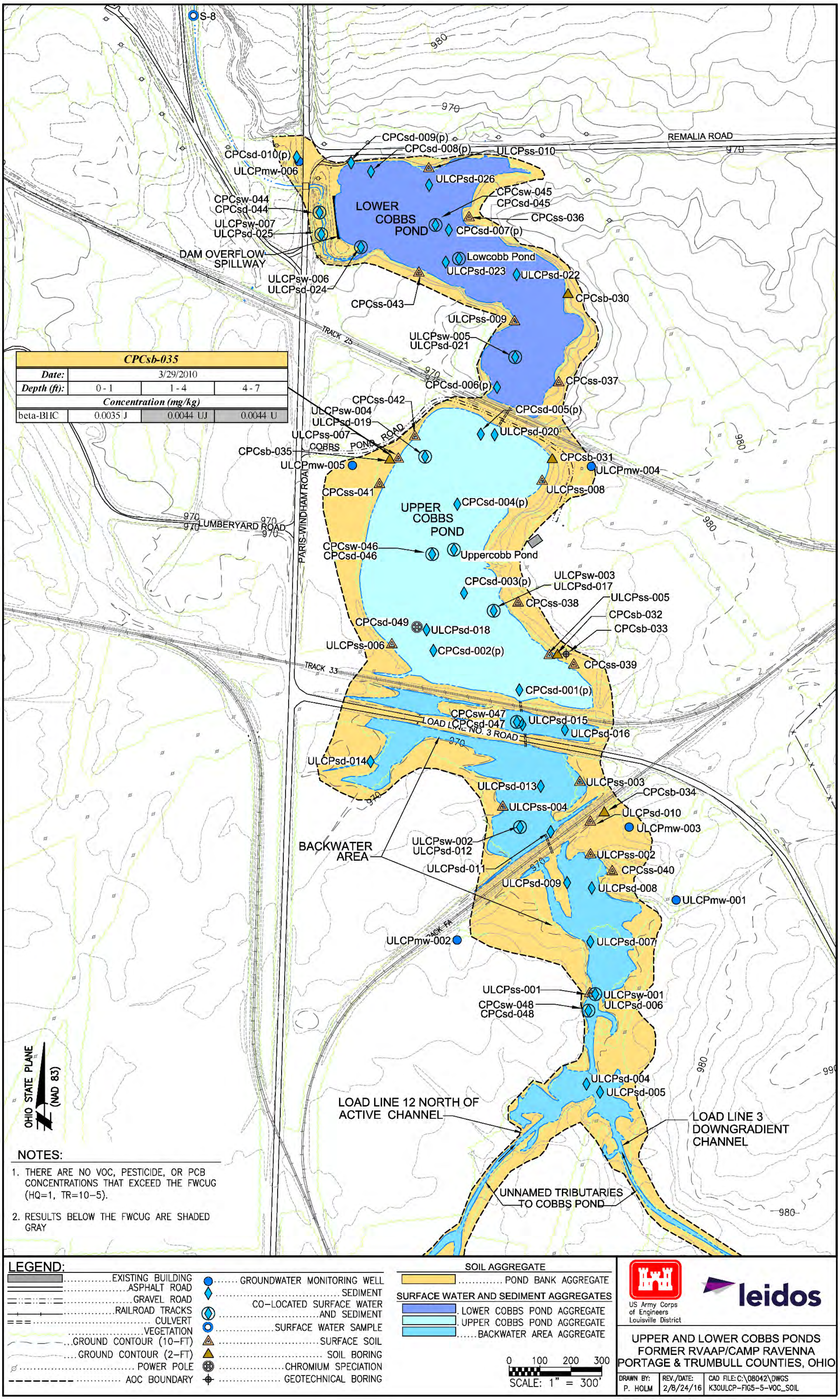
NOTES:

1. ANALYTES THAT EXCEED THE FWCUG (HQ=0.1, TR=10-6) ARE SHOWN AT EACH SAMPLE LOCATION.
2. RESULTS BELOW THE FWCUG ARE SHADED GRAY

UPPER AND LOWER COBBS PONDS
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV./DATE:	CAD FILE: C:\08042\DWGS
P. HOLM	2/6/13/16	K30ULCP-FIG5-4-PAH_SOIL

Figure 5-4. PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Soil (Discrete Soil Borings)

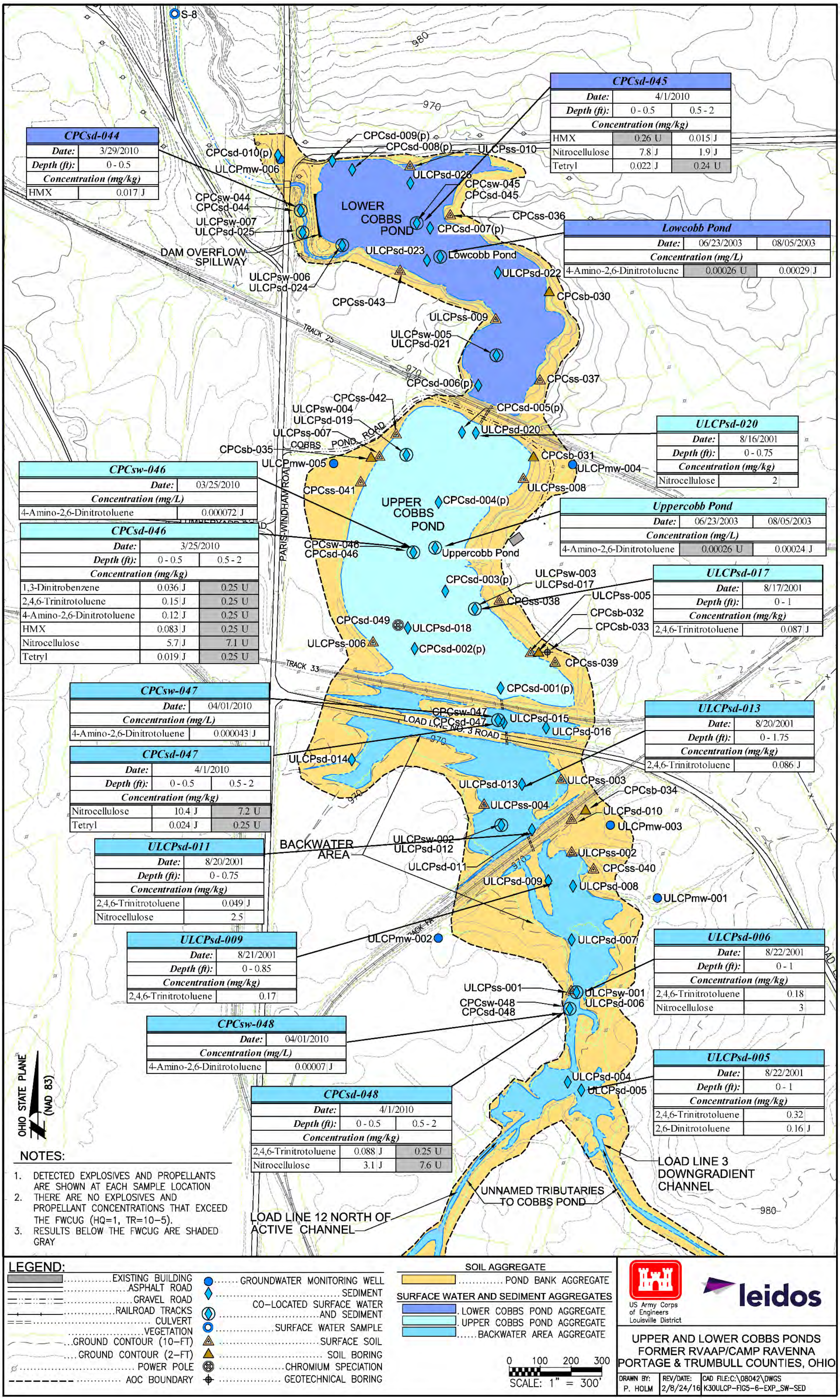


CPCsb-035			
Date:	3/29/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
beta-BHC	0.0035 J	0.0044 UJ	0.0044 U

NOTES:

1. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).
2. RESULTS BELOW THE FWCUG ARE SHADED GRAY

Figure 5–5. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil (Discrete Soil Borings)



CPCsd-044

Date:	3/29/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
HMX	0.017 J

CPCsd-045

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
HMX	0.26 U	0.015 J
Nitrocellulose	7.8 J	1.9 J
Tetryl	0.022 J	0.24 U

Lowcobb Pond

Date:	06/23/2003	08/05/2003
Concentration (mg/L)		
4-Amino-2,6-Dinitrotoluene	0.00026 U	0.00029 J

ULCPsd-020

Date:	8/16/2001
Depth (ft):	0 - 0.75
Concentration (mg/kg)	
Nitrocellulose	2

CPCsw-046

Date:	03/25/2010
Concentration (mg/L)	
4-Amino-2,6-Dinitrotoluene	0.000072 J

Uppercobb Pond

Date:	06/23/2003	08/05/2003
Concentration (mg/L)		
4-Amino-2,6-Dinitrotoluene	0.00026 U	0.00024 J

CPCsd-046

Date:	3/25/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
1,3-Dinitrobenzene	0.036 J	0.25 U
2,4,6-Trinitrotoluene	0.15 J	0.25 U
4-Amino-2,6-Dinitrotoluene	0.12 J	0.25 U
HMX	0.083 J	0.25 U
Nitrocellulose	5.7 J	7.1 U
Tetryl	0.019 J	0.25 U

ULCPsd-017

Date:	8/17/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.087 J

CPCsw-047

Date:	04/01/2010
Concentration (mg/L)	
4-Amino-2,6-Dinitrotoluene	0.000043 J

ULCPsd-013

Date:	8/20/2001
Depth (ft):	0 - 1.75
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.086 J

CPCsd-047

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
Nitrocellulose	10.4 J	7.2 U
Tetryl	0.024 J	0.25 U

ULCPsd-011

Date:	8/20/2001
Depth (ft):	0 - 0.75
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.049 J
Nitrocellulose	2.5

ULCPsd-009

Date:	8/21/2001
Depth (ft):	0 - 0.85
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.17

ULCPsd-006

Date:	8/22/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.18
Nitrocellulose	3

CPCsw-048

Date:	04/01/2010
Concentration (mg/L)	
4-Amino-2,6-Dinitrotoluene	0.00007 J

ULCPsd-005

Date:	8/22/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.32
2,6-Dinitrotoluene	0.16 J

CPCsd-048

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
2,4,6-Trinitrotoluene	0.088 J	0.25 U
Nitrocellulose	3.1 J	7.6 U

NOTES:

1. DETECTED EXPLOSIVES AND PROPELLANTS ARE SHOWN AT EACH SAMPLE LOCATION
2. THERE ARE NO EXPLOSIVES AND PROPELLANT CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).
3. RESULTS BELOW THE FWCUG ARE SHADED GRAY

1 Figure 5–6. Detected Concentrations of Explosives and Propellants in Surface Water and Sediment

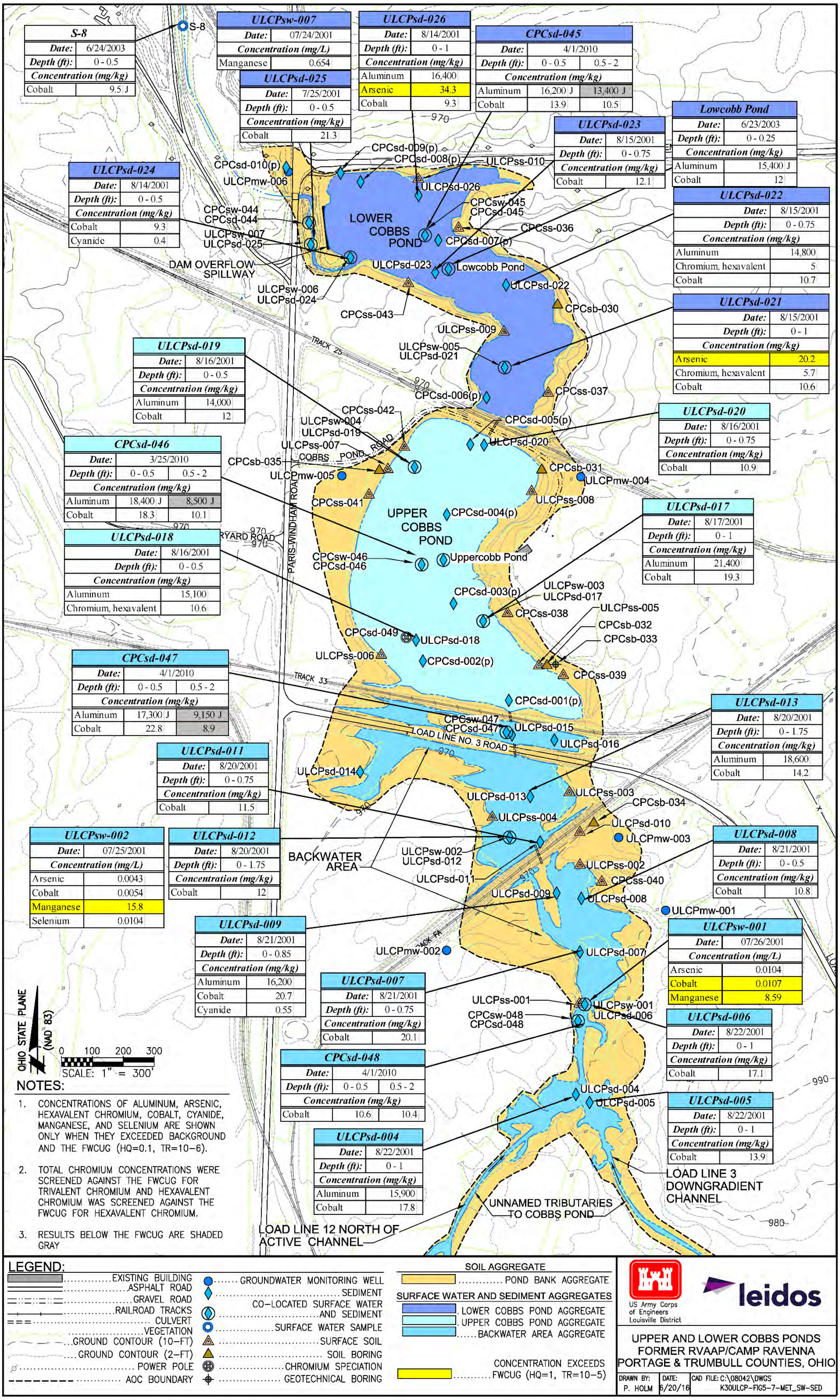
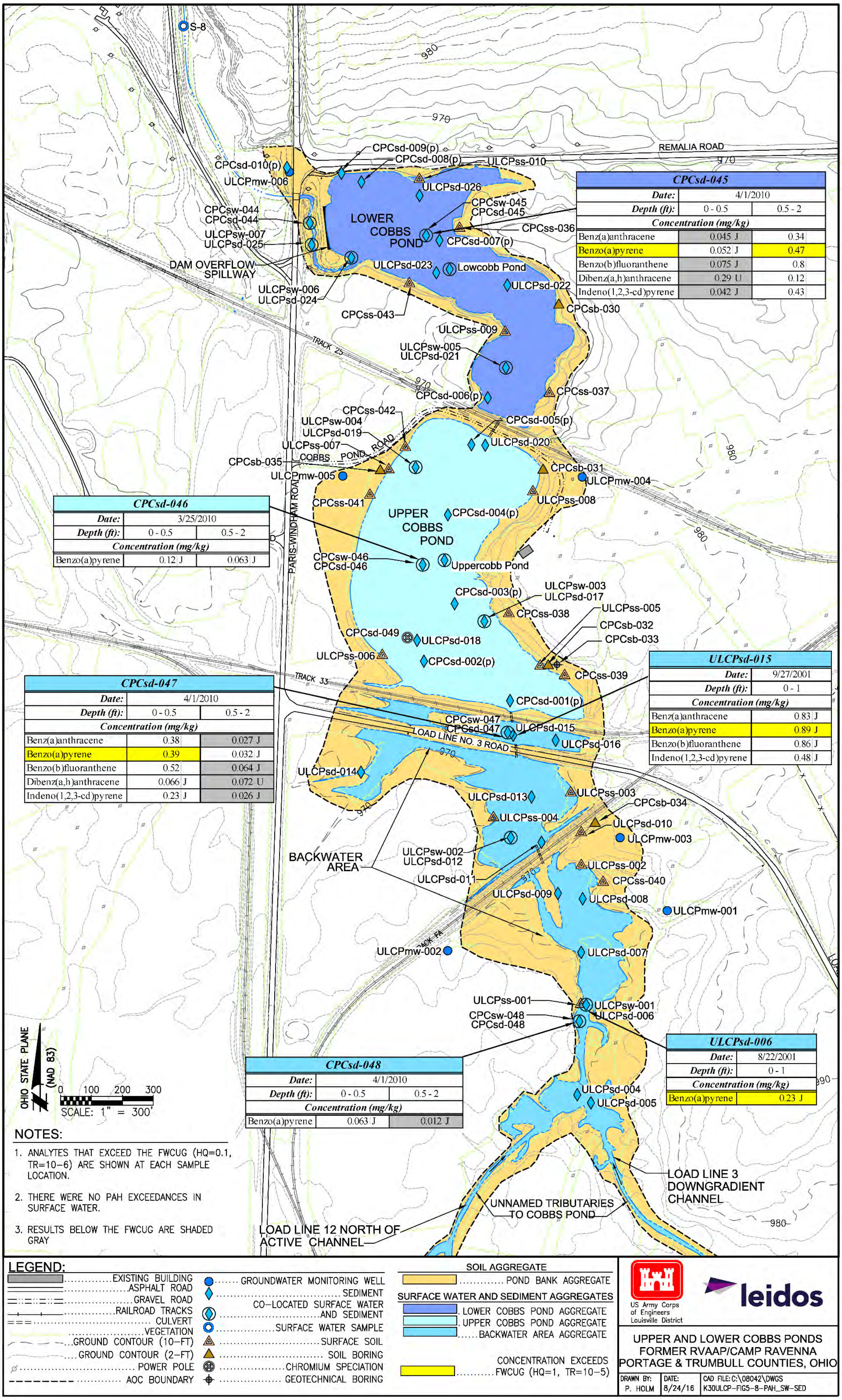


Figure 5–7. Exceedances of FWCUG (HQ of 0.1, TR of 10-6) for Aluminum, Arsenic, Hexavalent Chromium, Cobalt, Cyanide, Manganese, and Selenium in Surface Water and Sediment



CPCsd-045		
Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
Benz(a)anthracene	0.045 J	0.34
Benzo(a)pyrene	0.052 J	0.47
Benzo(b)fluoranthene	0.075 J	0.8
Dibenz(a,h)anthracene	0.29 U	0.12
Indeno(1,2,3-cd)pyrene	0.042 J	0.43

CPCsd-046		
Date:	3/25/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
Benzo(a)pyrene	0.12 J	0.063 J

ULCPsd-015	
Date:	9/27/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.83 J
Benzo(a)pyrene	0.89 J
Benzo(b)fluoranthene	0.86 J
Indeno(1,2,3-cd)pyrene	0.48 J

CPCsd-047		
Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
Benz(a)anthracene	0.38	0.027 J
Benzo(a)pyrene	0.39	0.032 J
Benzo(b)fluoranthene	0.52	0.064 J
Dibenz(a,h)anthracene	0.066 J	0.072 U
Indeno(1,2,3-cd)pyrene	0.23 J	0.026 J

ULCPsd-006	
Date:	8/22/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.23 J

CPCsd-048		
Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
Benzo(a)pyrene	0.063 J	0.012 J

NOTES:

1. ANALYTES THAT EXCEED THE FWCUG (HQ=0.1, TR=10−6) ARE SHOWN AT EACH SAMPLE LOCATION.
2. THERE WERE NO PAH EXCEEDANCES IN SURFACE WATER.
3. RESULTS BELOW THE FWCUG ARE SHADED GRAY

LEGEND:

▬	EXISTING BUILDING
═	ASPHALT ROAD
═::═	GRAVEL ROAD
─┼─	RAILROAD TRACKS
===	CULVERT
	VEGETATION
─ ─	GROUND CONTOUR (10−FT)
──	GROUND CONTOUR (2−FT)
ø	POWER POLE
– – – –	AOC BOUNDARY
●	GROUNDWATER MONITORING WELL
◆	SEDIMENT
◈	CO−LOCATED SURFACE WATER AND SEDIMENT
○	SURFACE WATER SAMPLE
△	SURFACE SOIL
▲	SOIL BORING
⊗	CHROMIUM SPECIATION
⌖	GEOTECHNICAL BORING

SOIL AGGREGATE

🟧	POND BANK AGGREGATE

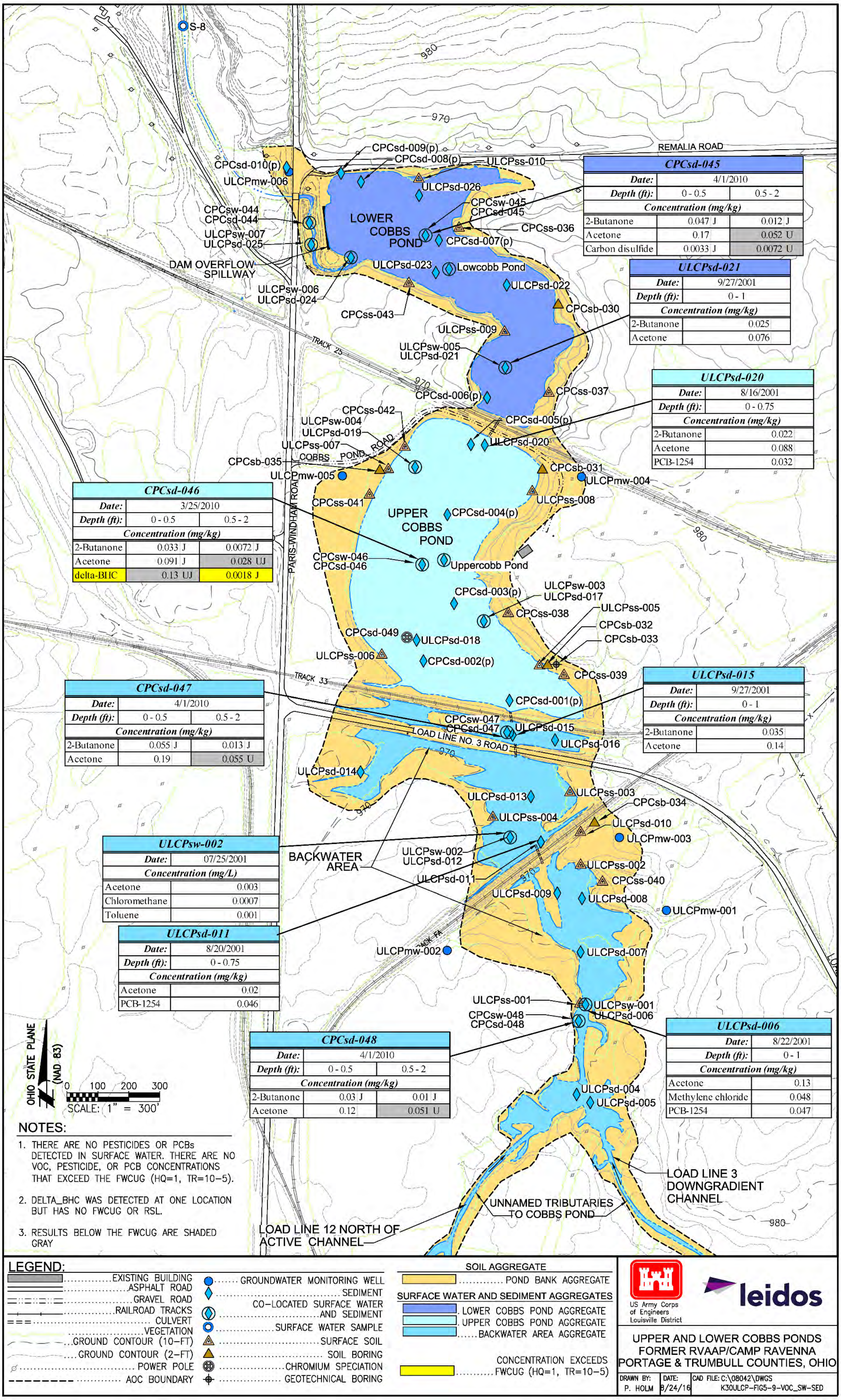
SURFACE WATER AND SEDIMENT AGGREGATES

🟦	LOWER COBBS POND AGGREGATE
▭	UPPER COBBS POND AGGREGATE
▭	BACKWATER AREA AGGREGATE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10−5)

UPPER AND LOWER COBBS PONDS
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	DATE:	CAD FILE: C:\08042\DWGS
P. HOLM	8/24/16	K30ULCP−FIG5−8−PAH_SW−SED

Figure 5–8. PAH Exceedances of FWCUG (HQ of 0.1, TR of 10-6) in Surface Water and Sediment



CPCsd-045

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
2-Butanone	0.047 J	0.012 J
Acetone	0.17	0.052 U
Carbon disulfide	0.0033 J	0.0072 U

ULCPsd-021

Date:	9/27/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
2-Butanone	0.025
Acetone	0.076

ULCPsd-020

Date:	8/16/2001
Depth (ft):	0 - 0.75
Concentration (mg/kg)	
2-Butanone	0.022
Acetone	0.088
PCB-1254	0.032

CPCsd-046

Date:	3/25/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
2-Butanone	0.033 J	0.0072 J
Acetone	0.091 J	0.028 UJ
delta-BHC	0.13 UJ	0.0018 J

CPCsd-047

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
2-Butanone	0.055 J	0.013 J
Acetone	0.19	0.055 U

ULCPsd-015

Date:	9/27/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
2-Butanone	0.035
Acetone	0.14

ULCPsw-002

Date:	07/25/2001
Concentration (mg/L)	
Acetone	0.003
Chloromethane	0.0007
Toluene	0.001

ULCPsd-011

Date:	8/20/2001
Depth (ft):	0 - 0.75
Concentration (mg/kg)	
Acetone	0.02
PCB-1254	0.046

CPCsd-048

Date:	4/1/2010	
Depth (ft):	0 - 0.5	0.5 - 2
Concentration (mg/kg)		
2-Butanone	0.03 J	0.01 J
Acetone	0.12	0.051 U

ULCPsd-006

Date:	8/22/2001
Depth (ft):	0 - 1
Concentration (mg/kg)	
Acetone	0.13
Methylene chloride	0.048
PCB-1254	0.047

NOTES:

1. THERE ARE NO PESTICIDES OR PCBs DETECTED IN SURFACE WATER. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).
2. DELTA_BHC WAS DETECTED AT ONE LOCATION BUT HAS NO FWCUG OR RSL.
3. RESULTS BELOW THE FWCUG ARE SHADED GRAY

LEGEND:

▬	EXISTING BUILDING
═	ASPHALT ROAD
═	GRAVEL ROAD
┼	RAILROAD TRACKS
═	CULVERT
⌒	VEGETATION
— —	GROUND CONTOUR (10–FT)
- - -	GROUND CONTOUR (2–FT)
⌀	POWER POLE
– – –	AOC BOUNDARY
●	GROUNDWATER MONITORING WELL
◆	SEDIMENT
◈	CO–LOCATED SURFACE WATER AND SEDIMENT
○	SURFACE WATER SAMPLE
△	SURFACE SOIL
▲	SOIL BORING
⊗	CHROMIUM SPECIATION
⊕	GEOTECHNICAL BORING

SOIL AGGREGATE

🟧	POND BANK AGGREGATE

SURFACE WATER AND SEDIMENT AGGREGATES

🟦	LOWER COBBS POND AGGREGATE
▭	UPPER COBBS POND AGGREGATE
▭	BACKWATER AREA AGGREGATE
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

US Army Corps of Engineers Louisville District

leidos

UPPER AND LOWER COBBS PONDS
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	DATE:	CAD FILE:
P. HOLM	8/24/16	C:\08042\DWGS K30ULCP–FIG5–9–VOC_SW–SED

1 Figure 5–9. Detected Concentrations of VOCs, Pesticides, and PCBs in in Surface Water and Sediment

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6.0 CONTAMINANT FATE AND TRANSPORT

Contaminant fate and transport modeling assesses the potential for SRCs to leach from surface soil, subsurface soil, and sediment sources at the Upper and Lower Cobbs Ponds AOC and impact groundwater beneath the sources and downgradient receptor locations. Modeling results were included in the decision-making process to determine whether performing remedial actions may be necessary to protect groundwater resources. Surface water exposure pathways are evaluated in the HHRA and ERA presented in Sections 7.2 and 7.3, respectively. A summary of the principles of contaminant fate and transport are presented in this section along with the results of the modeling.

Section 6.1 describes physical and chemical properties of SRCs found in soil and sediment at the AOC. Section 6.2 presents a conceptual model for contaminant fate and transport that considers AOC topography, hydrogeology, contaminant sources, and release mechanisms. Section 6.3 presents a soil screening analysis, and Section 6.4 presents a sediment screening analysis to identify SRCs with the potential to migrate from soil and sediment to groundwater as initial CMCOPCs. Section 6.5 describes fate and transport modeling of CMCOPCs and presents CMCOCs. Section 6.6 provides a list of the remaining CMCOCs and a qualitative assessment of the results and considerations of the limitations and assumptions. Section 6.7 presents the summary and conclusions of this fate and transport analysis.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CONTAMINANTS

The 1978 Installation Assessment identified the major contaminants of the former RVAAP to be TNT, composition B, sulfates, nitrates, lead styphnate, and lead azide. The assessment identified the pink wastewater and washout of residue, dusts, and spills at Load Lines 3 and 12, which were discharged through surface drainage channels towards Upper Cobbs Pond (USATHAMA 1978), as contaminants. Potential site-specific contaminants include TNT, RDX, HMX, nitrate, nitrocellulose, and heavy metals (i.e., lead, chromium, mercury, and arsenic) from the pink water. Other contaminants identified include washout from explosives melt-out and demilitarization activities at Load Lines 3 and 12 and ammonium nitrate and aluminum chloride from Load Line 12.

The evaluation of contaminant fate and transport not only includes chemicals identified as potential contaminants from previous use but also includes chemicals that were evaluated as part of the overall RI. The comprehensive list of surface and subsurface soil SRCs (18 inorganic chemicals and 19 organic chemicals) and surface and subsurface sediment SRCs (16 inorganic chemicals and 23 organic chemicals in the Backwater Area, 18 inorganic and 25 organic chemicals in Upper Cobbs Pond, and 20 inorganic and 24 organic chemicals in Lower Cobbs Pond) were detailed in Section 4.0 and are summarized below:

- Inorganic SRCs in surface and subsurface soil: aluminum, arsenic, barium, cadmium, chromium, hexavalent chromium, cobalt, copper, cyanide, lead, mercury, nickel, selenium, silver, thallium, vanadium, zinc, and nitrate/nitrite.

- Inorganic SRCs in sediment: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, cyanide, lead, mercury, nickel, nitrate/nitrite, selenium, silver, vanadium, ammonia, and total phosphorous.
- Organic SRCs in surface and subsurface soil: 2-methylnaphthalene, acenaphthylene, benz(a)anthracene, benzenemethanol, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, benzoic acid, bis(2-ethylhexyl)phthalate, chrysene, di-n-butyl phthalate, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, nitrocellulose, and beta-BHC.
- Organic SRCs in sediment: 2-methylnaphthalene; acenaphthene; acenaphthylene; anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(ghi)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; butyl benzyl phthalate; chrysene; dibenz(a,h)anthracene; di-n-butyl phthalate; fluoranthene; fluorene; indeno(1,2,3-cd)pyrene; naphthalene; phenanthrene; pyrene; 2-butanone; acetone; carbon disulfide; methylene chloride; 1,3-dinitrobenzene; TNT; 2,6-DNT; 4-amino-2,6-DNT; HMX; nitrocellulose; tetryl; delta-BHC; and PCB-1254.

Chemicals released into the environment are susceptible to several degradation pathways, including hydrolysis, oxidation, reduction, isomerization, photolysis, photo-oxidation, biotransformation, and biodegradation. Transformed products resulting from these processes may behave differently than their parent chemical in the environment.

The migration of chemicals is governed by their physical and chemical properties and the surface and subsurface media through which chemicals are transferred. In general, chemicals and structures with similar physical and chemical characteristics will show similar patterns of transformation, transport, or attenuation in the environment. Solubility, vapor pressure data, chemical partitioning coefficients, degradation rates, and Henry's Law Constant (HLC) provide information that can be used to evaluate contaminant mobility in the environment. Partitioning coefficients are used to assess relative affinities of chemicals for solution or solid phase adsorption. However, the synergistic effects of multiple migrating chemicals and complexity of soil/water interactions, including pH and oxidation-reduction potential, grain size, and clay mineral variability, are typically unknown.

The physical properties of the chemicals defined as SRCs in surface and subsurface soil and sediment are summarized in Appendix E, Tables E-1 and E-2. These properties are used to assess the anticipated behavior of each chemical under environmental conditions. The physical properties of the chemicals defined as SRCs detected in soil and sediment are summarized in Sections 6.1.1 through 6.1.5.

6.1.1 Chemical Factors Affecting Fate and Transport

The water solubility of a chemical is a measure of the saturated concentration of the chemical in water at a given temperature and pressure. The tendency for a chemical to be transported by groundwater is directly related to its solubility and inversely related to its tendencies to adsorb to soil and volatilize from water (OGE 1988). Chemicals with high water solubilities tend to desorb from soil, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a chemical varies with temperature, pH, and the presence of other dissolved chemicals (including organic carbon and humic acids).

The octanol-water partition coefficient (K_{ow}) can be used to estimate the tendency for a chemical to partition between environmental phases of different polarity. The K_{ow} is a laboratory-determined ratio of the concentration of a chemical in the n-octanol phase of a two-phase system to the concentration in the water phase. Chemicals with log K_{ow} values less than one are highly hydrophilic, while chemicals with log K_{ow} values greater than four will partition to soil particles (Lyman et al. 1990).

The water/organic carbon partition coefficient (K_{oc}) is a measure of the tendency of an organic chemical to partition between water and organic carbon in soil. K_{oc} is defined as the ratio of the absorbed chemical per unit weight of organic carbon to the aqueous solute concentration. This coefficient can be used to estimate the degree to which an organic chemical will adsorb to soil and thus not migrate with groundwater. The higher the K_{oc} value, the greater is the tendency of the chemical to partition into soil (OGE 1988). The soil/water partitioning coefficient (K_d) is calculated by multiplying the K_{oc} value by the fraction of organic carbon in the soil.

Vapor pressure is a measure of the pressure at which a chemical and its vapor are in equilibrium. The value can be used to determine the extent to which a chemical would travel in air, as well as the rate of volatilization from soil and solution (OGE 1988). In general, chemicals with vapor pressures lower than 10^{-7} mm mercury will not be present in the atmosphere or air spaces in soil in significant amounts, while chemicals with vapor pressures higher than 10^{-2} mm mercury will exist primarily in the air (Dragun 1988).

The HLC value for a chemical is a measure of the ratio of the chemical's vapor pressure to its aqueous solubility. The HLC value can be used to make general predictions about a chemical's tendency to volatilize from water. Chemicals with HLC values less than 10^{-7} atm-m^3/mol will generally volatilize slowly, while chemicals with a HLC greater than 10^{-3} atm-m^3/mol will volatilize rapidly (Lyman et al. 1990).

6.1.2 Biodegradation

Organic chemicals with differing chemical structures will biodegrade at different rates. Primary biodegradation consists of any biologically induced structural change in an organic chemical. Complete biodegradation is the biologically mediated degradation of an organic chemical into carbon dioxide, water, oxygen, and other metabolic inorganic products (Dragun 1988). The first order biodegradation rate of an organic chemical is proportional to the concentration:

$$-dC/dt = kC \qquad \text{(Equation 6-1)}$$

Where:

C = concentration

t = time

k = biodegradation rate constant = $\ln 2 / t_{1/2}$

$t_{1/2}$ = biodegradation half-life

The biodegradation half-life is the time necessary for half of the chemical to degrade. The biodegradation rate of an organic chemical generally depends on the presence and population size of soil microorganisms that are capable of degrading the chemical.

6.1.3 Inorganic Chemicals

Inorganic chemicals detected in soil and sediment samples are associated with the aqueous phase and leachable metal ions on soil particles. The transport of this material from unsaturated soil to the underlying water table is controlled by the physical processes of precipitation percolation, chemical interaction with the soil, and downward transport of metal ions by continued percolation. The chemistry of inorganic chemical interactions with percolating precipitation and varying soil conditions is complex and includes numerous chemical transformations that may result in altered oxidation states, including ion exchange, adsorption, precipitation, or complexation. The chemical reactions, which are affected by environmental conditions (i.e., pH, oxidation-reduction conditions, type and amount of organic matter, clay content, and the presence of hydrous oxides), may act to enhance or reduce the mobility and toxicity of metal ions. In general, these reactions are reversible and add to the variability commonly observed in distributions of inorganic chemicals in soil.

The chemical form of an inorganic chemical determines its solubility and mobility in the environment; however, chemical speciation is complex and difficult to delineate in routine laboratory analysis. Inorganic chemicals in soil are commonly found in several forms, including dissolved concentrations in soil pore water, metal ions occupying exchange sites on inorganic soil constituents (adsorbed to inorganic soil constituents), metal ions associated with insoluble organic matter, precipitated inorganic chemicals as pure or mixed solids, and metal ions present in the structure of primary or secondary minerals.

The dissolved (aqueous) fraction and its equilibrium sorbed fraction are important when considering the migration potential of inorganic chemicals through soil. Of the inorganic chemicals that are likely to form, chlorides, nitrates, and nitrites are commonly the most soluble. Sulfate, carbonate, and hydroxides generally have low to moderate solubility. Soluble chemicals are transported in aqueous forms subject to attenuation, whereas less soluble chemicals remain as a precipitate and limit the overall dissolution of metal ions. The solubility of the metal ions is also regulated by ambient chemical conditions, including pH and oxidation/reduction.

The attenuation of metal ions in the environment can be estimated numerically using the retardation factor (R), dispersion in higher flow systems (high conductivity environments), and diffusion in low conductivity environments. R defines the extent to which the velocity of the contaminant is slowed, which is largely derived from the K_d. R is calculated using the following equation:

$$R = 1 + (K_d \rho_b) / \theta_w \qquad \text{(Equation 6-2)}$$

Where:

ρ_b = the soil bulk dry density (g/cm^3)
θ_w = soil moisture content (dimensionless)

Metal ion concentrations in the environment do not attenuate by natural or biological degradation because of low volatility and solubility of the ions. Inorganic chemicals may be biotransformed or bioconcentrated through microbial activity.

6.1.4 Organic Chemicals

Organic chemicals, such as SVOCs or VOCs, may be transformed or degraded in the environment by processes including hydrolysis, oxidation/reduction, photolysis, volatilization, biodegradation, or biotransformation. The half-life of organic chemicals in transport media can vary from minutes to years, depending on environmental conditions and chemical structures. Some types of organic chemicals are very stable, and degradation rates can be very slow. Organic degradation may either enhance (by producing more toxic byproducts) or reduce (reducing concentrations) the toxicity of a chemical in the environment.

6.1.5 Explosives-Related Chemicals

Nitrocellulose was detected in surface and subsurface soil at the Upper and Lower Cobbs Ponds AOC, and several explosive chemicals were detected in sediment, including HMX, nitrocellulose; tetryl; 1,3-DNB; TNT; 2,6-DNT; and 4-amino-2,6-DNT. Microbiological and photochemical transformation may affect the fate and transport of explosive compounds in the environment. For example, based on the results of culture studies involving the removal of TNT by activated sludge microorganisms, it has been concluded that TNT undergoes biotransformation but not biodegradation (USABRDL 1989). The biotransformation of TNT occurs with the reduction of the nitro groups by microbial reduction, typically under anaerobic conditions. Beneficial bacteria in these reactions include pseudomonas, escherichia, bacillus, citrobacter, enterobacter, klebseilla, veillonella, and clostridium (USACHPPM 2000). It has been found that anaerobic metabolism occurs in two stages (Funk et al. 1993). The first stage is the reductive stage in which TNT is reduced to its amino derivatives. In the second stage, degradation to non-aromatic products begins after the reduction of the third nitro group. The biotransformation rate of TNT can be rapid (ERDC 2007) and may be increased with the presence of carbon (USACHPPM 2000). Fungi and photolysis can also biotransform TNT. The predominant transformation products due to photolysis of TNT are 1,3,5-TNB; 4,6-dinitroanthranil; 2,4,6-trinitrobezadehyde; and 2,4,6-trinitrobenzonitrite (USACHPPM 2000). The biotransformation pathway for TNT is shown in Appendix E, Figure E-1 (Kaplan and Kaplan 1982). The nitro groups of TNT are reduced to form 4-amino-2,6-DNT and can undergo further reduction of the nitro groups to form 2,4,6-triaminotoluene (Cockerham and Shane 1994).

The biotransformation of 2,6-DNT has been systematically studied in laboratory cell cultures. The biotransformation pathway is shown in Appendix E, Figure E-2 (Singh et al. 2015). The reduction products include the amino and azoxy derivatives as observed with TNT biotransformation. As with TNT and DNT, the principal mode of microbial transformation of the nitroaromatic chemical 1,3-DNB is reduction of nitro groups to form amino groups (Walsh 1990). DNB is a photolytic product of TNT, but will undergo further photolysis. DNB will resist hydrolysis. The breakdown of DNB is primarily through microbial degradation (USACHPPM 2001a).

Limited information exists regarding biotransformation or biodegradation of HMX, nitrocellulose, and tetryl. Biotransformation of HMX, primarily by anaerobic degradation (ERDC 2007), occurs at a slow rate in the environment (USACHPPM 2001b). HMX is primarily broken down by photolysis and has a photolytic rate constant of 0.15 days (USEPA 1988a). Breakdown products of HMX include nitrate, nitrite, and formaldehyde (USACHPPM 2001b). Appendix E, Figure E-3 shows the biotransformation pathway for HMX (ATSDR 1997). Nitrocellulose is an aliphatic nitrate ester that will gelatinize with nitroglycerin when the two are mixed. Nitrocellulose occurs as a fibrous solid that can act as a sorbent that will dissolve in water under highly basic conditions with high temperatures. Nitrocellulose can undergo denitrification as a degradation pathway. Degradation of nitrocellulose to non-reactive nitrocellulose has been observed under methanogenic and fungus-mediated reducing conditions (USACE 2006). Tetryl may undergo biotransformation, hydrolysis, and photodegradation to produce several different transformation products, such as N-methylpicramide and 4-amino-N-methyl-N,2,6-trinitroaniline (USACE 1994).

6.2 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

The conceptual site model (CSM), which defines the framework for fate and transport modeling, describes the conditions at the Upper and Lower Cobbs Ponds AOC, including the contaminant sources, surficial and subsurface hydrogeologic conditions, contaminant migration and pathways, and contaminant release mechanisms.

AOC conditions described in Sections 2.0 through 5.0 include contaminant source information, the surrounding geologic and hydrologic conditions, and the magnitude of SRCs and their current spatial distribution. Information from Section 3.0 and the nature and extent evaluation in Section 5.0 were used to develop the CSM for fate and transport modeling by identifying SRCs and migration pathways. The CSM is based on information and data collected for historical investigations, this RI Report, and informed assumptions about the AOC. Assumptions contained in the CSM are reiterated throughout this section. The better the information is and the more accurate the assumptions are, the more accurately the CSM describes the AOC, and therefore, the more reliable the fate and transport modeling predictions can be. A summary of the salient elements of the CSM that apply to fate and transport modeling are summarized in the following sections.

6.2.1 Contaminant Sources

No primary contaminant sources are located on the AOC. Secondary sources (contaminated soil) were identified in previous investigations and are further evaluated in this report. Another potential secondary source of contamination at the AOC is contaminated sediment in the ponds, which is in contact with the surface water and has the potential to leach contaminants to the groundwater.

6.2.2 Hydrogeology

A description of regional and AOC-specific geology and hydrology are provided in Sections 3.3.3 and 3.4.2, respectively, and are summarized below.

- The topography at the Upper and Lower Cobbs Ponds AOC ranges from approximately 960 ft amsl to approximately 980 ft amsl and is relatively flat with the exception of the bank areas around the ponds. Surface water drainage associated with heavy rainfall events follows the topography and drains into the ponds located in the center of the AOC (Figure 3-1). Upper Cobbs Pond is located in the center of the AOC and Lower Cobbs Pond is located in the northern portion of the AOC (downstream of Upper Cobbs Pond). Surface water exits Lower Cobbs Pond via a dam overflow spillway, which leaves the AOC and flows into an unnamed tributary to Sand Creek (MKM 2005).
- Soil along the banks at the AOC consists of clay to sand-rich silt tills with interbedded sands scattered throughout, as observed in subsurface borings installed during the PBA08 RI (Appendix A). Soil across the AOC is low to moderately permeable and poorly drained.
- Six groundwater monitoring wells were installed in the unconsolidated zone at the AOC to an average depth of 21.5 ft bgs. Potentiometric data indicate the groundwater flow direction is to the northwest with an average hydraulic gradient of 0.011 ft/ft (Figure 3-1).
- The water table in the unconsolidated bank soil occurs at approximately 5 ft bgs (ranging from 1 ft bgs to greater than 13 ft bgs) or around 965 ft amsl as observed in subsurface borings installed during the PBA08 RI (Appendix A).
- Contaminant leaching pathways from bank soil and sediment at the bottom of the ponds to the water table are typically through preferential flow paths created from the interbedded sands scattered throughout the smaller-grained unconsolidated soil.

6.2.3 Contaminant Release Mechanisms and Migration Pathways

Based on the information presented above, the following contaminant release mechanisms and migration pathways have been identified at the AOC:

- Contaminant leaching from bank soil to the water table (vertical migration) and lateral transport to a downgradient receptor (the ponds);
- Contaminated sediment transported to potential downstream receptors;
- Contaminated surface water migrating to potential downstream receptors;
- Contaminated sediment from the ponds as a secondary source of leaching to the water table (vertical migration) and lateral transport to downgradient receptors; and
- Contaminated sediment at the bottom of surface water bodies, assuming equilibrium with groundwater, and mixing with surface water based on a calculated, sample-specific dilution attenuation factor (DAF).

The first of these pathways, which considers a primary groundwater transport pathway, is treated explicitly in this fate and transport section. Sediment and surface water exposure pathways are evaluated in the HHRA and ERA presented in Sections 7.2 and 7.3, respectively. The fourth and fifth pathways listed above, which consider a secondary groundwater transport pathway and a primary groundwater transport pathway, respectively, are evaluated using the sediment screening analysis presented in Section 6.4.

One of the principal migration pathways at the AOC is percolation through the unsaturated soil to the water table (i.e., vertical leaching of contaminants from soil into groundwater). However, because of the very heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns within the unconsolidated soil are difficult to predict. Precipitation that does not leave the AOC as surface runoff percolates into the subsurface. Some of the percolating water leaves this environment via evapotranspiration after little or no vertical migration.

The remainder of the water percolates into the water table. As discussed in Section 6.2.4, the rate of percolation is controlled by soil cover, ground slope, saturated conductivity of the soil, and meteorological conditions. Figure 6-1 illustrates the contaminant migration conceptual model.

Once the contaminant leachate percolates through the soil and reaches the water table, it migrates with the local groundwater and discharges into the ponds. Groundwater flow likely occurs along preferential pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities. For inorganic chemicals, lateral migration through groundwater will be very limited due to their high retardation by the bedrock material (USACE 2003b).

Additional factors that affect the leaching rate include a chemical's solubility, sorption capacity (expressed by K_d), and the amount of percolation. Insoluble chemicals will precipitate out of the solution in the subsurface or remain in insoluble forms with little leaching.

Another factor that affects whether a chemical will reach the water table through percolation of precipitation is the chemical's rate of decay. Most organic compounds decay at characteristic rates proportional to the chemical's half-life. For a given percolation rate, those chemicals with long half-lives have a greater potential for contaminating groundwater than those with shorter half-lives. For this analysis, the rate of decay/half-life was not considered.

Contaminant releases through gaseous emissions and airborne particulates are not significant at the Upper and Lower Cobbs Ponds AOC. The AOC is vegetated, located in a humid temperate climate, and soil moisture is typically high, which prevents dust borne contaminant migration. Therefore, there is likely little to no gaseous emission, and contaminant levels in the air pathway are minor to nonexistent.

6.2.4 Water Budget

The potential for contaminant transport begins with precipitation. Percolation is the driving mechanism for soil contaminants leaching to groundwater. The actual amount of rainwater available for flow and percolation to groundwater is highly variable and depends upon soil type and climatic conditions. A water balance calculation can be used as a tool to quantitatively account for all components of the hydrologic cycle. The quantified elements of the water balance are used for inputs to the soil leaching and groundwater transport models discussed later. The components of a simple steady-state water balance model include precipitation, evapotranspiration, surface runoff, and groundwater recharge or percolation.

These terms are defined as follows:

$$P = ET + Sr + q \qquad \text{(Equation 6-3)}$$

or

$$\text{Rainwater available for flow} = Sr + q = P - ET \qquad \text{(Equation 6-4)}$$

Where:

P = precipitation
Sr = surface runoff
ET = evapotranspiration
q = groundwater recharge or percolation

It is expected that loss of runoff also occurs in the form of evaporation. The remaining water, after runoff and evaporation, is available for percolation, which includes loss to the atmosphere by evapotranspiration. The water balance estimations were developed using the Hydrologic Evaluation of Landfill Performance (HELP) model (USEPA 1994a). See Appendix E, Table E-3 for parameters used in the HELP model to develop the water budget estimates used in the evaluation. Calculations using precipitation and temperature data for a 100-year period were generated synthetically using coefficients for Cleveland, Ohio (e.g., the nearest weather station to Camp Ravenna with HELP model coefficients).

The annual average water balance estimates indicate an evapotranspiration of 28% (10.3 inches) of total precipitation (37 inches). The remaining 72% (26.7 inches) of rainwater is available for surface water runoff and percolation to groundwater. Of the 72% (26.7 inches) of water available for runoff or percolation, groundwater recharge (percolation) accounts for 13% (3.6 inches), and surface runoff (along downgradient topography to nearest surface water bodies) accounts for the remaining 87% (23.1 inches).

6.3 SOIL SCREENING ANALYSIS

Soil screening analyses are screening evaluations performed to identify SRCs with the potential to leach to groundwater as initial CMCOPCs. The five steps for the soil leachability analysis are illustrated in Figure 6-2.

6.3.1 Soil Screening Analysis

The first step of the soil screening analysis is developing SRCs, as presented in Section 4.0. A summary of SRCs identified for soil and sediment is presented in Section 6.1.

The second step of the soil screening process (Figure 6-2) involves comparing the maximum concentrations of the SRCs with MCL-based generic soil screening levels (GSSLs). GSSLs were developed for Superfund sites for contaminant migration to groundwater (USEPA 1996b, 2015). The GSSL is defined as the concentration of a chemical in soil that represents a level of contamination below which there is no concern for impacts to groundwater under CERCLA, provided conditions associated with USEPA risk-based soil screening levels (SSLs) are met. Generally, if chemical concentrations in soil fall below the GSSL, and there are no groundwater receptors of concern or anticipated exposures, then no further study or action is warranted for that chemical. If the GSSL for a chemical is not available, the USEPA risk-based SSL for groundwater migration, dated June 2015 (USEPA 2015), will be obtained from the USEPA RSL website and used. If neither the GSSL nor the USEPA risk-based SSL for a chemical are available, then no further evaluation of the chemical is performed and it is eliminated from the list of initial CMCOPCs. However, some chemicals have been assigned surrogates by risk assessors if the chemical without an SSL is similar to another chemical with an SSL. Surrogates used for this analysis include acenaphthene for acenaphthylene and pyrene for benzo(ghi)perylene and phenanthrene.

The initial CMCOPC screen, as presented in Appendix E, Table E-4, eliminated 9 inorganic chemicals and 15 organic chemicals from further consideration. Nine inorganic and four organic SRCs exceeded their GSSLs and were carried forward to the next screening step.

The third step of the soil screening process (Figure 6-2) involves comparing the maximum chemical concentrations with the site-specific soil screening levels (SSSLs). The SSSL is defined as the GSSL (or the USEPA risk-based SSL for groundwater protection if a GSSL is not available) multiplied by the AOC-specific DAF. Direct partitioning is used to derive GSSLs, assuming groundwater is in contact with the chemicals in soil and the groundwater concentration is equal to the leachate concentration. However, as leachate moves through soil, chemical concentrations are attenuated by adsorption and degradation. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations. This concentration reduction can be expressed by a DAF. DAFs can vary based on AOC-specific characteristics (e.g., hydrogeologic properties, contaminated source area, and depth to contamination). As described in the *Soil Screening Guidance: Technical Background Document* (USEPA 1996b), chemical dilution in groundwater is estimated at each AOC from an AOC-specific DAF. The DAF, which is defined as the ratio of soil leachate concentration to receptor point concentration, is minimally equal to one. Dilution in groundwater is derived from a simple mixing zone equation (Equation 6-5) and relies upon estimating the mixing zone depth (Equation 6-6).

$$\mathrm{DAF} = 1 + \frac{(\mathrm{K} \times i \times \mathrm{d})}{(\mathrm{q} \times \mathrm{L})} \qquad \text{(Equation 6-5)}$$

Where:

DAF = dilution attenuation factor
K = aquifer hydraulic conductivity (m/yr)
i = horizontal hydraulic gradient (m/m)
q = percolation rate (m/yr)
L = source length parallel to groundwater flow (m)
d = mixing zone depth (m) (which is defined below)

$$d = \sqrt{0.0112 \times L^2} + d_a \times \left[1 - \exp\left(\frac{-L \times I}{K \times i \times d_a} \right) \right] \qquad \text{(Equation 6-6)}$$

Where:

d_a = aquifer thickness (m)
$d \le d_a$

As stated above, if the aquifer thickness is less than the calculated mixing zone depth, then the aquifer thickness is used for “d” in the DAF calculation. The DAF calculation for the AOC is presented in Appendix E, Table E-5. However, the DAF calculated for the soil screening at this AOC was estimated to be 1.00. Therefore, initial CMCOPCs following the GSSL screening remained initial CMCOPCs throughout the SSSL analysis step. The SRCs identified as initial CMCOPCs are presented in Appendix E, Table E-6. It should be noted that the purpose of this screen is not to identify the chemicals that may pose risk at downgradient locations, but to target those chemicals that pose the greatest problem if they migrate from the AOC.

The fourth step of the soil screening process (Figure 6-2) involves eliminating initial CMCOPCs identified in the SSSL evaluation that require more than 1,000 years to leach through the unsaturated zone before reaching the water table from further consideration. A period of 1,000 years was conservatively selected to evaluate eventual migration of the contaminant front to the water table despite uncertainties in vadose zone hydraulic parameters and groundwater recharge over time. Additionally, USACE suggests a screening value of 1,000 years be used due to the high uncertainty associated with predicting conditions beyond that time frame (USACE 2003b). Therefore, the initial CMCOPCs at the selected sources were screened against a travel time of greater than 1,000 years. The travel time in this screen is the time required for an initial CMCOPC to migrate vertically from the base of the soil interval detected above the background concentration to the water table. This distance is known as the leaching zone, which is evaluated in Appendix E, Table E-7, which may vary across the AOC based on the varying depths of soil sample concentrations above the facility-wide background concentrations and the elevation of the water table. The estimated travel time for each initial CMCOPC to reach the water table is determined using the following equations:

$$T = \frac{Lz \times R}{V_p} \qquad \text{(Equation 6-7)}$$

Where:

T = leachate travel time (year)
Lz = thickness of attenuation zone (ft)
R = retardation factor (dimensionless) (Equation 6-2)
V_p = porewater velocity (ft/year)

and

$$V_p = \frac{q}{\theta_w} \qquad \text{(Equation 6-8)}$$

Where:

q = percolation rate (ft/year)
θ_w = fraction of total porosity that is filled by water

If the travel time for a chemical from a source area exceeded 1,000 years, then the chemical was eliminated from the list of initial CMCOPCs. Seven inorganic and seven organic SRCs were eliminated from further consideration based on their travel times exceeding 1,000 years. Initial CMCOPCs with travel times less than 1,000 years were retained for further evaluation (Appendix E, Table E-7). The constituents selected for further evaluation with Seasonal Soil Compartment (SESOIL) model are listed in Table 6-1.

In the fifth step (Figure 6-2), the initial CMCOPCs (presented in Table 6-1) are further evaluated using fate and transport models provided in Section 6.5.

6.3.2 Limitations and Assumptions of Soil Screening Analysis

It is important to recognize that acceptable soil concentrations for individual chemicals are highly AOC-specific. The GSSLs used in this screening are based on a number of default assumptions chosen to be protective of human health for most AOC conditions (USEPA 1996b). These GSSLs are expected to be more conservative than SSSLs based on AOC conditions. The conservative assumptions included in this analysis are: (1) no adsorption in the unsaturated zone or in the aquifer, (2) no biological or chemical degradation in the soil or aquifer, and (3) contamination is uniformly distributed throughout the source. However, the GSSL does not incorporate the existence of contamination already present within the aquifer.

6.4 SEDIMENT SCREENING ANALYSIS

Sediment SRCs were developed in Section 4.0 and are presented in Section 6.1. The purpose of this screening analysis is to identify CMCOPCs based on contaminant migration from sediment to groundwater. The steps for the sediment screening analysis are illustrated in Figure 6-3.

Three different aggregates exist for the sediment screening analysis at the Upper and Lower Cobbs Pond AOC: Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Each aggregate was screened separately to identify potential CMCOPCs. Sediment SRCs were screened by developing leachate concentrations assuming equilibrium between sediment and groundwater. The predicted leachate concentrations were diluted based on a sample-specific DAF calculated by dividing the calculated leachate concentrations by the co-located surface water concentrations. The DAF was calculated for each chemical that was detected in sediment and surface water at the same sample location. The calculated DAF was then used to calculate the maximum groundwater concentration, considering dilution for sediment SRCs and assuming that sediment is in direct contact with groundwater. The lowest DAF calculated for the sample area was used for sediment SRCs that did not have a sample-specific DAF. The DAFs calculated for each chemical are shown in Tables 6-2, 6-3, and 6-4.

This sediment screening analysis assumed that the sediment concentration and the recharging groundwater concentration were in equilibrium and a sample-specific DAF for each chemical was used for dilution in the aquifer. Based on this screening analysis, there were four initial sediment CMCOPCs [silver; 2,6-DNT; benz(a)anthracene; and methylene chloride] in the Backwater Area (Table 6-2 and Appendix E, Table E-8), two initial sediment CMCOPCs (hexavalent chromium and cobalt) in Upper Cobbs Pond (Table 6-3 and Appendix E, Table E-9), and four initial sediment CMCOPCs [chromium, hexavalent chromium, benz(a)anthracene, and naphthalene] in Lower Cobbs Pond (Table 6-4 and Appendix E, Table E-10).

These initial sediment CMCOPCs were further evaluated by comparing their maximum detected surface water concentrations against their respective MCL/RSLs. This analysis assumes that groundwater beneath sediment and surface water are in contact and in equilibrium. An initial sediment CMCOPC was eliminated if the detected concentration in surface water was below its MCL/RSL (Table 6-5) because there is no evidence that the initial sediment CMCOPC is contributing to groundwater/surface water that is in equilibrium. Based on this evaluation, all the initial sediment CMCOPCs from the Backwater Area were eliminated from further evaluation, and only hexavalent chromium from Upper Cobbs Pond and Lower Cobbs Pond was identified as a final sediment CMCOPC (Table 6-5) and was further evaluated in the WOE discussion to identify sediment CMCOCs.

6.5 FATE AND TRANSPORT MODELING

Contaminant fate and transport modeling represents the fifth step in the fate and transport screening and evaluation process (Figure 6-2). SESOIL modeling was performed for chemicals identified as initial CMCOPCs from the soil screening analysis presented in Section 6.3 and summarized in Table 6-1. SESOIL modeling was performed to predict chemical concentrations in the leachate immediately beneath the selected source areas and just above the water table. If the predicted maximum leachate concentration of an initial CMCOPC was higher than the facility-wide background concentration and the lowest risk-based screening value (Resident Receptor Adult FWCUG, MCL, or RSL), it was identified as a final CMCOPC and was further evaluated using the Analytical Transient 1-, 2-, 3- Dimensional (AT123D) model to predict future maximum concentrations in groundwater beneath the source, as well as at downgradient receptor locations, if applicable. The downgradient receptor location (if required) is the closest surface water body feature downgradient from the source areas that is connected to the groundwater, and for this AOC the nearest surface water body feature is the Cobbs Pond itself. If the AT123D predicted maximum concentration in groundwater beneath the source was higher than its facility-wide background concentration and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), the chemical was retained as a CMCOC for WOE discussion including a comparison to groundwater monitoring results for the AOC (if available).

6.5.1 Modeling Approach

Contaminant transport includes the movement of water and dissolved material from the source areas to groundwater. This occurs as rainwater infiltrates the surface and percolates through the area of contamination, its surrounding soil, and into the saturated zone. The downward movement of water, driven by gravitational potential, capillary pressure, and other components of total fluid potential, mobilizes the contaminants and carries them through the soil into the mixing zone with the water table. Lateral transport within the unconsolidated zone is controlled by the groundwater gradient. Vertical transport (evaluated with SESOIL) through the overburden to the water table and horizontal transport (evaluated with AT123D) through the unconsolidated zone to downgradient receptor locations are illustrated in Figure 6-1.

The output of the contaminant fate and transport modeling is presented as the expected maximum concentration of modeled contaminants at the selected receptor locations. For SESOIL, the receptor location is the groundwater table beneath the source area. For this analysis, four discrete sample locations were considered as sources of contamination based on the results of the soil screening analysis. A separate SESOIL analysis was performed for each initial CMCOPC listed in Table 6-1 and is presented in Figure 6-4.

The predicted maximum leachate concentration just above the water table, observed in the SESOIL results, was compared against its applicable RVAAP facility-wide background concentration, as well as the Resident Receptor Adult FWCUG, MCL, and RSL. If the predicted maximum leachate concentration of an initial CMCOPC was higher than the facility-wide background concentration, and the lowest risk-based screening value (Resident Receptor Adult FWCUG, MCL, or RSL), the initial CMCOPC was identified as a final CMCOPC and was further evaluated using AT123D to predict future maximum concentrations in groundwater beneath the source, as well as at downgradient receptor locations, if applicable.

If a predicted maximum leachate concentration was lower than the screening criteria, the chemical was no longer considered a CMCOPC.

For chemicals identified as final CMCOPCs, maximum concentrations predicted by AT123D in groundwater directly below the source areas and at the downgradient receptor locations were compared to the applicable RVAAP facility-wide background concentrations, as well as the Resident Receptor Adult FWCUG, MCL, and RSL. If the predicted maximum concentration of a final CMCOPC was higher than its facility-wide background concentration, and the lowest risk-based screening value (i.e., Resident Receptor Adult FWCUG, MCL, or RSL), the chemical was retained as a CMCOC for WOE evaluation. If the predicted maximum concentration of a final CMCOPC in groundwater directly below the source areas and at the downgradient receptor location was lower than the screening criteria, the chemical was eliminated as a CMCOC and was not considered in the WOE evaluation.

CMCOCs identified by modeling results were evaluated with respect to WOE for retaining or eliminating CMCOCs from further consideration as a basis for potential soil remedial actions. Lines of evidence include validating modeling results using available AOC-specific groundwater monitoring data. Modeled timelines for potential leaching and lateral transport were evaluated with respect to estimated times for contaminant releases during RVAAP operations to determine if peak leaching concentrations would likely have occurred in the past. Some CMCOCs present at or below RVAAP soil background concentrations may have predicted leachate or groundwater concentrations exceeding risk-based criteria due to conservative model assumptions; therefore, these were also identified and considered in the evaluation. Additionally, identified CMCOCs were compared to COCs identified in the HHRA to determine if they had an associated risk related to direct exposure to soil or if CMCOCs and COCs were co-located and may be addressed simultaneously under a potential remedial action.

6.5.2 Model Applications

The SESOIL model (GSC 1998) used for leachate modeling, when applicable, estimates pollutant concentrations in the soil profile following introduction via direct application and/or interaction with transport media. AT123D (DOE 1992) is an analytical groundwater pollutant fate and transport model. It computes the spatial-temporal concentration distribution of waste in the aquifer system and predicts the transient spread of a contaminant plume through a groundwater aquifer. The application of both of these models is discussed in the following subsections.

6.5.2.1 SESOIL Modeling

SESOIL defines the soil column as compartments extending from the ground surface through the unsaturated zone and to the upper level of the saturated soil zone or top of bedrock. Processes simulated in SESOIL are categorized in three cycles: hydrologic, sedimentation, and pollutant. Each cycle is a separate submodule in the SESOIL code. The hydrologic cycle includes rainfall, surface runoff, percolation, soil-water content, evapotranspiration, and groundwater recharge. The sediment washload cycle includes erosion and sediment transport. The pollutant cycle includes convective transport, volatilization, adsorption/desorption, and degradation/decay. A chemical in SESOIL can partition in up to four phases: liquid, adsorbed, air, and pure. Data requirements for SESOIL are not extensive and utilize a minimum of AOC-specific soil and chemical parameters and monthly or seasonal meteorological values as input.

SESOIL output includes pollutant concentrations at various soil depths and pollutant loss from the unsaturated soil zone in terms of surface runoff, percolation to groundwater, volatilization, and degradation. The mathematical representations in SESOIL generally consider the rate at which the modeled processes occur, the interaction of different processes with each other, and the initial conditions of the waste area and surrounding subsurface matrix material.

The input data for SESOIL can be grouped into four types: climatic, chemical, soil, and application. There are 61 separate parameters contained in these 4 data groups. Wherever possible, AOC-specific parameter values were used for modeling. However, certain parameters were not available for the source areas and were estimated based on pertinent scientific literature, geochemical investigations, and checks for consistency between model results and historical data. Conservative estimates were used when a range of values existed or parameter values were not available.

6.5.2.2 Climate Data

The climatic data file of SESOIL consists of an array of mean monthly temperature, mean monthly cloud cover fraction, average monthly relative humidity, average monthly reflectivity of the earth's surface (i.e., shortwave albedo), average daily evapotranspiration, monthly precipitation, mean number of storm events per month, mean duration of rainfall, and mean length of rainy season. The climatic data are presented in Appendix E, Table E-11. The data set was taken from the Youngstown National Weather Service Office weather station at the Youngstown-Warren Regional Airport in Vienna, Ohio, as it was determined to be most appropriate in corresponding to the latitude and longitude at Camp Ravenna.

Climate data from the Youngstown weather station did not have all of the necessary climatic parameters for the HELP model simulation. Accordingly, the water balance evaluation presented in Section 6.2.4 was based on the nearest available weather station data with all necessary coefficients stored within the HELP model (Cleveland, Ohio). Inputs for the SESOIL (Youngstown station) and HELP models (Cleveland station) produced virtually the same recharge rate (9.40 cm/yr for Cleveland and 9.42 cm/yr for Youngstown) for each location. Therefore, the use of the two different weather station data sets did not impact modeling results.

6.5.2.3 Chemical Data

The pollutant fate cycle of SESOIL focuses on various chemical transport and transformation processes that may occur in the soil zone. These processes include volatilization/diffusion, adsorption/desorption, cation exchange, biodegradation and hydrolysis, and metal complexation. The chemical-specific parameters used for SESOIL are presented in Appendix E, Table E-12. The distribution coefficients (K_ds) for inorganic chemicals and the K_{oc} values for organic chemicals were obtained from the chemical-specific parameter table associated with the USEPA Risk Based Generic Screening Tables (USEPA 2015). The K_ds for organic chemicals were estimated from organic, carbon-based K_{oc} using the relationship $K_d = (f_{oc})(K_{oc})$, where f_{oc} = mass fraction of the organic carbon soil content obtained from AOC-specific measurements. In general, biodegradation rates are not applicable for inorganic CMCOPCs and biodegradation was not considered for the organic chemicals in this evaluation.

6.5.2.4 Soil Data

The soil data file of SESOIL contains input parameters describing the physical characteristics of the subsurface soil and is presented in Table 6-6. These parameters include soil bulk density, intrinsic permeability, soil disconnectedness index, soil porosity, organic carbon content, and cation exchange capacity. AOC-specific data were used from geotechnical samples collected at the AOC during the PBA08 RI. There is, however, no measurement method for the soil disconnectedness index or a measured value of the Freundlich exponent. The soil disconnectedness index is a parameter that relates the soil permeability to the moisture content, and the Freundlich exponent relates to the concentration of a solute on the surface of an adsorbent to the concentration of the solute in the liquid with which it is in contact. Thus, SESOIL default values were used for these two parameters.

An average intrinsic permeability for the vadose zone, representing the unconsolidated zone above the water table, was calibrated using the percolation rate of 9.42 cm/yr (3.6 inches/year) as the calibration target. The model was calibrated against the percolation rate by varying the intrinsic permeability and keeping all other AOC-specific geotechnical parameters fixed. The final hydrogeologic parameter values used in this modeling are shown in Table 6-6. The soil porosity was set to the AOC-specific value. The intrinsic permeability, calibrated in SESOIL to the percolation rate (determined from a water balance estimated in HELP), was found to match the AOC-specific measurements from geotechnical samples.

The soil disconnectedness index replaces the moisture retention curves (or characteristic curves) used by other unsaturated zone leaching models. SESOIL's User Guide defines this parameter to be the exponent relating the "wetting" and "drying" time-dependent permeability of soil to its saturated permeability (Hetrick and Scott 1993). This "one variable" approach of using the soil disconnectedness index in SESOIL simplifies the data estimation process and reduces computational time. In addition, this parameter was calibrated for four different soil types ranging from sandy loam to clay (Hetrick et al. 1986), and calibrated values fell within the default range specified in the SESOIL's User Guide.

6.5.2.5 Source Terms

Analytical data from surface and subsurface soil collected at the AOC were used as source terms for SESOIL. All the samples collected at different depth intervals were compiled to provide a detailed loading option for SESOIL. The maximum soil concentrations for each initial CMCOPC, listed in Table 6-1, were used as source term concentrations for SESOIL.

6.5.2.6 Application Data

Four different layering schemes were developed for sample locations within the AOC due to varying thicknesses of the loading and leaching zones that are based on varying soil sample and groundwater depths throughout the AOC. A model with a 3-ft vadose zone was used to model arsenic, barium, hexavalent chromium, and thallium. A model with a 10-ft vadose zone was used to model nickel and selenium. A model with a 13-ft vadose zone was used to model beta-BHC. Details of the model layers utilized in this modeling are presented in Appendix E, Table E-13.

Each model was arranged in four layers. The top layer (layer 1) of the 3-ft-thick model contained two sublayers, each 0.5 ft thick, for a total thickness of 1 ft for layer 1. The top 0.5 ft of layer 1 constituted the loading zone for arsenic and hexavalent chromium and corresponded to the maximum contamination depth for arsenic and hexavalent chromium at their respective sample locations. All of Layer 1 (the top 1 ft) constituted the loading zone for barium and thallium. The second and third layers of the 3-ft-thick model were 0.75 ft thick each with three 0.25-ft-thick sublayers for each model layer. The fourth layer was 0.5 ft thick and did not contain any sublayers. Layer 4 was included just above the water table to read output results at the water table/vadose zone interface. Layers 2 through 4 served as the leaching zone.

The vadose zones varied for nickel, selenium, and beta-BHC based on the depth to water observed in soil borings CPCsb-032 and CPCsb-035, respectively. Based on the depth to water in CPCsb-032, the vadose zone was 10 ft thick for nickel and selenium. Nickel and selenium contamination were detected throughout the entire soil interval in CPCsb-032. Therefore, nickel and selenium were loaded in all model layers in SESOIL with a 0.25-ft-thick fourth layer just above the water table to read output results at the water table/vadose zone interface. CPCsb-035 extended to a depth of 13 ft bgs, but groundwater was not encountered in the soil boring. Therefore, the depth to groundwater was set to the minimum thickness available at 13 ft bgs. Beta-BHC was detected at a maximum depth of 1 ft bgs in CPCsb-035, which resulted in a 12-ft-thick leaching zone for beta-BHC.

6.5.3 SESOIL Modeling Results

SESOIL modeling was performed for initial CMCOPCs (i.e., arsenic, barium, hexavalent chromium, nickel, selenium, thallium, and beta-BHC) that have the potential to reach the water table within 1,000 years based on the soil screening analysis results (Table 6-1). Table 6-7 presents the predicted peak leachate concentrations beneath the source areas relative to the discrete sample locations corresponding to the time of peak leachate concentrations. The Resident Receptor Adult FWCUGs, RVAAP facility-wide background concentrations, and MCL/RSL values for the initial CMCOPCs, if available, are also shown in this table for comparison purposes. The maximum concentrations of arsenic, barium, nickel, selenium, thallium, and beta-BHC in the leachate below the source and just above the water table exceeded their respective screening criteria. Therefore, these chemicals were selected as the final CMCOPCs for AT123D modeling. Hexavalent chromium was eliminated based on the SESOIL modeling results. Appendix E, Figures E-4 through E-10 show the leachate mass flux versus time plots generated by SESOIL to be used as input to AT123D modeling.

Arsenic, barium, nickel, selenium, thallium, and beta-BHC were identified as the final soil CMCOPCs based on SESOIL results for each sample location within the AOC where the leachate concentration exceeded its screening criteria. This leachate concentration does not reflect the groundwater concentration beneath the source. When the leachate reaches the water table, dilution by groundwater further reduces leachate concentrations.

6.5.4 AT123D Modeling in the Saturated Zone

The fate and transport processes accounted for in the AT123D model include advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the groundwater resulting from a mass release over a source area (point, line, area, or volume source). The model can handle instantaneous, as well as continuous, source loadings of CMCOPC concentrations. AT123D is frequently used by the scientific and technical community to perform quick and conservative estimates of groundwater plume movements in space and time. SESOIL and AT123D are linked in a software package (RISKPRO) so that mass loading to the groundwater predicted by SESOIL can be transferred directly to AT123D. Therefore, AT123D was chosen to predict the maximum concentration of contaminants in groundwater after mixing with the leachate and the future concentrations for the contaminants in groundwater at the receptor locations.

The hydrogeologic parameter values used in this modeling are shown in Table 6-6. Most of the parameters presented in this table are AOC-specific values, unless otherwise indicated. The chemical-specific parameters used for AT123D are presented in Appendix E, Table E-14. A discussion of model assumptions and limitations is presented in Section 6.5.6.

Appendix E, Figures E-11 through E-16 show the predicted concentration versus time curves based on AT123D modeling for final CMCOPCs for soil.

6.5.5 AT123D Modeling Results

Results of AT123D modeling for final soil CMCOPCs are shown in Table 6-8. The results show predicted groundwater concentrations for final CMCOPCs beneath the source area and at the selected downgradient receptor location (i.e., surface water at the Backwater Area and Upper Cobbs Pond). Observed groundwater concentrations from AOC monitoring wells are included in Table 6-8; however, it should be noted that these wells may not exist at the sample location with the maximum concentration and should not be considered in direct correlation. The observed groundwater concentrations were added for comparison, not for screening criteria. The distances to the downgradient receptors were based on the distance along the groundwater flow direction to the edge of the pond/surface water.

The maximum predicted concentrations of arsenic, nickel, selenium, and thallium were predicted to exceed the screening criteria in groundwater beneath the source area and were modeled to the downgradient receptors (i.e., surface water at the Backwater Area and Upper Cobbs Pond). The maximum predicted concentrations of barium and beta-BHC in the groundwater were not predicted to exceed the screening criteria beneath the source area and were eliminated as CMCOCs.

Lateral transport modeling showed the maximum predicted concentrations of all remaining final soil CMCOPCs (i.e., nickel, selenium, and thallium) except arsenic did not exceed the screening criteria at their downgradient receptor location (i.e., surface water at the Backwater Area and Upper Cobbs Pond). However, because arsenic, nickel, selenium, and thallium exceeded screening criteria in groundwater beneath their respective source areas, they were retained for further evaluation. Figure 6-5 presents CMCOCs identified for WOE evaluation based on AT123D modeling.

6.5.6 Limitations/Assumptions

In general, a conservative modeling approach was used, which may overestimate the contaminant concentration in the leachate for migration from observed soil concentrations. Important assumptions used in this analysis include:

- The contaminant fate and transport evaluation included not only chemicals identified as being previously used during historical operations but also chemicals identified during the RVAAP SRC screening process.
- Some SRCs were identified due to the lack of background concentration data available or having limited or slight exceedances of established background concentrations.

- Chemical and biological degradation rates for organic CMCOPCs were not considered in the SESOIL and AT123D models.
- The use of K_d and R to describe the reaction term of the transport equation assumes that an equilibrium relationship exists between the solid-phase and solution-phase concentrations and that the relationship is linear and reversible.
- Since AOC-specific data are not available, the K_d and K_{oc} values used in this analysis for all CMCOPCs represent literature or calculated values and may not represent conditions at the AOC.
- The K_d for inorganic chemicals used here assumed a pH of 6.8 [i.e., the middle value in the USEPA's evaluation presented in the soil screening guidance document (USEPA 1996b)]. The K_d for inorganic chemicals varies with pH (generally decreasing with decreasing pH, although there are few exceptions); therefore, if AOC-specific pH measurements are greater or less than 6.8, the K_d and calculated screening parameters (such as R) will deviate from those presented here.
- Flow and transport in the vadose zone is one-dimensional (i.e., only in the vertical direction).
- This modeling used the current soil concentrations that were collected approximately 65 years after historical operations were terminated at the AOC. Therefore, it does not account for constituents that have already leached to groundwater.
- Flow and transport are not affected by density variations.
- A realistic distribution of soil contamination was not considered. The maximum concentration value was used as the source term concentrations for SESOIL model layers; this is a highly conservative assumption that is expected to produce higher leachate concentrations for CMCOPCs than the average condition. The horizontal distribution of soil contamination was assumed based on concentration levels from nearby sample locations as opposed to taking into account the entire area.
- The water balance represents an overall average rainwater recharge and assumes an even distribution of infiltration in the modeled area. An average water balance assumes some areas will have higher or lower recharge based on the heterogeneity of the soil and varying topography.
- Soil samples were taken along the banks of the AOC which resulted in a maximum horizontal transport distance for the AT123D model of 20 ft. Hydraulic parameters presented in Appendix E, Table E-5 for the aquifer, such as the horizontal hydraulic gradient and aquifer thickness, are assumed applicable within 20 ft of the ponds for evaluating lateral contaminant migration with AT123D.

The inherent uncertainties associated with using these assumptions must be recognized. K_d values are highly sensitive to changes in the major chemistry of the solution phase. Therefore, it is important that the values be measured or estimated under conditions that will closely represent those of the contaminant plume. Deviations from actual AOC-specific parameter values from assumed literature values may significantly affect contaminant fate predictions. It is also important to note that the contaminant plume will change over time and will be affected by multiple solutes present at the AOC. The effects of heterogeneity and anisotropy are not addressed in these simulations.

The discrepancy between the contaminant concentrations measured in the field and the values predicted by the model could be investigated by performing sensitivity analyses on the following model input parameters that have the most influence on the model predictions: (1) biodegradation rate constants for organic chemicals; (2) saturated hydraulic conductivity; (3) soil porosity; (4) f_{oc} for organic chemicals; (5) K_d for inorganic chemicals; and (6) longitudinal, transverse, and vertical dispersivity values. Generally, higher biodegradation rates will produce lower concentrations, and lower rates will produce higher concentrations for organic chemicals without impacting the results of the inorganic chemicals. Higher hydraulic conductivity and dispersivity causes higher advection and dispersion, thereby producing lower peaks near the source area, but increasing the migration distance. The reverse will be true with lower hydraulic conductivity and dispersivity values. Higher f_{oc} values have a similar effect on organic chemicals as higher K_d has on inorganic chemicals; they decrease the mobility of the chemicals as well as produce lower concentrations in groundwater.

6.6 EVALUATION TO IDENTIFY CMCOCS

This evaluation of contaminant fate and transport uses a soil screening analysis to identify SRCs that have potential to leach to groundwater, performs SESOIL modeling to conservatively estimate final CMCOPC leachate concentrations before the SRCs enter the groundwater system beneath the sources with highest level of contamination, and uses AT123D modeling to present a conservative maximum concentration in groundwater of final CMCOPCs beneath the sources and at downgradient receptor locations.

This analysis also includes a sediment screening analysis that was performed for sediment samples at the AOC. Chemical-specific DAFs were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. The estimated groundwater concentrations using these DAFs along with observed maximum surface water concentrations were used in the sediment screening analysis to identify the final sediment CMCOPCs for further evaluation.

The limitations and assumptions of the overall process are presented in Section 6.5.6. The text below provides a list of the remaining CMCOCs after AT123D modeling, final sediment CMCOPCs, and a qualitative assessment of the results and considerations of the limitations and assumptions.

6.6.1 Evaluation of Remaining Soil CMCOCs

Arsenic. Of the 30 surface and subsurface soil samples collected, only 1 sample (ULCPsd-010-0001-SD) exceeded the subsurface soil background concentration of 19.8 mg/kg at a concentration of 28.4 mg/kg. Arsenic was not considered a COC in the HHRA. Arsenic was detected in the AOC groundwater samples collected from 2008–2011 at concentrations above its MCL (Table 6-8). Using the maximum soil concentration, arsenic modeling results indicate it would take more than 150 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.01 mg/L), and approximately 400 years to migrate to the downgradient receptor location at a concentration above its MCL (Table 6-8). However, it should be noted that the background concentration of arsenic in unconsolidated groundwater also exceeds the MCL. Therefore, if arsenic is detected in groundwater above its MCL, it should be considered background related, and not due to contamination from the site.

Nickel. Although the maximum concentration of nickel (31.7 mg/kg) was detected above its surface soil background concentration (21.1 mg/kg), it is well below the subsurface soil background concentration of 60.7 mg/kg. Nickel was not considered a COPC in the HHRA. Although nickel was detected in the AOC groundwater samples collected from 2008–2011, the maximum detection (0.0038 mg/L) was below its tap water RSL of 0.39 mg/L (Table 6-8). Using the maximum detected soil concentration, nickel modeling results indicate it would take more than 350 years for a breakthrough in groundwater beneath the source at a concentration above its RSL, and nickel is not predicted to migrate to the downgradient receptor location at concentrations exceeding its RSL within 1,000 years (Table 6-8).

Selenium. Of the 30 surface and subsurface soil samples collected, only 1 sample (CPCsb-032-5114-SO) at a concentration of 1.6 mg/kg exceeded the surface or subsurface soil background concentrations (1.4 and 1.5 mg/kg, respectively). Selenium was not considered a COPC in the HHRA. This MDC in soil is well below the RSL of 39 mg/kg. Although selenium was detected in the AOC groundwater samples collected from 2008–2011, the maximum detection (0.0046 mg/L) was below its MCL of 0.05 mg/L (Table 6-8). Using the maximum soil concentration, selenium modeling results indicate it would take about 15 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.05 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (Table 6-8). Based on the AOC period of operations, selenium should have already been detected in groundwater with concentrations exceeding its MCL. Therefore, this evaluation concludes that the model-predicted concentrations are very conservative and selenium would be expected to continue to be below its MCL based on its more realistic attenuation rate.

Thallium. None of the 30 surface and subsurface soil samples collected for thallium exceeded the subsurface soil background concentration of 0.91 mg/kg. Thallium was not considered a COPC in the HHRA. Thallium was not detected in the AOC groundwater samples collected from 2008-2011 (Table 6-8). Using the maximum soil concentration, thallium modeling results indicate it would take more than 600 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.002 mg/L), and thallium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (Table 6-8). Because the maximum soil concentration of thallium does not exceed its subsurface soil background, this evaluation concludes that the model-predicted groundwater concentrations are very conservative and thallium would be expected to be below its MCL based on its more realistic attenuation rate.

6.6.2 Evaluation of Remaining Sediment CMCOPCs

Hexavalent Chromium. The maximum sediment concentrations for hexavalent chromium (10.6 mg/kg in Upper Cobbs Pond and 5.7 mg/kg in Lower Cobbs Pond) were below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1, and hexavalent chromium was not identified as a sediment COC for the Resident Receptor in the HHRA. Hexavalent chromium was not analyzed in the AOC groundwater samples collected from 2008–2011; however, total chromium was detected in groundwater at a maximum detection of 0.009 mg/L which was well below its MCL of 0.1 mg/L.

It should be noted here that the reason hexavalent chromium in groundwater is considered to be of concern is because the evaluation assumes the DAF calculated using chromium data in surface water and sediment can be applicable to hexavalent chromium. This assumption was made because hexavalent chromium was not analyzed in surface water.

This qualitative assessment concludes that the soil and sediment contaminants identified for WOE evaluation, due to predicted groundwater concentrations beneath the source and at the downgradient receptor location, are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts. Potential additional investigation under the Facility-wide Groundwater AOC may be warranted, but based on the fate and transport evaluation, CMCOCs were not identified for the Backwater Area and Upper and Lower Cobbs Ponds, and no further action is required of soil and sediment to be protective of groundwater.

6.7 SUMMARY AND CONCLUSIONS

Inorganic and organic SRCs exist in surface soil, subsurface soil, and sediment at the Upper and Lower Cobbs Ponds AOC. These SRCs include chemicals that were identified as potential contaminants from previous site usage and chemicals that were identified from the SRC screening process using available data. All SRCs were further evaluated to determine if residual concentrations in soil and sediment may potentially impact groundwater quality and warrant evaluation in an FS.

All SRCs identified in the surface soil, subsurface soil, and sediment at Upper and Lower Cobbs Ponds were evaluated through the stepwise fate and transport evaluation. Evaluation of modeling results identified the following CMCOCs for soil and final CMCOPC for sediment:

- Arsenic, nickel, selenium, and thallium in soil were predicted to exceed the screening criteria in groundwater beneath the source area; arsenic was predicted to exceed the screening criteria in groundwater at the downgradient receptor location.
- Hexavalent chromium in Upper Cobbs Pond and Lower Cobbs Pond sediment was predicted to exceed the screening criteria in groundwater beneath the source areas.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any CMCOCs are present in soil or sediment at the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond that may potentially impact groundwater at the AOC beneath the source or at the downgradient receptor location. This qualitative assessment concluded that there were no CMCOCs present in soil and sediment that may impact the groundwater beneath the source or at the downgradient receptor location. No further action is required of soil and sediment to be protective of groundwater.

Table 6–1. Initial CMCOPCs Evaluated with SESOIL Modeling

SRC	Maximum Concentration (mg/kg)	Discrete Sample Location	Sample Depth (ft bgs)	Leachate Modeling Required[a]? (Yes/No)
Inorganic Chemicals				
Arsenic	28.4	ULCPsd-010	0–0.5	Yes
Barium	90.4	ULCPss-001	0–1	Yes
Hexavalent chromium	1.00	ULCPsd-010	0–0.5	Yes
Nickel	31.7	CPCsb-032	7–10	Yes
Selenium	1.60	CPCsb-032	0–4	Yes
Thallium	0.250	ULCPss-001	0–1	Yes
Pesticide/PCB				
beta-BHC	0.0035	CPCsb-035	0–1	Yes

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
mg/kg = Milligrams per kilogram.
PCB = Polychlorinated biphenyl.
SESOIL = Seasonal Soil Compartment Model.
SRC = Site-related contaminant.

Table 6–2. Sediment Screening Results for the Backwater Area Aggregate

Analyte	CAS Number	Background Criteria (mg/kg)^a	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)^b	DAF^c	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Inorganic Chemicals															
Aluminum	7429-90-5	1.39E+04	1.86E+04	ULCPsd-013-0001-SD	NA	-	1.50E+03	f	1.24E+01	32	3.84E-01	2.00E+01	RSL	No	No
Antimony	7440-36-0	0.00E+00	2.10E+00	CPCsd-047-5025-SD	NA	-	4.50E+01	f	4.67E-02	49	9.60E-04	6.00E-03	MCL	No	No
Barium	7440-39-3	1.23E+02	1.51E+02	CPCsd-047-5025-SD	NA	-	4.10E+01	f	3.68E+00	171	2.16E-02	2.00E+00	MCL	No	No
Beryllium	7440-41-7	3.80E-01	1.10E+00	ULCPsd-004-0001-SD	NA	-	7.90E+02	f	1.39E-03	21	6.60E-05	4.00E-03	MCL	No	No
Cadmium	7440-43-9	0.00E=00	2.30E+00	CPCsd-047-5025-SD	NA	-	7.50E+01	f	3.07E-02	511	6.00E-05	5.00E-03	MCL	No	No
Chromium	7440-47-3	1.81E+01	5.65E+01	ULCPsd-009-0001-SD	NA	-	1.90E+01	f	2.97E+00	2,063	1.44E-03	1.00E-01	MCL	No	No
Cobalt	7440-48-4	9.10E+00	2.28E+01	CPCsd-047-5025-SD	NA	-	4.50E+01	f	5.07E-01	1,299	3.90E-04	6.00E-03	RSL	No	No
Copper	7440-50-8	2.76E+01	6.23E+01	CPCsd-047-5025-SD	NA	-	3.50E+01	f	1.78E+00	848	2.10E-03	1.30E+00	MCL	No	No
Cyanide	57-12-5	0.00E+00	5.50E-01	ULCPsd-009-0001-SD	NA	-	9.90E+00	f	5.56E-02	21	2.63E-03	2.00E-01	MCL	No	No
Lead	7439-92-1	2.74E+01	5.79E+01	ULCPsd-009-0001-SD	NA	-	9.00E+02	f	6.43E-02	96	6.67E-04	1.50E-02	MCL	No	No
Mercury	7439-97-6	6.00E-02	1.10E-01	ULCPsd-005-0001-SD	NA	-	5.20E+01	f	2.12E-03	21	1.00E-04	2.00E-03	MCL	No	No
Nickel	7440-02-0	1.77E+01	3.55E+01	CPCsd-047-5025-SD	NA	-	6.50E+01	f	5.46E-01	287	1.90E-03	3.90E-01	RSL	No	No
Selenium	7782-49-2	1.70E+00	2.70E+00	CPCsd-047-5025-SD	NA	-	5.00E+00	f	5.40E-01	2,348	2.30E-04	5.00E-02	MCL	No	No
Silver	**7440-22-4**	**0.00E=00**	**2.30E+01**	**ULCPsd-007-0001-SD**	**NA**	**-**	**8.30E+00**	**f**	**2.77E+00**	**21**	**1.31E-01**	**9.40E-02**	**RSL**	**Yes**	**Yes**
Vanadium	7440-62-2	2.61E+01	3.00E+01	ULCPsd-013-0001-SD	NA	-	1.00E+03	f	3.00E-02	51	5.86E-04	8.60E-02	RSL	No	No
Anions															
Nitrate/Nitrite (NO_3/NO_2-N)	14797-55-8	0.00E+00	2.20E+00	ULCPsd-016-0001-SD	None	-	None	-	NA	NA	NA	1.00E+01	MCL	No	No
Explosives															
2,4,6-Trinitrotoluene	118-96-7	None	3.20E-01	ULCPsd-005-0001-SD	2.81E+03	f	1.15E+01	g	2.78E-02	21	1.32E-03	2.50E-03	RSL	No	No
2,6-Dinitrotoluene	**606-20-2**	**None**	**1.60E-01**	**ULCPsd-005-0001-SD**	**5.87E+02**	**f**	**2.41E+00**	**g**	**6.64E-02**	**21**	**3.15E-03**	**4.80E-05**	**RSL**	**Yes**	**Yes**
Nitrocellulose	9004-70-0	None	1.04E+01	CPCsd-047-5025-SD	1.00E+01	f	4.10E-02	g	2.54E+02	21	1.20E+01	6.00E+04	RSL	No	No
Tetryl	479-45-8	None	2.40E-02	CPCsd-047-5025-SD	4.61E+03	f	1.89E+01	g	1.27E-03	21	6.02E-05	3.90E-02	RSL	No	No
Semi-volatile Organic Compounds															
Anthracene	120-12-7	None	2.20E-01	ULCPsd-015-0002-SD	1.64E+04	f	6.71E+01	g	3.28E-03	21	1.55E-04	1.80E+00	RSL	No	No
Benz(a)anthracene	**56-55-3**	**None**	**8.30E-01**	**ULCPsd-015-0002-SD**	**1.77E+05**	**f**	**7.26E+02**	**g**	**1.14E-03**	**21**	**5.42E-05**	**1.20E-05**	**RSL**	**Yes**	**Yes**
Benzo(a)pyrene	50-32-8	None	8.90E-01	ULCPsd-015-0002-SD	5.87E+05	f	2.41E+03	g	3.70E-04	21	1.75E-05	2.00E-04	MCL	No	No
Benzo(b)fluoranthene	205-99-2	None	8.60E-01	ULCPsd-015-0002-SD	5.99E+05	f	2.46E+03	g	3.50E-04	21	1.66E-05	3.40E-05	RSL	No	No
Benzo(ghi)perylene^d	191-24-2	None	4.90E-01	ULCPsd-015-0002-SD	1.07E+07	h	4.39E+04	g	1.12E-05	21	5.29E-07	1.20E-01	RSL	No	No
Benzo(k)fluoranthene	207-08-9	None	8.00E-01	ULCPsd-015-0002-SD	5.87E+05	f	2.41E+03	g	3.32E-04	21	1.58E-05	3.40E-04	RSL	No	No
Bis(2-ethylhexyl)phthalate	117-81-7	None	1.60E-01	CPCsd-047-5025-SD	1.20E+05	f	4.90E+02	g	3.26E-04	21	1.55E-05	6.00E-03	MCL	No	No
Chrysene	218-01-9	None	9.30E-01	ULCPsd-015-0002-SD	1.81E+05	f	7.42E+02	g	1.25E-03	21	5.94E-05	3.40E-03	RSL	No	No
Di-n-butyl phthalate	84-74-2	None	3.40E-02	CPCsd-048-5786-SD	1.16E+03	f	4.76E+00	g	7.15E-03	21	3.39E-04	9.00E-01	RSL	No	No
Dibenz(a,h)anthracene	53-70-3	None	6.60E-02	CPCsd-047-5025-SD	1.91E+06	f	7.84E+03	g	8.42E-06	21	3.99E-07	3.40E-06	RSL	No	No
Fluoranthene	206-44-0	None	1.80E+00	ULCPsd-015-0002-SD	5.55E+04	f	2.28E+02	g	7.91E-03	21	3.75E-04	8.00E-01	RSL	No	No
Fluorene	86-73-7	None	5.30E-02	CPCsd-047-5025-SD	9.16E+03	f	3.76E+01	g	1.41E-03	21	6.69E-05	2.90E-01	RSL	No	No
Indeno(1,2,3-cd)pyrene	193-39-5	None	4.80E-01	ULCPsd-015-0002-SD	1.95E+06	f	8.00E+03	g	6.00E-05	21	2.85E-06	3.40E-05	RSL	No	No
Phenanthrene^e	85-01-8	None	9.10E-01	ULCPsd-015-0002-SD	1.82E+04	h	7.46E+01	g	1.22E-02	21	5.78E-04	1.20E-01	RSL	No	No
Pyrene	129-00-0	None	1.90E+00	ULCPsd-015-0002-SD	5.43E+04	f	2.23E+02	g	8.53E-03	21	4.04E-04	1.20E-01	RSL	No	No

Table 6–2. Sediment Screening Results for the Backwater Area Aggregate (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)[b]	DAF[c]	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Organics-Pesticide/PCB															
PCB-1254	11097-69-1	None	4.70E-02	ULCPsd-006-0001-SD	1.31E+05	f	5.35E+02	g	8.78E-05	21	4.16E-06	7.80E-06	RSL	No	No
Organics-Volatile															
2-Butanone	78-93-3	None	5.50E-02	CPCsd-047-5025-SD	4.51E+00	f	1.85E-02	g	2.97E+00	21	1.41E-01	5.60E+00	RSL	No	No
Acetone	67-64-1	None	1.90E-01	CPCsd-047-5025-SD	2.36E+00	f	9.69E-03	g	1.96E+01	21	9.29E-01	1.40E+01	RSL	No	No
Methylene chloride	**75-09-2**	**None**	**4.80E-02**	**ULCPsd-006-0001-SD**	**2.17E+01**	**f**	**8.91E-02**	**g**	**5.39E-01**	**21**	**2.55E-02**	**5.00E-03**	**MCL**	**Yes**	**Yes**

Sediment samples were taken from 0–1.8 ft below ground surface at discrete sample locations in the Backwater Area south of the railroad trackbed that is just north of Load Line 3 Road.

[a] Background criteria are the criteria for sediment from final facility-wide background values for the Ravenna Army Ammunition Plant, published in the *Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001b).

[b] Maximum calculated leachate concentration = maximum sediment concentration divided by the distribution coefficient (K_d).

[c] An aggregate-specific DAF was calculated based on the sediment and co-located surface water concentrations. The lowest calculated DAF (21 for beryllium) was used for analytes that did not have an aggregate-specific DAF.

[d] Pyrene RSL was used as a surrogate for benzo(*ghi*)perylene.

[e] Pyrene RSL was used as a surrogate for phenanthrene.

[f] U.S. Environmental Protection Agency (USEPA) RSL generic tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.

[g] K_d value for organic chemicals calculated by multiplying K_{oc} by f_{oc} of 0.0041 (the average of the Performance-Based Acquisition 2008 RI geotechnical samples CPCSB-033-5117-SO and CPCSB-033-5118-SO).

[h] USEPA 1994b. Risk Reduction Engineering Laboratory Treatability Database, Version 5.0, Office of Research and Development, Cincinnati, Ohio.

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration chemical of potential concern.
DAF = Dilution attenuation factor.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram.
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.
RSL = Regional screening level (USEPA 2015).
Bold = Identified initial sediment CMCOPC.

Table 6–3. Sediment Screening Results for Upper Cobbs Pond Aggregate

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)[b]	DAF[c]	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Inorganic Chemicals															
Aluminum	7429-90-5	3.39E+04	2.14E+04	ULCPsd-017-0001-SD	NA	-	1.50E+03	f	1.43E+01	37	3.86E-01	2.00E+01	RSL	No	No
Antimony	7440-36-0	0.00E+00	1.90E+00	CPCsd-046-5024-SD	NA	-	4.50E+01	f	4.22E-02	45	9.40E-04	6.00E-03	MCL	No	No
Barium	7440-39-3	1.23E+02	1.57E+02	CPCsd-046-5024-SD	NA	-	4.10E+01	f	3.83E+00	228	1.68E-02	2.00E+00	MCL	No	No
Beryllium	7440-41-7	3.80E-01	1.30E+00	ULCPsd-017-0001-SD	NA	-	7.90E+02	f	1.65E-03	31	5.31E-05	4.00E-03	MCL	No	No
Cadmium	7440-43-9	0.00+00	2.30E+00	CPCsd-046-5024-SD	NA	-	7.50E+01	f	3.07E-02	31	9.89E-04	5.00E-03	MCL	No	No
Chromium	7440-47-3	1.81E+01	9.16E+01	CPCsd-046-5024-SD	NA	-	1.90E+01	f	4.82E+00	8,171	5.90E-04	1.00E-01	MCL	No	No
Chromium, hexavalent	**18540-29-9**	**0.00+00**	**1.06E+01**	**ULCPsd-018-0001-SD**	**NA**	**-**	**1.90E+01**	**f**	**5.58E-01**	**8,171**	**6.83E-05**	**3.50E-05**	**RSL**	**Yes**	**Yes**
Cobalt	**7440-48-4**	**9.10E+00**	**1.93E+01**	**ULCPsd-017-0001-SD**	**NA**	**-**	**4.50E+01**	**f**	**4.29E-01**	**31**	**1.38E-02**	**6.00E-03**	**RSL**	**Yes**	**Yes**
Copper	7440-50-8	2.76E+01	1.06E+02	ULCPsd-017-0001-SD	NA	-	3.50E+01	f	3.03E+00	1,564	1.94E-03	1.30E+00	MCL	No	No
Lead	7439-92-1	2.74E+01	5.24E+01	CPCsd-046-5024-SD	NA	-	9.00E+02	f	5.82E-02	149	3.90E-04	1.50E-02	MCL	No	No
Mercury	7439-97-6	6.00E-02	1.50E-01	CPCsd-046-5024-SD	NA	-	5.20E+01	f	2.88E-03	31	9.30E-05	2.00E-03	MCL	No	No
Nickel	7440-02-0	1.77E+01	4.11E+01	CPCsd-046-5024-SD	NA	-	6.50E+01	f	6.32E-01	333	1.90E-03	3.90E-01	RSL	No	No
Selenium	7782-49-2	1.70E+00	2.90E+00	CPCsd-046-5024-SD	NA	-	5.00E+00	f	5.80E-01	2,417	2.40E-04	5.00E-02	MCL	No	No
Silver	7440-22-4	0.00E+00	1.10E+01	ULCPsd-017-0001-SD	NA	-	8.30E+00	f	1.33E+00	31	4.28E-02	9.40E-02	RSL	No	No
Vanadium	7440-62-2	2.61E+01	3.34E+01	ULCPsd-018-0001-SD	NA	-	1.00E+03	f	3.34E-02	31	1.08E-03	8.60E-02	RSL	No	No
Anions															
Nitrate/Nitrite (NO_3/NO_2-N)	14797-55-8	0.00+00	5.30E+00	FSW-SD-030-0000	None	-	None	-	NA	NA	NA	1.00E+01	MCL	No	No
Miscellaneous															
Ammonia	7664-41-7	0.00+00	6.90E+01	FSW-SD-030-0000	None	-	None	-	NA	NA	NA	None	NA	No	No
Total Phosphorus as P	7723-14-0	0.00+00	2.70E+02	FSW-SD-030-0000	None	-	None	-	NA	NA	NA	None	NA	No	No
Explosives															
1,3-Dinitrobenzene	99-65-0	None	3.60E-02	CPCsd-046-5024-SD	3.52E+02	f	1.44E+00	g	2.50E-02	31	8.06E-04	2.00E-03	RSL	No	No
2,4,6-Trinitrotoluene	118-96-7	None	1.50E-01	CPCsd-046-5024-SD	2.81E+03	f	1.15E+01	g	1.30E-02	31	4.20E-04	2.50E-03	RSL	No	No
4-Amino-2,6-Dinitrotoluene	19406-51-0	None	1.20E-01	CPCsd-046-5024-SD	2.83E+02	f	1.16E+00	g	1.03E-01	1,480	6.99E-05	3.90E-02	RSL	No	No
HMX	2691-41-0	None	8.30E-02	CPCsd-046-5024-SD	5.32E+02	f	2.18E+00	g	3.81E-02	31	1.23E-03	1.00E+00	RSL	No	No
Nitrocellulose	9004-70-0	None	5.70E+00	CPCsd-046-5024-SD	1.00E+01	f	4.10E-02	g	1.39E+02	31	4.48E+00	6.00E+04	RSL	No	No
Tetryl	479-45-8	None	1.90E-02	CPCsd-046-5024-SD	4.61E+03	f	1.89E+01	g	1.01E-03	31	3.25E-05	3.90E-02	RSL	No	No
Semi-volatile Organic Compounds															
Acenaphthylene	208-96-8	None	2.00E-02	CPCsd-046-5784-SD	7.40E+03	f	3.03E+01	g	6.59E-04	31	2.13E-05	5.30E-01	RSL	No	No
Anthracene	120-12-7	None	1.00E-02	CPCsd-046-5784-SD	1.64E+04	f	6.72E+01	g	1.49E-04	31	4.80E-06	1.80E+00	RSL	No	No
Benz(a)anthracene	56-55-3	None	7.80E-02	CPCsd-046-5024-SD	1.77E+05	f	7.26E+02	g	1.07E-04	31	3.47E-06	1.20E-05	RSL	No	No
Benzo(a)pyrene	50-32-8	None	1.20E-01	CPCsd-046-5024-SD	5.87E+05	f	2.41E+03	g	4.99E-05	31	1.61E-06	2.00E-04	MCL	No	No
Benzo(b)fluoranthene	205-99-2	None	1.90E-01	CPCsd-046-5024-SD	5.99E+05	f	2.46E+03	g	7.74E-05	31	2.50E-06	3.40E-05	RSL	No	No
Benzo(ghi)perylene[d]	191-24-2	None	1.10E-01	CPCsd-046-5024-SD	1.07E+07	h	4.39E+04	g	2.51E-06	31	8.09E-08	1.20E-01	RSL	No	No
Benzo(k)fluoranthene	207-08-9	None	6.70E-02	CPCsd-046-5024-SD	5.87E+05	f	2.41E+03	g	2.78E-05	31	8.98E-07	3.40E-04	RSL	No	No
Bis(2-ethylhexyl)phthalate	117-81-7	None	8.40E-01	FSW-SD-030-0000	1.20E+05	f	4.92E+02	g	1.71E-03	31	5.51E-05	6.00E-03	RSL	No	No
Butyl benzyl phthalate	85-68-7	None	1.60E-01	FSW-SD-030-0000	7.16E+03	f	2.94E+01	g	5.45E-03	31	1.76E-04	1.60E-02	RSL	No	No
Chrysene	218-01-9	None	1.10E-01	CPCsd-046-5024-SD	1.81E+05	f	7.42E+02	g	1.48E-04	31	4.78E-06	3.40E-03	RSL	No	No
Di-n-butyl phthalate	84-74-2	None	2.70E+00	FSW-SD-030-0000	1.16E+03	f	4.76E+00	g	5.68E-01	31	1.83E-02	9.00E-01	RSL	No	No
Fluoranthene	206-44-0	None	2.20E-01	CPCsd-046-5024-SD	5.55E+04	f	2.28E+02	g	9.67E-04	31	3.12E-05	8.00E-01	RSL	No	No

Table 6–3. Sediment Screening Results for Upper Cobbs Pond Aggregate (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)[b]	DAF[c]	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Indeno(1,2,3-cd)pyrene	193-39-5	None	9.00E-02	CPCsd-046-5024-SD	1.95E+06	f	8.00E+03	g	1.13E-05	31	3.63E-07	3.40E-05	RSL	No	No
Phenanthrene[e]	85-01-8	None	7.00E-02	CPCsd-046-5024-SD	1.82E+04	h	7.46E+01	g	9.38E-04	31	3.03E-05	1.20E-01	RSL	No	No
Pyrene	129-00-0	None	1.80E-01	CPCsd-046-5024-SD	5.43E+04	f	2.23E+02	g	8.09E-04	31	2.61E-05	1.20E-01	RSL	No	No
Pesticide/PCB															
delta-BHC	319-86-8	None	1.80E-03	CPCsd-046-5784-SD	None	-	None	-	NA	NA	NA	None	NA	No	No
PCB-1254	11097-69-1	None	3.20E-02	ULCPsd-020-0001-SD	1.31E+05	f	5.35E+02	g	5.98E-05	31	1.93E-06	7.80E-06	RSL	No	No
Volatile Organic Compounds															
2-Butanone	78-93-3	None	3.30E-02	CPCsd-046-5024-SD	4.51E+00	f	1.85E-02	g	1.78E+00	31	5.76E-02	5.60E+00	RSL	No	No
Acetone	67-64-1	None	9.10E-02	CPCsd-046-5024-SD	2.36E+00	f	9.69E-03	g	9.39E+00	31	3.03E-01	1.40E+01	RSL	No	No

Sediment samples were taken from 0–2 ft below ground surface at discrete sample locations and one incremental sampling method sample in the Upper Cobbs Pond Area.

[a] Background criteria for sediment from final facility-wide background values for the Ravenna Army Ammunition Plant, published in the *Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001b).

[b] Maximum calculated leachate concentration = maximum sediment concentration divided by the distribution coefficient (K_d).

[c] An aggregate-specific DAF was calculated based on the sediment and co-located surface water concentrations. The lowest calculated DAF (31 for vanadium) was used for analytes that did not have an aggregate-specific DAF.

[d] Pyrene RSL was used as a surrogate for benzo(*ghi*)perylene.

[e] Pyrene RSL was used as a surrogate for phenanthrene.

[f] U.S. Environmental Protection Agency (USEPA) regional screening level generic tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.

[g] K_d value for organics calculated by multiplying K_{oc} by f_{oc} of 0.0041 (the average of the Performance-Based Acquisition 2008 RI geotechnical samples CPCSB-033-5117-SO and CPCSB-033-5118-SO).

[h] USEPA 1994b. Risk Reduction Engineering Laboratory Treatability Database, Version 5.0, Office of Research and Development, Cincinnati, Ohio

BHC = Hexachlorocyclohexane.
CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration chemical of potential concern.
DAF = Dilution attenuation factor.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram.
MCL = Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.
RSL = Regional screening level (USEPA 2015).
Bold = Identified initial sediment CMCOPC.

Table 6–4. Sediment Screening Results for Lower Cobbs Pond Aggregate

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)[b]	DAF[c]	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Inorganic Chemicals															
Aluminum	7429-90-5	1.39E+04	1.64E+04	ULCPsd-026-0001-SD	NA	-	1.50E+03	f	1.09E+01	21	5.23E-01	3.65E+01	RSL	No	No
Antimony	7440-36-0	0.00+00	1.40E+00	CPCsd-045-5023-SD	NA	-	4.50E+01	f	3.11E-02	35	8.80E-04	6.00E-03	MCL	No	No
Arsenic	7440-38-2	1.95E+01	3.43E+01	ULCPsd-026-0001-SD	NA	-	2.90E+01	f	1.18E+00	389	3.04E-03	1.00E-02	MCL	No	No
Barium	7440-39-3	1.23E+02	1.49E+02	CPCsd-045-5023-SD	NA	-	4.10E+01	f	3.63E+00	148	2.46E-02	2.00E+00	MCL	No	No
Beryllium	7440-41-7	3.80E-01	9.30E-01	CPCsd-045-5023-SD	NA	-	7.90E+02	f	1.18E-03	39	3.00E-05	4.00E-03	MCL	No	No
Cadmium	7440-43-9	0.00+00	1.50E+00	CPCsd-045-5023-SD	NA	-	7.50E+01	f	2.00E-02	500	4.00E-05	5.00E-03	MCL	No	No
Chromium	**7440-47-3**	**1.81E+01**	**1.50E+02**	**ULCPsd-023-0001-SD**	**NA**	**-**	**1.90E+01**	**f**	**7.89E+00**	**16**	**4.78E-01**	**1.00E-01**	**MCL**	**Yes**	**Yes**
Chromium, hexavalent	**18540-29-9**	**0.00+00**	**5.70E+00**	**ULCPsd-021-0001-SD**	**NA**	**-**	**1.90E+01**	**f**	**3.00E-01**	**16**	**1.82E-02**	**3.50E-05**	**RSL**	**Yes**	**Yes**
Cobalt	7440-48-4	9.10+00	2.13E+01	ULCPsd-025-0001-SD	NA	-	4.50E+01	f	4.73E-01	2,059	2.30E-04	6.00E-03	RSL	No	No
Copper	7440-50-8	2.76E+01	1.49E+02	ULCPsd-023-0001-SD	NA	-	3.50E+01	f	4.26E+00	229	1.86E-02	1.30E+00	MCL	No	No
Cyanide	57-12-5	0.00	4.00E-01	ULCPsd-024-0001-SD	NA	-	9.90E+00	f	4.04E-02	16	2.45E-03	2.00E-01	MCL	No	No
Lead	7439-92-1	27.40	6.04E+01	ULCPsd-024-0001-SD	NA	-	9.00E+02	f	6.71E-02	43	1.57E-03	1.50E-02	MCL	No	No
Mercury	7439-97-6	0.06	1.00E-01	FSW-SD-031-0000	NA	-	5.20E+01	f	1.92E-03	16	1.17E-04	2.00E-03	MCL	No	No
Nickel	7440-02-0	17.70	3.02E+01	CPCsd-045-5023-SD	NA	-	6.50E+01	f	4.65E-01	147	3.16E-03	3.90E-01	RSL	No	No
Selenium	7782-49-2	1.70	2.20E+00	CPCsd-045-5023-SD	NA	-	5.00E+00	f	4.40E-01	1,375	3.20E-04	5.00E-02	MCL	No	No
Silver	7440-22-4	0.00	2.40E+00	ULCPsd-021-0001-SD	NA	-	8.30E+00	f	2.89E-01	16	1.75E-02	9.40E-02	RSL	No	No
Vanadium	7440-62-2	26.10	3.22E+01	ULCPsd-026-0001-SD	NA	-	1.00E+03	f	3.22E-02	24	1.33E-03	8.60E-02	RSL	No	No
Anions															
Nitrate/Nitrite (NO_3/NO_2-N)	14797-55-8	0.00	8.50E+00	FSW-SD-031-0000	None	-	None	-	NA	NA	NA	1.00E+01	MCL	No	No
Miscellaneous															
Ammonia	7664-41-7	0.00	6.10E+01	FSW-SD-031-0000	None	-	None	-	NA	NA	NA	None	NA	No	No
Total Phosphorus as P	7723-14-0	0.00	3.60E+02	FSW-SD-031-0000	None	-	None	-	NA	NA	NA	None	NA	No	No
Explosives															
HMX	2691-41-0	None	1.70E-02	CPCsd-044-5022-SD	5.32E+02	f	2.18E+00	g	7.80E-03	16	4.73E-04	1.00E+00	RSL	No	No
Nitrocellulose	9004-70-0	None	7.80E+00	CPCsd-045-5023-SD	1.00E+01	f	4.10E-02	g	1.90E+02	16	1.15E+01	6.00E+04	RSL	No	No
Tetryl	479-45-8	None	2.20E-02	CPCsd-045-5023-SD	4.61E+03	f	1.89E+01	g	1.17E-03	16	7.06E-05	3.90E-02	RSL	No	No
Semi-volatile Organic Compounds															
2-Methylnaphthalene	91-57-6	None	2.50E-02	CPCsd-045-5783-SD	2.48E+03	f	1.02E+01	g	2.46E-03	16	1.49E-04	3.60E-02	RSL	No	No
Acenaphthene	83-32-9	None	9.90E-03	CPCsd-045-5783-SD	5.03E+03	f	2.06E+01	g	4.80E-04	16	2.91E-05	5.30E-01	RSL	No	No
Acenaphthylene	208-96-8	None	9.10E-02	CPCsd-045-5783-SD	7.40E+03	f	3.03E+01	g	3.00E-03	16	1.82E-04	5.30E-01	RSL	No	No
Anthracene	120-12-7	None	7.00E-02	CPCsd-045-5783-SD	1.64E+04	f	6.72E+01	g	1.04E-03	16	6.31E-05	1.80E+00	RSL	No	No
Benz(a)anthracene	**56-55-3**	**None**	**3.40E-01**	**CPCsd-045-5783-SD**	**1.77E+05**	**f**	**7.26E+02**	**g**	**4.69E-04**	**16**	**2.84E-05**	**1.20E-05**	**RSL**	**Yes**	**Yes**
Benzo(a)pyrene	50-32-8	None	4.70E-01	CPCsd-045-5783-SD	5.87E+05	f	2.41E+03	g	1.95E-04	16	1.18E-05	2.00E-04	MCL	No	No
Benzo(b)fluoranthene	205-99-2	None	8.00E-01	CPCsd-045-5783-SD	5.99E+05	f	2.46E+03	g	3.26E-04	16	1.97E-05	3.40E-05	RSL	No	No
Benzo(ghi)perylene[d]	191-24-2	None	4.70E-01	CPCsd-045-5783-SD	1.07E+07	h	4.39E+04	g	1.07E-05	16	6.49E-07	1.20E-01	RSL	No	No
Benzo(k)fluoranthene	207-08-9	None	2.10E-01	CPCsd-045-5783-SD	5.87E+05	f	2.41E+03	g	8.73E-05	16	5.29E-06	3.40E-04	RSL	No	No
Chrysene	218-01-9	None	4.00E-01	CPCsd-045-5783-SD	1.81E+05	f	7.42E+02	g	5.39E-04	16	3.27E-05	3.40E-03	RSL	No	No
Di-n-butyl phthalate	84-74-2	None	1.04E+00	FSW-SD-031-0000	1.16E+03	f	4.74E+00	g	2.18E-01	16	1.32E-02	9.00E-01	RSL	No	No

Table 6–4. Sediment Screening Results for Lower Cobbs Pond Aggregate (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Calculated Leachate Concentration (C_L) (mg/L)[b]	DAF[c]	Maximum Calculated Groundwater Concentration (C_L/DAF) (mg/L)	MCL or RSL (mg/L)	MCL or RSL?	Maximum Calculated Groundwater Concentration > MCL or RSL?	Initial Sediment CMCOPC?
Dibenz(a,h)anthracene	53-70-3	None	1.20E-01	CPCsd-045-5783-SD	1.91E+06	f	7.83E+03	g	1.53E-05	16	9.29E-07	3.40E-06	RSL	No	No
Fluoranthene	206-44-0	None	4.80E-01	CPCsd-045-5783-SD	5.55E+04	f	2.28E+02	g	2.11E-03	16	1.28E-04	8.00E-01	RSL	No	No
Fluorene	86-73-7	None	2.00E-02	CPCsd-045-5783-SD	9.16E+03	f	3.76E+01	g	5.33E-04	16	3.23E-05	2.90E-01	RSL	No	No
Indeno(1,2,3-cd)pyrene	193-39-5	None	4.30E-01	CPCsd-045-5783-SD	1.95E+06	f	8.00E+03	g	5.38E-05	16	3.26E-06	3.40E-05	RSL	No	No
Naphthalene	**91-20-3**	**None**	**3.80E-02**	**CPCsd-045-5783-SD**	**1.54E+03**	**f**	**6.31E+00**	**g**	**6.02E-03**	**16**	**3.65E-04**	**1.70E-04**	**RSL**	**Yes**	**Yes**
Phenanthrene[e]	85-01-8	None	1.50E-01	CPCsd-045-5783-SD	1.82E+04	h	7.46E+01	g	2.01E-03	16	1.22E-04	1.20E-01	RSL	No	No
Pyrene	129-00-0	None	4.10E-01	CPCsd-045-5783-SD	5.43E+04	f	2.23E+02	g	1.84E-03	16	1.12E-04	1.20E-01	RSL	No	No
Volatile Organic Compounds															
2-Butanone	78-93-3	None	4.70E-02	CPCsd-045-5023-SD	4.51E+00	f	1.85E-02	g	2.54E+00	16	1.54E-01	5.60E+00	RSL	No	No
Acetone	67-64-1	None	1.70E-01	CPCsd-045-5023-SD	2.36E+00	f	9.69E-03	g	1.75E+01	16	1.06E+00	1.40E+01	RSL	No	No
Carbon Disulfide	75-15-0	None	3.30E-03	CPCsd-045-5023-SD	2.17E+01	f	8.91E-02	g	3.70E-02	16	2.24E-03	8.10E-01	RSL	No	No

Sediment samples were taken from 0– 2 ft below ground surface at discrete sample locations and one incremental sampling method sample in Lower Cobbs Pond Area.

[a] Background criteria for sediment from final facility-wide background values for the Ravenna Army Ammunition Plant, published in the *Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001b).

[b] Maximum calculated leachate concentration = maximum sediment concentration divided by the distribution coefficient (K_d).

[c] An aggregate-specific DAF was calculated based on the sediment and co-located surface water concentrations. The lowest calculated DAF (16 for thallium) was used for analytes that did not have an aggregate-specific DAF.

[d] Pyrene RSL was used as a surrogate for benzo(*ghi*)perylene.

[e] Pyrene RSL was used as a surrogate for phenanthrene.

[f] U.S. Environmental Protection Agency (USEPA) regional screening level generic tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.

[g] K_d value for organic chemicals calculated by multiplying K_{oc} by f_{oc} of 0.0041 (the average of the Performance-Based Acquisition 2008 RI geotechnical samples CPCSB-033-5117-SO and CPCSB-033-5118-SO).

[h] USEPA 1994b. Risk Reduction Engineering Laboratory Treatability Database, Version 5.0, Office of Research and Development, Cincinnati, Ohio

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration chemical of potential concern.
DAF = Dilution Attenuation Factor.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram.
MCL = Maximum Contaminant Level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not applicable.
RSL = Regional screening level (USEPA 2015).
Bold = Identified initial sediment CMCOPC.

Table 6–5. Identification of Final Sediment CMCOPCs

Initial Sediment CMCOPCs	CAS Number	Maximum Detected Surface Water Concentration (mg/L)	Surface Water Sample ID at Maximum Detect	MCL or RSL (mg/L)	MCL or RSL?	Maximum Detected Surface Water Concentration > MCL or RSL?	Final Sediment CMCOPC?[a]
Backwater Area Aggregate							
Silver	7440-22-4	1.70E-03	ULCPsw-002-0001-SW	9.40E-02	RSL	No	No
2,6-Dinitrotoluene	606-20-2	ND	NA	4.80E-05	RSL	No	No
Benz(a)anthracene	56-55-3	ND	NA	1.20E-05	RSL	No	No
Methylene chloride	75-09-2	ND	NA	5.00E-03	MCL	No	No
Upper Cobbs Pond Aggregate							
Chromium, hexavalent	**18540-29-9**	**Not Analyzed**	**NA**	**3.50E-05**	**RSL**	**NA**	**Yes**
Cobalt	7440-48-4	ND	NA	6.00E-03	RSL	No	No
Lower Cobbs Pond Aggregate							
Chromium	7440-47-3	1.10E-03	FSW-SW-031-0000	1.00E-01	MCL	No	No
Chromium, hexavalent	**18540-29-9**	**Not Analyzed**	**NA**	**3.50E-05**	**RSL**	**NA**	**Yes**
Benz(a)anthracene	56-55-3	ND	NA	1.20E-05	RSL	No	No
Naphthalene	91-20-3	ND	NA	1.70E-04	RSL	No	No

[a] Analyte is a final sediment CMCOPC if the maximum detected surface water concentration exceeds the MCL or RSL, or if there is no surface water data available. This analysis assumes that groundwater and surface water are in contact and in equilibrium.

CAS = Chemical Abstract Service.
CMCOPC = Contaminant migration chemical of potential concern.
ID = Identification.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
NA = Not applicable.
ND = Not detected.
RSL = Regional screening level (USEPA 2015).
Bold = Identified final sediment CMCOPC.

Table 6–6. Unit-Specific Parameters Used in SESOIL and AT123D Modeling

Parameters	Symbol	Units	Value	Source for Value
SESOIL				
Percolation Rate (Recharge Rate)	q	m/yr	9.42E-02	0.1 * SESOIL Precipitation for Youngstown, Ohio
Horizontal Area of Aggregate	A_p	cm^2	Sample specific	Sample specific
Intrinsic Permeability - clayey sand	p	cm^2	1.05E-10	Calibrated from SESOIL model
Disconnectedness Index	c	unitless	11	Calibrated from SESOIL model
Freundlich Equation Exponent	n	unitless	1	SESOIL default
Fraction Organic Carbon	f_{oc}	unitless	4.10E-03	The average of the PBA08 RI Geotechnical Samples CPCSB-033-5117-SO and CPCSB-033-5118-SO
Bulk Density	ρ_b	kg/L	1.71	
Moisture Content	w	wt %	20.3	
Water-filled Soil Porosity	Tw	unitless	0.347	
Air-filled Soil Porosity	Ta	unitless	0.039	
Porosity – total	n_T	unitless	0.386	
Vadose Zone Thickness	Vz	m	1.52	Average depth to water table from potentiometric surface map (Figure 6-4)
Leaching Zone Thickness	Th	m	0 to 3.66	Based on distance from deepest detection of a CMCOPC above criteria to the water table from potentiometric surface maps (Figure 6-4)
AT123D				
Aquifer Thickness	h	m	6	Facility-wide assumption for the unconsolidated aquifer presented the Load Line 1 investigation (USACE 2003b)
Hydraulic Conductivity in Saturated Zone	K_S	cm/s	5.64E-06	Average of slug test results from MKM (2005)
Hydraulic Gradient	i	unitless	1.10E-02	Calculated from Cobbs Pond potentiometric surface map (Figure 6-4)
Effective porosity	n_e	unitless	0.2	Assumed for sandstone (USEPA 1985)
Dispersivity, longitudinal	α_L	m	30	Assumed
Dispersivity, transverse	α_T	m	3	0.1 α_L
Dispersivity, vertical	α_V	m	0.3	0.01 α_L
Retardation factor	R_d	unitless	chemical-specific	Presented in Table E-7 in Appendix E

MKM (MKM Engineers) 2005. *Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. September 2005.

USACE (U.S.Army Corps of Engineers) 2003b. *Phase II Remedial Investigation Report for the Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. June 2003.

USEPA (U.S. Environmental Protection Agency) 1985. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water*, Revised 1985 Parts 1 and 2, USEPA/600/6-85/002. Office of Research and Development, Environmental Research Laboratory, Athens, Georgia. September 1985.

AT123D = Analytical Transient 1-,2-,3-Dimensional modeling.
cm^2 = Square centimeters.
cm/s = Centimeters per second.
kg/L = Killograms per liter.
m/yr = Meter per year.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
SESOIL = Seasonal Soil Compartment model.
wt % = Weight percent.

Table 6–7. Summary of SESOIL Modeling Results

Initial CMCOPC	Maximum Soil Concentration (mg/kg)	Discrete Sample Location	Maximum Depth of Contamination (ft bgs)	Depth to Groundwater (ft bgs)	Predicted $C_{L,\,max}$ Beneath the Source (mg/L)	Time Required to Reach $C_{L,\,max}$ (years)	MCL/RSL (mg/L)	Resident Receptor Adult FWCUG[a] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	Final CMCOPC?[b] (Yes/No)
Inorganic Chemicals										
Arsenic	**28.4**	**ULCPsd-010**	**0.5**	**3**	**5.80E-01**	**239**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Barium	**90.4**	**ULCPss-001**	**1**	**3**	**2.61E+00**	**299**	**2.00E+00**	**7.06E-01**	**8.21E-02**	**Yes**
Hexavalent Chromium	1	ULCPsd-010	0.5	3	3.11E-02	157	1.10E-01	None	0.00E+00	No
Nickel	**31.7**	**CPCsb-032**	**10**	**10**	**7.72E-01**	**1000**	**3.90E-01**	**7.29E-02**	**0.00E+00**	**Yes**
Selenium	**1.6**	**CPCsb-032**	**10**	**10**	**4.30E-01**	**102**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Thallium	**0.25**	**ULCPss-001**	**1**	**3**	**4.18E-03**	**516**	**2.00E-03**	**2.91E-04**	**0.00E+00**	**Yes**
Pesticide/PCB										
beta-BHC	**0.0035**	**CPCsb-035**	**1**	**13**	**6.73E-05**	**433**	**2.50E-05**	**4.70E-05**	**None**	**Yes**

[a] The FWCUG is based on a target risk of 10^{-6} and/or a hazard quotient of 0.1.

[b] The final CMCOPC was identified comparing predicted maximum leachate concentration to MCL/RSL, FWCUGs, and facility-wide background concentrations. A constituent is a final CMCOPC if its predicted leachate concentration exceeds its MCL/RSL within 1,000 years.

bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
$C_{L,\,max}$ = Maximum leachate concentration.
CMCOPC = Contaminant migration chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
ft = Feet.
MCL = Maximum contaminant level.
mg/kg = Milligram per kilogram.
mg/L = Milligram per liter.
PCB = Polychlorinated biphenyl.
RSL = Regional screening level.
SESOIL = Seasonal Soil Compartment model.
Bold = CMCOPCs exceeding MCL/RSL, FWCUGs, and facility-wide background concentrations.

Table 6–8. Summary of AT123D Modeling Results

Final CMCOPC	Maximum Leachate Concentration, $C_{L,\ max}$[a] (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{gw,\ MAX}$) Beneath Source (mg/L)	Predicted Max Groundwater Concentration[b] ($C_{R,\ MAX}$) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentration[c] (mg/L)	MCL/RSL (mg/L)	Resident Adult FWCUG[d] (mg/L)	Facility-wide Background Unconsolidated Groundwater (mg/L)	CMCOC for Further WOE Evaluation?[e] (Yes/No)
Inorganic Chemicals									
Arsenic	5.80E-01	3.14E-01	2.91E-02	2.00E+01	6.51E-02	1.00E-02	5.60E-05	1.17E-02	Yes
Barium	2.61E+00	1.33E+00	6.94E-01	1.00E+01	1.55E-01	2.00E+00	7.06E-01	8.21E-02	No
Nickel	7.72E-01	7.26E-01	1.37E-02	2.00E+01	3.80E-03	3.90E-01	7.29E-02	0.00E+00	Yes
Selenium	4.30E-01	4.15E-01	4.76E-02	2.00E+01	4.60E-03	5.00E-02	None	0.00E+00	Yes
Thallium	4.18E-03	2.15E-03	1.12E-03	1.00E+01	ND	2.00E-03	2.91E-04	0.00E+00	Yes
Pesticide/PCB									
beta-BHC	6.73E-05	9.26E-07	8.79E-07	1.00E+01	1.60E-05	2.50E-05	4.70E-05	None	No

[a] Represents Seasonal Soil Compartment (SESOIL) modeling predicted maximum leachate concentration just above the water table.

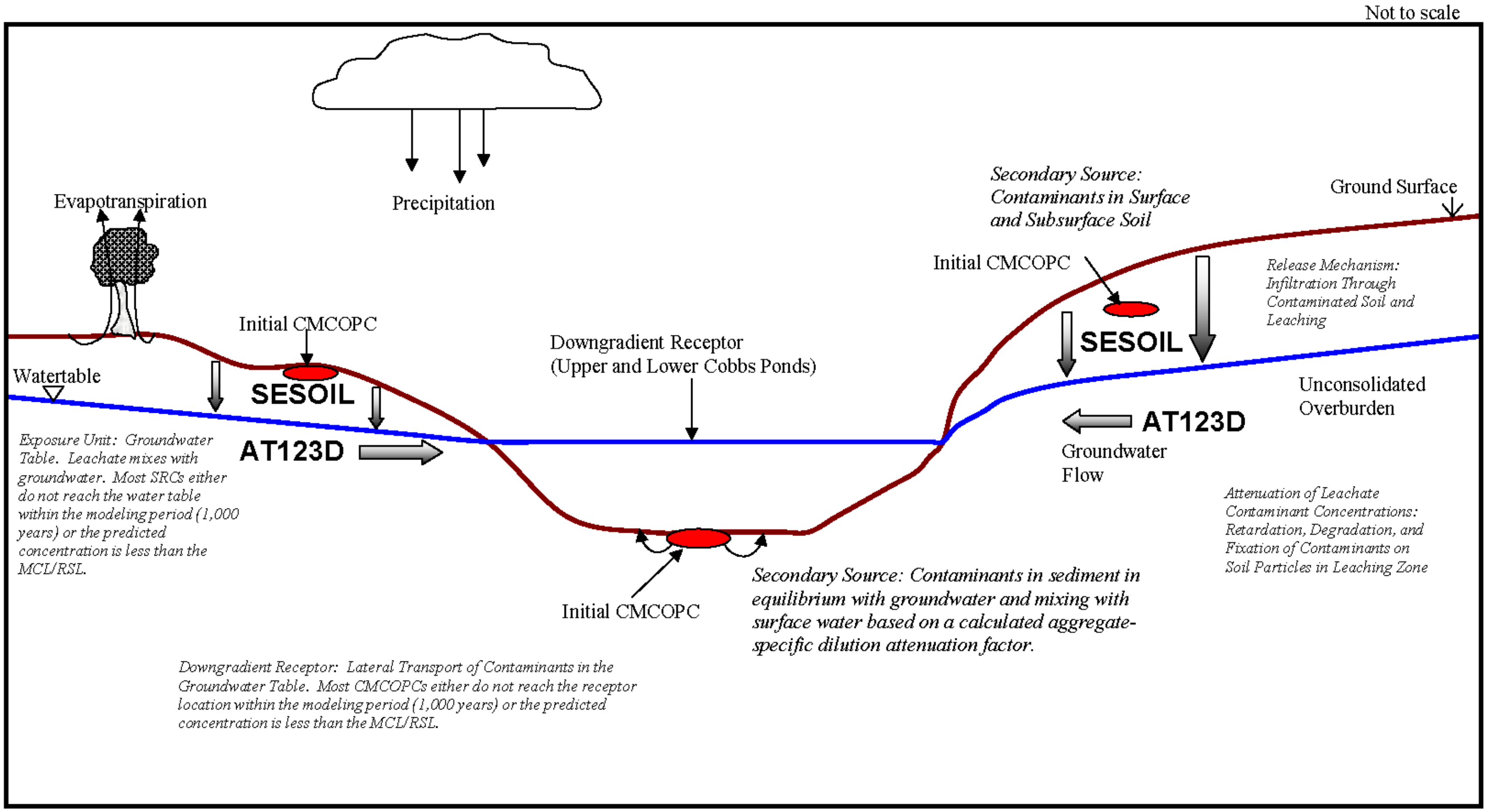
[b] The predicted concentration was estimated using the results from SESOIL and applying AT123D model.

[c] Observed groundwater concentrations were reported in the *Facility-wide Groundwater Monitoring Program Annual Report for 2009* (EQM 2010b) and sampling in January 2011.

[d] The FWCUG is based on a target risk of 10^{-6} and/or a hazard quotient of 0.1.

[e] The CMCOC was identified comparing predicted concentration in groundwater beneath the source to MCL/RSL, Resident Receptor Adult FWCUG, and facility-wide background concentration. A constituent is a CMCOC if its predicted concentration in groundwater exceeds all its screening criteria within 1,000 years.

AT123D = Analytical Transient 1-,2-,3-Dimensional model.
BHC = Hexachlorocyclohexane.
C_{gw} = Groundwater concentration.
C_L = Leachate concentration.
C_R = Groundwater concentration at the downgradient receptor location.
CMCOC = Contaminant migration chemical of concern.
CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
FWCUG = Facility-wide clean-up goal.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
ND = Not detected.
PCB = Polychlorinated biphenyl.
RSL = Regional screening level.
WOE = Weight of evidence.



Release Mechanism: Infiltration Through Contaminated Soil and Leaching

Exposure Unit: Groundwater Table. Leachate mixes with groundwater. Most SRCs either do not reach the water table within the modeling period (1,000 years) or the predicted concentration is less than the MCL/RSL.

Attenuation of Leachate Contaminant Concentrations: Retardation, Degradation, and Fixation of Contaminants on Soil Particles in Leaching Zone

Secondary Source: Contaminants in sediment in equilibrium with groundwater and mixing with surface water based on a calculated aggregate-specific dilution attenuation factor.

Downgradient Receptor: Lateral Transport of Contaminants in the Groundwater Table. Most CMCOPCs either do not reach the receptor location within the modeling period (1,000 years) or the predicted concentration is less than the MCL/RSL.

Figure 6–1. Contaminant Migration Conceptual Model

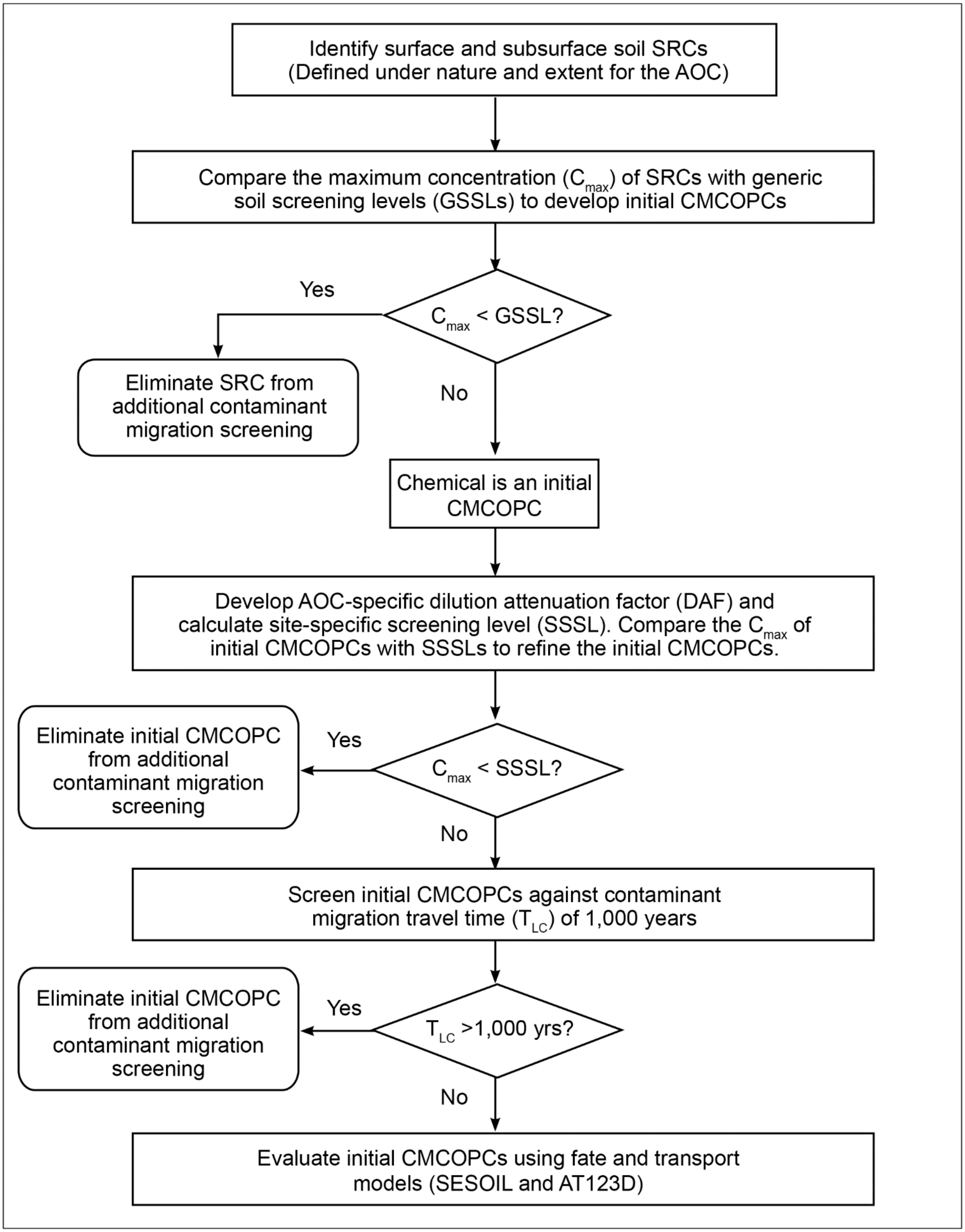


Figure 6–2. AOC Fate and Transport Modeling Approach - Soil

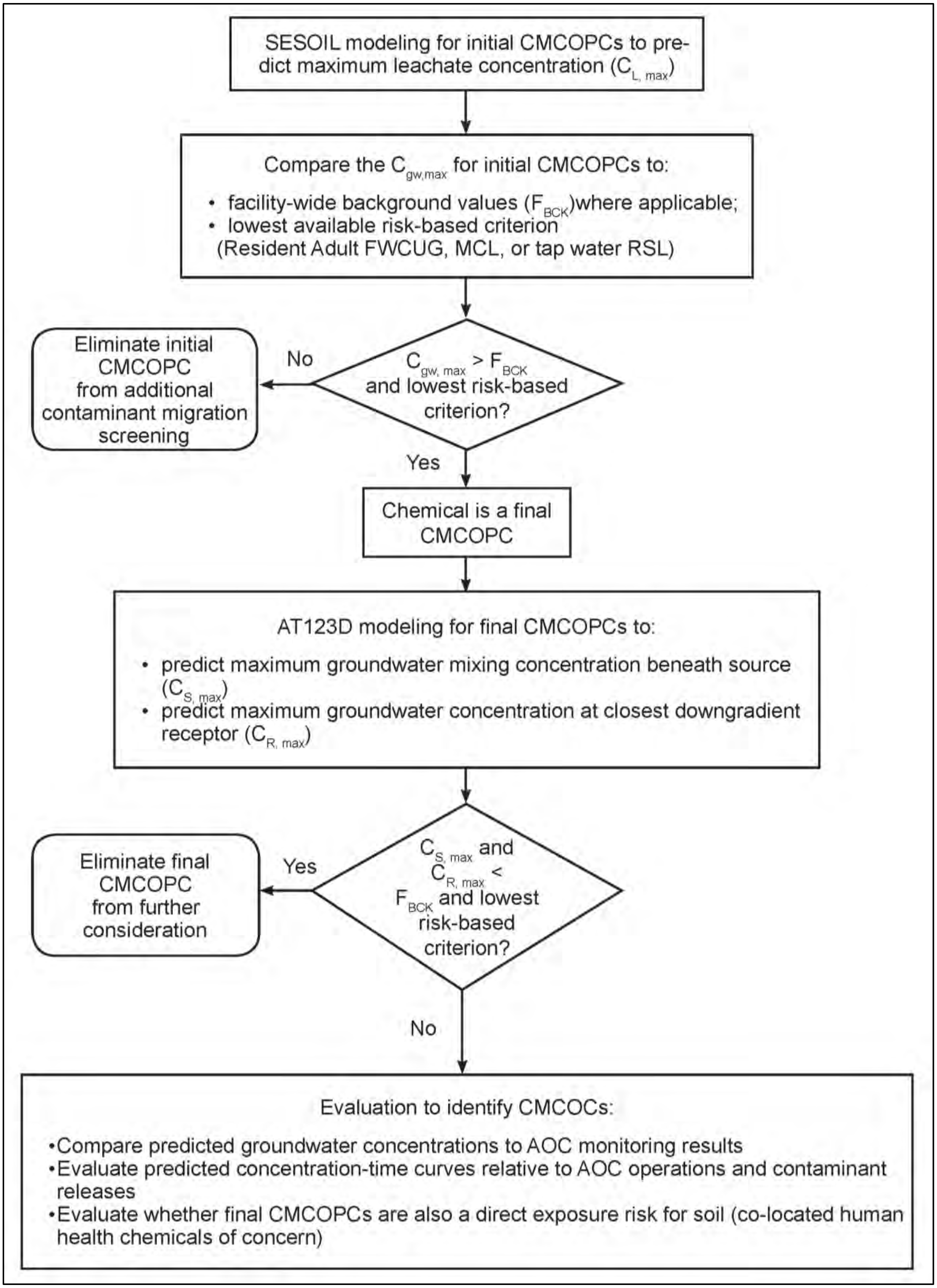


Figure 6–2. AOC Fate and Transport Modeling Approach - Soil (continued)

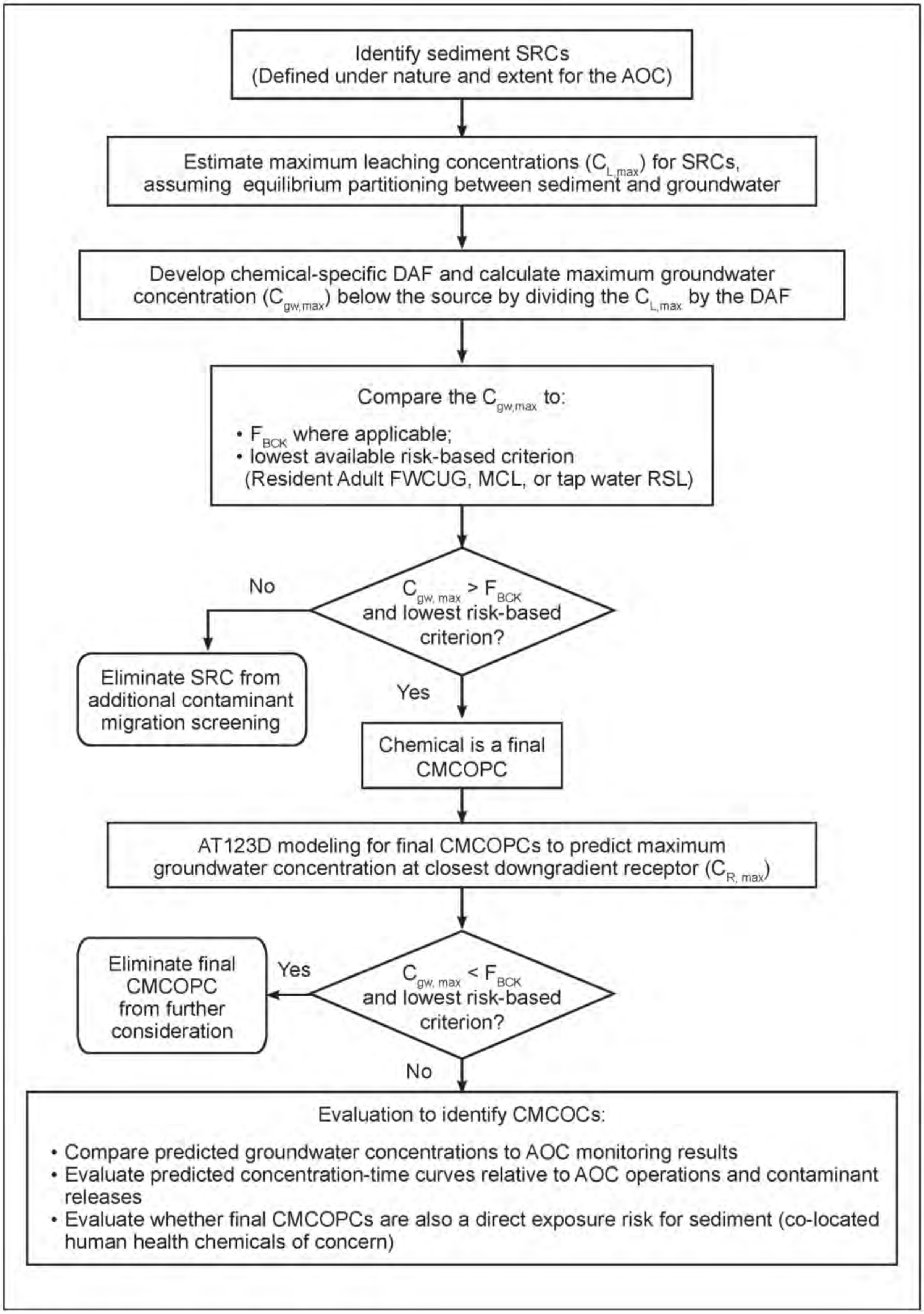


Figure 6–3. AOC Fate and Transport Modeling Approach - Sediment

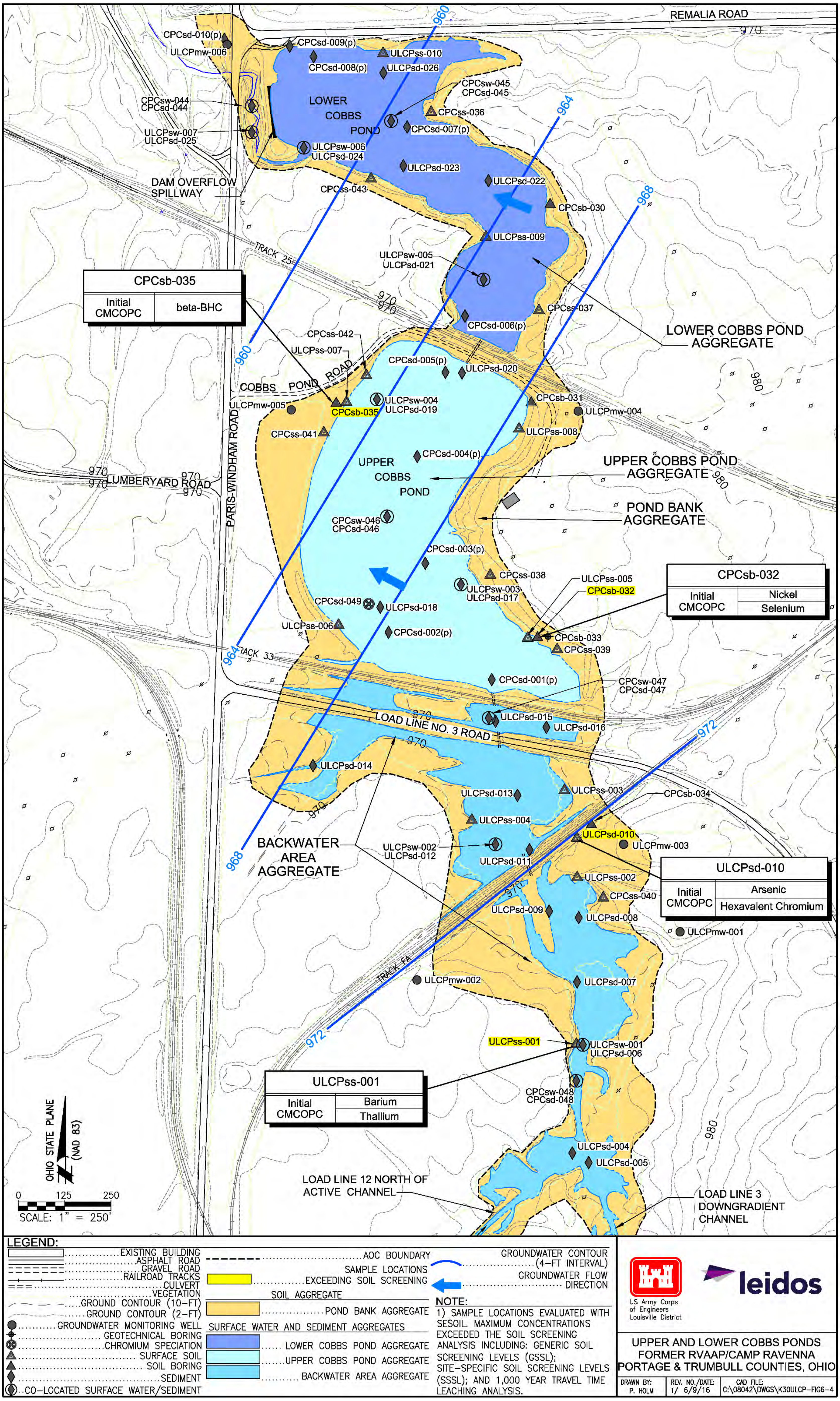
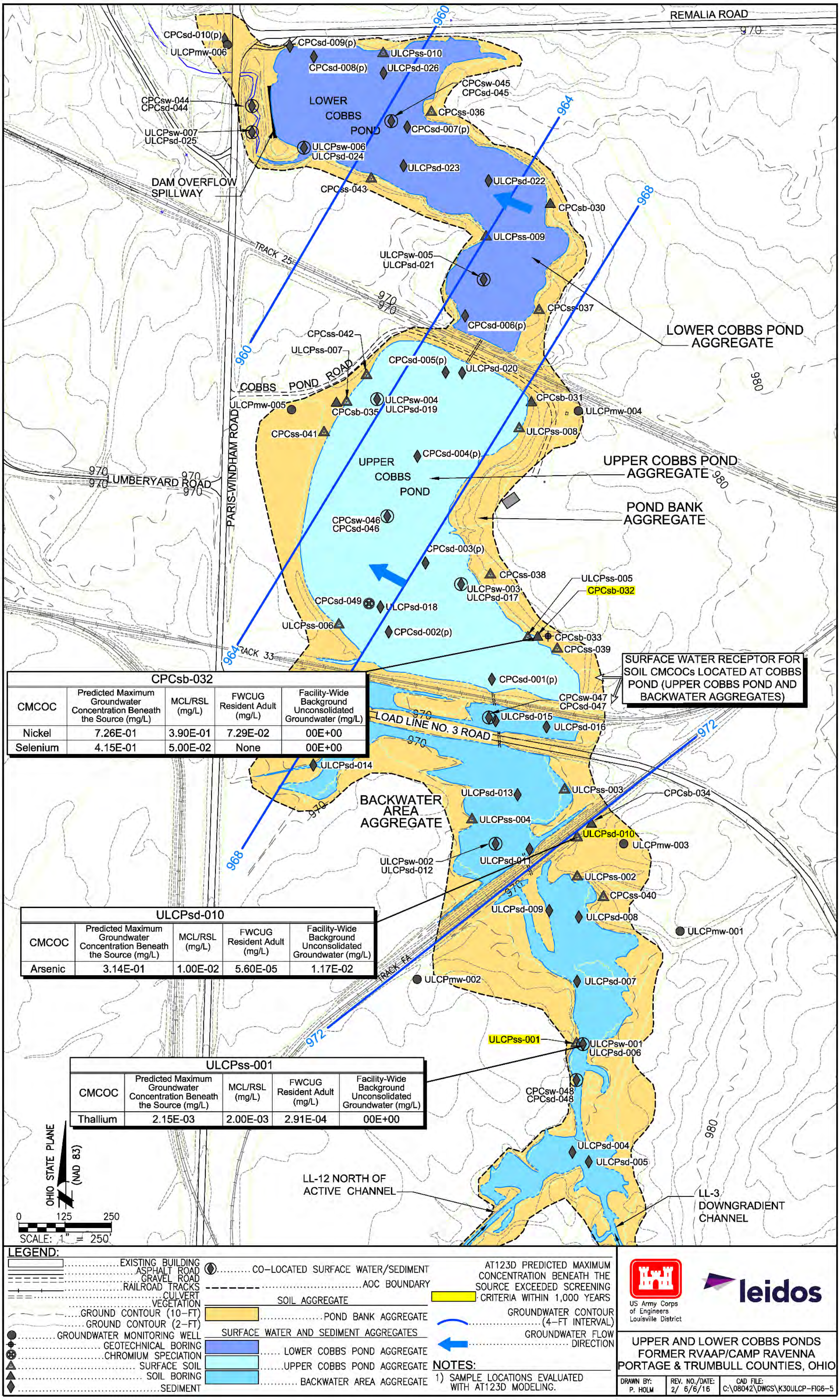


Figure 6–4. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation



CPCsb-032

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Nickel	7.26E-01	3.90E-01	7.29E-02	00E+00
Selenium	4.15E-01	5.00E-02	None	00E+00

ULCPsd-010

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Arsenic	3.14E-01	1.00E-02	5.60E-05	1.17E-02

ULCPss-001

CMCOC	Predicted Maximum Groundwater Concentration Beneath the Source (mg/L)	MCL/RSL (mg/L)	FWCUG Resident Adult (mg/L)	Facility-Wide Background Unconsolidated Groundwater (mg/L)
Thallium	2.15E-03	2.00E-03	2.91E-04	00E+00

Figure 6–5. CMCOCs Identified for Further Weight-of-Evidence Evaluation Based on AT123D Modeling

7.0 RISK ASSESSMENT

Camp Ravenna is a controlled-access facility. The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of the facility. The AOC is approximately 39 acres and is comprised of the Backwater Area (5.2 acres), Upper Cobbs Pond (9.4 acres), Lower Cobbs Pond (6.4 acres), and surrounding pond banks (18 acres).

Upper Cobbs Pond ranges from 3–8 ft in depth, and Lower Cobbs Pond ranges from 2–7 ft in depth (MKM 2005). The Backwater Area is located to the south (upstream) of Upper Cobbs Pond and was created through beaver dam construction activity. Flow from the Backwater Area into Upper Cobbs Pond and, subsequently, into Lower Cobbs Pond is through culverts beneath the railroad trackbeds and roads that cross the AOC. Lower Cobbs Pond terminates in a dam overflow spillway adjacent to the intersection of Remalia and Paris-Windham Roads.

Upper Cobbs Pond and Lower Cobbs Pond are used for recreational purposes. In addition, both ponds are used by OHARNG for fishing. The AOC may also be accessed by hunters (during annual controlled hunts) and trappers. Security patrols and maintenance activities also occur at the AOC. Future OHARNG Land Use for the AOC (which includes the ponds and their associated sediment and banks) includes recreational use, dam maintenance, wildlife management activities, and training purposes. Surrounding adjacent areas may be used for recreational activities as well as maneuver and multipurpose military training operations.

Three Land Uses for the RVAAP restoration program are specified in the Technical Memorandum (ARNG 2014) for consideration in the RI along with the following Representative Receptors:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA's Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and those other Land Uses do not require evaluation.

7.1 DATA EVALUATION FOR HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

The purpose of this data evaluation is to develop a set of chemical data suitable for use in the HHRA and ERA. The Upper and Lower Cobbs Ponds AOC data were evaluated to establish data aggregates and identify a list of SRCs.

7.1.1 Data Aggregates

This section describes the data aggregates for the media for which human and ecological receptors are potentially exposed, followed by a summary of SRCs in Section 7.1.2. Section 4.0 provides a summary of available data.

7.1.1.1 Soil Data

Soil at the Pond Bank was aggregated by the following depth intervals:

- Surface soil with an exposure depth of 0–1 ft bgs was evaluated for the Resident Receptor (Adult and Child) and for potential risk to ecological receptors because this layer is the most active biological zone (USACE 2003a). Table 7-1 presents the risk assessment data set for surface soil (0–1 ft bgs). For this risk assessment, discrete samples collected in July–August 2001 during the Phase II RI (MKM 2005) and February–March 2010 during the PBA08 RI were used to characterize surface soil.
- Subsurface soil with an exposure depth of 1–13 ft bgs was evaluated for the Resident Receptor (Adult and Child). Discrete samples collected in March 2010 during the PBA08 RI with a starting depth within these intervals were used to characterize subsurface soil. Table 7-2 presents the risk assessment data sets for subsurface soil.

7.1.1.2 Sediment and Surface Water Data

The AOC is naturally divided into three sediment and surface water EUs (Figure 2-2): Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Two channels from Load Lines 3 and 12 drain northward through the Backwater Area and into Upper Cobbs Pond. Overflow from Upper Cobbs Pond discharges through a spill way into Lower Cobbs Pond and to a receiving unnamed tributary to Sand Creek. The channels tend to hold water for extended periods of time due to the low permeability of soil in the AOC.

Discrete sediment samples collected in August–September 2001 during the Phase II RI (MKM 2005) and in March–April 2010 during the PBA08 RI and ISM samples collected in June 2003 for the FWBWQS (USACE 2005a) were used to characterize risks. Sediment samples included in the risk assessments are limited to sediment samples collected with a starting depth of 0 ft bgs (e.g., 0–0.5 or 0–1.75 ft bgs). Sediment samples collected from 0.5–2 ft bgs were not used in the risk assessment because exposure of human and ecological receptors is generally limited to surface sediment. Sediment data from samples collected from 0.5–2 ft bgs and older (1996) data not included in the risk assessment were used to characterize nature and extent of contamination (Section 5.0) and are only considered for evaluating trends over time and depth. Samples included in the risk assessment data sets for sediment are listed in Table 7-3. It is inappropriate to combine ISM and discrete sample data due to different levels of variability in these two data types; therefore, the discrete and ISM sediment data were evaluated separately.

Surface water samples collected in July 2001 during the Phase II RI (MKM 2005), in March–April 2010 during the PBA08 RI, and in June 2003 for the FWBWQS (USACE 2005a) were used to characterize risks from exposure to chemicals in these EUs. Samples included in the risk assessment data sets for surface water are listed in Table 7-4.

7.1.2 Identification of SRCs

Section 4.4 presents the statistical methods and screening criteria used to identify SRCs. The purpose of identifying SRCs is to determine the presence or absence of contamination that is above naturally occurring levels.

The 1978 Installation Assessment identified the pink wastewater and washout of residue, dusts, and spills at Load Lines 3 and 12, which were discharged through surface drainage channels towards Upper Cobbs Pond (USATHAMA 1978), as contaminants. Potential site-specific contaminants include TNT, RDX, HMX, nitrate, nitrocellulose, and heavy metals (i.e., lead, chromium, mercury, and arsenic) from the pink water. Other contaminants identified include washout from explosives melt-out and demilitarization activities at Load Lines 3 and 12 and ammonium nitrate and aluminum chloride from Load Line 12.

The SRC screen was not limited to only contaminants that may have been products of previous site use. Rather, the SRC screen followed the three steps outlined in the FWCUG Report, as summarized below, using all chemical data available:

- **Background screening.** MDCs of naturally occurring inorganic chemicals were compared to the facility-wide background concentrations for RVAAP, which are summarized in the FWCUG Report. Inorganic constituents detected above facility-wide background concentrations or having no background concentrations were retained as SRCs. All detected organic chemicals were retained as SRCs.
- **Screening of essential human nutrients.** Chemicals considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated provided they are: (1) present at low concentrations (i.e., only slightly above naturally occurring levels) and (2) toxic at only very high doses (i.e., much higher than those that could be associated with contact at the AOC) (USEPA 1989). Essential nutrients detected near or below their RDA/RDI-based SLs were eliminated as SRCs.
- **Frequency of detection screening**. In accordance with the FWCUG Report and as revised in the FWCUG Position Paper (USACE 2012a), analytes detected in less than 5% of the samples are screened out from further consideration with the exception of explosives and propellants. A frequency of detection screen was included in the SRC screening for data sets having at least 20 discrete samples; however, no SRCs were screened out on this basis.

Details of the SRC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-4. The SRCs identified for the Upper and Lower Cobbs Ponds AOC are summarized in Table 7-5.

7.2 HUMAN HEALTH RISK ASSESSMENT

This HHRA identifies COCs that may pose potential health risks to humans resulting from exposure to contamination at the Upper and Lower Cobbs Ponds AOC. This HHRA was conducted as part of the PBA08 RI and is based on the methods from the following guidance documents:

- FWHHRAM (USACE 2005b),
- FWCUG Report (USACE 2010a),
- FWCUG Position Paper (USACE 2012a), and
- Technical Memorandum (ARNG 2014).

To accomplish the goal of streamlined decision making, the FWCUG Report was developed to support risk assessments of the remaining AOCs within the former RVAAP. The FWCUG Report contains calculated FWCUGs and guidance for applying FWCUGs to accelerate the risk assessment process. This approach takes advantage of the many risk assessment inputs and decisions that have previously been accepted by stakeholders applying the CERCLA process at the former RVAAP.

The agreed-upon risk assessment methods have been documented in the FWHHRAM (USACE 2005b) and follow standard USEPA-approved risk assessment guidance. Other approaches, such as calculating the sum-of-ratios (SOR), were developed in the FWCUG Report (USACE 2010a) and FWCUG Position Paper (USACE 2012a). The Technical Memorandum (ARNG 2014) identifies future Land Uses and prescribes the applicable receptors for these Land Uses to be evaluated in an RI.

Using the FWCUGs and information from the RI sampling, the approach to the HHRA is as follows:

1. **Specify Land Use(s) and Representative Receptor(s).**
2. **Identify Media of Concern.**
3. **Synthesize and analyze data to Identify SRCs** – Follow the requirements specified in the FWHHRAM (USACE 2005b) and the FWCUG Position Paper (USACE 2012a), perform data analysis and mapping to identify SRCs, establish EUs, and calculate exposure point concentrations (EPCs) for each COPC. The results of the mapping and data analysis for the Upper and Lower Cobbs Ponds AOC to identify SRCs are presented in Sections 4.0 and 5.0 and are summarized in Section 7.1.
4. **Identify COPCs** – To identify COPCs, the MDC of all SRCs are screened against the most stringent chemical-specific FWCUG of all RVAAP receptors at a target cancer risk level of 1E-06 and non-carcinogenic target HQ of 0.1 for the Resident Receptor (Adult and Child) and National Guard Trainee. If no FWCUGs exist for an SRC, the USEPA residential RSLs (from RSL table dated June 2015) are used for this screen.

5. **Compare to Appropriate FWCUGs and Identify COCs** – Comparing COPC exposure concentrations to FWCUGs and determining COCs follows guidance presented in the FWCUG Position Paper (USACE 2012a) and Technical Memorandum (ARNG 2014). The COC determination process is as follows:
   - Report all carcinogenic- and non-carcinogenic-based FWCUGs corresponding to a TR of 1E-05 and target HQ of 1 using the most stringent of the Resident Receptor (Adult and Child) FWCUGs to evaluate Unrestricted (Residential) Land Use for each COPC. If no FWCUG is available for a COPC, the residential RSL, adjusted to represent a TR of 1E-05 or target HQ of 1, is used.
   - Report critical effect and target organ for each non-carcinogenic-based FWCUG.
   - Compare the selected FWCUG to the EPC, including an SOR.
     - For non-carcinogens, compare the EPC to the target HQ FWCUG. Sum the ratios of EPC/FWCUG for COPCs that affect similar target organs or do not have an identified target organ.
     - For carcinogens, compare the EPC to the TR FWCUG. Sum the ratios of EPC/FWCUG for all carcinogens.
   - Identify the COPC as a COC for a given receptor if:
     - The EPC exceeds the most stringent of the Resident Receptor (Adult and Child) FWCUGs for either the 1E-05 target cancer risk or the target HQ of 1; or
     - The SOR for all carcinogens or non-carcinogens that may affect the same organ is greater than one. Chemicals contributing at least 10% to an SOR greater than one are also considered COCs. In accordance with the FWCUG Position Paper (USACE 2012a), chemicals contributing greater than 5% but less than 10% to the SOR must be further evaluated before being eliminated as COCs.

The process for calculating FWCUGs rearranges the cancer risk or non-cancer hazard equations to obtain a concentration that will produce a specific risk or hazard level (USEPA 1991, USACE 2010a). For example, the FWCUG for arsenic at the cancer risk level of 1E-05 for the Resident Receptor Adult is the concentration of arsenic that produces a risk of 1E-05 when using the exposure parameters specific to the Resident Receptor Adult.

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the increased chance of cancer above the normal background rate. In the United States, the background chance of contracting cancer is a little more than 3 in 10 for women and a little less than 5 in 10 for men, or 3E-01 to 5E-01 (American Cancer Society 2015). The calculated incremental lifetime cancer risk (ILCR) is compared to the range specified in the NCP of 10^{-6} to 10^{-4}, or 1 in a million to 1 in 10,000 exposed persons developing cancer (USEPA 1990). Cancer risks above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is of concern, and any decisions to address risk further in this range, either through additional study or engineered control measures, should account for uncertainty in the risk estimates. The Ohio EPA Division of Environmental Response and

Revitalization (DERR) program has adopted a human health cumulative ILCR goal within this range of 1E-05 to be used as the level of acceptable excess cancer risk and for developing remediation goals for the site. The DERR notes that the defined risk goal should be applied as a goal, recognizing the need to retain flexibility during the evaluation and selection of remedial alternatives.

In addition to developing cancer from exposure to chemicals, an individual may experience other adverse effects. The term "adverse effects" is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects, such as kidney or liver disease and neurological damage. The risk associated with non-carcinogenic chemicals is evaluated by comparing an estimated exposure (i.e., intake or dose) from AOC media to an acceptable exposure expressed as a reference dose (RfD). The RfD is the threshold level below which no adverse effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (USEPA 1989).

The SOR is used to account for potential additive effects from exposure to multiple chemicals that can cause the same effect (e.g., cancer) or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action (i.e., target organ such as liver or critical effect such as adversely affecting the ability to reproduce). This approach compares the EPC of each COPC to the FWCUG to determine a ratio. The sum of these individual ratios is then compared to one (using one significant figure). The SOR method is based on the principle that a ratio greater than one represents unacceptable cumulative exposure (i.e., above FWCUGs if adjusted for exposure to multiple COPCs), and a ratio less than or equal to one represents acceptable cumulative exposure (i.e., below FWCUGs if adjusted for exposure to multiple COPCs). The FWCUGs for some chemical/receptor combinations are less than the background concentration. In these instances, the chemical concentrations are compared to background concentrations to identify COCs. Since the background concentration is not risk-based, these chemicals are not included in the SOR calculations.

COCs identified by comparing EPCs to FWCUGs are further evaluated in an uncertainty analysis to identify COCs requiring evaluation in an FS.

1. **Uncertainty Assessment** – Assess sources of uncertainty, as well as the potential bias they impart to the risk assessment (i.e., whether conservatism is increased or decreased) and approaches for minimizing their impact on the conclusions of the RI.
2. **Identify COCs for Potential Remediation** – Make a final determination of COCs requiring evaluation in an FS and potential remediation.

These steps are executed in the following subsections.

7.2.1 Land Use and Representative Receptors

Three Land Uses for the RVAAP restoration program are specified in the Technical Memorandum (ARNG 2014) for consideration in the RI along with the following Representative Receptors:

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA's Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and those other Land Uses do not require evaluation.

7.2.2 Identify Media of Concern

Media of concern at the Upper and Lower Cobbs Ponds AOC are surface soil, subsurface soil, surface water, and sediment. Groundwater is present at this AOC but will be evaluated (including risk assessment) in a separate document, as described in Section 1.2.

7.2.3 Data Synthesis and Analysis to Identify SRCs

The results of the mapping and data analysis for the Upper and Lower Cobbs Ponds AOC to identify SRCs are presented in Sections 4.0 and 5.0 and are summarized in Section 7.1.

7.2.4 Identify COPCs

Details of the COPC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-4. The COPCs identified for the media of concern at the Upper and Lower Cobbs Ponds AOC are presented in Table 7-6 and are summarized below.

No RfD or cancer potency factors are available for acenaphthylene, benzo(*ghi*)perylene, and phenanthrene; therefore, the RSL for pyrene was used for these PAHs (NDEP 2006). Hexavalent chromium was detected in 1 of 2 soil samples and 3 of 23 sediment samples analyzed for hexavalent and total chromium at the AOC. Since hexavalent chromium was detected as part of the conservative screening approach for identifying COPCs, the FWCUG for hexavalent chromium (the more toxic of the two chromium species evaluated) was used at this stage.

7.2.4.1 <u>COPCs in Surface Soil</u>

Of the 44 chemicals detected in surface soil (0–1 ft bgs) samples collected from the Pond Bank, 36 (18 inorganic chemicals, 16 SVOCs, 1 pesticide, and 1 explosive) were identified as SRCs. Risk-based screening identified five inorganic chemicals (aluminum, arsenic, chromium, cobalt, and cyanide) and one SVOC [benzo(a)pyrene] as COPCs in surface soil (0–1 ft bgs).

7.2.4.2 COPCs in Subsurface Soil

Of the 37 chemicals detected in the subsurface soil (1–13 ft bgs) samples collected from the Pond Bank, 18 (4 inorganic chemicals, 13 VOCs, and 1 explosive) were identified as SRCs. Risk-based screening identified only benzo(a)pyrene as a COPC.

7.2.4.3 COPCs in Sediment

Backwater Area

Of the 47 chemicals detected in discrete sediment samples collected at the Backwater Area, 38 (16 inorganic chemicals, 14 SVOCs, 3 VOCs, 4 explosives, and 1 PCB) were identified as SRCs. Risk-based screening identified three inorganic chemicals (aluminum, chromium, and cobalt) and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] as COPCs in the Backwater Area.

Upper Cobbs Pond

Of the 43 chemicals detected in discrete sediment samples collected at Upper Cobbs Pond, 34 (15 inorganic chemicals, 10 SVOCs, 2 VOCs, 6 explosives, and 1 PCB) were identified as SRCs. Risk-based screening identified four inorganic chemicals (aluminum, chromium, hexavalent chromium, and cobalt) and 1 SVOC [benzo(a)pyrene] as COPCs in Upper Cobbs Pond. Of the 27 chemicals detected in the sediment ISM sample collected at Upper Cobbs Pond, 10 (7 inorganic chemicals and 3 SVOCs) were identified as SRCs. Risk-based screening identified two inorganic chemicals (chromium and ammonia) as COPCs in this sample.

Lower Cobbs Pond

Of the 42 chemicals detected in discrete sediment samples collected at Lower Cobbs Pond, 34 (17 inorganic chemicals, 11 SVOCs, 3 VOCs, and 3 explosives) were identified as SRCs. Risk-based screening identified six inorganic chemicals (aluminum, arsenic, chromium, hexavalent chromium, cobalt, and cyanide) and one SVOC [benzo(a)pyrene] as COPCs in Lower Cobbs Pond. Of the 24 chemicals detected in the sediment ISM sample collected at Lower Cobbs Pond, 14 (13 inorganic chemicals and 1 SVOC) were identified as SRCs. Risk-based screening identified four inorganic chemicals (aluminum, ammonia, chromium, and cobalt) as COPCs in this sample.

Ammonia was initially identified as a COPC in two sediment ISM samples because no FWCUGs or RSLs are available. Ammonia is reported for evaluation of water quality for protection of aquatic receptors and has very low toxicity to humans. Therefore, ammonia is not evaluated further in this HHRA.

7.2.4.4 COPCs in Surface Water

Backwater Area

Of the 28 chemicals detected in surface water samples collected at the Backwater Area, 22 (18 inorganic chemicals, 3 VOCs, and 1 explosive) were identified as SRCs. Risk-based screening identified five inorganic chemicals (arsenic, cobalt, manganese, sulfate, and sulfite) as COPCs in the Backwater Area.

Upper Cobbs Pond

Of the 21 chemicals detected in surface water samples collected at Upper Cobbs Pond, 11 (9 inorganic chemicals, 1 SVOC, and 1 explosive) were identified as SRCs. Risk-based screening identified sulfate and sulfite as COPCs in Upper Cobbs Pond.

Lower Cobbs Pond

Of the 24 chemicals detected in surface water samples collected at Lower Cobbs Pond, 14 (12 inorganic chemicals and 2 SVOCs) were identified as SRCs. Risk-based screening identified three inorganic chemicals (manganese, sulfate, and sulfite) as COPCs in Lower Cobbs Pond.

Sulfate and sulfite were initially identified as COPCs in surface water because no FWCUGs or RSLs are available. These anions are reported for evaluation of water quality for protection of aquatic receptors and have very low toxicity to humans. There is a secondary maximum contaminant level (SMCL) of 250 mg/L established for sulfate in drinking water. SMCLs are established only as guidelines for aesthetic considerations, such as taste, color, and odor. Chemicals are not considered to present a risk to human health at the SMCL, and the concentration of sulfate and sulfite detected in all three EUs are well below the sulfate SMCL. Therefore, sulfate and sulfite are not evaluated further in this HHRA.

7.2.5 Compare to Appropriate FWCUGs

7.2.5.1 Selection of Appropriate FWCUGs

As specified in the Technical Memorandum (ARNG 2014), EPCs for each AOC should initially be evaluated to determine if no further action is necessary at an AOC to attain Unrestricted (Residential) Land Use. Unrestricted (Residential) Land Use is evaluated using FWCUGs for the Resident Receptor (Adult and Child). The Resident Receptor (Adult and Child) FWCUGs provided in Tables 7-7 through 7-9 are the lower of the Resident Receptor (Adult and Child) values for each COPC and endpoint (non-cancer and cancer) corresponding to a TR of 1E-05 and target HQ of 1. The critical effect or target organ associated with the toxicity values used to calculate the non-cancer FWCUGs are also provided.

Chromium Speciation

FWCUGs and RSLs are available for hexavalent and trivalent chromium. Existing data at other AOCs, such as Building 1200 and Anchor Test Area (USACE 2012b, USACE 2012c), indicate chromium exists predominantly in the trivalent state rather than the more toxic hexavalent state.

Total chromium concentrations in soil at this AOC are at or near background concentrations. The MDC of chromium in soil at the Upper and Lower Cobbs Ponds AOC is 24.8 mg/kg compared to the RVAAP background concentrations of 17.4 mg/kg in surface soil and 27.2 mg/kg in subsurface soil. Historical and current earth moving activities at Camp Ravenna have reduced the distinction between surface and subsurface soil. One surface soil sample was analyzed for both hexavalent and total chromium. The reported concentration of hexavalent chromium (1 mg/kg) was 10.4% of the total chromium concentration of 9.6 mg/kg [i.e., less than the 14% present in the study used to calculate the unit risk factor (URF) for hexavalent chromium]. This hexavalent chromium concentration is also less than the residential RSL (3 mg/kg based on a TR of 1E-05) for hexavalent chromium, indicating hexavalent chromium is not present above the residential RSL for hexavalent chromium. Therefore, total chromium results for surface soil were evaluated using the FWCUGs and RSLs for trivalent chromium.

Chromium concentrations appear elevated in sediment at the Upper and Lower Cobbs Ponds AOC with reported concentrations in 12 of 30 samples exceeding the Ohio EPA SRV of 29 mg/kg. Most of the discrete sediment samples (23 of 28) were analyzed for both hexavalent and total chromium. The results indicate most of the chromium present is not in the hexavalent form (i.e., hexavalent chromium was detected in only 3 of 23 samples). However, in the samples where hexavalent chromium was detected it made up 5%, 15%, and 53% of the total chromium. The detected hexavalent chromium concentrations also exceed the hexavalent chromium-specific residential RSL of 3 mg/kg. Because adequate hexavalent chromium data are available to characterize the sediment EUs, total chromium results are evaluated using the trivalent chromium FWCUGs and RSLs because the hexavalent portion of the total chromium result is evaluated separately.

No surface water samples were analyzed for hexavalent chromium. Chromium was not identified as a COPC in surface water using the screening values for hexavalent chromium.

7.2.5.2 Exposure Point Concentrations for Comparison to FWCUGs

Soil EPCs

EPCs were calculated for each depth interval using analytical results from the discrete samples presented in Tables 7-1 and 7-2. As indicated in Section 7.1.1.1, the depth intervals for the Resident Receptor are 0–1 ft bgs for surface soil and 1–13 ft bgs for subsurface soil. Per the FWHHRAM, the EPC is either the 95% upper confidence limit (UCL) of the mean or the MDC, whichever value is lowest. If the 95% UCL could not be determined, the EPC is the MDC.

Sediment and Surface Water EPCs

EPCs were calculated for each EU using analytical results from the discrete samples presented in Tables 7-3 and 7-4. As indicated in Section 7.1.1.2, the sediment risk assessment for the Resident Receptor includes sediment samples collected with a starting depth of 0 ft bgs (e.g., 0–0.5 or 0–1.75 ft bgs). Per the FWHHRAM, the EPC is either the 95% UCL of the mean or the MDC, whichever value is lowest. If the 95% UCL could not be determined, the EPC is the MDC. In addition to the EPC calculated from the discrete data, the reported concentration in each sediment ISM sample was evaluated separately.

7.2.5.3 Identification of COCs for Unrestricted (Residential) Land Use

The Upper and Lower Cobbs Ponds AOC COCs for Unrestricted (Residential) Land Use, as represented by the Resident Receptor (Adult and Child), are presented below.

COCs for Surface Soil (0–1 ft bgs)

COC screening for surface soil (0-1 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Table G-5. No COCs were identified in surface soil (0-1 ft bgs) for the Resident Receptor (Adult and Child), as explained below.

COPCs with EPCs Lower than the Resident Receptor (Adult and Child) FWCUG

All aluminum, chromium, cobalt, cyanide, and benzo(a)pyrene EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with EPCs Exceeding the Resident Receptor (Adult and Child) FWCUG

The EPC of arsenic (13.5 mg/kg) exceeds the FWCUG of 4.25 mg/kg but is below the surface soil facility-wide background concentration of 15.4 mg/kg. Because the FWCUG is less than the background concentration, the background concentration is used as the CUG for this inorganic chemical. Thus, arsenic is representative of background and is not a COC in surface soil.

SOR Analysis

No COCs were identified based on the SOR analysis as summarized below.

- Five COPCs (aluminum, arsenic, chromium, cobalt, and cyanide) identified in surface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, arsenic, chromium, and cobalt are less than the facility-wide background concentrations for surface soil; therefore, these metals are not included in the SOR. Only one COPC (cyanide) with a non-cancer endpoint is present above background concentrations; therefore, no SOR was calculated.

- Three surface soil COPCs [arsenic, cobalt, and benzo(a)pyrene] have FWCUGs for the cancer endpoint. The FWCUG for arsenic is less than the background concentration for this inorganic chemical; therefore, the background concentration is used as the CUG, and arsenic is not included in the SOR. The EPC for cobalt is less than the facility-wide background concentration for surface soil; therefore, this metal is not included in the SOR. Only one COPC [benzo(a)pyrene] with a cancer endpoint is present above background concentrations; therefore, no SOR was calculated.

COCs for Subsurface Soil (1–13 ft bgs)

COC screening for subsurface soil (1-13 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Table G-6. No COCs were identified in subsurface soil (1–13 ft bgs) for the Resident Receptor (Adult and Child) because the EPC of the only COPC [benzo(a)pyrene] is lower than the Resident Receptor (Adult and Child) FWCUG. Because only one COPC is present in subsurface soil, no SOR was calculated.

COCs for Sediment

COC screening for sediment for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-7 through G-9. Arsenic, benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs for the Resident Receptor (Adult and Child), as explained below.

COPCs with EPCs Lower than the Resident Receptor (Adult and Child) FWCUG

All aluminum, total chromium, hexavalent chromium, cobalt, cyanide, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with EPCs Exceeding the Resident Receptor (Adult and Child) FWCUG

The EPCs of benzo(a)pyrene at the Backwater Area and arsenic at Lower Cobbs Pond exceed the FWCUG.

- The EPC for benzo(a)pyrene (0.89 mg/kg) at the Backwater Area exceeds the FWCUG of 0.221 mg/kg. The EPC is the MDC at ULCPsd-015 collected in 2001. Detected benzo(a)pyrene concentrations in the other Backwater Area samples ranged from 0.063–0.39 mg/kg. Benzo(a)pyrene was identified as a COC at the Backwater Area. PAHs are not COPCs at Upper Cobbs Pond or Lower Cobbs Pond.
- Arsenic was identified as a COC at Lower Cobbs Pond because the EPC (26.9 mg/kg) exceeds both the FWCUG for the Resident Receptor Adult of 4.25 mg/kg and facility-wide background concentration of 19.5 mg/kg. The MDC of arsenic (34.3 mg/kg) at ULCPsd-026, collected in 2001, is the only sample concentration greater than the facility-wide background

concentration. Reported arsenic concentrations in the other Lower Cobbs Pond samples ranged from 5.1–20.2 mg/kg.

SOR Analysis

Three additional COCs, all PAHs, were identified based on the SOR analysis, as summarized below.

- Four COPCs [aluminum, chromium (as trivalent chromium), cobalt, and cyanide] identified in sediment at the Backwater Area have FWCUGs for non-cancer endpoints. The total SOR for these COPCs is less than or equal to one; therefore, no COCs were identified.
- Four COPCs [aluminum, chromium (as trivalent chromium), hexavalent chromium, and cobalt] identified in sediment at Upper Cobbs Pond have FWCUGs for non-cancer endpoints. The total SOR for these COPCs is less than or equal to one; therefore, no COCs were identified.
- Six COPCs [aluminum, arsenic, chromium (as trivalent chromium), hexavalent chromium, cobalt, and cyanide] identified in sediment at Lower Cobbs Pond have FWCUGs for non-cancer endpoints. The total SOR for these COPCs is less than or equal to one; therefore, no COCs were identified.
- Six COPCs [cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] identified in sediment at the Backwater Area have FWCUGs for the cancer endpoint. The SOR of five is primarily due to benzo(a)pyrene having an EPC above the FWCUG. Benzo(a)pyrene was previously identified as a COC at this EU. Benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene each contribute at least 5% to the SOR; therefore, the SOR identifies three additional PAHs as COCs at the Backwater Area.
- Three COPCs [hexavalent chromium, cobalt, and benzo(a)pyrene] identified in sediment at Upper Cobbs Pond have FWCUGs for the cancer endpoint. The calculated SOR is less than or equal to one; therefore, no additional COCs were identified at Upper Cobbs Pond.
- Four COPCs [arsenic, hexavalent chromium, cobalt, and benzo(a)pyrene] identified in sediment at Lower Cobbs Pond have FWCUGs for the cancer endpoint. The FWCUG for arsenic is less than the background concentration for this inorganic chemical; therefore, the background concentration is used as the CUG, and arsenic is not included in the SOR. The calculated SOR for the remaining chemicals is less than or equal to one; therefore, no additional COCs were identified at Lower Cobbs Pond.

COCs for Surface Water

COC screening for surface water for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-10 and G-11. Cobalt and manganese were identified as COCs as explained below.

COPCs with EPCs Lower than the Resident Receptor (Adult and Child) FWCUG

All arsenic and selenium EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.

COPCs with EPCs Exceeding the Resident Receptor (Adult and Child) FWCUG

The EPCs of cobalt and manganese at the Backwater Area exceed the Resident Receptor (Adult and Child) FWCUG.

- No FWCUGs are available for cobalt in surface water. The EPC for cobalt (0.01 mg/L) exceeds the USEPA tap water RSL of 0.006 mg/L. Reported concentrations of cobalt range from 0.00039–0.0107 mg/L with the MDC reported in sample ULCPsw-001 collected in 2001. Cobalt is identified as a COC at the Backwater Area. Cobalt was not detected at Upper Cobbs Pond. Cobalt was detected in one sample at Lower Cobbs Pond at a concentration of 0.00015 mg/L. Thus, cobalt is not a COC at these two EUs.
- The EPC for manganese (15.1 mg/L) in the Backwater Area exceeds the Resident FWCUG of 6.3 mg/L. The highest concentration of manganese (15.8 mg/L) was detected in the Backwater Area at sample location ULCPsw-002 in 2001. The field duplicate for this sample had a reported concentration of 7.36 mg/L. Manganese was identified as a COC at the Backwater Area. The MDCs of manganese in surface water in Upper Cobbs Pond and Lower Cobbs Pond are 0.528 mg/L and 0.654 mg/L, respectively. Thus, manganese is not a COC in surface water at these two EUs.

SOR Analysis

No additional COCs were identified based on the SOR analysis, as explained below.

- Four COPCs (arsenic, cobalt, manganese, and selenium) identified in surface water at the Backwater Area have FWCUGs for non-cancer endpoints. The total SOR for these COPCs is four due to cobalt and manganese each having a ratio of two. Therefore, no additional COCs were identified.
- Only one COPC (arsenic) identified in surface water at the Backwater Area has a FWCUG for the cancer endpoint; therefore, no SOR was calculated.
- No COPCs were identified in surface water at Upper Cobbs Pond and only one COPC (manganese) was identified in surface water at Lower Cobbs Pond; therefore, no SOR was conducted for these EUs.

7.2.6 Uncertainty Assessment

The sources of uncertainty, as well as the potential bias they impart to the risk assessment (i.e., whether conservatism is increased or decreased) and approaches for minimizing their impact on the conclusions of the RI, are briefly discussed below.

7.2.6.1 Uncertainty in Estimating Potential Exposure

Sources of uncertainty in estimating potential human exposure include sampling and analysis limitations, comparison to background concentrations to identify SRCs, and estimation of EPCs.

Sampling Limitations. Uncertainties arise from limits on the media sampled, the total number and specific locations that can be sampled, and the parameters chosen for analysis to characterize the AOC. A total of 75 surface soil (0-1 ft bgs) samples, 32 sediment samples, and 16 surface water samples were available for the HHRA. Samples were collected from areas biased toward areas anticipated to have the highest level of potential contamination to delineate potential sources. The results of surface soil sampling were used to efficiently guide selection of locations for subsurface soil sampling with a bias toward the areas of highest potential contamination.

Analytical Limitations. Uncertainty is associated with the chemical concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment was maximized and uncertainty was minimized by implementing QA/QC procedures that specify how samples are selected and handled; however, sampling errors, laboratory analysis errors, and data analysis errors can occur. Beyond the potential for errors, there is normal variability in analytical results.

Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based SLs. Under these circumstances, it is uncertain whether the true concentration is above or below the SLs that are protective of human health. When analytes have a mixture of detected and non-detected concentrations, EPC calculations may be affected by these detection limits. Risks may be overestimated as a result of some sample concentrations being reported as non-detected at the method detection limit (MDL), when the actual concentration may be much smaller than the MDL. Risks may also be underestimated if some analytes that were not detected in any sample were removed from the COPC list. If the concentrations of these analytes are below the MDL but are above the SL, the risk from these analytes would not be included in the risk assessment results.

Identifying SRCs. Part of determining SRCs is to identify chemicals detected above the established RVAAP facility-wide background concentrations. This screen does not account for the potential sources of chemicals, and background values are only available for inorganic chemicals.

Uncertainty associated with screening against background results from statistical limitations and natural variation in background concentrations. Because of this variation, inorganic chemical concentrations below the background concentration are likely representative of background conditions. Inorganic chemical concentrations above the background concentration may be above background concentrations or may reflect natural variation. This is especially true for measured concentrations close to the background concentration.

At the Upper and Lower Cobbs Ponds AOC, the MDCs of all inorganic chemicals in all soil intervals are less than 2.4x times their background concentrations. Nine inorganic chemicals detected in sediment had MDCs that were one to two times their background concentrations. The consequences of carrying most inorganic chemicals forward as SRCs, even if they actually represent background concentrations, is negligible because they are not toxic at near background concentrations. By contrast, naturally occurring (background) arsenic in soil and sediment exceeds some risk-based CUGs. Therefore, the consequence of identifying arsenic as an SRC if it is, in fact, representative of background can have a significant impact on the conclusions of the risk assessment. The MDCs of arsenic at the AOC are 28.4 mg/kg in surface soil, 17.9 mg/kg in subsurface soil, and 34.3 mg/kg in sediment. The facility-wide background concentrations for arsenic at RVAAP are 15.4 mg/kg for surface soil, 19.8 mg/kg for subsurface soil, and 19.5 mg/kg for sediment. The Ohio SRV for arsenic is 25 mg/kg (Ohio EPA 2008). Vosnakis and Perry (2009) recently published the results of arsenic background studies that included 313 samples of Ohio soil. Naturally-occurring arsenic in these samples ranged from 1.6–71.3 mg/kg with 95th percentiles of 21.7 mg/kg in surface soil, 25.5 mg/kg in subsurface soil, and upper tolerance limits of 22.8 and 29.6 mg/kg for surface and subsurface soil, respectively. In other studies, native soil concentrations of arsenic in Ohio have been reported as ranging from 0.5-56 mg/kg (Ohio EPA 1996) and the U.S. Geological Survey's Certificate of Analysis of the Devonian Ohio Shale estimates arsenic concentrations of 68.5 mg/kg are naturally present in bedrock shales (USGS 2004). Based on this information, arsenic appears to be present at the Upper and Lower Cobbs Ponds AOC at naturally occurring concentrations.

Organic chemicals are not screened against background concentrations even though some organic compounds are present in the environment as a result of natural or human activities not related to the AOC. For example, PAHs are present in the environment as a result of burning fossil fuels and as a component of road dust, vehicle exhaust, tire wear particles, pavement, and slag used as railroad ballast and fill. Samples collected near roadways or parking areas may represent normal "urban" sources of PAHs. These issues represent significant sources of uncertainty at sites where low levels of PAHs are found over large areas of the AOC. At the Upper and Lower Cobbs Ponds AOC, PAHs were detected in sediment across the ponds; one or more PAHs were detected in 7 of 10 discrete sediment samples analyzed for SVOCs. PAH concentrations were less than the Resident Receptor (Adult and Child) FWCUGs in all but three sediment samples where concentrations of benzo(a)pyrene ranged from 0.23–0.89, exceeding the FWCUG of 0.221 mg/kg. The highest concentrations were reported near a culvert between Load Line 3 Road and Track 33 in 2001 (0.89 mg/kg) and 2010 (0.39 mg/kg).

Background concentrations of PAHs in sediment are limited; however, numerous studies have been conducted that examine environmental levels of PAHs in rural and urban surface soil (e.g., ATSDR 1995, Bradley et al. 1994, IEPA 2005, MADEP 2002, and Teaf et al. 2008). Reported minimum, maximum, and 95th percentile concentrations of benzo(a)pyrene from numerous studies are shown in Table 7-10. These studies demonstrate the high variability in environmental levels of PAHs within a single study area and among multiple studies.

The lack of established RVAAP background concentrations for identifying SRCs for PAHs is a source of uncertainty. Evaluating potential RVAAP process-related sources and other common anthropogenic (non-CERCLA) sources using available PAH environmental data minimizes the impact of this uncertainty on the conclusions of the RI (see Section 7.2.6).

Exposure Point Concentrations. Generally, the 95% UCL on the arithmetic mean was adopted as the EPC for discrete sample results and is considered to represent a conservative estimate of the average concentration. This imparts a small but intentional conservative bias to the risk assessment, provided the sampling captured the most highly contaminated areas. Thus, representative EPCs for the EUs were calculated from discrete data based on the assumption that the samples collected from the EUs were truly random samples. This assumption is not true for the Upper and Lower Cobbs Ponds AOC where sample locations were biased to identify areas of highest contaminant concentrations. Therefore, EPCs generated from these data are likely to represent an upper bound of potential exposure concentrations.

In addition to calculating EPCs for each EU, individual discrete sample results are evaluated to identify whether potential hotspots are present as a result of specific source areas.

The EPC of arsenic is less than the FWCUG in surface soil at the Pond Bank, but the MDC exceeds the FWCUG. The MDC of arsenic in surface soil at the Pond Bank was 28.4 mg/kg at sample location ULCPsd-010, collected in 2001, near the railroad trackbeds in the Backwater Area. The reported concentrations in the other 23 surface soil samples range from 4.2–19.7 mg/kg. The RVAAP background concentration for arsenic in surface soil is 15.4 mg/kg and in subsurface soil is 19.8 mg/kg. The RVAAP background concentration of arsenic in sediment is 19.5 mg/kg and the Ohio EPA SRV is 25 mg/kg. As noted previously, other studies indicate arsenic may be naturally occurring in Ohio soils at greater than 20 mg/kg. For example, an environmental study of three locations in Cuyahoga County performed for Ohio EPA (Weston 2012) showed arsenic ranged from 4.6-25.2 mg/kg (22.9 mg/kg excluding statistical outliers) in surface soil (0–2 ft bgs) and 5.3-34.8 mg/kg (22.6 mg/kg excluding statistical outliers) in subsurface soil (2–4 ft bgs). Based on this evaluation, arsenic does not represent a hotspot and is not identified as a COC.

There are no other instances of COPCs having an MDC greater than a FWCUG with an EPC less than the FWCUG. Therefore, no hotspots are identified at the Upper and Lower Cobbs Ponds AOC.

7.2.6.2 Uncertainty in Use of FWCUGs

Sources of uncertainty in the FWCUGs used to identify COCs include selecting appropriate receptors and exposure parameters, exposure models, and toxicity values used in calculating FWCUGs.

Selection of Representative Receptors. Camp Ravenna is a controlled-access facility. The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of the facility and is used for recreational purposes. In addition, both ponds are used by OHARNG for fishing. The AOC may also be accessed by hunters (during annual controlled hunts) and trappers. Security patrols and maintenance activities also occur at the AOC. Future OHARNG Land Use for the AOC (which includes ponds and associated sediment and banks) includes recreational use, dam maintenance, wildlife management activities, and training purposes. Surrounding adjacent areas may be used for recreational activities as well as maneuver and multipurpose military training operations.

While residential Land Use is unlikely, an evaluation using Resident Receptor (Adult and Child) FWCUGs is included to provide an Unrestricted (Residential) Land Use evaluation. As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential)

Land Use, then all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use] will be evaluated.

Exposure Parameters and Exposure Models. For each primary exposure pathway included in the FWCUGs, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. Most exposure parameters have been selected so that errors occur on the side of human health protection. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile and outside of the range that may be reasonably expected. Therefore, consistently selecting upper-bound parameters generally leads to overestimation of the potential risk.

Sediment FWCUGs are based on the same exposure assumptions as the soil FWCUGs and assume Resident Receptors are exposed daily to sediment, as they would be exposed to soil in a residential yard (i.e., exposure occurs daily from age 0–30 years old and children ingest significant amounts of material while playing in the yard). Exposure to sediment in a water body and under more than a foot of water will be less frequent and for a shorter duration. Also, very young children (e.g., less than two years) are not expected to be exposed to sediment located under water and sediment ingestion rates are expected to be less than soil because the presence of overlying water will reduce adherence of sediment and thus ingestion by hand-to-mouth contact. To evaluate the uncertainty associated with the assumption that exposure to sediment is the same as exposure to soil in a residential yard, the online USEPA RSL calculator at https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search was used to calculate screening levels based on slightly more realistic, but still conservative exposure assumptions. It was assumed that a resident could contact sediment during the warmer months of the year (i.e., June through September). It was further assumed that toddlers (i.e., children under 2 years old) would not be exposed to underwater sediment, young children (2–6 years) and adults would visit the ponds 2 days per month (i.e., 8 days per year) and older children (age 6–16 years) would visit the ponds 2 days per week (35 days/year). All other assumptions were unchanged from default soil assumptions (i.e., ingestion rate, exposure time, and exposed skin surface area). The complete input and output files for the calculator are provided in Appendix G, Exhibit G-1. The calculated RSL for exposure to benzo(a)pyrene in sediment during the summer months as described above is 9 mg/kg. The maximum detected benzo(a)pyrene concentration in sediment is 0.89 mg/kg.

Toxicity Values. The toxicity of chemicals is under constant study and values change from time to time. The toxicity values used in calculating FWCUGs were the most recent values available at the time of those calculations (September 2008). These values are designed to be conservative and provide an upper-bound estimate of risk.

The toxicity and mobility of many inorganic chemicals in the environment depends on the chemical species present. Two important examples are arsenic and chromium. The toxicity values used in developing FWCUGs are for inorganic arsenic; however, these values do not distinguish between arsenite and arsenate. Chromium is generally present in the environment as either the trivalent (Cr+3) or hexavalent (Cr+6) species, with the trivalent form generally being more stable and therefore more common. FWCUGs are available for hexavalent and trivalent chromium. Trivalent chromium has not been shown to be carcinogenic. It is an essential micronutrient but can also be toxic at high doses (i.e., above the RfD used to calculate the FWCUG). FWCUGs for trivalent chromium are based on non-cancerous effects. Hexavalent chromium is much more toxic than trivalent chromium. It is classified as a "known human carcinogen" and may also cause non-cancerous effects. The cancer URF for hexavalent chromium published in USEPA's Integrated Risk Information System (IRIS) is based on epidemiological data on lung cancer in workers associated with chromate production. Workers in the chromate industry are exposed to trivalent and hexavalent compounds of chromium. The cancer mortality in the study used to establish the URF was assumed to be due to hexavalent chromium. It was further assumed that hexavalent chromium constituted no less than one seventh of the total chromium in air that the workers were exposed to. As noted in IRIS, the assumption that the ratio of hexavalent to trivalent chromium was 1:6 in this study may lead to a sevenfold underestimation of risk when using this URF to evaluate exposure to hexavalent chromium alone.

To avoid underestimating risk, selecting the FWCUG for chromium includes a step that compares the maximum concentration of hexavalent chromium detected in chromium speciation samples to the residential RSL for hexavalent chromium of 3 mg/kg. Concentrations of hexavalent chromium in chromium speciation samples that are less than or equal to 3 mg/kg indicate that hexavalent chromium is not present above hexavalent chromium FWCUGs and supports using trivalent chromium FWCUGs for evaluating total chromium. Using speciation samples to identify the appropriate FWCUG minimizes the associated uncertainty.

FWCUGs and RSLs below Background Concentrations. One purpose of the HHRA process is to identify COCs and CUGs for evaluating remedial alternatives for remediating residual contamination that has resulted from process operations at the AOC. FWCUGs and RSLs are risk-based values. In some cases, natural or anthropogenic background concentrations, unrelated to process operations, exceed the risk-based FWCUGs and RSLs. For naturally occurring inorganic chemicals this problem is addressed by using the background concentration as the CUG. This introduces uncertainty in the chosen CUG because there is uncertainty in assigning a specific value to background, which can be highly variable.

No background concentrations are available for organic chemicals, although PAHs are often present in the environment from natural and anthropogenic sources and regulatory standards are often much lower than environmental levels of PAHs in urban and rural surface soil, especially near areas of vehicle traffic (e.g., roads and parking areas). Given their frequent presence in environmental media, and especially in areas influenced by vehicle exhaust and tire particles, it is important to compare risk-based cleanup levels with typical environmental concentrations before utilizing unrealistically low cleanup targets. Numerous studies have been conducted that examine ambient levels of PAHs in rural and urban surface soil (e.g., ATSDR 1995, Bradley et al. 1994, MADEP 2002, and Teaf et al. 2008). These studies indicate that given the multitude of non-point mobile sources for PAHs, it is not uncommon for ambient concentrations to exceed health-based regulatory recommendations. Some states have begun to consider ambient anthropogenic levels by establishing minimum screening levels based on environmental studies. For example, the New York State Department of Environmental

Conservation has established a minimum soil cleanup objective of 1 mg/kg for benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene and 0.1 mg/kg for dibenz(a,h)anthracene, based on the 95th percentile concentrations of these PAHs in rural areas near roads (NYSDEC 2006).

7.2.6.3 Uncertainty in the Identification of COCs

All of the sources of uncertainty described in the previous sections potentially impact the identification of COCs. The exposure and toxicity values used to calculate FWCUGs and RSLs as well as the approach for identifying SRCs, COPCs, and ultimately COCs based on the FWCUGs and RSLs were designed to ensure overestimation, rather than underestimation, of potential risk. The uncertainty assessment attempts to put the identified COCs in perspective to facilitate informed risk management decisions for the AOC.

The SOR is used to account for the potential additive effects from exposure to multiple chemicals that can cause the same effect or affect the same target organ. Cancer risk is assumed to be additive for all carcinogens. Non-cancer risk is assumed to be additive for chemicals with similar sites of toxicological action. In the event that any combination of COPCs results in synergistic effects, risk might be underestimated. Conversely, the assumption of additivity would overestimate risk if a combination of COPCs acted antagonistically. It is unclear whether the potential for chemical interaction has been inadvertently understated or overstated. It seems unlikely that the potential for chemical interaction contributes significant uncertainty to the conclusions of the risk assessment.

7.2.7 Identification of COCs for Potential Remediation

COCs were identified in Section 7.2.5 as any COPC having an EPC greater than an applicable FWCUG or contributing more than 5–10% to an SOR greater than one. For inorganic chemicals with FWCUGs below background concentrations, the background concentration was used as the point of comparison. The TR for the FWCUGs used to identify COCs is 1E-05 per the Ohio EPA DERR program, which has adopted a human health cumulative ILCR goal of 1E-05 to be used as the level of acceptable excess cancer risk and for developing site remediation goals.

The results of the COC screening (Section 7.2.5) are combined with the results of the uncertainty assessment (Section 7.2.6) to identify COCs to be carried forward for potential remediation.

Several PAHs were identified as COCs in sediment. The MDC of benzo(a)pyrene (0.89 mg/kg) at the Backwater Area exceeds the FWCUG (0.221 mg/kg). The MDC is at ULCPsd-015, which was collected in 2001. Sample ULCPsd-047 was collected at approximately the same location in 2010 and showed a benzo(a)pyrene concentration of 0.39 mg/kg. Detected benzo(a)pyrene concentrations in the other Backwater Area samples ranged from 0.063–0.23 mg/kg. Three additional PAHs, present below FWCUGs, were identified as COCs based on the SOR analysis.

Benzo(a)pyrene, and by association the other PAHs, were not identified as COCs to be carried forward for potential remediation based on the following WOE factors:

- Samples ULCPsd-015 and ULCPsd-047 are located near a culvert between Load Line 3 Road and Track 33. The source of the PAHs in sediment is most likely runoff from the road and railroad. Samples collected upgradient (in the Backwater area) and downgradient (in Upper Cobbs Pond) show lower concentrations.
- The FWCUGs for exposure to sediment are the same as the FWCUGs for soil (i.e., exposure is assumed to be the same for soil in a residential yard and sediment in a pond). Using more realistic (but still conservative) exposure assumptions (e.g., exposure only occurs during the warmer months of the year) results in a screening level of 9 mg/kg. The MDC at the backwater area (0.89 mg/kg) is below this still conservative value.

The EPC of arsenic in sediment at Lower Cobbs Pond (26.9 mg/kg) exceeds the FWCUG for the Resident Receptor Adult of 4.25 mg/kg, the facility-wide background concentration of 19.5 mg/kg, and the Ohio EPA SRV of 25 mg/kg. The MDC of arsenic (34.3 mg/kg) at ULCPsd-026, collected in 2001, is the only sample concentration greater than the facility-wide background concentration and Ohio EPA SRV. Reported arsenic concentrations in the other Lower Cobbs Pond samples ranged from 5.1–20.2 mg/kg. Arsenic was not identified as a COC for potential remediation because the reported concentrations appear to represent naturally occurring levels in sediment.

No FWCUG is available for cobalt in surface water; the screening value used for the Resident (Adult and Child) is the tap water RSL of 0.006 mg/L. The EPC of cobalt (0.01 mg/L) is less than two times the tap water RSL. The Backwater Area is a shallow pond created through beaver dam construction activity upstream of Upper Cobbs Pond. This limited shallow surface water is not a potential source of residential drinking water; therefore, this low exceedance of the tap water RSL does not warrant potential remediation in this EU.

The EPC of manganese in surface water at the Backwater Area EU (15.1 mg/L) exceeds the FWCUG for the Resident Receptor (Adult and Child) (6.326 mg/L). The EPC is strongly influenced by the MDC (15.8 mg/L) reported in sample ULCPsw-002 collected in 2001. The field duplicate of this sample reported a concentration of 7.36 mg/L. The manganese concentrations in all samples collected in 2010 are below the facility-wide background concentration of 0.391 mg/L. Because the field duplicate of the MDC concentration is much closer to the Resident Receptor FWCUG and recent sample data indicate manganese is present at naturally occurring background concentrations, manganese does not warrant potential remediation in this EU.

7.2.8 Summary of HHRA

This HHRA documents COCs that may pose potential health risk to human receptors resulting from exposure to contamination at the Upper and Lower Cobbs Ponds AOC. This HHRA was conducted as part of the RI and was based on the streamlined approach described in the FWCUG Report (USACE 2010a), FWCUG Position Paper (USACE 2012a), and Technical Memorandum (ARNG 2014). The components of the risk assessment (i.e., receptors, exposure media, EPCs, and results) are summarized below.

Receptors. Camp Ravenna is a controlled-access facility. The Upper and Lower Cobbs Ponds AOC is located in the east-central portion of the facility. The Upper Cobbs Pond and Lower Cobbs Pond are used for recreational purposes. In addition, both ponds are used by OHARNG for fishing. Security patrols and maintenance activities also occur at the AOC. Future OHARNG Land Use for the AOC (which includes ponds and associated sediment and banks) includes recreational use, dam maintenance, wildlife management activities, and training purposes. Surrounding adjacent areas may be used for recreational activities as well as military training operations.

Three Land Uses for the RVAAP restoration program are specified in the Technical Memorandum (ARNG 2014) for consideration in the RI along with their Representative Receptors. Unrestricted (Residential) Land Use [Resident Receptor (Adult and Child)] is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training).

Exposure Media. Media of concern at the Upper and Lower Cobbs Ponds AOC are surface soil, subsurface soil, surface water, and sediment.

Estimation of EPCs. The EPCs were calculated from the results of all of the discrete samples collected from a given depth interval at each EU. The EPC was either the 95% UCL of the mean or the MDC, whichever value is lowest.

The EPCs for soil, sediment, and surface water were calculated from the results of all of the discrete samples collected at each EU. The EPC was either the 95% UCL of the mean or the MDC, whichever value is lowest. In addition to the discrete data, the results of sediment ISM data were evaluated separately with each ISM sample representing a decision unit.

Results of Human Health Risk Assessment. No COCs were identified for potential remediation for soil, sediment, or surface water at the Upper and Lower Cobbs Ponds AOC.

7.3 ECOLOGICAL RISK ASSESSMENT

7.3.1 Introduction

The ERA presented in this Phase III RI Report follows a unified approach of methods integrating Army, Ohio EPA, and USEPA guidance. This ERA approach is consistent with the general approach by these agencies and primarily follows the Level I Scoping ERA, Level II Screening ERA, and Level III Baseline ERA outlined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008), with specific application of components from the FWERWP, *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010b), and *Ecological Risk Assessment Guidance* *for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997). The process implemented in this RI Report combines these guidance documents to meet requirements of the Ohio EPA and Army, while following previously accepted methods established for RVAAP. This unified approach resulted from coordination between USACE and Ohio EPA during the summer of 2011.

7.3.1.1 Scope and Objective

The Upper and Lower Cobbs Ponds AOC contains habitats that support ecological receptors. These terrestrial and aquatic habitats have known chemical contamination (MKM 2005). Habitat types and an assessment of the ecological resources found at the AOC are presented in subsequent subsections.

Additionally, the conclusions of a historical ERA (a SERA) performed as part of the *Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds* (MKM 2005)] state the following:

> "No additional action is recommended based on ecological risk because, based on the Step 3a refinement step, it was determined that site-related risks were not great enough to warrant proceeding further into the ecological risk assessment process."

The results of the historical ERA and PBA08 RI are combined in this report to evaluate the conclusions of the historical ERA and determine whether a qualitative ERA (Level I) is sufficient, based on the quality of the habitat and the presence of contamination, or a more rigorous ERA (Level II or III) will be conducted.

7.3.2 Level I: Scoping Level Ecological Risk Assessment

The ERA method for Level I follows guidance documents listed in Section 7.3.1. Level I is intended to evaluate if the AOC had past releases, has the potential for current contamination, and has important ecological resources on or near the AOC.

The following two questions should be answered when the Level I ERA is complete:

1. **Are current or past releases suspected at the AOC?** Current or past releases are determined by evidence that chemical contaminants or COPECs are present.
2. **Are important ecological resources present at or in the locality of the AOC***?* Important ecological resources are defined in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) and *Technical Document for Ecological Risk Assessment: Process for Developing Management Goals* (BTAG 2005).

If an AOC has contaminants but lacks important ecological resources, the ERA process can stop at Level I. Contamination and important ecological resources must both be present to proceed to a Level II Screening Level ERA.

7.3.2.1 AOC Description and Land Use

The Upper and Lower Cobbs Ponds AOC is approximately 39 acres. The AOC includes Upper Cobbs Pond (9.4 acres), Lower Cobbs Pond (6.4 acres), the Backwater Area (5.2 acres), and Pond Bank (18 acres, including a portion of Wetland 1). Water flows from the Backwater Area to Upper Cobbs Pond and then to Lower Cobbs Pond. The surrounding soil is large enough to support cover and food for riparian birds and mammals that typically inhabit areas of about 1 acre (USEPA 1993). The combined area of 39 acres would represent a small portion of the home range of other wildlife such as duck, wild turkey, and deer. Another way of understanding the habitat is the length of the pond perimeter along which riparian animals feed. The perimeter lengths of Upper Cobbs Pond (3,360 ft), Lower Cobbs Pond (3,630 ft), and Backwater Area (8,870 ft) total 15,860 ft of linear habitat for herons and other aquatic birds and mammals. The 39 acres of habitat at the Upper and Lower Cobbs Ponds AOC represents 0.18% of the 21,683 acres at Camp Ravenna.

The Upper and Lower Cobbs Ponds AOC is currently utilized for recreational purposes, as it contains abundant fish and wildlife. OHARNG uses the ponds for fishing. A picnic area, pavilion, and playground are located approximately 100 ft from the edge of the eastern bank of Upper Cobbs Pond.

7.3.2.2 Evidence of Historical Chemical Contamination

The 1978 Installation Assessment identified the major contaminants of the former RVAAP to be TNT, composition B, sulfates, nitrates, lead styphnate, and lead azide. The assessment identified the pink wastewater and washout of residue, dusts, and spills at Load Lines 3 and 12, which were discharged through surface drainage channels towards Upper Cobbs Pond (USATHAMA 1978), as contaminants. Potential site-specific contaminants include TNT, RDX, HMX, nitrate, nitrocellulose, and heavy metals (i.e., lead, chromium, mercury, and arsenic) from the pink water. Other contaminants identified include washout from explosives melt-out and demilitarization activities at Load Lines 3 and 12 and ammonium nitrate and aluminum chloride from Load Line 12.

The goal of the historical ERA (MKM 2005) was to identify COPECs in surface soil, sediment, and surface water for the Upper and Lower Cobbs Ponds AOC. The historical ERA followed instructions presented in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003) and consisted of the first two of six steps listed in Figure III of the FWERWP (USACE 2003a). These two steps identified the evaluation procedures, which were used to determine AOC-related COPECs. First, the MDC of each chemical was compared to its respective facility-wide background concentration. Chemicals were not considered COPECs if the MDC was below the background concentration. For all chemicals detected above background concentrations, the MDC was compared to an ESV. The hierarchy of screening values was based on the guidance included in the FWERWP and *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). In addition to the ESV comparison, it was determined if the chemical was a persistent, bioaccumulative, and toxic (PBT) compound. For soil, in addition to the PBT determination, chemicals that were bioaccumulative (whether or not they were persistent and toxic as well) were also identified. For sediment, chemicals were also compared with the Ohio SRV. Chemicals were retained as COPECs if they exceeded background concentrations and the ESV, if the chemical exceeded background concentrations and had no toxicity information, or if the chemical was a bioaccumulative or PBT compound.

Groundwater was not included in the historical ERA. As explained in Section 3.2.2 of the FWERWP, groundwater is not considered an exposure medium to ecological receptors because these receptors are unlikely to contact groundwater greater than 5 ft bgs. As discussed in Section 3.4.2, groundwater varies from 5.75–39.75 ft bgs throughout the AOC.

The historical ERA tables for soil, sediment, and surface water are included in Appendix H, Tables H-1 to H-10. The screening tables (Appendix H, Tables H-1 to H-3) contain the following:

- Frequency of detection,
- Average concentration,
- MDC,
- Selected UCL (soil and sediment only),
- Background concentration for each medium (surface soil, sediment, and surface water),
- Comparison of MDC to background concentrations (SRC determination),
- SRVs (sediment only),
- Comparison of MDC to SRVs (sediment only),
- Screening levels (surface soil, sediment, and surface water),
- Comparison of MDC to screening values (HQ, MDC/screening level ratio),
- Bioaccumulative chemical (soil only),
- PBT compound identification,
- COPEC determination, and
- COPEC rationale.

Historical COPECs for Soil

The historical ERA conducted as part of the Phase II RI reported 26 chemicals detected in surface soil (0–1 ft bgs) along the banks of the Upper Cobbs Pond and Lower Cobbs Pond (MKM 2005). A total of 25 chemicals either exceeded background concentrations or did not have an associated background concentration for comparison. Four chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen. A total of 11 inorganic chemicals (aluminum, arsenic, cadmium, chromium, copper, iron, mercury, nickel, silver, vanadium, and zinc) were identified as COPECs because detected concentrations were above ESVs (Table 7-11). Mercury is also a PBT compound. Two other chemicals (nitrocellulose and nitrate) were also identified as COPECs because there were no associated background concentrations or ESVs for comparison. In total, 13 chemicals were identified as COPECs in soil (Table 7-11). Appendix H, Table H-1 presents the historical ecological screening for soil at Upper and Lower Cobbs Ponds AOC.

Historical COPECs for Sediment

The historical ERA conducted as part of the Phase II RI reported 45 chemicals in sediment (MKM 2005). A total of 33 chemicals either exceeded background concentrations and SRVs or did not have an associated background concentration for comparison. Four chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen. A total of 8 inorganic chemicals (arsenic, cadmium, chromium, copper, cyanide, lead, nickel, and silver), 11 organic chemicals [2,6-DNT; anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(ghi)perylene; benzo(k)fluoranthene; chrysene; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; and pyrene], and total PAHs were identified as COPECs because detected concentrations were above ESVs. Two chemicals (mercury and aroclor-1254) are below ESVs, but they are PBT compounds. Five other chemicals (antimony, beryllium, TNT, nitrocellulose, and nitrate) were also identified as COPECs due to a lack of ESV. In total, 27 COPECs were identified in sediment (Table 7-11). Appendix H, Table H-2 presents the historical ecological screening for sediment at the Upper and Lower Cobbs Ponds AOC.

Historical COPECs for Surface Water

The historical ERA conducted as part of the Phase II RI reported 22 chemicals in surface water (MKM 2005). A total of 20 chemicals either exceeded background concentrations or did not have an associated background concentration for comparison. Four chemicals (calcium, magnesium, potassium, and sodium) were essential nutrients and were excluded from the COPEC screen. Four inorganic chemicals (iron, selenium, silver, and sulfide) were identified as COPECs because their detected concentrations were above ESVs. Four other chemicals (acetone, chloromethane, manganese, and sulfate) were also identified as COPECs due to a lack of ESVs. In total, eight chemicals were identified as COPECs in surface water (Table 7-11). Appendix H, Table H-3 presents the historical ecological screening for surface water at the Upper and Lower Cobbs Ponds AOC.

Summary of Historical ERA

As explained previously, a historical SERA was performed to determine COPECs in surface soil, sediment, and surface water at the AOC. The COPECs are summarized in Table 7-11. Based on the identified historical COPECs, and given additional data for current (2010) samples and updated ESVs, ecological risk in surface soil, sediment, and surface water is re-evaluated in this report.

7.3.2.3 Ecological Significance

Sources of data and information about the ecological resources at the AOC include the *Integrated Natural Resource Management Plan* (OHARNG 2014) (herein referred to as the INRMP), FWBWQS (USACE 2005a), previous characterization work (e.g., Phase I and Phase II RIs), and visits to the Upper and Lower Cobbs Ponds AOC conducted for the PBA08 RI.

One of the two key questions to answer in the Level I Scoping ERA is whether there are ecologically important and especially ecologically significant resources at the Upper and Lower Cobbs Ponds AOC. Ecological importance is defined as a place or resource that exhibits unique, special, or other attributes that makes it of great value. Ecological significance is defined as an important resource found at an AOC or in its vicinity that is subject to contaminant exposure. The underlying basis for this distinction can be found in *Ecological Significance and Selection of Candidate Assessment Endpoints* (USEPA 1996a), and is stated as follows:

> "A critical element in the ERA process requires distinguishing important environmental responses to chemical releases from those that are inconsequential to the ecosystem in which the site resides: in other words, determining the ecological significance of past, current, or projected site-related effects."

Important places and resources identified by the Army and Ohio EPA (Appendix H, Table H-11) include wetlands, terrestrial areas used for breeding by large or dense aggregations of animals, habitat known to be used by threatened or endangered species, state land designated for wildlife or game management, locally important ecological places, and state parks. The Army and Ohio EPA recognize 17 important places and resources. The Army recognizes an additional 16 important places (BTAG 2005), and the Ohio EPA recognizes another 6 important places (Ohio EPA 2008). In total, there are 39 important places. Presence or absence of an ecologically important place can be determined by comparing environmental facts and characteristics of the AOC with each of the important places and resources listed in Appendix H, Table H-11.

Presence of an important ecological resource or place and proximity to contamination at an AOC makes a resource ecologically significant. Thus, any important places and resources listed in Appendix H, Table H-11 are elevated to ecologically significant when present on the AOC and there is exposure to contaminants. For all 39 important places and resources, it is relatively clear the ecological place or resource is present or absent on the AOC; therefore, the decision process is objective. If no important or significant resource is present at an AOC, the evaluation will not proceed to Level II regardless of the presence of contamination. Instead, the Level I Scoping ERA would acknowledge that there are important ecological places but that those resources are not ecologically significant, and no further evaluation is required.

Management Goals for the AOC

Regardless of whether the evaluation is concluded at Level I or continues to Level II, there is another level of environmental protection for the AOC through the natural resource management goals expressed in the INRMP (OHARNG 2014). OHARNG manages the ecological and natural resources at Camp Ravenna to maintain or enhance the current integrity of the natural resources and ecosystems at the facility. Natural resource monitoring and management activities in place at Camp Ravenna may also be applicable to any degradation noted from contamination.

Some natural resources management goals of OHARNG (listed in Appendix H, Table H-12) benefit the AOC. For example, Goal 1 states the natural resources need to be managed in a compatible way with the military mission, and Goal 5 requires the Army to sustain usable training lands and native natural resources by implementing a natural resource management plan that incorporates invasive species management and by utilizing native species mixes for revegetation after ground disturbance activities. These management goals help detect degradation (whether from training activities or historical contamination). While the applicability of the remaining 10 management goals to the Upper and Lower Cobbs Ponds AOC varies, all of the management goals are intended to monitor, maintain, or enhance the facility's natural resources and ecosystem. While these goals are for managing all types of resources at and near the AOC, they do not affect decisions concerning the presence or absence of important or significant ecological places or resources at the AOC.

Important Places and Resources

Ecological importance means a place or resource that exhibits a unique, special, or other attribute that makes it of great value. Examples of important places and resources include wetlands, terrestrial areas used for breeding by large or dense aggregations of animals, and habitat of state- or federally-listed species. An important resource becomes significant when found on an AOC and there is contaminant exposure. The ponds and wetlands are important/significant ecological resources at the AOC. In addition, the Least Bittern (*Ixobrychus exilis*), which is a state of Ohio threatened species, uses the AOC and nests or resides at Camp Ravenna; the Least Bittern (*Ixobrychus exilis*) and its habitat at the AOC are important/significant ecological resources.

Terrestrial Resources

The habitat area for the Upper and Lower Cobbs Ponds AOC contains terrestrial and aquatic resources in approximately equal amounts (Figure 7-1). There are approximately 18 acres of terrestrial resources surrounding the ponds, Backwater Area, and other wetlands identified in Figure 7-1. A small portion of the 18 acres includes Wetland 1. The terrestrial habitat is described below.

Habitat Descriptions and Species. SAIC scientists conducted a field survey at the AOC in May 2010 and confirmed that terrestrial vegetation habitat surrounding the ponds consists of four forest community types, one shrub community type, and three herbaceous community types (Figure 7-1). The dominant forest community at the AOC is the red maple (*Acer rubrum)* successional forest. This community surrounds nearly all of Lower Cobbs Pond and a large portion of Upper Cobbs Pond. Other forest communities present include a small area of green ash (*Fraxinus pennsylvanica),* American elm (*Ulmus americana*), and hackberry (*Celtis occidentalis* and *laevigata*) temporarily flooded forest alliance at the extreme northern end of Lower Cobbs Pond. At Upper Cobbs Pond, other forest communities include small areas of mixed, needle-leaved evergreen, cold-deciduous forest dominated by Norway spruce (*Picea abies*) and red maple and mixed, cold-deciduous, hardwood forest dominated by white ash (*Fraxinus americana*), wild black cherry (*Prunus serotina*), red maple, black locust (*Robinia pseudoacacia*), quaking aspen (*Populus tremuloides*), and bigtooth aspen (*Populus grandidentata*).

Dry, mid-successional, cold-deciduous shrubland habitat (SU1) occurs on both sides of Upper Cobbs Pond and includes various willows (*Salix* spp.), gray dogwood (*Cornus racemosa*), autumn olive (*Elaeagnus umbellata*), blackberry (*Rubus allegheniensis*), hawthorn (*Crataegus* spp.), and multiflora rose (*Rosa multiflora*).

Herbaceous communities at the AOC include dry, early-successional field; intermittently flooded, early-successional field; and permanently flooded, herbaceous alliance. Dry, early-successional field is an upland habitat largely maintained by routine periodic disturbance (e.g., mowing). Dominant plants include an assortment of grasses, forbs, and seedlings of trees and shrubs. Common species include several species of goldenrod (*Solidago* spp.), clasping-leaf dogbane (*Apocynum cannabinum*), yarrow (*Achillea millefolium*), gray dogwood (*Cornus racemosa*), blackberry (*Rubus allegheniensis*), autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*). The intermittently flooded, early-successional field habitat is dominated by nearly pure stands of narrow-leaf cattail (*Typha angustifolia*) and broad-leaf (*Typha latifolia*) cattail, with various sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), and broad-leaf wetland plants as associate species. The permanently flooded herbaceous alliance is dominated by submerged aquatic plants such as spatterdock (*Nuphar lutea*) and white water lily (*Nymphaea odorata*).

Terrestrial habitat at the AOC includes a diverse mixture of forest, shrubland, and herbaceous communities. The habitats provide cover and food for numerous birds and mammals that typically inhabit areas of about 1 acre (USEPA 1993) as well as animals with much larger home ranges, such as wild turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*).

Based on August 2008 observations (Photographs 7-1 and 7-2), SAIC scientists assessed the terrestrial habitat at the ponds to be healthy and functioning. Functional habitat was determined by noting the absence of large bare spots and dead vegetation or other obvious visual signs of an unhealthy ecosystem. Additional habitat photographs are provided in Appendix H.

Threatened, Endangered, and Other State- or Federally-Listed Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed wildlife species and no critical habitat on Camp Ravenna. The Upper and Lower Cobbs Ponds AOC has not been previously surveyed for rare, threatened, or endangered species; however, there has been one sighting of a state-threatened species at the AOC—the Least Bittern (*Ixobrychus exilis*) (OHARNG 2014).

Other Terrestrial Resources. While there are no other known important terrestrial places and resources, there are other resources at or near the AOC (e.g., vegetation, animals) that interact in their ecosystems and support nutrient cycling and energy flow. For example, wildlife such as wild turkey and white-tailed deer could use the area. The INRMP provides information about species and habitat surveys at Camp Ravenna (e.g., timber and ecological succession) (OHARNG 2014). There are no other reported surveys of habitats and wildlife at the AOC beyond those summarized in the INRMP (OHARNG 2014).

Aquatic Resources

Aquatic habitats make up approximately 50% of the AOC. There are two types of aquatic resources at the Upper and Lower Cobbs Ponds AOC: ponds and wetlands.

Habitat Descriptions and Species. Ponds are the dominant aquatic habitat at the AOC (Figure 7-2). Upper Cobbs Pond (9.4 acres; Photograph 7-1), Lower Cobbs Pond (6.4 acres; Photograph 7-2), and the Backwater Area (5.2 acres) comprise 21 acres. The ponds support a variety of aquatic animals (e.g., fish, turtles, frogs) and semi-aquatic wildlife, such as waterfowl (e.g., ducks and geese) and wading birds (e.g., great blue heron).

Wetlands. Wetlands are important resources with water-saturated soil or sediment and plant life that can survive saturation. Wetlands are home to many different species and are also chemical sinks that can serve as detoxifiers and natural water purifiers. It is expected the wetlands at the AOC perform these and other related functions.

There are planning level survey [i.e., based on desktop surveys conducted for OHARNG of wetland data and resources (e.g., National Wetland Inventory maps, aerials)] wetlands and wetland complexes at the AOC (Figure 7-2). These wetlands include a small area around the Lower Cobbs Pond outlet (Wetland 1), fringe areas around the shoreline, shallow coves and embayments, and floodplains of larger tributaries associated with the Backwater Area (Wetlands 2 and 3). No jurisdictional wetlands determination has been conducted at this AOC. For any wetland at the AOC potentially affected by remedial activities, a jurisdictional determination by USACE would be required to determine the regulatory status.

Photograph 7-1. Upper Cobbs Pond on August 12, 2008
(looking south from the access road and dam between the two ponds)

Photograph 7-2. Lower Cobbs Pond on August 12, 2008
(looking northeast from the access road and dam between the two ponds)

An SAIC Professional Wetland Scientist used the Ohio Rapid Assessment Method (ORAM) (Ohio EPA 2001) in May 2010 to assess the condition of the wetland complex discussed above and to determine its potential ecological importance (Appendix H, Figures H-1 through H-3).

Using the ORAM, wetlands are classified into three categories:

- Category 1 wetlands are described as "limited quality waters." They are considered to be a resource that has been degraded, has limited potential for restoration, or is of such low functionality that lower standards for avoidance, minimization, and mitigation can be applied. Scores range from 1–29.
- Category 2 includes wetlands of moderate quality and wetlands that are degraded but exhibit reasonable potential for restoration. Scores range from 30–59.
- Category 3 includes wetlands of very high quality and wetlands of concern regionally and/or statewide, such as wetlands that provide habitat for species listed as threatened or endangered. Scores range from 60–100.

The field sheets detailing the ORAM evaluations at the Upper and Lower Cobbs Ponds AOC are presented in Appendix H, Figures H-1 through H-3. Figure 7-2 shows the locations of the wetlands at the AOC. Wetlands were consolidated into the following three groups for ORAM evaluations (Table 7-12). Wetland 1 is a small, forested wetland associated with the drainage channel below the Lower Cobbs Pond dam on the west side of Paris-Windham Road; its total size is 0.34 acres, with 0.17 acres inside the AOC. Wetland 2 is a wetland complex consisting of several small- and medium-sized wetland habitat types in the northern half of the Backwater Area between Track 33 and Track FA; its total size is 4.75 acres, with 3.60 acres inside the AOC. Wetland 3 is a wetland complex consisting of several small- and medium-sized wetland habitat types in the southern half of the Backwater Area, south of Track FA; its total size is 4.62 acres, with 3.90 acres inside the AOC. Wetland 3 includes portions of the drainage ditches from Load Lines 3 and 12.

Threatened and Endangered and Other State- or Federally-listed Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed wildlife species and no critical habitat on Camp Ravenna. The Upper and Lower Cobbs Ponds AOC has not been previously surveyed for rare, threatened, or endangered species; however, there has been one sighting of a state-threatened species at the AOC—the Least Bittern (*Ixobrychus exilis*) (OHARNG 2014).

Other Aquatic Resources. There are no other known aquatic resources (e.g., vegetation, animals) at or near the AOC (Appendix H, Table H-11). There are no other reported surveys of aquatic habitats and wildlife at the AOC beyond those summarized in the INRMP (OHARNG 2014). There are three nearby biological and water quality stations. The following subsections provide a summary of the biological/water quality stations in the vicinity of the Upper and Lower Cobbs Ponds AOC.

Biological/Water Quality Sampling Stations. Ohio EPA and USACE investigated 11 ponds and several streams at Camp Ravenna using a network of biological/water quality sampling stations (USACE 2005a). The purpose of the investigation was to document ecological effects of contamination at AOCs on stream or pond biota and conditions. One stream sampling location (S-8) is in the vicinity of the AOC. Sampling Station S-8 (River Mile 0.1) is located on an unnamed tributary downgradient and northwest of Lower Cobbs Pond (Figure 7-1) and provides information about potential contamination from the Upper and Lower Cobbs Ponds AOC and other upgradient AOCs (e.g., Load Lines 3 and 12). The station is located about 350 ft upstream from the confluence with Sand Creek. If the S-8 sampling station has a positive rating (e.g., good, excellent, full attainment, and other positive terms reported in the study), it means that the Upper and Lower Cobbs Ponds AOC and other upstream AOCs are not adversely impacting the quality of Sand Creek. In addition, both Upper Cobbs Pond and Lower Cobbs Pond were sampled under this program.

According to the FWBWQS (USACE 2005a), each sampling station included a sediment sampling/assessment, surface water sampling/assessment, fish and macroinvertebrate community assessment, and habitat assessment. The sampling reach for stream sampling stations ranged 120–210 meters.

Sediment evaluations were conducted in June 2003 using guidelines established in the *Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al. 2000), SRVs for inorganic chemicals (Ohio EPA 2003), and USEPA Region 5 ecological screening levels (ESLs) (USEPA 2003b). Sediment samples were analyzed for SVOCs, pesticides, PCBs, TAL metals, explosives, percent solids, cyanide, ammonia, nitrate, and phosphorus. Surface water grab samples collected in June, August, and September 2003 were evaluated by being compared to Ohio WQS criteria, reference conditions, or those conditions cited in the FWBWQS (USACE 2005a). Surface water samples were analyzed for TAL metals, pesticides, PCBs, explosives, SVOCs, and several nutrients.

The fish and macroinvertebrate sampling and assessment at stream locations occurred in August and September 2003, while pond sampling occurred between June and August 2003. Fish were sampled using electrofishing methods. Macroinvertebrate communities were assessed using artificial substrates (quantitative sampling) supplemented with a composite natural substrate sample (qualitative sampling). Both the fish and macroinvertebrate community assessments followed the methods contained in the *Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (Ohio EPA 1989). Funnel traps designed to collect any amphibians, fish, or macroinvertebrates that swim or crawl into the funnel openings were used to assess macroinvertebrate communities in the ponds (Ohio EPA 2002b). Laboratory analysis of the funnel trap macroinvertebrate samples followed standardized Ohio EPA procedures (Ohio EPA 1989).

Community Similarity Index (CSI) values were used to determine impairment of the fish and macroinvertebrate communities contained in the ponds. For fish, CSI values were calculated based on fish relative abundance and relative biomass, and a pond-by-pond comparison was made. Eight ponds at Camp Ravenna were sampled, with three of them being reference ponds. For macroinvertebrates, CSI values were calculated based on the presence of macroinvertebrate taxa in the artificial substrate/qualitative samples (Hester Dendy sampling) and abundance of macroinvertebrates in funnel trap samples. Using the CSI method, ponds with identical composition would have a value of 1 and those with no similarity at all would have a value of 0. Comparisons with values of 0.65 or greater were regarded as having strong resemblances, a criterion used previously by Hanson (1955), Beckett (1978), and Ohio EPA (1981).

The physical habitat assessment for stream locations was conducted in June 2003 and used the Qualitative Habitat Evaluation Index (QHEI) developed by Ohio EPA (Rankin 1989, 1995). The types(s) and quality of substrates; amount and quality of instream cover; channel morphology; and extent and quality of riparian vegetation, pool, run, riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score. Pond habitat assessments were conducted between June and August 2003 and used the Lake Erie shoreline Qualitative Habitat Evaluation Index (L-QHEI) developed by the Ohio EPA (Ohio EPA 2002a). The types(s) and quality of substrates, amount and quality of cover types, shoreline morphology, extent and quality of riparian vegetation, and aquatic vegetation are habitat characteristics used to determine the L-QHEI score.

Summary of Station S-8 Sampling/Assessment Results. Data from S-8 (USACE 2005a) showed many positive attribute ratings (e.g., good, excellent, full attainment) and no sign of aquatic impairment, and the station was rated at Full Use Attainment Status, which indicates that all indices met Ohio EPA biological criteria.

At S-8, all inorganic chemicals tested in sediment were below Ohio SRVs and TEC levels. All tested explosives and PCBs were not detected in sediment samples from S-8. The few detected pesticides and SVOCs were measured at low levels, with all concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at S-8 exceeded Ohio WQS aquatic life maximum or average water quality criteria (WQC), and none of the chemicals measured exceeded criteria protective of the warmwater habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at S-8 were rated “excellent.” The fish community at S-8 was rated “very good.” The index of biotic integrity score was 48, and nine species were reported. The macroinvertebrate community at S-8 was rated “good.” The QHEI score was 61.0, indicating a “good” stream habitat capable of supporting warmwater habitat biological communities.

Summary of Pond Sampling/Assessment Results. Review of the data from the ponds (USACE 2005a) indicates the biological communities of the two ponds are not currently affected by activities that occurred at Load Line 12 and other nearby AOCs.

At Upper Cobbs Pond, all inorganic chemicals tested in sediment were near or below Ohio SRVs. Silver, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate were measured above ESLs, and zinc was above the TEC. All tested explosives, pesticides, and PCBs were not detected in sediment samples collected from Upper Cobbs Pond. Ammonia and total phosphorus levels were measured below screening guidelines. One explosive compound (4-amino-2,6-DNT) was detected in the surface water of Upper Cobbs Pond, but the measurement was below the Ohio WQS aquatic life maximum and average WQC. Lead and pH were the only parameters that were not within the aquatic life outside mixing zone average (OMZA) criteria (USACE 2005a). Overall, the sediment quality and water quality in Upper Cobbs Pond was of sufficient quality to not adversely impact the biological community (USACE 2005a).

Fish abundance similarity index values revealed a strong resemblance (CSI greater than or equal to 0.65) of Upper Cobbs Pond to Lower Cobbs Pond, Fuze and Booster Ponds, and two reference ponds (Frank’s Pond and Route 80 Trout Pond located along Hinkley Creek). Stronger similarities were observed based on fish biomass. Similarity index values based on abundance of macroinvertebrates in funnel trap samples were highly variable, and it is difficult to make generalizations about the similarity of Upper Cobbs Pond to the other ponds due to the dominance of a few macroinvertebrate taxa. Similarity index values based on the presence of macroinvertebrate species at an AOC were not as variable as the abundance data. Upper Cobbs Pond was most similar to Lower Cobbs Pond and the Load Line 4 Pond. The most similar reference pond for macroinvertebrates was Franks Pond (Hester Dendy CSI of 0.57).

The physical habitat was also evaluated at Upper Cobbs Pond, and the L-QHEI score was 43, indicating “poor” habitat quality. This was primarily due to excessive amounts of undesirable species (or low amounts of preferred species) and bottom substrates dominated by muck.

At Lower Cobbs Pond, three inorganic chemicals (cadmium, copper, and zinc) were above the Ohio SRVs and TEC levels. Chromium was measured above the PEC, a level above which harmful effects to aquatic biota could potentially occur. Silver was above the ESL and SRV. Arsenic and nickel were above TEC levels but below the SRV. All other inorganic chemicals, tested explosives, pesticides, PCBs, and SVOCs were low (below TEC or ESL) or not detected in sediment samples collected from Lower Cobbs Pond. Ammonia and total phosphorus levels were measured below screening guidelines. One explosive compound (4-amino-2,6-DNT) was detected in the surface water of Lower Cobbs Pond but the measurement was below the Ohio WQS aquatic life maximum and average WQC. Lead and pH were the only parameters that were not within the aquatic life OMZA criteria. At Lower Cobbs Pond, only chromium in sediment exceeded the PEC; surface water quality did not appear to impact the biological community (USACE 2005a).

Fish abundance similarity index values revealed a strong resemblance of Lower Cobbs Pond to Upper Cobbs Pond, Fuze and Booster Ponds, and two reference ponds (Frank’s Pond and Trout Pond). Stronger similarities were observed based on fish biomass. Similarity index values based on abundance of macroinvertebrates in funnel trap samples were highly variable, and it is difficult to make generalizations about the similarity of Lower Cobbs Pond to the other ponds due to the dominance of a few macroinvertebrate taxa. However, Lower Cobbs Pond had a strong resemblance to Boy Scout Pond, which is a 3.4-acre pond that resulted from an old concrete dam across from Eagle Creek and west of Wadsworth Road. Similarity index values based on the presence of macroinvertebrate species at an AOC were not as variable as the abundance data, and Lower Cobbs Pond was most similar to Upper Cobbs Pond and Load Line 4 Pond. The most similar reference pond for macroinvertebrates was Trout Pond (Hester Dendy CSI of 0.54).

The physical habitat was also evaluated at Lower Cobbs Pond, and the L-QHEI score was 42.5, indicating “poor” habitat quality. This was primarily due to excessive amounts of undesirable species (or low amounts of preferred species) and bottom substrates dominated by muck.

Overall, the data collected indicate Upper Cobbs Pond and Lower Cobbs Pond are not currently affected by activities that occurred at the former RVAAP when it was in operation, as stated in the conclusions for all ponds in the study (USACE 2005a):

> “Upper Cobbs Pond [is] not currently affected by activities that occurred at RVAAP when it [was] in operation. Biological conditions at [Upper Cobbs Pond] were comparable to reference ponds, sediment chemicals were below benchmark levels, and surface water quality was consistent with reference conditions and/or below surface WQC. Biological communities in Lower Cobbs Pond…were not affected by chemical exposures from past activities at RVAAP. Fish communities from [Lower Cobbs Pond] were strongly similar to reference ponds. Poor quality vegetative cover in [Lower Cobbs Pond] influenced macroinvertebrate results. Surface water quality was consistent with reference conditions and/or below WQC. Although sediment quality (lead, zinc, or chromium) suggest[s] the potential for negative impacts, aquatic results confirmed conditions comparable to reference ponds.”

Ecosystem and Landscape Roles and Relationships

There were four spatial areas evaluated to assess the ecosystem and landscape roles and relationships at the Upper and Lower Cobbs Ponds AOC: the actual AOC, the vicinity of the AOC, the entire Camp Ravenna, and the ecoregion of northeastern Ohio. Information about the first spatial area (the AOC) is provided in the terrestrial and aquatic resources subsections above.

Vicinity of the AOC. The same vegetation types previously described at the AOC occur to the east, south, west, and north of AOC for many hundreds of feet. These forest, shrub, and herb communities are not unique and are in abundance at Camp Ravenna. The quality of the forest and other habitats appears to be typical of forests at other places at Camp Ravenna and the northeastern Ohio ecoregion. Thus, the type and quality of forest, shrub, and herbaceous habitats are not unique.

As discussed previously, there are several wetlands inside the AOC (Table 7-12). There are many other wetlands of various sizes located near the east, north, west, and south boundaries of the habitat area (e.g., the wetland complex associated with the Load Line 12 ditch southwest of the AOC) (Table 7-13).

One state-threatened bird, the Least Bittern (*Ixobrychus exilis*), has been observed at the AOC (OHARNG 2014). The closest recorded state- or federally-listed species outside the habitat boundary is the state-endangered yellow-bellied sapsucker (*S. varius*) (located within 500 ft of the southern end of the AOC and about 1,700 ft of the northern end of the AOC). The butternut tree (*Juglans cinerea*) is a federal species of concern located at the Paris-Windham Dump about 2,200 ft north of the AOC (OHARNG 2014) (Table 7-13).

There are three beaver dams in or near the AOC (Figure 7-1). There is a 100-year floodplain along Sand Creek, near the northwestern corner of the AOC. There are biological and water quality stations within 900 ft of the AOC (Table 7-13).

The Entire Camp Ravenna. The AOC is approximately 39 acres, which represents 0.18% of the total area of Camp Ravenna (21,683 acres). There are approximately 2,310 acres of forest type FL1 [temporarily flooded forest alliance (e.g., green ash and American elm)] at Camp Ravenna (OHARNG 2014); this represents 10.7% of the habitat at Camp Ravenna. There are approximately 3,500 acres of forest type FU4 (red maple and green/red ash) (OHARNG 2014), representing 16.1% of the habitat at Camp Ravenna. There are approximately 2,050 acres of vegetation type HU1 (goldenrod and clasping-leaf dogbane) (OHARNG 2014), representing 9.5% of the habitat at Camp Ravenna. There are approximately 169 acres of vegetation type HL4 (cattail and bulrush) (OHARNG 2014), representing 0.78% of the habitat at Camp Ravenna. There are approximately 79 acres of vegetation type HL5 (spatterdock and white water lily) (OHARNG 2014), representing 0.36% of the habitat at Camp Ravenna. There are approximately 136 acres of vegetation type MFU2 (Norway spruce, white ash, and red maple) (OHARNG 2014), representing 0.63% of the habitat at Camp Ravenna. There are approximately 2,900 acres of vegetation type SU1 (gray dogwood and northern arrowwood) (OHARNG 2014), representing 13.4% of the habitat at Camp Ravenna. There are approximately 1,970 acres of wetlands (jurisdictional and planning level survey) as defined in the INRMP (OHARNG 2014), representing 9.1% of the habitat at Camp Ravenna. Most of these types of resources are abundant and are not unique to the Upper and Lower Cobbs Ponds AOC at Camp Ravenna. HL5 occupies a small area at the AOC and represents an especially small percentage of the entire Camp Ravenna.

Ecoregion. In the area surrounding Camp Ravenna, forests occupy a high percentage of the terrain. Ohio's forests cover approximately 8,000,000 acres or 30% of the state (USDA 2009). The Erie/Ontario Drift and Lake Plain ecoregions (USGS 1998) are located in the northeastern part of Ohio, and both contain communities of temporarily flooded forest alliance (e.g., green ash and American elm); red maple successional forest; herbaceous field (e.g., goldenrod and dogbane); semi-permanently flooded herbaceous alliance (e.g., cattail and bulrush); permanently flooded herbaceous alliance (e.g., spatterdock and white water lily); mixed, needle-leaved evergreen, cold-deciduous forest (Norway spruce and red maple); and dry, mid-successional, cold-deciduous shrubland (e.g., dogwood and arrowwood). The Erie/Ontario Drift and Lake Plain ecoregion exhibit rolling to level terrain formed by lacustrine and low lime drift deposits. Lakes, wetlands, and swampy streams occur where stream networks converge or where the land is flat and clayey (USGS 1998). The U.S. Forest Service has a Forest Inventory Data Online tool that was queried for the forest types in the surrounding counties in or near Camp Ravenna (USFS 2011). In 2009, approximately 93,900 acres of forest type FL1; 265,290 acres of forest type FU4; and approximately 367,200 acres of forest type MFU2 were found throughout northwestern Ohio in Cuyahoga, Geauga, Mahoning, Portage, Stark, Summit, and Trumbull counties that surround Camp Ravenna (USFS 2011). The herbaceous fields and shrubland were not individually found in this query because they are not classified as a main group of trees in the forest inventory data tool. However, herbaceous fields (HU1 and HL4) and shrubland (SU1) are common across the ecoregion (USDA 2011). Wetlands across the ecoregion make up 207,800 acres (USEPA 1999a). The vegetation and wetland communities at the Upper and Lower Cobbs Ponds AOC are also found in the surrounding counties in the ecoregion of northeastern Ohio.

In summary, the current vegetation types found in the vicinity of the AOC consist of: (1) temporarily flooded forest alliance (e.g., green ash and American elm); (2) red maple forest alliance; (3) dry, early-successional, herbaceous field (e.g., golden rod and dogbane); (4) semi-permanently flooded herbaceous alliance (e.g., cattail and bulrush); (5) permanently flooded herbaceous alliance (e.g., spatterdock and white water lily); (6) mixed, needle-leaved evergreen, cold-deciduous forest (e.g., Norway spruce and red maple); (7) dry, mid-successional, cold-deciduous shrubland (e.g., dogwood and arrowwood); and wetlands. The forest types, herbaceous fields, shrubland, and wetlands are in abundance at Camp Ravenna and the larger surrounding local ecoregion. There is no known unique resource at the AOC that cannot be found in the immediate vicinity of the AOC, Camp Ravenna, and in the large part of the ecoregion of northeastern Ohio. The forest types, herbaceous fields, shrubland, and wetlands are in abundance at Camp Ravenna (with the exception of HL5) and the larger surrounding local ecoregion. There is one known unique resource (HL5) at the AOC that is not common in the immediate vicinity of the AOC, is not frequently found at Camp Ravenna, and is not believed to be common to the ecoregion of northeastern Ohio.

7.3.2.4 Evaluation of Historical Chemical Contamination and Ecological Significance

There were 13 surface soil, 27 sediment, and 8 surface water COPECs identified in the historical SERA as part of the Phase II RI (Table 7-11).

The Army and Ohio EPA provide a checklist of important ecological places and resources to determine if such ecological resources are present in an AOC and/or nearby. The ponds and wetlands are important/significant ecological resources. In addition, the Least Bittern (*Ixobrychus exilis*), a state of Ohio threatened species, has been observed at the AOC. OHARNG environmental management goals and objectives, including Goal 1 that requires natural resources management to be compatible with military mission and Goal 5 that requires the Army to sustain usable training lands and native natural resources by implementing a natural resource management plan that incorporates invasive species management and by utilizing native species mixes for revegetation after ground disturbance activities, are applicable to the AOC.

The AOC is approximately 39 acres and includes Upper Cobbs Pond (9.4 acres), Lower Cobbs Pond (6.4 acres), the Backwater Area (5.2 acres), and the Pond Bank (18 acres, including a portion of Wetland 1). The terrestrial vegetation habitat at the AOC consists of four forest community types, one shrub community type, and three herbaceous community types. The dominant forest community at the AOC is the red maple (*A. rubrum)* successional forest. Wetlands are associated with the Backwater Area and Lower Cobbs Pond. The vegetation types and wetlands at the AOC are found nearby, at Camp Ravenna, and in the ecoregion.

Because there is contamination and important or ecologically significant resources at the AOC, this ERA will continue to a Level II Screening Level ERA.

7.3.3 Level II: Screening Level Ecological Risk Assessment

The Level II method follows the guidance documents listed in Section 7.3.1 and identifies evaluation procedures used for problem formulation and ecological effects evaluation to determine AOC-related COPECs. This work includes defining habitats/environmental setting, suspected contaminants, possible pathways, and mechanisms for ecotoxicity and contaminant transport. Level II also includes establishing screening values.

In addition, technical and refinement factors can be used to assess outcomes of the above procedures. The factors include using mean exposure concentrations and discussing approved ESVs, wetland quality at the AOC, and other topics that evaluate and refine the COPECs from the Level II Screening ERA. This type of assessment is called Step 3A in the ERA process (USEPA 1997).

7.3.3.1 Generic Ecological Conceptual Exposure Model

The conceptual site exposure model (CSEM) identifies the interconnections of contaminant sources and transport mechanisms for contaminant migration through the environment to the receptors. The CSEM provides an understanding of the relationships of all sources, release and transport pathways, potential exposure media, and receptors. The CSEM includes:

- **Source Media.** Based on historical AOC information, operations associated with various load lines upstream of the AOC (e.g., former buildings at Load Line 12) are the contaminant source to the surrounding soil, sediment, and surface water (MKM 2005).
- **Transport Mechanisms.** Contaminants in soil, sediment, surface water, and/or groundwater can migrate via erosion and leaching. Migration to sediment and surface water via erosion is controlled by the amount of precipitation, type of ground cover, and topography of the AOC. Although parts of the land are relatively sloped, little erosion is expected to occur at the AOC. The slopes and pond banks are extensively vegetated. This will help increase infiltration and decrease erosion. While some of the precipitation landing on this area is expected to infiltrate the soil, some rainfall will leave the AOC as runoff into the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond and eventually into the unnamed tributary of Sand Creek.
- **Exposure Media.** Exposure media are media where contaminants are available for exposure to ecological receptors. Potential exposure media at the AOC are sediment, surface water, soil, vegetation, animals, and groundwater.
- **Exposure Pathways.** A main exposure pathway is ingesting contaminated food. Other pathways may include ingesting soil, sediment, and water and dermal contact by receptors with soil, sediment, or water.
- **Ecological Receptors.** A variety of ecological receptors, such as terrestrial birds and mammals, are present in the area. Receptors associated with various published toxicological endpoints (e.g., reproduction, physiology) are assumed to represent these various plants and animals.

7.3.3.2 Habitats and Species (Including Generic Receptors)

Habitats and species were defined in the Level I ERA (Section 7.3.2). For example, the terrestrial vegetation habitat at the ponds consists of four forest community types, one shrub community type, and three herbaceous community types. Habitats, species, and other resources were analyzed, and it was determined that important or significant ecological resources are present at the Upper and Lower Cobbs Ponds AOC and vicinity. The Backwater Area, Upper Cobbs Pond, Lower Cobbs Pond, associated wetlands, and the state-threatened Least Bittern (*Ixobrychus exilis*) are present at the AOC. Contamination is present; therefore, a Level II analysis is needed. Level II assumes ecological receptors are sensitive to various chemicals based on a variety of toxicological data from field-observed effects and laboratory tests. The ESV is utilized as a toxicity metric representing multiple generic receptors, including plants, microorganisms, and animals.

7.3.3.3 Procedure to Identify COPECs

The screening level approach to evaluate sample results from the PBA08 RI followed a similar approach used in the historical SERA. Section 5.0 details chemical concentration data. This ERA uses current soil, sediment, and surface water data collected during the PBA08 RI, as well as previously collected data used in the historical SERA and sediment and surface water data collected during the FWBWQS (USACE 2005a). The PBA08 RI included surface soil (0–1 ft bgs) and subsurface soil samples collected from the Pond Banks and discrete sediment and surface water samples from the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Some locations were different from the historical sample locations and some were co-located with previous samples.

As discussed previously, sediment and surface water data were aggregated into three EUs: the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. The soil surrounding the ponds was evaluated as one aggregate. This ERA uses updated SRVs (Appendix H, Table H-13) and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008), as provided in Appendix H, Tables H-14 through H-16.

The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003a). The MDC of each chemical is compared to its respective facility-wide background concentration. Sediment concentrations are also compared to the SRV. Chemicals are not considered site-related if the MDC is below the background concentration. For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV (and SRVs for sediment if an ESV is not available). In addition to the ESV comparison, it was determined if the chemical is a PBT compound. Chemicals are retained as COPECs if they exceed background concentrations (and SRVs for sediment) and the ESV, if the chemical exceeds background concentrations (and SRVs for sediment) and had no toxicity information, or if the chemical is considered a PBT compound. MDC to ESV ratios are used to determine the integrated COPECs that result from the combined current and historical data sets. A ratio greater than one suggests a possible environmental consequence. Any chemicals with ratios greater than one are identified as integrated COPECs.

Based on comment resolution with Ohio EPA in July 2014, the selection of integrated COPECs for surface water was modified to include two screens. Along with comparing the MDC to the Ohio EPA outside mixing zone maximum (OMZM) ESV, when available, Ohio EPA requested the MDC and average concentrations also be compared to the Ohio EPA OMZA ESV at each EU when available.

Maximum Detected Concentrations

The MDCs were compared to background concentrations and ESVs (Appendix H, Tables H-17 through H-28) for each detected chemical. These comparisons are provided in Appendix H, Table H-17 for surface soil; Tables H-18 through H-22 for discrete and ISM sediment; and Tables H-23 through H-28 for surface water.

Ecological Screening Values

Although the historical SERA used ESVs from the 2003 version of the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003), this ERA uses updated ESVs from the 2008 version of this guidance document (Ohio EPA 2008). The hierarchy for soil is ecological soil screening levels (EcoSSLs), PRGs, and ESLs. The hierarchy for sediment is the Sediment Quality Guidelines, followed by ESLs. The hierarchy for surface water is the Ohio EPA WQC, National Recommended Water Quality Criteria, and ESLs. Appendix H provides values and sources for ESVs in Tables H-14 through H-16.

7.3.3.4 Integrated COPECs for Soil (0-1 ft bgs)

Historical and PBA08 RI surface soil (0–1 ft bgs) data were evaluated as a single aggregate to determine integrated COPECs. During the evaluation, 44 chemicals were detected in surface soil. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 17 inorganic chemicals and 18 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 35 SRCs, only 8 chemicals (aluminum, arsenic, cadmium, cobalt, lead, mercury, vanadium, and zinc) exceeded the ESVs and were identified as integrated COPECs (Table 7-14). In addition, three other chemicals (nitrate/nitrite, nitrocellulose, and benzoic acid) were selected as COPECs because they do not have an ESV. Beta-BHC is below its ESV, but it is included because it is a PBT compound (Ohio EPA 2008). Mercury is also a PBT compound. In total, 12 chemicals were identified as integrated COPECs in soil (Table 7-14). The calculated ratio of MDC to ESV is shown in Table 7-14 for each integrated COPEC. Appendix H, Table H-17 presents the details of the ESV comparisons for surface soil.

Most of the surface soil COPECs reported in the historical SERA (Table 7-11) are also identified in the current ERA. The earlier work (Phase II RI) identified five COPECs (chromium, copper, iron, nickel, and silver) that are not integrated COPECs. Chromium, copper, nickel, and silver were below the new ESVs (Ohio EPA 2008, Appendix H, Table H-14), and iron was considered an essential nutrient in the new data set. Four new integrated COPECs (cobalt, lead, benzoic acid, and beta-BHC) are identified in the PBA08 RI. The addition of cobalt and lead are due to both being detected at concentrations higher than the updated, more conservative ESV. Benzoic acid is a new integrated COPEC because it was detected in a sample collected during the PBA08 RI, and it lacks a screening value. The pesticide beta-BHC was not identified as a PBT compound in the historical investigation, but it is in the PBA08 RI per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008); therefore, it is an integrated COPEC. Based on the presence of 12 integrated COPECs, this ERA predicts the potential for ecological risk in surface soil.

7.3.3.5 Integrated COPECs for Sediment

Historical and PBA08 RI discrete sediment data were evaluated as three EUs: the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. ISM sediment data from the FWBWQS (USACE 2005a) was available for two of the three EUs (Upper Cobbs Pond and Lower Cobbs Pond) and was evaluated separately from the discrete samples for each EU. Sediment SRVs and ESVs are published in Appendix H, Tables H-13 and H-15, respectively. Detected chemical concentrations were compared to the sediment background concentrations, SRVs, and ESVs (Appendix H, Tables H-18 through H-22), and the results are summarized in Tables 7-16 through 7-18. Five of the chemicals at each EU (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A summary of the integrated COPECs identified in sediment in the three sediment EUs follows.

Integrated COPECs for Sediment at the Backwater Area

At the Backwater Area, 35 of 47 chemicals detected in discrete sediment were identified as SRCs because they either exceeded background concentrations or were organic chemicals with no background concentrations (Appendix H, Table H-18). Of the 35 SRCs, 21 integrated COPECs [cadmium; chromium; copper; cyanide; silver; 2,6-DNT; anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(ghi)perylene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; fluoranthene; indeno(1,2,3-cd)pyrene; lead; nickel; phenanthrene; pyrene; 2-butanone; and acetone] were identified in sediment at the Backwater Area because they exceeded ESVs. In addition, seven chemicals (antimony, beryllium, selenium, nitrate/nitrite, TNT, nitrocellulose, and tetryl) are integrated COPECs because they do not have an ESV and they exceed their SRVs when SRVs are available. Mercury is below its ESV, but it is included as a PBT compound per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008). PCB-1254 is also a PBT compound; therefore, it is an integrated COPEC. In total, 30 chemicals were identified as integrated COPECs in sediment at the Backwater Area (Table 7-15). The calculated ratio of MDC to ESV is shown in Table 7-15 for each integrated COPEC. Appendix H, Table H-18 presents the details of the ESV comparisons for sediment at the Backwater Area.

Integrated COPECs for Sediment at Upper Cobbs Pond

At Upper Cobbs Pond, 31 of 43 chemicals detected in discrete sediment were identified as SRCs (Appendix H, Table H-19). Of the 31 SRCs, 8 integrated COPECs (cadmium; chromium; copper; lead; nickel; silver; 1,3-dinitrobenzene; and acetone) were identified in sediment at Upper Cobbs Pond because they exceeded ESVs. In addition, nine chemicals (antimony; beryllium; hexavalent chromium; selenium; TNT; 4-amino-2,6-DNT; HMX; nitrocellulose; and tetryl) are integrated COPECs because they do not have an ESV and exceed their SRVs when available. Mercury is below its ESV, but it is included as a PBT compound per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008). PCB-1254 is also a PBT compound; therefore, it is an integrated COPEC. In total, 19 chemicals were identified as integrated COPECs in discrete sediment at Upper Cobbs Pond (Table 7-16). The calculated ratio of MDC to ESV is shown in Table 7-16 for each integrated COPEC. Appendix H, Table H-19 presents the details of the ESV comparisons for discrete sediment at Upper Cobbs Pond.

In the single ISM sediment sample at Upper Cobbs Pond, 8 of 27 chemicals detected were identified as SRCs (Appendix H, Table H-20). Of the 8 SRCs, 3 integrated COPECs [silver, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate] were identified in sediment at Upper Cobbs Pond because they exceeded ESVs. In addition, three chemicals (nitrate/nitrite, ammonia, and total phosphorous) are integrated COPECs because they do not have an ESV or background criteria. Mercury is below its ESV, but it is included as a PBT compound per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008). Seven chemicals were identified as integrated COPECs in ISM sediment at Upper Cobbs Pond (Table 7-16). The calculated MDC to ESV ratio is shown in Table 7-16 for each integrated COPEC. Appendix H, Table H-20 presents the details of the ESV comparisons for ISM sediment at Upper Cobbs Pond.

Integrated COPECs for Sediment at Lower Cobbs Pond

At Lower Cobbs Pond, 30 of 42 chemicals detected in discrete sediment were identified as SRCs (Appendix H, Table H-21). Of the 30 SRCs, 9 integrated COPECs (arsenic, cadmium, chromium, copper, cyanide, lead, silver, 2-butanone, and acetone) were identified in sediment at Lower Cobbs Pond because they exceeded ESVs. In addition, seven chemicals (antimony, beryllium, hexavalent chromium, selenium, HMX, nitrocellulose, and tetryl) are integrated COPECs because they do not have an ESV or exceed their SRVs when available. Mercury is below its ESV, but it is included as a PBT compound per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008). In total, 17 chemicals were identified as integrated COPECs in discrete sediment at Lower Cobbs Pond (Table 7-17). The calculated ratio of MDC to ESV is shown in Table 7-17 for each integrated COPEC. Appendix H, Table H-21 presents the details of the ESV comparisons for sediment at Lower Cobbs Pond.

In the single ISM sediment sample at Lower Cobbs Pond, 9 of 24 chemicals detected were identified as SRCs (Appendix H, Table H-22). Of the nine SRCs, three integrated COPECs (cadmium, chromium, and silver) were identified in sediment at Lower Cobbs Pond because they exceeded ESVs. In addition, one chemical (beryllium) is an integrated COPEC because it does not have an ESV and it exceeds the SRV, and three chemicals (nitrate/nitrite, ammonia, and total phosphorous) are integrated COPECs because they do not have an ESV or background criteria. Mercury is below its ESV, but it is included as a PBT compound per the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008). In total, eight chemicals were identified as integrated COPECs in ISM sediment at Upper Cobbs Pond (Table 7-17). The calculated MDC to ESV ratio is shown in Table 7-17 for each integrated COPEC. Appendix H, Table H-22 presents the details of the ESV comparisons for ISM sediment at Lower Cobbs Pond.

Most of the sediment COPECs reported in the historical ERA (Table 7-11) are also identified in the current ERA. The earlier work (Phase II RI) identified one COPEC (total PAHs) that is not an integrated COPEC, as total PAHs were not analyzed for during the PBA08 RI. Rather, the PAH assessment during the PBA08 RI was for individual PAHs [e.g., benzo(a)pyrene and dibenz(a,h)anthracene] as currently performed in the Camp Ravenna full-suite parameters and in accordance with the PBA08 SAP. A total of 13 new integrated COPECs [hexavalent chromium;

selenium; ammonia; total phosphorous; 1,3-dinitrobenzene; 4-amino-2,6-DNT; HMX; tetryl; bis(2-ethylhexyl)phthalate; di-n-butyl phthalate; dibenz(a,h)anthracene; 2-butanone; and acetone] are identified in the PBA08 RI. Of these, hexavalent chromium, ammonia, and phosphorous lack ESVs. The addition of selenium is due to a higher concentration detected in the PBA08 RI samples that exceeded the SRV. 1,3-Dinitrobenzene; 4-amino-2,6-DNT; HMX; and tetryl are new integrated COPECs due to detections in samples collected during the PBA08 RI, and bis(2-ethylhexyl)phthalate and di-n-butyl phthalate are new integrated COPECs due to detections in samples collected in the FWBWQS (USACE 2005a). Dibenz(a,h)anthracene, 2-butanone, and acetone were detected during the PBA08 RI at concentrations greater than the updated, more conservative ESV.

7.3.3.6 Integrated COPECs for Surface Water

Surface water at the AOC was evaluated as three EUs: the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Surface water ESVs are published in Appendix H, Table H-16. Detected chemical concentrations were compared to surface water background concentrations and ESVs (Appendix H, Tables H-23 through H-28). Five of the chemicals at each EU (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A summary of the integrated COPECs identified in surface water is presented below.

Integrated COPECs for Surface Water at the Backwater Area

At the Backwater Area, 22 of 28 detected chemicals were identified as SRCs because they exceeded background concentrations or were organic chemicals with no background concentrations (Appendix H, Table H-23). Of the 22 SRCs, 6 chemicals were identified as integrated COPECs at the Backwater Area. Four inorganic chemicals (manganese, selenium, silver, and sulfide) exceeded ESVs, while two other chemicals (sulfate and chloromethane) are COPECs because they do not have an ESV. An additional inorganic chemical (barium) did not exceed the OMZM but did exceed the OMZA, and was selected as an integrated COPEC (Table 7-18). The calculated ratio of MDC to ESV is shown in Table 7-18 for each integrated COPEC. Appendix H, Tables H-23 and H-24 present the details of the OMZM and OMZA ESV comparisons for surface water at the Backwater Area. These comparisons used the OMZM and OMZA from the Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

Integrated COPECs for Surface Water at Upper Cobbs Pond

At Upper Cobbs Pond, 13 of 24 detected chemicals were identified as SRCs (Appendix H, Table H-25). Of the 13 SRCs, 4 integrated COPECs (manganese, nitrate/nitrite, sulfate, and sulfide) were identified in surface water at Upper Cobbs Pond. Manganese and sulfide are integrated COPECs because they exceeded ESVs, and nitrate/nitrite and sulfate are integrated COPECs because they do not have an ESV. The calculated ratio of MDC to ESV is shown in Table 7-19 for each integrated COPEC. Appendix H, Tables H-25 and H-26 present the details of the OMZM and OMZA ESV comparisons for surface water at the Upper Cobbs Pond. These comparisons used the OMZM and

OMZA from the Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

Integrated COPECs for Surface Water at Lower Cobbs Pond

At Lower Cobbs Pond, 19 of 30 detected chemicals were identified as SRCs (Appendix H, Table H-27). Of the 19 SRCs, 4 integrated COPECs (manganese, nitrate/nitrite, sulfate, and sulfide) were identified in surface water at Lower Cobbs Pond. Manganese and sulfide are integrated COPECs because they exceeded ESVs, and nitrate/nitrite and sulfate are integrated COPECs because they do not have an ESV. The calculated ratio of MDC to ESV is shown in Table 7-20 for each integrated COPEC. Appendix H, Tables H-27 and H-28 present the details of the OMZM and OMZA ESV comparisons for surface water at Lower Cobbs Pond. These comparisons used the OMZM and OMZA from the Ohio EPA WQC, when available, as the ESV; when the OMZM or OMZA were not available, the hierarchy of preferred sources was followed, as presented in Section 7.3.3.3.

Of the eight surface water COPECs identified in the historical ERA (Phase II RI), six COPECs (manganese, selenium, silver, sulfate, sulfide, and chloromethane) were identified as integrated COPECs in the PBA08 RI. Iron was considered an essential nutrient in the integrated data set and acetone was detected at a concentration less than the new ESV. One new integrated COPEC (nitrate/nitrite) was identified from the biological water quality study data.

7.3.3.7 Step 3A: Refinement of Integrated COPECs

Step 3A refines the list of integrated COPECs to determine if: (1) there are final COPECs requiring further evaluation in a Level III assessment or if remediation is required to protect ecological receptors; or (2) integrated COPECs can be eliminated from further consideration. This section applies and evaluates refinement factors to the integrated COPECs for the AOC. This evaluation is an important part of the Level II assessment and is adapted from USEPA Step 3A, as outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997) and *Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE 2010b). The purpose of Step 3A is stated as follows by the Army (BTAG 2005):

> "The results of Step 3A will be used to determine if threats to ecological receptors are negligible and an appropriate risk management decision may be made to end the ERA process, or potential threats are still indicated and a BERA should be initiated."

The evaluation and refinement factors used in Step 3A are as follows:

- Comparison of average (i.e., mean) concentration to ESV,
- Comparison of mean concentration to background concentration,
- Comparison of background concentration to ESV,
- Frequency of chemical occurrence relative to ESV,

- Magnitude of ESV exceedance (ratio of ESV to chemical concentrations),
- Discussion of Ohio EPA approved and preferred ESVs,
- Category of wetland quality inside the AOC,
- Geographical relationship of on-site wetlands to AOC exceedance area,
- Information about on-site migration of chemicals to on-site wetlands, and
- Evaluation of off-site migration of chemicals at biological/water quality stations.

Surface soil at the Upper and Lower Cobbs Ponds AOC consists of pond bank soil. Twelve integrated COPECs were identified in surface soil, as presented in Table 7-14. Eight chemicals (aluminum, arsenic, cadmium, cobalt, lead, mercury, vanadium, and zinc) exceeded ESVs; three other chemicals (nitrate/nitrite, nitrocellulose, and benzoic acid) were selected as integrated COPECs because they do not have an ESV. Beta-BHC is below its ESV, but it is included because it is a PBT compound (Ohio EPA 2008).

Sediment at the Upper and Lower Cobbs Ponds AOC is divided into three EUs: the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Upper Cobbs Pond and Lower Cobbs Pond both include a single ISM sediment sample in addition to the discrete samples taken in each of the three EUs. In the Backwater Area, there are 30 integrated COPECs in sediment, as presented in Table 7-15. Twenty-one integrated COPECs [cadmium; chromium; copper; cyanide; silver; 2,6-DNT; anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(ghi)perylene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; fluoranthene; indeno(1,2,3-cd)pyrene; lead; nickel; phenanthrene; pyrene; 2-butanone; and acetone] were identified because they exceeded ESVs. In addition, seven chemicals (antimony, beryllium, selenium, nitrate/nitrite, TNT, nitrocellulose, and tetryl) are integrated COPECs because they do not have an ESV. Mercury and PCB-1254 did not exceed ESVs, but were identified as integrated COPECs because they are PBT compounds.

In Upper Cobbs Pond, there are 19 integrated COPECs in discrete sediment and 7 integrated COPECs in ISM sediment, as presented in Table 7-16. In discrete sediment, eight chemicals (cadmium; chromium; copper; lead; nickel; silver; 1,3-dinitrobenzene; and acetone) were integrated COPECs because they exceeded ESVs; nine chemicals (antimony; beryllium; hexavalent chromium; selenium; TNT; 4-amino-2,6-DNT; HMX; nitrocellulose; and tetryl) were integrated COPECs because they do not have an ESV; mercury and PCB-1254 were PBT compounds. In ISM sediment, three integrated COPECs [silver, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate] were identified at Upper Cobbs Pond because they exceeded ESVs; three chemicals (nitrate/nitrite, ammonia, and total phosphorous) are integrated COPECs because they do not have an ESV or background criteria; and mercury is a PBT compound.

In Lower Cobbs Pond, there are 17 integrated COPECs in discrete sediment and 8 integrated COPECs in ISM sediment, as presented in Table 7-17. In discrete sediment, nine chemicals (arsenic, cadmium, chromium, copper, cyanide, lead, silver, 2-butanone, and acetone) were integrated COPECs because they exceeded ESVs; seven chemicals (antimony, beryllium, hexavalent chromium, selenium, HMX, nitrocellulose, and tetryl) were integrated COPECs because they do not have an ESV; mercury was a PBT compound. In ISM sediment, three integrated COPECs (cadmium, chromium, and silver) were identified at Lower Cobbs Pond because they exceeded ESVs; four chemicals (beryllium, nitrate/nitrite, ammonia, and total phosphorous) are integrated COPECs because they do not have an ESV; mercury is a PBT compound.

Surface water at the Upper and Lower Cobbs Ponds AOC is divided into three EUs: the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. In the Backwater Area, there are seven integrated COPEC in surface water, as presented in Table 7-18. Five chemicals (barium, manganese, selenium, silver, and sulfide) exceeded ESVs; two other chemicals (sulfate and chloromethane) were selected as integrated COPECs because they do not have an ESV. In both the Upper Cobbs Pond EU and Lower Cobbs Pond EU, there are four integrated COPEC in surface water, as presented in Tables 7-20 and 7-21. Two chemicals (manganese and sulfide) exceeded ESVs; two other chemicals (nitrate/nitrite and sulfate) do not have an ESV.

Chemicals with no ESVs are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). PBT compounds are discussed later in Step 3A. All integrated COPECs that have an MDC to ESV ratio greater than one are evaluated based on a series of evaluation or refinement factors. The first four evaluation and refinement factors are organized to compare key quantitative information. These factors are:

- Comparison of average or mean concentration to ESV,
- Comparison of mean concentration to background concentration,
- Comparison of background concentration to ESV, and
- Frequency of chemical occurrence relative to ESV.

Multiple evaluation factors can be used to define whether an integrated COPEC should be retained or eliminated from further consideration. There are two types of comparisons and associated decisions in the first steps of the refinement process (Table 7-21).

Comparing the background concentration to the ESV is an important consideration in this part of the evaluation. Additionally, frequency of detection is provided. The evaluations are presented by type of decision on a COPEC-by-COPEC basis (Table 7-22). These evaluations are followed by the application of additional evaluation and refinement factors, when necessary.

Evaluation of Integrated COPECs in Soil

There are 12 integrated COPECs identified in soil at the AOC. Eight integrated COPECs (aluminum, arsenic, cadmium, cobalt, lead, mercury, vanadium, and zinc) had MDCs that exceeded ESVs, and mercury is also a PBT compound. Beta-BHC has a ratio below 1 but is an integrated COPEC because it is a PBT compound. Three other chemicals (nitrate/nitrite, nitrocellulose, and benzoic acid) are integrated COPECs because they do not have an ESV; they are evaluated later in the refinement process.

Comparison of Mean Concentration to ESV

Three integrated COPECs (arsenic, cadmium, and cobalt) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-29). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-22 shows the relevant data and various comparisons.

Arsenic. Arsenic was detected in all 24 surface soil samples analyzed for inorganic chemicals at the AOC. Only four samples had detections above the background concentration, and only two samples had arsenic concentrations exceeding the ESV (Table 7-22). Although the MDC for arsenic in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentrations. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 19 of 24 surface soil samples analyzed for inorganic chemicals at the AOC. Cadmium was not detected during the facility-wide background investigation. Only one sample had a concentration exceeding the ESV (Table 7-22). Although the MDC for cadmium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 24 surface soil samples analyzed for inorganic chemicals at the AOC. Eight samples had detections above the background concentration, but only two of these samples had cobalt concentrations exceeding the ESV (Table 7-22). Although the MDC for cobalt in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and background concentration. Therefore, cobalt is eliminated from further consideration and will not be a final COPEC.

Of the eight integrated soil COPECs with MDCs exceeding the ESV, arsenic, cadmium, and cobalt were eliminated from further consideration based on the mean comparison to ESV refining factor. Five remaining integrated COPECs with MDCs greater than the ESV (aluminum, lead, mercury, vanadium, and zinc) in surface soil also have mean concentrations larger than the ESV.

Comparison of Mean Concentration Above ESV to Background Concentration

Three integrated COPECs in surface soil (aluminum, lead, and vanadium) are eliminated in this step because the mean concentrations are larger than the ESVs but smaller than background concentrations. Each remaining integrated COPEC is presented below and discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in surface soil has a mean concentration less than the background concentration (Table 7-22). The background concentration is more than 350 times greater than the ESV, so the ESV can be considered conservative. Although aluminum was detected in all 24 surface soil samples at concentrations above the ESV, only two samples had a detection that exceeded the background concentration. Having only two samples exceed the background concentration suggests the concentration of aluminum in surface soil is not likely a concern. Additionally, aluminum is not likely a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6-7 at one of the nearby load lines at Camp Ravenna (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, the USEPA states, "aluminum is identified as a COPC only for soil with a pH less than 5.5" (USEPA 2003a). Therefore, because the mean concentration is less than the background concentration, the ESV is rather conservative, and the soil pH at Camp Ravenna is higher than the USEPA dissociation limit, aluminum is eliminated from further consideration and will not be a final COPEC.

Lead. Lead in surface soil has a mean concentration less than the background concentration (Table 7-22). The background concentration is more than two times greater than the ESV, so the ESV can be considered conservative. Although lead was detected in 23 of the 24 surface soil samples at concentrations above the ESV, only three samples had detections exceeding the background concentration. Having only 3 of 24 samples exceed the background concentration suggests the concentration of lead in surface soil is not likely a concern. Therefore, because the mean concentration is less than the background concentration and the ESV is conservative, lead is eliminated from further consideration and will not be a final COPEC.

Vanadium. Vanadium in surface soil has a mean concentration less than the background concentration (Table 7-22). The background concentration is more than three times greater than the ESV, so the ESV can be considered conservative. Although vanadium was detected in all 24 discrete samples at concentrations above the ESV, only one sample had a detection exceeding the background concentration. Having only one sample exceed the background concentration suggests the concentration of vanadium in surface soil is not likely a concern. Therefore, because the mean concentration is less than the background concentration and the ESV is conservative, vanadium is eliminated from further consideration and will not be a final COPEC.

Continued Evaluations

The remaining two integrated COPECs (mercury and zinc) with ESVs in soil have mean concentrations greater than the ESV and the background concentration. Each remaining integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Mercury. Mercury was detected in 21 of 24 discrete samples. Mercury in surface soil has a mean concentration greater than the background concentration and ESV. Mercury was detected above the background concentration in 10 of 21 surface soil samples, and it was detected at concentrations above the ESV in all 21 samples (Table 7-22). The background concentration is 70 times greater than the ESV, suggesting the ESV may be very conservative. Although mercury has a very conservative ESV, it is a PBT compound, and the mean concentration exceeds both the background concentration and ESV. Mercury requires further evaluation as a COPEC.

Zinc. Zinc was detected in all 24 discrete samples. Zinc in surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 10 of 24 discrete samples, and it was detected at concentrations above the ESV in all 24 samples (Table 7-22). The ESV is lower than the background concentration, which indicates the ESV for zinc may be conservative. Because the mean concentration in surface soil exceeds both the background concentration and the ESV, zinc requires further evaluation as a COPEC.

Additional Aspects of Continued Evaluations

The second refinement factor comparing the mean concentration to background concentration evaluates how much higher the mean soil concentration is compared to the background concentration. Two COPECs (mercury and zinc) have mean concentrations higher than their background concentrations. If the degree of difference between the mean concentration and the background concentration is small, the integrated COPEC may not be considered a final COPEC. Table 7-23 shows that while the mean concentration exceeds the background concentration, the exceedance is small in both cases. For example, the mean concentration for zinc is 63.9 mg/kg, while the background concentration is 61.8 mg/kg.

Additional Technical and Refinement Factors

The next two evaluation and refinement factors include:

- Evaluating the magnitude of ESV exceedance (ratio of ESV to chemical concentrations), and
- Discussion of Ohio EPA approved and preferred ESVs.

Evaluating the Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for mercury (84) and zinc (1.4) indicate a possibility of risk, the zinc ratio is relatively small. The small ratio for zinc indicates the potential for toxicity is relatively low, and this likely supports elimination of this integrated COPEC. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) states:

> "If only minor exceedances are detected and other evidence can substantiate, a claim may be made that some or all of the site-associated soils have not been impacted and no additional ecological investigation of the soils is warranted."

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives specific guidance on selecting media screening values (ESVs) for Level II evaluation. For soil, three possible sources of ESV values are listed in order of preference: (1) USEPA EcoSSLs, (2) *Preliminary Remediation Goals for Ecological Endpoints* (DOE 1997), and (3) *Region 5 Ecological Screening Levels* (USEPA 2003b). However, it is important to note the preferred source (EcoSSLs) can have up to four values per chemical—one for each receptor type (plants, soil invertebrates, birds, and mammals). Because Ohio EPA does not provide guidance on which value to select of these four, the most conservative (lowest) value was chosen for this ERA.

It is possible the chosen ESV is too conservative. Alternative ESVs are presented below for the remaining three integrated COPECs.

The Ohio EPA approved and preferred mercury ESV used in this ERA is 0.00051 mg/kg (Appendix H, Table H-14). The ESV is lower than other ESVs for mercury (0.1 mg/kg), the ESV for methylmercury (0.0016 mg/kg) (USEPA 2003b) (Appendix H, Table H-14), and the background concentration (0.036 mg/kg) (Appendix H, Table H-29). The *Preliminary Remediation Goals for Ecological Endpoints* labels the form of mercury as an "inorganic chemical" and notes the ESV for mercury is "so low that it may often be within background soil concentrations" (DOE 1997). Although mercury can bioaccumulate in food chains as a PBT compound, the Ohio EPA approved and preferred ESV is very low; therefore, the selection of mercury as a COPEC is very conservative.

The Ohio EPA approved and preferred zinc ESV used in this ERA is 46 mg/kg. This value is taken from the USEPA EcoSSLs (Appendix H, Table H-14). The zinc ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for zinc include 79, 120, and 160 mg/kg (USEPA 2007b). The ESV of 46 mg/kg is about five times greater than the ESV (8.5 mg/kg) (DOE 1997), the next source of ESVs approved by Ohio EPA (Appendix H, Table H-14). However, the preferred ESV used for zinc is lower than the background concentration of 61.8 mg/kg (Appendix H, Table H-29), while all other EcoSSLs are above the background concentration. These factors indicate the Ohio EPA approved and preferred ESV for zinc is somewhat conservative, and the selection of zinc as a COPEC is conservative.

The above information about alternative ESVs shows there are less conservative ESVs that could be chosen for the Level II work. Table 7-24 shows the ratio of ESV to mean concentration for the preferred ESV and an alternative ESV. This alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration. For the two remaining integrated COPECs, using the alternative ESV would decrease the ratios for mercury and zinc to less than one. Thus, if the alternative ESVs were used, mercury and zinc would be eliminated from further consideration and would not be final COPECs.

Based on the three previous refinement factors, the two integrated soil COPECs remaining in Table 7-24 are dismissed as final COPECs. More specifically, mean concentrations are only slightly higher than background concentrations (i.e., mercury and zinc). Mean concentration-to-ESV ratios of exceedance are near one (i.e., zinc). Using alternate ESVs results in ratios below one for mercury and zinc.

Evaluation of Integrated COPECs in Sediment

Integrated COPECs in each sediment EU were subjected to some of the same evaluation and refinement factors applied to integrated COPECs for surface soil. Some factors, such as those concerning wetlands and off-site migration, apply to the whole AOC and are discussed after the surface water evaluation.

Backwater Area

At the Backwater Area there are 30 integrated COPECs. Nitrate/nitrite, TNT, nitrocellulose, tetryl, and PCB-1254 (also a PBT compound) were conservatively identified as integrated COPECs because they do not have ESVs, background concentrations, or SRVs; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Mercury and PCB-1254 are PBT compounds and discussed later in Step 3A. Cadmium; chromium; copper; cyanide; lead; nickel; silver; 2,6-DNT; anthracene; benz(a)anthracene; benzo(a)pyrene; benzo(ghi)perylene; benzo(k)fluoranthene; chrysene; dibenz(a,h)anthracene; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; pyrene; 2-butanone; and acetone had MDCs that exceeded the respective ESV. Although antimony, beryllium, and selenium did not have ESVs, their MDCs exceeded SRVs; these 24 COPECs are discussed below.

Comparison of Mean Concentration to ESV – Backwater Area

Seven integrated COPECs [cadmium, chromium, copper, lead, nickel, indeno(1,2,3-cd)pyrene, and 2-butanone] in sediment at the Backwater Area are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-30). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-25 shows the relevant data and various comparisons.

Cadmium. Cadmium was detected in all 14 samples. Cadmium was not detected during the facility-wide background investigation. Six samples had a concentration exceeding the SRV, and five samples had a concentration exceeding the ESV (Table 7-25). Although the MDC for cadmium in sediment exceeds the ESV, the mean concentration is less than the ESV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 14 samples. Nine samples had detections above the background concentration, but only one sample had a chromium concentration exceeding the ESV (Table 7-25). Although the MDC for chromium in sediment exceeds the ESV, the mean concentration is less than the ESV. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 14 samples. Only four samples had detections above both the background concentration and the ESV (Table 7-25). Although the MDC for copper in sediment exceeds the background concentration, ESV, and SRV, the mean concentration is less than the ESV and SRV. Therefore, copper is eliminated from further consideration and will not be a final COPEC.

Lead. Lead was detected in all 14 samples. Seven samples had detections above the background concentration, and only four samples had lead concentrations exceeding the ESV (Table 7-25). However, only one sample exceeded the SRV. Although the MDC for lead in sediment exceeds the background concentration, ESV, and SRV, the mean concentration is less than the ESV and SRV. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all 14 discrete samples. Eight samples had detections above the background concentration, and six samples had nickel concentrations exceeding the ESV (Table 7-25). However, only one sample exceeded the SRV. Although the MDC for nickel in sediment exceeds the background concentration, ESV, and SRV, the mean concentration is less than the ESV and SRV. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Indeno(1,2,3-cd)pyrene. Indeno(1,2,3-cd)pyrene was detected in three of five discrete samples. There was no background concentration for comparison, but two samples had concentrations exceeding the ESV (Table 7-25). Although the MDC for indeno(1,2,3-cd)pyrene in sediment exceeds the ESV, the mean concentration is less than the ESV. Therefore, indeno(1,2,3-cd)pyrene is eliminated from further consideration and will not be a final COPEC.

2-Butanone. 2-Butanone was detected in three of five samples. There was no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-25). Although the MDC for 2-butanone in sediment exceeds the ESV, the mean concentration is less than the ESV. Therefore, 2-butanone is eliminated from further consideration and will not be a final COPEC.

Comparison of Mean Concentration to Background Concentration and SRVs - Backwater Area

Three integrated COPECs in sediment (antimony, beryllium, and selenium) are eliminated in this step because the mean concentrations are smaller than background concentrations or SRVs (Appendix H, Table H-30). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the background concentration or SRV and the related evaluation and refinement factors. Table 7-25 shows the relevant data and various comparisons.

Antimony. Antimony was detected in 11 of 14 samples. There was no background concentration or ESV for comparison, but only two samples had a concentration exceeding the SRV (Table 7-25). Although the MDC for antimony in sediment exceeds the SRV, the mean concentration is less than the SRV. Therefore, antimony is eliminated from further consideration and will not be a final COPEC.

Beryllium. Beryllium was detected in all 14 samples. There was no ESV for comparison, but 13 of 14 samples had a concentration above the background concentration (Table 7-25). In addition, 8 of 14 samples exceeded the SRV. Although the MDC for beryllium in sediment exceeds the background concentration and SRV, the mean concentration is less than the SRV. Therefore, beryllium is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium was detected in 8 of 14 samples. There was no ESV for comparison, but only 1 of 14 samples had a concentration above background concentration and the SRV (which is equal to the background concentration) (Table 7-25). Although the MDC for selenium in sediment exceeds the background concentration and SRV, the mean concentration is less than both. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Continued Evaluations - Backwater Area

The remaining 14 integrated COPECs with ESVs in sediment have mean concentrations greater than the ESV and the background concentration. Each remaining integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Cyanide. Cyanide was detected in 3 of 12 samples. There was no background concentration for comparison, but three samples had detections exceeding the ESV (Table 7-25). Because cyanide also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very high; the mean concentration to ESV ratio was 2,240 (Appendix H, Table H-30). The highest concentration of cyanide (0.55 mg/kg at ULCPSD-009-0001-SD) in all three EUs occurred in the Backwater Area. There is also uncertainty related to cyanide due to the fact it was not included in the 2010 sampling event. However, the overall frequency of detection for all three sediment EUs is small–there are only 4 detections in 27 samples, which include a few QA/QC samples. Cyanide, being a negatively charged ion, is relatively mobile by itself; however, it forms very strong complexes with iron and other inorganic chemicals in the environment that effectively immobilize it. These complexes dramatically reduce the availability of cyanide to benthic organisms because the complexes are difficult to decompose (EC 1999). Therefore, it is not likely cyanide in sediment is causing a risk to aquatic receptors in the Backwater Area. Due to the low frequency of detection (4 of 27) throughout the three sediment EUs and the immobility of the COPEC, cyanide is eliminated from further consideration and will not be a final COPEC.

Silver. Silver was detected in 13 of 14 samples. Silver was not detected during the facility-wide background investigation. A total of 13 of 14 samples had a concentration exceeding the ESV (Table 7-25). Because silver also had a mean concentration that exceeded the ESV, it was evaluated further. The mean concentration to ESV ratio was 11.4 (Appendix H, Table H-30). Therefore, silver will be evaluated further.

2,6-DNT. 2,6-DNT in sediment had a mean concentration above its ESV (Table 7-25). It was detected in only 1 of 14 samples. There was no background concentration for comparison, but the sample had a concentration exceeding the ESV (Table 7-25). Because 2,6-DNT also had a mean concentration that exceeded the ESV, it was evaluated further. Despite only one detection, the mean concentration remained higher than the ESV because of high detection limits in the non-detected samples (one-half the detection limit for the non-detectable concentrations was used to calculate the mean). The magnitude of the ESV exceedance was very low; the mean concentration to ESV ratio was 1.21 (Appendix H, Table H-30). Due to the low frequency of detection (1 of 14) and the low mean concentration to ESV ratio, 2,6-DNT is eliminated from further consideration and will not be a final COPEC.

Anthracene. Anthracene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in two of five samples. There was no background concentration for comparison, but both samples had concentrations exceeding the ESV (Table 7-25). Because anthracene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 1.67 (Appendix H, Table H-30). Due to the low mean concentration to ESV ratio, anthracene is eliminated from further consideration and will not be a final COPEC.

Benz(a)anthracene. Benz(a)anthracene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five samples. There was no background concentration for comparison, and two samples had concentrations exceeding the ESV (Table 7-25). Because benz(a)anthracene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was fairly low; the mean concentration to ESV ratio was 2.53 (Appendix H, Table H-30). While the mean concentration to ESV ratio was low, it was not considered low enough to dismiss benz(a)anthracene as a final COPEC. Benz(a)anthracene will be evaluated further.

Benzo(a)pyrene. Benzo(a)pyrene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in four of five samples. There was no background concentration for comparison, and three samples had concentrations exceeding the ESV (Table 7-25). Because benzo(a)pyrene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very low; the mean concentration to ESV ratio was 2.15 (Appendix H, Table H-30). While the mean concentration to ESV ratio was low, it was not considered low enough to dismiss benzo(a)pyrene as a final COPEC. Benzo(a)pyrene will be evaluated further.

Benzo(ghi)perylene. Benzo(ghi)perylene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five discrete samples. There was no background concentration for comparison, and two samples had concentrations exceeding the ESV (Table 7-25). Because benzo(ghi)perylene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 1.29 (Appendix H, Table H-30). Due to the low mean concentration to ESV ratio, benzo(ghi)perylene is eliminated from further consideration and will not be a final COPEC.

Benzo(k)fluoranthene. Benzo(k)fluoranthene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five samples. There was no background concentration for comparison, and two samples had concentrations exceeding the ESV (Table 7-25). Because benzo(k)fluoranthene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very low; the mean concentration to ESV ratio was 1.1 (Appendix H, Table H-30). Due to the very low mean concentration to ESV ratio (1.1), benzo(k)fluoranthene is eliminated from further consideration and will not be a final COPEC.

Chrysene. Chrysene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in four of five samples. There was no background concentration for comparison, and three samples had concentrations exceeding the ESV (Table 7-25). Because chrysene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 2.04 (Appendix H, Table H-30). While the mean concentration to ESV ratio was low, it was not considered low enough to dismiss chrysene as a final COPEC. Chrysene will be evaluated further.

Dibenz(a,h)anthracene. Dibenz(a,h)anthracene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in one of five samples. There was no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-25). Because dibenz(a,h)anthracene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 2.88 (Appendix H, Table H-30). Due to the low frequency of detection (one of five) in the Backwater Area and low mean concentration to ESV ratio, dibenz(a,h)anthracene is eliminated from further consideration and will not be a final COPEC.

Fluoranthene. Fluoranthene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five samples. There was no background concentration for comparison, and two samples had concentrations exceeding the ESV (Table 7-25). Because fluoranthene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very low; the mean concentration to ESV ratio was 1.44 (Appendix H, Table H-30). Due to the low mean concentration to ESV ratio, fluoranthene is eliminated from further consideration and will not be a final COPEC.

Phenanthrene. Phenanthrene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five discrete samples. There was no background concentration for comparison, but only two samples had concentrations exceeding the ESV (Table 7-25). Because phenanthrene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 1.4 (Appendix H, Table H-30). Due to the low mean concentration to ESV ratio, phenanthrene is eliminated from further consideration and will not be a final COPEC.

Pyrene. Pyrene in sediment had a mean concentration above its ESV (Table 7-25). It was detected in three of five samples. There was no background concentration for comparison, but only two samples had concentrations exceeding the ESV (Table 7-25). Because pyrene also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 3.10 (Appendix H, Table H-30). While the mean concentration to ESV ratio was low, it was not considered low enough to dismiss pyrene as a final COPEC. Pyrene will be evaluated further.

Acetone. Acetone in sediment had a mean concentration above its ESV (Table 7-25). It was detected in all five samples. There was no background concentration for comparison, but all five samples had concentrations exceeding the ESV (Table 7-25). Because acetone also had a mean concentration that exceeded the ESV, it was evaluated further. The mean concentration to ESV ratio was 12.1 (Appendix H, Table H-30). Therefore, acetone will be evaluated further.

Upper Cobbs Pond

At Upper Cobbs Pond, there are 19 integrated COPECs in discrete sediment and 7 integrated COPECs in ISM sediment. Nitrate/nitrite, ammonia, and total phosphorous were conservatively identified as integrated COPECs for ISM sediment, because they do not have ESVs, background concentrations, or SRVs; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Mercury is a PBT compound and is discussed later in Step 3A. Silver, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate had MDCs that exceeded the ESV; however, because there is only one ISM sample at Upper Cobbs Pond, the average is equal to the MDC, and these three COPECs are thus discussed in further evaluations later in Step 3A. For discrete sediment samples, hexavalent chromium; TNT; 4-amino-2,6-DNT; HMX; nitrocellulose; and tetryl were conservatively identified as integrated COPECs because they do not have ESVs, background concentrations, or SRVs; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Mercury and PCB-1254 are PBT compounds and discussed later in Step 3A. Cadmium; chromium; copper; lead; nickel; silver; 1,3-dinitrobenzene; and acetone had an MDC that exceeded the ESV. Although antimony, beryllium, and selenium did not have ESVs, their MDCs exceeded SRVs; these 11 COPECs are discussed below.

Comparison of Mean Concentration to ESV - Upper Cobbs Pond

Two integrated COPECs (cadmium and lead) in sediment at Upper Cobbs Pond are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-31). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-26 shows the relevant data and various comparisons.

Cadmium. Cadmium was detected in three of five samples. Cadmium was not detected during the facility-wide background investigation. Two samples had a concentration exceeding the ESV (Table 7-26). Although the MDC for cadmium in sediment exceeds the ESV, the mean concentration is less than the ESV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Lead. Lead was detected in all five samples. Only two samples had detections above the background concentration and the ESV (Table 7-26). Although the MDC for lead in sediment exceeds the background concentration, ESV, and SRV, the mean concentration is less than the ESV and SRV. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Comparison of Mean Concentration to SRV - Upper Cobbs Pond

Four integrated COPECs (antimony, beryllium, nickel, and selenium) in sediment at Upper Cobbs Pond are eliminated in this step because the mean concentration is smaller than the SRV (Appendix H, Table H-31). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the SRV and the related evaluation and refinement factors. Table 7-26 shows the relevant data and various comparisons.

Antimony. Antimony was detected in all five samples. Antimony was not detected during the facility-wide background investigation. There also was no ESV for comparison, but only one sample had a concentration exceeding the SRV (Table 7-26). Although the MDC for antimony in sediment exceeds the SRV, the mean concentration is less than the SRV. Therefore, antimony is eliminated from further consideration and will not be a final COPEC.

Beryllium. Beryllium was detected in all five samples. There was no ESV for comparison, but all five samples had concentrations above the background concentration (Table 7-26). In addition, two of five samples exceeded the SRV. Although the MDC for beryllium in sediment exceeds the background concentration and SRV, the mean concentration is essentially equal to the SRV. Therefore, beryllium is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all five samples. Four samples had detections above the background concentration and the ESV, and two samples had nickel concentrations exceeding the SRV (Table 7-26). Although the MDC and mean concentration for nickel in sediment exceeds the background concentration and ESV, the mean concentration is less than the SRV. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium was detected in three of five samples. There was no ESV for comparison, but only one of five samples had a concentration above background concentration and the SRV, which is equal to the background concentration (Table 7-26). Although the MDC for selenium in sediment exceeds the background concentration and SRV, the mean concentration is less than both. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Continued Evaluations - Upper Cobbs Pond

The remaining five integrated COPECs with ESVs in sediment have mean concentrations greater than the ESV and the background concentration. Each remaining integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Chromium. Chromium was detected in all six samples. All six samples had detections above the background concentration, and three samples had a chromium concentration exceeding the ESV (Table 7-26). Because chromium also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very low; the mean concentration to ESV ratio was 1.17 (Appendix H, Table H-31). Due to the very low mean concentration to ESV ratio (1.17), chromium is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all five samples. Four samples had detections above the background concentration, and three samples had detections exceeding the ESV and SRV (Table 7-26). Because copper also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was fairly low; the mean concentration to ESV ratio was 1.81 (Appendix H, Table H-31). The mean concentration to background concentration ratio also is low at 2.07. Due to the low mean concentration to ESV ratio and low mean to background concentration ratio, copper is eliminated from further consideration and will not be a final COPEC.

Silver. Silver was detected in three of five samples. Silver was not detected during the facility-wide background investigation. All three samples had concentrations exceeding the ESV (Table 7-26). Because silver also had a mean concentration that exceeded the ESV, it was evaluated further. The mean concentration to ESV ratio was 7.6 (Appendix H, Table H-31). Therefore, silver will be evaluated further.

1,3-Dinitrobenzene. 1,3-Dinitrobenzene was detected in only one of five samples. There was no background concentration for comparison, but the sample had a concentration exceeding the ESV (Table 7-26). Because 1,3-dinitrobenzene also had a mean concentration that exceeded the ESV, it was evaluated further. Despite only one detection, the mean concentration remained higher than the ESV because of high detection limits in the non-detected samples (one-half the detection limit for the non-detectable concentrations was used to calculate the mean). The magnitude of ESV exceedance was low; the mean concentration to ESV ratio was 1.67 (Appendix H, Table H-31). Due to the low frequency of detection (one of five) in Upper Cobbs Pond, the absence of any detections in the other two sediment EUs, and the low mean concentration to ESV ratio (1.67), 1,3-dinitrobenzene is eliminated from further consideration and will not be a final COPEC.

Acetone. Acetone was detected in both samples collected. There was no background concentration for comparison, but both samples had concentrations exceeding the ESV (Table 7-26). Because acetone also had a mean concentration that exceeded the ESV, it was evaluated further. The mean concentration to ESV ratio was 9 (Appendix H, Table H-31). Therefore, acetone will be evaluated further.

Lower Cobbs Pond

At Lower Cobbs Pond, there are 17 integrated COPECs in discrete sediment and 8 integrated COPECs in ISM sediment. For ISM sediment, nitrate/nitrite, ammonia, and total phosphorous were conservatively identified as integrated COPECs because they do not have ESVs, background concentrations, or SRVs, and beryllium exceeds the background and SRV but does not have an ESV; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Mercury is a PBT compound and is discussed later in Step 3A. Cadmium, chromium, and silver, had an MDC that exceeded the ESV; however, because there is only one ISM sample at Lower Cobbs Pond and the average is equal to the MDC, these three COPECs are discussed in further evaluations later in Step 3A. For discrete sediment samples, hexavalent chromium, HMX, nitrocellulose, and tetryl were conservatively identified as integrated COPECs because they do not have ESVs, SRVs, or background concentrations; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Mercury is a PBT compound and is discussed later in Step 3A. Arsenic, cadmium, chromium, copper, cyanide, lead, silver, 2-butanone, and acetone had an MDC that exceeded the ESV. Although antimony, beryllium, and selenium did not have ESVs, their MDCs exceeded SRVs; these 12 COPECs are discussed below.

Comparison of Mean Concentration to ESV and SRV- Lower Cobbs Pond

Seven integrated COPECs (antimony, arsenic, beryllium, cadmium, lead, selenium, and 2-butanone) in sediment at Lower Cobbs Pond are eliminated in this step because the mean concentration is smaller than the ESV or SRV (Appendix H, Table H-32). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV or SRV and the related evaluation and refinement factors. Table 7-27 shows the relevant data and various comparisons.

Antimony. Antimony was detected in only one of eight samples. Antimony was not detected during the facility-wide background investigation. There also was no ESV for comparison, but the sample had a concentration exceeding the SRV (Table 7-27). Although the MDC for antimony in sediment exceeds the SRV, the mean concentration is less than the SRV. Therefore, antimony is eliminated from further consideration and will not be a final COPEC.

Arsenic. Arsenic was detected in all eight samples. Five samples had detections above the ESV, but two samples had detections exceeding the background concentration, and only one sample exceeded the SRV (Table 7-27). Although the MDC and mean concentration for arsenic in sediment exceed the ESV, the mean concentration is less than the background concentration and SRV. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Beryllium. Beryllium was detected in all eight samples. There was no ESV for comparison, but all eight samples had concentrations above the background concentration (Table 7-27). In addition, two of eight samples exceeded the SRV. Although the MDC for beryllium in sediment exceeds the SRV, the mean concentration is less than the SRV. Therefore, beryllium is eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in six of eight samples. Cadmium was not detected during the facility-wide background investigation. Two samples had a concentration exceeding the ESV, and three samples had concentrations exceeding the SRV (Table 7-27). Although the MDC for cadmium in sediment exceeds the ESV and SRV, the mean concentration is less than the ESV and SRV. Therefore, cadmium is eliminated from further consideration and will not be a final COPEC.

Lead. Lead was detected in all eight samples. Four samples had detections above the background concentration, and three samples had a lead concentration exceeding the ESV (Table 7-27). Although the MDC for lead in sediment exceeds the background concentration, ESV, and SRV, the mean concentration is less than the ESV and SRV. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium was detected in four of eight samples. There was no ESV for comparison, but one of eight samples had a concentration above the background concentration, and the SRV is equal to the background concentration (Table 7-27). Although the MDC for selenium in sediment exceeds the background concentration and SRV, the mean concentration is less than both. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

2-Butanone. 2-Butanone was detected in both discrete samples. There was no background concentration for comparison, and one sample had a concentration exceeding the ESV (Table 7-27). Although the MDC for 2-butanone in sediment exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, 2-butanone is eliminated from further consideration and will not be a final COPEC.

Continued Evaluations – Lower Cobbs Pond

The remaining five integrated COPECs with ESVs in sediment have mean concentrations greater than the ESV and the background concentration. Each remaining integrated COPEC is presented below and discussed relative to the first four and related evaluation and refinement factors.

Chromium. Chromium was detected in all eight samples. Five samples had detections above the background concentration, and three samples had a chromium concentration exceeding the ESV (Table 7-27). Because chromium also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was very low; the mean concentration to ESV ratio was 1.36 (Appendix H, Table H-32). The mean to SRV ratio was low at 2.03. Due to the low mean concentration to ESV ratio and low mean to SRV ratio, chromium is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all eight samples. Four samples had detections above the background concentration and the ESV, and three samples had detections exceeding the SRV (Table 7-27). Because copper also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was fairly low; the mean concentration to ESV ratio was 1.79 (Appendix H, Table H-32). The mean to background ratio was low at 2.05. Due to the low mean concentration to ESV ratio and low mean to background ratio, copper is eliminated from further consideration and will not be a final COPEC.

Cyanide. Cyanide was detected in only one of six samples. PBA08 RI samples were not analyzed for cyanide. Cyanide was detected in the one sample at a concentration above the background concentration and ESV (Table 7-27). Because cyanide also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was high; the mean concentration to ESV ratio was 2,250 (Appendix H, Table H-32). The second highest concentration of cyanide (0.4 mg/kg at ULCPSD-024-0001-SD) in all three EUs occurred in the Backwater Area. The overall frequency of detection for all three sediment EUs is small–there are only 4 detections in 27 samples, which includes QA/QC samples. Cyanide, being a negatively charged ion is relatively mobile by itself; however, it forms very strong complexes with iron and other inorganic chemicals in the environment that effectively immobilize it. These complexes dramatically reduce the availability of cyanide to benthic organisms because the complexes are difficult to decompose (EC 1999).

Therefore, it is not likely the cyanide in sediment is causing a risk to aquatic receptors in Lower Cobbs Pond. Due to the low frequency of detection (4 of 27) across the three sediment EUs and the immobility of the COPEC, cyanide is eliminated from further consideration and will not be a final COPEC.

Silver. Silver was detected in five of eight samples. Silver was not detected during the facility-wide background investigation. Three samples had concentrations exceeding the ESV (Table 7-27). Because silver also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was fairly low; the mean concentration to ESV ratio was 1.7 (Appendix H, Table H-32). The mean to SRV ratio was low at 1.98. Due to the low mean concentration to ESV ratio and low mean to SRV ratio, silver is eliminated from further consideration and will not be a final COPEC.

Acetone. Acetone was detected in both discrete samples collected. There was no background concentration for comparison, but both samples had concentrations exceeding the ESV (Table 7-27). Because acetone also had a mean concentration that exceeded the ESV, it was evaluated further. The mean concentration to ESV ratio was 12.4 (Appendix H, Table H-32). Therefore, acetone will be evaluated further.

The remaining sediment COPECs still requiring evaluation are silver, benz(a)anthracene, benzo(a)pyrene, chrysene, pyrene, and acetone in the Backwater Area; silver and acetone in Upper Cobbs Pond; and acetone in Lower Cobbs Pond.

Evaluation of Integrated COPECs in Surface Water

Integrated COPECs in surface water were subjected to some of the same evaluation and refinement factors applied to integrated COPECs for soil and sediment. Some factors, such as those concerning wetlands and off-site migration, apply to the whole AOC and are discussed after this section.

Backwater Area. Sulfate and chloromethane were conservatively identified as integrated COPECs because they do not have an ESV or background concentration; these chemicals are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Barium, manganese, selenium, silver, and sulfide had an MDC that exceeded the ESV; these four COPECs are discussed below.

Barium. Barium was detected in all four surface water samples. Two of four samples had detections above the background concentration, but only one chemical detection was above the OMZA ESV; none were above the OMZM ESV (Appendix H, Tables H-16, H-23, and H-24; Table 7-28). Although the MDC for barium in surface water exceeds the OMZA ESV, the mean concentration is less than the OMZA ESV. Therefore, barium is eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese was detected in all four surface water samples. All four samples had detections above the ESV, but only two chemical detections were above background concentrations

(Table 7-28). The background concentration is more than 3.2 times greater than the ESV; therefore, the ESV can be considered conservative. Because manganese also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was fairly high; the mean concentration to ESV ratio was 51.3 (Appendix H, Table H-33). Because the mean concentration of manganese was above the ESV, this COPEC will be evaluated further.

Selenium. Selenium was detected in three of four surface water samples. All three samples had detections above the background concentration, but only one chemical detection was above the ESV (Table 7-28). Although the MDC for selenium in surface water exceeds the ESV, the mean concentration is less than the ESV. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Silver. Silver was detected in only one of four surface water samples, and it was detected above its background concentration and ESV (Table 7-28). Although the MDC for silver in surface water exceeds the ESV, the mean concentration is less than the ESV. Therefore, silver is eliminated from further consideration and will not be a final COPEC.

Sulfide. Sulfide was detected in one of two surface water samples. There was no background concentration for comparison, but the sample had a concentration above the ESV (Table 7-28). Because sulfide also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was high; the mean concentration to ESV ratio was 640 (Appendix H, Table H-33). Because the mean concentration of sulfide was above the ESV, this COPEC will be evaluated further.

Upper Cobbs Pond. At Upper Cobbs Pond, there are four surface water integrated COPECs: manganese, nitrate/nitrite, sulfate, and sulfide. Nitrate/nitrite and sulfate were conservatively identified as integrated COPECs because they do not have an ESV or background concentration. Therefore, they are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Manganese and sulfide had an MDC that exceeded the ESV; these two COPECs are discussed below.

Manganese. Manganese was detected in all five surface water samples. Three of five samples had detections above the ESV, but only one chemical detection was above background concentration (Table 7-29). The background concentration is more than 3.2 times greater than the ESV; therefore, the ESV can be considered conservative. Although the MDC for manganese in surface water exceeds the background concentration, the mean concentration is less than the background concentration. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Sulfide. Sulfide was detected in both surface water samples. There was no background concentration for comparison, but both samples had concentrations above the ESV (Table 7-29). Because sulfide also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was high; the mean concentration to ESV ratio was 350 (Appendix H, Table H-34). Because the mean concentration of sulfide was above the ESV, this COPEC will be evaluated further.

Lower Cobbs Pond. At Lower Cobbs Pond, there are four surface water integrated COPECs: manganese, nitrate/nitrite, sulfate, and sulfide. Nitrate/nitrite and sulfate were conservatively identified as integrated COPECs because they do not have an ESV or background concentration. Therefore, they are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.9). Manganese and sulfide had an MDC that exceeded the ESV; these two COPECs are discussed below.

Manganese. Manganese was detected in all seven surface water samples. Four samples had detections above the ESV, but only one chemical detection was above background concentration (Table 7-30). The background concentration is more than 3.2 times greater than the ESV; therefore, the ESV can be considered conservative. Although the MDC for manganese in surface water exceeds the background concentration, the mean concentration is less than the background concentration. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Sulfide. Sulfide was detected in one of three surface water samples. There was no background concentration for comparison, but the sample had a concentration above the ESV (Table 7-30). Because sulfide also had a mean concentration that exceeded the ESV, it was evaluated further. The magnitude of ESV exceedance was high; the mean concentration to ESV ratio was 200 (Appendix H, Table H-35). Because the mean concentration of sulfide was above the ESV, this COPEC will be evaluated further.

Wetland Quality, Geographical Information, and On-site Migration of Chemicals

The next three evaluation and refinement factors are concerned with risk to wetlands. The three factors are:

- Category of wetland quality inside the AOC;
- Geographical relationship of on-site wetlands to AOC exceedance area; and
- Information about on-site migration of chemicals to on-site wetlands.

If the wetland quality is low, it is distant from the AOC exceedance area (i.e., high concentration area), or on-site migration is unlikely, it increases the likelihood that the remaining integrated COPECs [cadmium, chromium, silver, benz(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butyl phthalate, pyrene, and acetone in sediment and manganese and sulfide in surface water] will not be of ecological concern and do not need to be evaluated as final COPECs.

There are three wetlands partially inside the AOC. They range in size from 0.34–4.75 acres, with between 0.17 acres and 3.9 acres inside the AOC boundary. Wetlands 1 and 2 are Category 2 wetlands, while Wetland 3 is a Category 3 wetland (Table 7-12). Category 2 indicates moderate wetland quality, with some degradation of wetland functions. Category 3 indicates high wetland quality that is often forested. Camp Ravenna contains about 1,970 acres of wetlands, and the 7.67 acres of wetland inside the habitat boundary at the AOC represent 0.39% of the total wetlands at

Camp Ravenna (OHARNG 2014). The availability of many more wetland acres at Camp Ravenna lowers the importance of the wetlands at the AOC.

The three wetlands (Figure 7-2) are adjacent geographically to either the Backwater Area (Wetlands 2 and 3), Upper Cobbs Pond (Wetland 2), or to the unnamed tributary that drains Lower Cobbs Pond (Wetland 1). Wetland 3, the highest quality wetland, is associated with the Backwater Area, which contains the greatest number of sediment and surface water COPECs. This suggests integrated COPEC effects on wetland quality could be minimal.

Over a period of years, contaminants from Load Lines 3 and 12, as well as other upgradient AOCs, may have flowed northward through the Backwater Area, into Upper Cobbs Pond and Lower Cobbs Pond, and finally out of the AOC through the unnamed tributary to Sand Creek. Soluble contaminants are likely to be discharged, dispersed, and diluted. Insoluble (immobile) chemicals are more likely to be retained. The three wetlands associated with the AOC are considered an ecosystem sink during most seasons of the year. Based on the number of sediment and surface COPECs in the three EUs, it appears that COPEC migration becomes more limited moving downstream (i.e., northward) in the AOC. Off-site migration to downstream sample locations also does not appear to be an issue (see following section). These factors further reduce the concern about the remaining integrated COPECs.

Evaluation of Biological and Water Quality Sampling Stations

The last evaluation and refinement factor is:

- Evaluation of off-site migration of chemicals at biological/water quality stations.

As discussed in Section 7.3.2.3, various biological measurements of macroinvertebrates and fish, as well as chemical and physical measurements of surface water and sediment, were taken and assessed for evidence of downgradient contamination from AOCs. The results indicated that Upper Cobbs Pond and Lower Cobbs Pond are not currently affected by contamination from activities that occurred at the former RVAAP when it was in operation. Review of the FWBWQS (USACE 2005a) data from the downstream sampling location (Station S-8) showed many positive attribute ratings (e.g., good, excellent, full attainment), no sign of aquatic impairment, and the station was rated at Full Use Attainment Status, which indicated that all indices met the Ohio EPA biological criteria.

Therefore, COPECs at the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond have not adversely affected downstream ecological conditions. These findings greatly reduce concern for the remaining COPECs [cadmium, chromium, silver, benz(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, pyrene, di-n-butyl phthalate, and acetone in sediment and manganese and sulfide in surface water] at the AOC. In essence, while there is some uncertainty associated with dismissing these COPECs (because chemical data suggested the possibility for adverse effects), the lack of obvious biological effects in the ponds and at the downstream station outweighs the chemical findings. As a result, these remaining COPECs are not considered final COPECs and will not be evaluated further.

Evaluation of PBT Compounds and COPECs Without ESVs

As discussed in Level II, there are PBT compounds in soil and sediment as well as chemicals that are integrated COPECs because they did not have ESVs in surface soil, sediment, and surface water. These chemicals are evaluated below.

PBT Compounds. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) includes a PBT compound screen in the Level II ERA. This screen is necessary because not all ESVs account for bioaccumulation; instead, they are derived based primarily on toxicity to endpoint receptors exposed by direct contact (e.g., plants, soil-dwelling invertebrates) or ingesting soil or water (e.g., mammals, birds). Ohio EPA allows PBTs to be screened out in Level II if the "method used to derive the screening value considered exposure to higher trophic level organisms in the development of the screening value" (Ohio EPA 2008).

For the first two sources of soil ESVs preferred by Ohio EPA (EcoSSLs and PRGs), bioaccumulation in higher trophic levels is considered when developing the ESV. According to the EcoSSL guidance, "wildlife receptors may be exposed to contaminants in soil by two main pathways: incidental ingestion of soil while feeding, and ingestion of food items that have become contaminated due to uptake from soil" (USEPA 2007a). Deriving EcoSSL values includes uptake equations that account for both direct ingestion and food chain bioaccumulation (USEPA 2007a). The same is true of PRGs: "the 90th percentile of the soil-to-biota uptake factor was used as a conservative estimate of the chemical concentrations in wildlife food types (earthworms, plants, or small mammals)," and "the model accounts for the ingestion of soil as well as food" (DOE 1997). It is also important to note that both sources often derive values for multiple receptors, and the most conservative (lowest) value is chosen. Thus, for soil ESVs from these two sources, PBT compounds that have ratios less than one can be dismissed as final COPECs.

The USEPA Region 5 ESLs (USEPA 2003b) are an Ohio EPA-approved source of soil, sediment, and surface water ESVs (see Appendix H, Tables H-14 to H-16 for hierarchies) for some PBT compounds not covered in the EcoSSLs or PRGs. The ESLs also account for bioaccumulation in the food chain, as "development of ESLs focused on mammalian or avian species and identified those chemicals that have the potential for significant bioaccumulation or biomagnification" (USEPA 1999b). Thus, development of ESLs included bioaccumulation in higher tropic levels as a standard component in the equations, and PBT compounds with ESVs in soil, sediment, and surface water from this source that have ratios less than one can be dismissed as final COPECs. For this ERA, this includes beta-BHC in surface soil.

The other PBT compound detected in Pond Bank surface soil was mercury, which was detected above the ESV, which accounts for bioaccumulation (DOE 1997). This exceedance is to be expected, considering the background concentration is 70 times greater than the ESV. While the mean concentration of mercury (0.043 mg/kg) is above the background concentration (0.036 mg/kg) (Table 7-23), the similarity between the concentrations suggests exposures to mercury are not very different from background concentrations. Mercury was evaluated in the food chain during the historical ERA

(MKM 2005). Because the conservative scenario and no observed adverse effect level (NOAEL) did not result in HQs that were greater than 1, the risk was determined to be acceptable. Thus, mercury is eliminated from further consideration as a PBT chemical and will not be a final COPEC.

For sediment, mercury and PCB-1254 were identified as PBT chemicals. Mercury was detected in 13 of 14 samples at an average concentration of 0.0816 mg/kg in the Backwater Area, in 5 of 5 samples at an average concentration of 0.0662 mg/kg in Upper Cobbs Pond discrete sediment, in 1 of 1 samples at a concentration of 0.048 mg/kg in Upper Cobbs Pond ISM sediment, in 7 of 8 samples at an average concentration of 0.0538 mg/kg in Lower Cobbs Pond discrete sediment, and in 1 of 1 samples at a concentration of 0.1 mg/kg in Lower Cobbs Pond ISM sediment. The background concentration of mercury in sediment is 0.059 mg/kg, and the SRV is 0.12 mg/kg. Based on the similarity of the mean concentration and background concentration, mercury is not considered an ecological concern for the AOC. PCB-1254 was detected in two of four samples in the Backwater Area at a maximum concentration of 0.047 mg/kg and in one of two discrete samples collected in Upper Cobbs Pond at a maximum concentration of 0.032 mg/kg. The ESV for PCB-1254 is 0.0598 mg/kg and does not account for bioaccumulation. PCB-1254 was not detected in Lower Cobbs Pond. Both PCB-1254 and mercury were evaluated in the food chain during the historical ERA (MKM 2005). Because the NOAEL HQs were less than 1 for avian piscivores (heron and kingfisher; Appendix H, Table H-9), NOAEL HQs were low for mink (1.02 using the average exposure scenario; Appendix H, Table H-9). LOAEL HQs were less than 1 for all piscivores (Appendix H, Table H-10); therefore, risks to piscivorous wildlife from PCB-1254 were acceptable. In addition, dietary exposure doses based on mercury did not exceed dietary toxicity benchmarks for the heron, kingfisher, or mink. Thus, wildlife exposure to mercury and PCB-1254 is not a concern at the AOC. PCB-1254 and mercury are eliminated from further consideration as PBT chemicals and will not be final COPECs.

COPECs without ESVs. The *Guidance for Conducting Ecological Risk Assessments* specifies chemicals without screening benchmark values should be retained as COPECs (Ohio EPA 2008). While Ohio EPA allows the use of additional screening benchmark values, such values need to be approved prior to submitting the report. For the AOC, a search for (and subsequent approval of) additional values was not deemed necessary. Rather, to mitigate concern for the uncertainties associated with COPECs that lack ESVs, a limited additional evaluation was conducted for each medium, focusing on frequency of detection, relationship to background concentration, and other chemical-specific refinement factors.

For Pond Bank soil, the integrated COPECs without ESVs are nitrate/nitrite, nitrocellulose, and benzoic acid. Nitrate/nitrite was detected in 1 of 11 samples and benzoic acid was detected in 1 of 13 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in three of three samples, it is essentially non-toxic (USEPA 1987), and this chemical is also not expected to be an ecological concern.

For Backwater Area sediment, antimony, beryllium, selenium, nitrate/nitrite, TNT, nitrocellulose, and tetryl were identified as integrated COPECs without an ESV. Antimony was detected in 11 of 14 samples. The mean concentration (0.607 mg/kg) is below the SRV (1.3 mg/kg). Sediment concentrations can be compared to the Ohio specific SRVs in conjunction with site-specific background concentrations to determine whether sediment has been potentially impacted by site-related activities. Because the mean concentration for antimony is below the SRV, antimony is not considered of ecological concern in sediment. Beryllium was detected in all 14 samples collected; however, the mean concentration was 0.782 mg/kg which is below the SRV of 0.8 mg/kg. As a result, beryllium is not considered of ecological concern for sediment. Selenium was detected in 8 of 14 samples collected; however, the mean concentration was 0.5 mg/kg, which is below the SRV of 2.1 mg/kg, indicating selenium is not of ecological concern in sediment. Nitrate/nitrite was detected in 1 of 12 samples, and tetryl was detected in 1 of 14 samples. Thus, exposure to these chemicals would be limited. TNT was detected in 6 of 14 samples, with a mean concentration of 0.0811 mg/kg. The findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about TNT in the Backwater Area. While nitrocellulose was detected in four of four samples, it is essentially non-toxic (USEPA 1987) and not expected to be of ecological concern.

For Upper Cobbs Pond sediment, antimony; beryllium; hexavalent chromium; selenium; nitrate/nitrite; ammonia; total phosphorous; TNT; 4-amino-2,6-DNT; HMX; nitrocellulose; and tetryl were identified as integrated COPECs without an ESV. Antimony was detected in all five discrete samples collected. The mean concentration (0.78 mg/kg) is below the SRV (1.3 mg/kg). Because the mean concentration for antimony is below the SRV, antimony is not considered of ecological concern in sediment. Beryllium was detected in all five discrete samples collected; however, the mean concentration was 0.842 mg/kg, which is very close to the SRV of 0.8 mg/kg. As a result, beryllium is not considered of ecological concern for sediment. Selenium was detected in three of five discrete samples; however, the mean concentration was 0.839 mg/kg which is well below the SRV of 2.1 mg/kg, indicating selenium is not of ecological concern in sediment. Nitrate/nitrite, ammonia, and total phosphorous were detected in the ISM sediment sample taken at Upper Cobbs Pond in the 2003 FWBWQS. Because nitrate/nitrate was only detected in 3 of 24 sediment samples collected across all three EUs, it is not expected to be a concern. Although discrete samples at the AOC were not analyzed for ammonia or phosphorous, the findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about them in Upper Cobbs Pond. Hexavalent chromium was detected in one of five discrete samples, and TNT was detected in two of five discrete samples. The findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about hexavalent chromium and TNT in Upper Cobbs Pond. 4-Amino-2,6-DNT was detected in the one discrete sample collected at Upper Cobbs Pond and was not detected in the ISM sample at Upper Cobbs Pond or in the sediment samples collected at other EUs. 4-Amino-2,6-DNT was only detected in one sample in all three EUs and is not expected to be of ecological concern in sediment. HMX was detected in one of five discrete sediment samples. Because HMX was only detected in 2 of 27 discrete samples collected across all three EUs and was not detected in the ISM sample at either pond, it is not expected to be a concern. Due to the infrequent detection of this chemical, exposure would be limited, and HMX is not expected to be of ecological concern. Nitrocellulose was detected in both discrete samples collected, but is essentially non-toxic (USEPA 1987); this chemical is not expected to be of ecological concern. Tetryl was detected in one of five discrete samples collected. Because tetryl was only detected in 3 of 27 discrete samples collected across all three EUs and was not detected in the ISM sample at either pond, it is not expected to be of ecological concern.

For Lower Cobbs Pond sediment, antimony, beryllium, hexavalent chromium, selenium, nitrate/nitrite, ammonia, total phosphorous, HMX, and nitrocellulose were identified as integrated COPECs without an ESV. Antimony was detected in one of eight discrete samples collected. The mean concentration (0.328 mg/kg) is below the SRV (1.3 mg/kg), and antimony is not considered an ecological concern in sediment. Beryllium was detected in all eight discrete samples collected; however, the mean concentration was 0.679 mg/kg, which is below the SRV of 0.8 mg/kg. For the ISM sediment sample, the detected concentration was 0.83 mg/kg, which is essentially equal to the SRV. As a result, beryllium is not considered of ecological concern for sediment. Nitrate/nitrite, ammonia, and total phosphorous were detected in the ISM sediment sample taken at Lower Cobbs Pond in the FWBWQS. Because nitrate/nitrate was only detected in 3 of 24 sediment samples collected across all three EUs, it is not expected to be a concern. Although discrete samples at the AOC were not analyzed for ammonia or phosphorous, the findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about them in Lower Cobbs Pond. Hexavalent chromium was detected in two of six discrete samples. The findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about hexavalent chromium in Lower Cobbs Pond. Selenium was detected in four of eight discrete samples collected; however, the mean concentration was 0.839 mg/kg, which is below the SRV of 2.1 mg/kg and indicates selenium is not of ecological concern in sediment. HMX was detected in one of eight sediment samples. Because HMX was only detected in 2 of 27 discrete samples collected across all three EUs and was not detected in the ISM sample at either pond, it is not expected to be a concern. Nitrocellulose was detected in the one discrete sample collected, but it is essentially non-toxic (USEPA 1987) and not expected to be of ecological concern.

For Backwater Area surface water, sulfate and chloromethane were identified as integrated COPECs without an ESV. For Upper Cobbs Pond and Lower Cobbs Pond, nitrate/nitrite and sulfate were identified as integrated COPECs without an ESV. Nitrate/nitrite was detected in the four samples taken for the FWBWQS at Upper Cobbs Pond and Lower Cobbs Pond but was not detected in the six RI samples taken in the Backwater Area and Upper Cobbs Pond and Lower Cobbs Pond. Between the lack of detection in the RI samples and the findings of the biological and water quality sampling stations discussed in the previous section, nitrate/nitrite is not expected to be an ecological concern. For surface water at the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond, sulfate was detected in six of seven samples. The findings of the biological and water quality sampling stations discussed in the previous section alleviate concerns about sulfate throughout the AOC. Chloromethane was detected in the Backwater Area in one of three samples. Chloromethane was not detected in any of the three samples at the other EUs; based on this information and chloromethane having only one detection in the Backwater Area, it is not expected to be of ecological concern.

Threatened and Endangered Species

The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) specifies that threatened and endangered species should be evaluated in a Level III Baseline ERA. The Least Bittern (*Ixobrychus exilis*), a state-threatened species, has been observed at the AOC. This bird, the smallest in the heron family, feeds on insects and fish and has a diet similar to the Great Blue Heron. The historical ERA evaluated the Great Blue Heron and other piscivores (kingfisher and mink) for food web exposures to COPECs at the AOC. In particular, PCB-1254 and mercury (the two most likely COPECs to be of bioaccumulative concern) were evaluated. The historical Level III work reported NOAEL HQs for PCB-1254 were less than 1 for avian piscivores (heron and kingfisher; Appendix H, Table H-9), NOAEL HQs were low for mink (1.02 using the average exposure scenario; Appendix H, Table H-9), and LOAEL HQs were less than 1 for all piscivores (Appendix H, Table H-10). In addition, dietary exposure doses based on mercury did not exceed dietary toxicity benchmarks for the heron, kingfisher, or mink (Appendix H, Tables H-9 and H-10). The sediment concentrations used in the historical ERA (0.042–0.047 mg/kg for PCB-1254 and 0.064-0.18 mg/kg for mercury) are similar to those used in the PBA08 RI ERA (0.032–0.047 mg/kg for PCB-1254 and 0.054–0.15 mg/kg for mercury); therefore, the doses used in the historical ERA are similar to current doses. Thus, wildlife exposure and risk to PCB-1254 and mercury are similar to the historical findings and are not a current concern at the AOC. Based on the results of the food web modeling in the historical ERA (MKM 2005), another Level III ERA is not recommended for the Least Bittern (*Ixobrychus exilis*).

Summary of Findings in Step 3A

Of the 12 integrated COPECs in surface soil, 3 COPECs (nitrate/nitrite, nitrocellulose, and benzoic acid) were eliminated because they did not have ESVs and had low frequency of detection or little to no toxicity. One PBT compound (beta-BHC) was eliminated because it had a ratio less than one, using an ESV that accounted for bioaccumulation. Additional integrated COPECs were eliminated from further consideration because the mean concentration is smaller than the ESV (arsenic, cadmium, and cobalt) or the mean concentration is smaller than the background concentration (aluminum, lead, and vanadium).

The remaining two integrated COPECs in soil (mercury and zinc) have the following combination of factors that together eliminated them from further consideration.

1. Mean concentrations are only slightly higher than background concentrations (mercury and zinc).
2. Mean concentration-to-ESV ratios of exceedance are near one (zinc).
3. Ohio EPA guidance allows alternative ESVs that are less conservative than the ESVs used in this ERA. These alternate ESVs (unlike the preferred ESV) are above background concentrations. If these alternate ESVs were used in lieu of the current ones, ratios for mercury and zinc would be below one.

No final COPECs were identified for surface soil.

Of the 40 integrated COPECs in sediment, 12 were eliminated as COPECs because they did not have ESVs and (1) they had mean concentrations below or slightly above the SRV (antimony, beryllium, and selenium), (2) they had low frequency of detection (nitrate/nitrite; 4-amino-2,6-DNT; HMX; and tetryl), (3) they are essentially non-toxic (nitrocellulose), or (4) the findings of the biological and water quality sampling stations alleviated concerns (ammonia, total phosphorous, hexavalent chromium, and TNT). Mercury and PCB-1254 were identified as PBT chemicals in sediment. Mercury was detected above the background concentration but below the SRV. Both PCB-1254 and mercury were evaluated in the food chain during the historical ERA (MKM 2005) and determined to not be a concern. For the 26 remaining integrated COPECs, most were eliminated because (1) the mean concentration was less than the ESV, (2) the mean concentration was less than their background concentrations and/or SRVs, (3) the frequency of detection was low, or (4) the frequency of detection was low in combination with a low mean to ESV or low mean to background and/or SRV ratio. After applying these factors, only silver, benz(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, chrysene, pyrene, and acetone remained as integrated COPECs in sediment. The findings of the biological and water quality sampling stations alleviated concerns about these remaining integrated COPECs.

No final COPECs were identified for sediment for the Backwater Area, Upper Cobbs Pond, or Lower Cobbs Pond.

Of the eight integrated COPECs in surface water throughout all three EUs, three were eliminated as COPECs because they did not have ESVs and either had low frequency of detection (chloromethane), or the findings of the biological and water quality sampling stations alleviated concerns about their detection throughout the AOC (nitrate/nitrite and sulfate). No PBT compounds were detected in surface water. Barium, selenium, and silver were eliminated from further consideration because the mean concentration is smaller than the ESV. Manganese was eliminated in two of the three EUs because its mean was below its background concentration. Sulfide at Upper Cobbs Pond, Lower Cobbs Pond, and the Backwater Area and manganese in the Backwater Area were eliminated based on the biological and water quality station sampling results.

No final COPECs in surface water were identified for the Backwater Area, Upper Cobbs Pond, or Lower Cobbs Pond.

7.3.3.8 <u>Consideration of Human Health Driven Remediation</u>

The HHRA does not identify any COCs and recommends no further action for soil, sediment, or surface water at the AOC. Thus, there would be no remediation implemented to further protect human health that would also protect ecological resources.

7.3.3.9 <u>Uncertainties and Mitigations</u>

Uncertainties or unknowns are present in both exposure data and effects data. To mitigate uncertainty in exposure data, the MDCs of all available and appropriate data were used in Level I. In Level II, the

MDC and mean COPEC concentrations were used to mitigate uncertainty concerning exposure data for receptors in the AOC. To mitigate uncertainty in effects information, a site visit for habitat condition was conducted, and the latest INRMP of state- or federally-listed species sightings and jurisdictional wetlands was used (OHARNG 2014). In addition, the ORAM was applied to the wetland complexes at the AOC. Conservative ESVs, which are typically based on concentrations observed to have no effect on test species in laboratory studies, were used in Level II to mitigate uncertainty concerning effects on receptors in the AOC. Some chemicals are COPECs because they do not have ESVs. Even though all individual PAHs were eliminated as final COPECs, they contribute to the combined (joint action) toxicity of PAHs on ecological receptors. As a result, the average concentrations of all integrated PAH COPECs in Backwater Area sediment (the only EU and medium with PAH COPECs) were summed (3.3 mg/kg) and compared to the total PAH ESV in sediment (1.61 mg/kg), resulting in a ratio of 2.05. While the magnitude of the ratio suggests a limited potential for concern to ecological receptors, there is other evidence that mitigates this concern. Specifically, Wetland 3 (Category 3) is the highest quality wetland and is associated with the Backwater Area. The high ORAM score suggests total PAH effects on wetland quality are minimal.

In Level II, to mitigate uncertainty concerning effects on receptors in the AOC, the ESVs for COPECs are compared to background concentrations. Using ESVs that are lower than background concentrations indicates the conservative nature of the evaluation. Conservative ESVs are appropriate for use as screening thresholds in Level I and II (i.e., soil constituents with an MDC below the ESV need no further consideration in Level II).

7.3.3.10 Summary and Recommendations of the Ecological Risk Assessment

COPECs were identified in bank soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. Those chemicals retained after screening historical and PBA08 RI data and data from the FWBWQS were termed integrated COPECs.

A total of 12 integrated soil COPECs, 40 integrated sediment COPECs, and 8 integrated surface water COPECs were further evaluated in Step 3A with technical and refinement factors. All integrated soil, sediment, and surface water COPECs were determined to be of no ecological concern—none require remediation or further evaluation. Consequently, the ERA for the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond can conclude with a Level II that no further action is necessary to be protective of important ecological resources.

7.3.4 Conclusions

There is chemical contamination present in soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. This contamination was identified using historical and PBA08 RI data and data from the FWBWQS. The terrestrial vegetation habitat at the AOC consists of four forest community types, one shrub community type, and three herbaceous community types. The dominant forest community at the AOC is the red maple (*A. rubrum)* successional forest. Upper Cobbs Pond, Lower Cobbs Pond, and the wetlands are important/significant ecological resources. In addition, the Least

Bittern (*Ixobrychus exilis*), which is a state of Ohio threatened species, uses the AOC. The Least Bittern (*Ixobrychus exilis*) and its habitat at the AOC are important/significant ecological resources. These findings invoked a Level II assessment.

The Level II assessment evaluated soil, sediment, and surface water using historical and PBA08 RI data, identified integrated COPECs, and evaluated the integrated COPECs using technical and refinement factors in Step 3A. The factors in Step 3A showed there is no further evaluation necessary for integrated COPECs, and there is no ecological concern requiring remediation. Consequently, the ERA for the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond can conclude with a Level II ERA that no further action is necessary to be protective of important ecological resources. This supports the conclusion from the Phase II RI, which states:

> "No additional action is recommended based on ecological risk because, based on the Step 3a refinement step, it was determined that site-related risks were not great enough to warrant proceeding further into the ecological risk assessment process."

Table 7–1. Risk Assessment Data Set for Surface Soil (0–1 ft bgs) Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
CPCsb-030	CPCsb-030-5105-SO	3/29/2010	0 – 1
CPCsb-031	CPCsb-031-5109-SO	3/24/2010	0 – 1
CPCsb-032	CPCsb-032-5113-SO	3/24/2010	0 – 1
CPCsb-034	CPCsb-034-5119-SO	3/29/2010	0 – 1
CPCsb-035	CPCsb-035-5123-SO	3/29/2010	0 – 1
CPCss-036	CPCss-036-5014-SO	2/23/2010	0 – 1
CPCss-037	CPCss-037-5015-SO	2/23/2010	0 – 1
CPCss-038	CPCss-038-5016-SO	2/23/2010	0 – 1
CPCss-039	CPCss-039-5017-SO	2/23/2010	0 – 1
CPCss-040	CPCss-040-5018-SO	2/23/2010	0 – 1
CPCss-041	CPCss-041-5019-SO	2/23/2010	0 – 1
CPCss-042	CPCss-042-5020-SO	2/23/2010	0 – 1
CPCss-043	CPCss-043-5021-SO	2/23/2010	0 – 1
ULCPsd-010	ULCPsd-010-0001-SD	8/21/2001	0 – 0.5
ULCPss-001	ULCPss-001-0001-SO	7/17/2001	0 – 1
ULCPss-002	ULCPss-002-0001-SO	7/17/2001	0 – 1
ULCPss-003	ULCPss-003-0001-SO	7/18/2001	0 – 1
ULCPss-004	ULCPss-004-0001-SO	7/17/2001	0 – 1
ULCPss-005	ULCPss-005-0001-SO	7/18/2001	0 – 1
ULCPss-006	ULCPss-006-0001-SO	7/19/2001	0 – 1
ULCPss-007	ULCPss-007-0001-SO	7/18/2001	0 – 1
ULCPss-008	ULCPss-008-0001-SO	7/18/2001	0 – 1
ULCPss-009	ULCPss-009-0001-SO	7/19/2001	0 – 1
ULCPss-010	ULCPss-010-0001-SO	7/19/2001	0 – 1

bgs = Below ground surface.
ft = Feet.
ID = Identification.

Table 7–2. Risk Assessment Data Set for Subsurface Soil Discrete Samples

Location	Sample ID	Date	Depth (ft bgs)
CPCsb-032	CPCsb-032-5114-SO	3/24/2010	1 – 4
CPCsb-034	CPCsb-034-5120-SO	3/29/2010	1 – 4
CPCsb-035	CPCsb-035-5124-SO	3/29/2010	1 – 4
CPCsb-032	CPCsb-032-5115-SO	3/24/2010	4 – 7
CPCsb-035	CPCsb-035-5125-SO	3/29/2010	4 – 7
CPCsb-032	CPCsb-032-5116-SO	3/24/2010	7 – 10

bgs = Below ground surface.
ft = Feet.
ID = Identification.

Table 7–3. Risk Assessment Data Set for Sediment

Location	Sample ID	Date	Depth (ft bgs)
Backwater Area – Discrete Samples			
CPCsd-047	CPCsd-047-5025-SD	4/1/2010	0 – 0.5
CPCsd-048	CPCsd-048-5026-SD	4/1/2010	0 – 0.5
ULCPsd-004	ULCPsd-004-0001-SD	8/22/2001	0 – 1
ULCPsd-005	ULCPsd-005-0001-SD	8/22/2001	0 – 1
ULCPsd-006	ULCPsd-006-0001-SD	8/22/2001	0 – 1
ULCPsd-007	ULCPsd-007-0001-SD	8/21/2001	0 – 0.75
ULCPsd-008	ULCPsd-008-0001-SD	8/21/2001	0 – 0.5
ULCPsd-009	ULCPsd-009-0001-SD	8/21/2001	0 – 0.85
ULCPsd-011	ULCPsd-011-0001-SD	8/20/2001	0 – 0.75
ULCPsd-012	ULCPsd-012-0001-SD	8/20/2001	0 – 1.75
ULCPsd-013	ULCPsd-013-0001-SD	8/20/2001	0 – 1.75
ULCPsd-014	ULCPsd-014-0001-SD	7/25/2001	0 – 0.5
ULCPsd-015	ULCPsd-015-0001-SD	8/17/2001	0 – 0.5
ULCPsd-015	ULCPsd-015-0002-SD	9/27/2001	0 – 1
ULCPsd-016	ULCPsd-016-0001-SD	8/17/2001	0 – 1.5
Upper Cobbs Pond – Discrete Samples			
CPCsd-046	CPCsd-046-5024-SD	3/25/2010	0 – 0.5
CPCsd-049	CPCsd-049-5032-SD	3/25/2010	0 – 0.5
ULCPsd-017	ULCPsd-017-0001-SD	8/17/2001	0 – 1
ULCPsd-018	ULCPsd-018-0001-SD	8/16/2001	0 – 0.5
ULCPsd-019	ULCPsd-019-0001-SD	8/16/2001	0 – 0.5
ULCPsd-020	ULCPsd-020-0001-SD	8/16/2001	0 – 0.75
Upper Cobbs Pond – ISM Samples			
Uppercobb Pond	FSW-SD-030-0000	6/23/2003	0 – 0.25
Lower Cobbs Pond – Discrete Samples			
CPCsd-044	CPCsd-044-5022-SD	3/29/2010	0 – 0.5
CPCsd-045	CPCsd-045-5023-SD	4/1/2010	0 – 0.5
ULCPsd-021	ULCPsd-021-0001-SD	8/15/2001	0 – 1
ULCPsd-021	ULCPsd-021-0002-SD	9/27/2001	0 – 1
ULCPsd-022	ULCPsd-022-0001-SD	8/15/2001	0 – 0.75
ULCPsd-023	ULCPsd-023-0001-SD	8/15/2001	0 – 0.75
ULCPsd-024	ULCPsd-024-0001-SD	8/14/2001	0 – 0.5
ULCPsd-025	ULCPsd-025-0001-SD	7/25/2001	0 – 0.5
ULCPsd-026	ULCPsd-026-0001-SD	8/14/2001	0 – 1

Table 7–3. Risk Assessment Data Set for Sediment (continued)

Location	Sample ID	Date	Depth (ft bgs)
Lower Cobbs Pond – ISM Samples			
Lowcobb Pond	FSW-SD-031-0000	6/23/2003	0 – 0.25

bgs = Below ground surface.
ft = Feet.
ID = Identification.
ISM = Incremental sample method.

Table 7–4. Risk Assessment Data Set for Surface Water

Location	Sample ID	Date
Backwater Area		
CPCsw-047	CPCsw-047-5030-SW	4/1/2010
CPCsw-048	CPCsw-048-5031-SW	4/1/2010
ULCPsw-001	ULCPsw-001-0001-SW	7/26/2001
ULCPsw-002	ULCPsw-002-0001-SW	7/25/2001
Upper Cobbs Pond		
CPCsw-046	CPCsw-046-5029-SW	3/25/2010
Uppercobb Pond	FSW-SW-030-0000	6/23/2003
Uppercobb Pond	FSW-SW-070-0000	6/23/2003
ULCPsw-003	ULCPsw-003-0001-SW	7/24/2001
ULCPsw-004	ULCPsw-004-0001-SW	7/24/2001
Lower Cobbs Pond		
CPCsw-044	CPCsw-044-5027-SW	3/29/2010
CPCsw-045	CPCsw-045-5028-SW	4/1/2010
Lowcobb Pond	FSW-SW-031-0000	6/23/2003
Lowcobb Pond	FSW-SW-071-0000	6/23/2003
ULCPsw-005	ULCPsw-005-0001-SW	7/24/2001
ULCPsw-006	ULCPsw-006-0001-SW	7/24/2001
ULCPsw-007	ULCPsw-007-0001-SW	7/24/2001

ID = Identification.

Table 7–5. Summary of SRCs

SRC	Surface Soil (0–1 ft bgs)	Subsurface Soil (1–13 ft bgs)	Surface Water			Sediment		
			BW	UCP	LCP	BW	UCP	LCP
Inorganic Chemicals								
Aluminum	X	--	--	--	--	X	X	X
Antimony	--	--	X	X	X	X	X	X
Arsenic	X	--	X	--	--	--	--	X
Barium	X	--	X	--	--	X	X	X
Beryllium	--	--	X	--	X	X	X	X
Cadmium	X	X	X	--	X	X	X	X
Chromium	X	--	X	X	--	X	X	X
Chromium, hexavalent	X	--	--	--	--	--	X	X
Cobalt	X	--	X	--	X	X	X	X
Copper	X	--	X	--	--	X	X	X
Cyanide	X	--	--	--	--	X	--	X
Lead	X	X	X	X	X	X	X	X
Manganese	--	--	X	X	X	--	--	--
Mercury	X	--	--	--	--	X	X	X
Nickel	X	--	X	X	X	X	X	X

Table 7–5. Summary of SRCs (continued)

SRC	Surface Soil (0–1 ft bgs)	Subsurface Soil (1–13 ft bgs)	Surface Water			Sediment		
			BW	UCP	LCP	BW	UCP	LCP
Nitrate/Nitrite	X	--	--	X	X	X	--	--
Selenium	X	X	X	X	X	X	X	X
Silver	X	X	X	--	--	X	X	X
Sulfate	--	--	X	X	X	--	--	--
Sulfide	--	--	X	X	X	--	--	--
Thallium	X	--	X	--	X	--	--	--
Vanadium	X	--	X	X	X	X	X	X
Zinc	X	--	X	--	--	--	--	--
Explosives								
4-Amino-2,6-Dinitrotoluene	--	--	X	X	--	--	X	--
1,3-Dinitrobenzene	--	--	--	--	--	--	X	--
2,6-Dinitrotoluene	--	--	--	--	--	X	--	--
2,4,6-Trinitrotoluene	--	--	--	--	--	X	X	--
HMX	--	--	--	--	--	--	X	X
Nitrocellulose	X	X	--	--	--	X	X	X
Tetryl	--	--	--	--	--	X	--	X
Pesticide/PCB								
beta-BHC	X	--	--	--	--	--	--	--
delta-BHC	--	--	--	--	--	--	--	--
PCB-1254	--	--	--	--	--	X	X	--
Semi-volatile Organic Compounds								
2-Methylnaphthalene	X	X	--	--	--	--	--	--
Acenaphthene	--	--	--	--	--	--	--	--
Acenaphthylene	X	--	--	--	--	--	--	--
Anthracene	--	--	--	--	--	X	--	--
Benz(a)anthracene	X	X	--	--	--	X	X	X
Benzenemethanol	X	--	--	--	X	--	--	--
Benzo(a)pyrene	X	X	--	--	--	X	X	X
Benzo(b)fluoranthene	X	X	--	--	--	X	X	X
Benzo(ghi)perylene	X	X	--	--	--	X	X	X
Benzo(k)fluoranthene	X	X	--	--	--	X	X	X
Benzoic acid	X	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	X	--	--	X		X	--	--
Butyl benzyl phthalate	--	--	--	--	X	--	--	--
Chrysene	X	X	--	--	--	X	X	X
Dibenz(a,h)anthracene		X	--	--	--	X	--	--
Di-n-butyl phthalate	X	X	--	--	--	--	--	X
Fluoranthene	X	X	--	--	--	X	X	X
Fluorene	--	--	--	--	--	X	--	--
Indeno(1,2,3-cd)pyrene	X	X	--	--	--	X	X	X
Naphthalene	--	--	--	--	--	--	--	--
Phenanthrene	X	X	--	--	--	X	X	X
Pyrene	X	X	--	--	--	X	X	X

Table 7–5. Summary of SRCs (continued)

SRC	Surface Soil (0–1 ft bgs)	Subsurface Soil (1–13 ft bgs)	Surface Water			Sediment		
			BW	UCP	LCP	BW	UCP	LCP
Volatile Organic Compounds								
2-Butanone	--	--	--	--	--	X	X	X
Acetone	--	--	X	--	--	X	X	X
Carbon disulfide	--	--	--	--	--	--	--	X
Chloromethane	--	--	X	--	--	--	--	--
Methylene chloride	--	--	--	--	--	X	--	--
Toluene	--	--	X	--	--	--	--	--

Exposure Units:
BW = Backwater.
LCP = Lower Cobbs Pond.
UCP = Upper Cobbs Pond.bgs = Below ground surface.
BHC = Hexachlorocyclohexane.
EU = Exposure unit.
ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.
X = Chemical is an SRC at this EU.
-- = Chemical is not an SRC at this EU.

Table 7–6. Summary of COPCs

COPC	Surface Soil (0–1 ft bgs)	Subsurface Soil (1–13 ft bgs)	Surface Water			Sediment		
			BW	UCP	LCP	BW	UCP	LCP
Inorganic Chemicals								
Aluminum	X	--	--	--	--	X	X	X
Ammonia[a]	--	--	--	--	--	--	X	X
Arsenic	X	--	X	--	--	--	--	X
Chromium	X	--	--	--	--	X	X	X
Chromium, hexavalent	--	--	--	--	--	--	X	X
Cobalt	X	--	X	--	--	X	X	X
Cyanide	X	--	--	--	--	X	--	X
Manganese	--	--	X	--	X	--	--	--
Nitrate/Nitrite[a]	--	--	--	X	X	--	--	--
Selenium	--	--	X	--	--	--	--	--
Sulfate[a]	--	--	X	X	X	--	--	--
Sulfide[a]	--	--	X	X	X	--	--	--
Semi-volatile Organic Compounds								
Benz(a)anthracene	--	--	--	--	--	X	--	--
Benzo(a)pyrene	X	X	--	--	--	X	X	X
Benzo(b)fluoranthene	--	--	--	--	--	X	--	--
Dibenz(a,h)anthracene	--	--	--	--	--	X	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	X	--	--

[a] Analyte identified as COPC because no screening criteria are available, these parameters are reported as water quality parameters for protection of aquatic organisms and have very low toxicity to humans.

Exposure Units:
BW = Backwater.
LCP = Lower Cobbs Pond.
UCP = Upper Cobbs Pond.
bgs = Below ground surface.
COPC = Chemical of potential concern.
ft = Feet.
X = Chemical is a COPC at this depth interval.
-- = Chemical is not a COPC in this exposure unit.

Table 7–7. Screening Levels for Soil Corresponding to an HQ of 1 and TR of 1E-05

COPC	Critical Effect or Target Organ	Screening Level	
		Resident Receptor[a] FWCUG	
		HQ=1	TR=1E-05
Aluminum	Neurotoxicity in offspring	73,798	--
Arsenic	Skin	20.2	4.25[b]
Chromium, trivalent	NOAEL	81,473	--
Cobalt	NS	1,313	8,030
Cyanide	Reproductive	2.7	--
Benzo(a)pyrene	NA	--	0.221

All units are milligrams/kilogram (mg/kg).

[a] Resident Receptor FWCUGs are the smaller of the Adult or Child values for each COPC and endpoint (non-cancer and cancer).

[b] Risk-based FWCUG is less than the background screening values for arsenic in surface soil (15.4 mg/kg) and subsurface soil (19.8 mg/kg).

COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
NA = Not applicable.
NOAEL = No observed adverse effect level.
NS = Not specified.
TR = Target risk.
-- = No value available.

Table 7–8. Screening Levels for Sediment Corresponding to an HQ of 1 and TR of 1E-05

COPC	Critical Effect or Target Organ	Screening Level	
		Resident Receptor[a] FWCUG	
		HQ=1	TR=1E-05
Aluminum	Neurotoxicity in offspring	73,798	--
Arsenic	Skin	20.2	4.25[b]
Chromium, trivalent	NOAEL	81,473	--
Chromium, hexavalent	Stomach, liver/kidney	199	268[d]
Cobalt[c]	NS	23	4200
Cyanide	Reproductive	2.7	--
Benz(a)anthracene	NA	--	2.21
Benzo(a)pyrene	NA	--	0.221
Benzo(b)fluoranthene	NA	--	2.21
Dibenz(a,h)anthracene	NA	--	0.221
Indeno(1,2,3-cd)pyrene	NA	--	2.21

COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
NA = Not applicable.
NOAEL = No observed adverse effect level.
NS = Not specified.
TR = Target risk.
-- = No value available.

Table 7–9. Screening Levels for Surface Water Corresponding to an HQ of 1 and TR of 1E-05

COPC	Critical Effect or Target Organ	Screening Level	
		Resident Receptor[a] FWCUG	
		HQ=1	TR=1E-05
Arsenic	Skin	0.0463	0.011
Cobalt[b]	NS	0.006	--
Manganese	CNS	6.326	--
Selenium[b]	--	0.1	--

CNS = Central nervous system.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
NS = Not specified.
TR = Target risk.
-- = No value available.

Table 7–10. Concentrations of Benzo(a)pyrene in Soil from Various Environmental Studies

Study	Number of Samples	Geometric Mean or Median	Minimum	95th Percentile[a]	Maximum
CA/T Project[b]	873	0.3	0.031	17	230
LSPA Project[b]	489	0.44	ND	--	222
Watertown[b]	17	0.95	0.6	4.77	6.08
Worcester[b]	67	--	ND	3.3	9.7
New England[c]	62	0.686	ND	1.82	13
Illinois[d] Urban	--	--	--	2.1	--
Illinois[d] Rural	--	--	--	0.98	--
ATSDR[e] Urban	--	--	0.165	--	0.22
ATSDR[e] Rural	--	--	0.002	--	1.3
ATSDR[e] Agricultural	--	--	0.0046	--	0.9
NYSDEC Rural Near Roads[f]	28	--	ND	1.1	2.4
NYSDEC Rural Distant Roads[f]	118	--	ND	0.12	3.4

[a] Lognormal 95th percentile value for all studies except: (1) New England value is 95% upper confidence limit and (2) NYSDEC values are distribution-free 95th percentile.

[b] Data reported by Massachusetts Department of Environmental Protection (MADEP 2002) are from the following data sets:
CA/T = Data collected by Mass Highway Department as part of the Central Artery/Tunnel (CA/T) project.
LSPA = Preliminary data compiled by the Massachusetts Licensed Site professional Association (LSPA) from data submitted by its members in 2001.
Water Town and Worcester Site-specific samples.

[c] Data from three New England locations from Bradley et al. 1994.

[d] Concentrations of polycyclic aromatic hydrocarbons (PAHs) in Illinois metropolitan statistical areas (urban) and non-metropolitan statistical areas (rural) as reported by Illinois Environmental Protection Agency (IEPA 2005).

[e] Data published by the Agency for Toxic Substances and Disease Registry (ATSDR) in PAHs August 1995.

[f] Distribution-free 95th percentile values for near roads (less than 10 ft from roads and pavement) and not near roads (more than 15 ft from roads and pavement) from New York State Brownfield Cleanup program Development of Soil Cleanup Objectives Technical Support Document (September 2006), Appendix D.

ND = Not detected.
NYSDEC = New York State Department of Environmental Conservation.
-- = No value reported for this source.

Table 7–11. Summary of Historical COPECs per the Phase II RI

Group	COPEC	Shallow Soil	Sediment	Surface Water
Inorganic Chemicals	Aluminum	X	--	--
	Antimony	--	Q	--
	Arsenic	X	X	--
	Beryllium	--	Q	--
	Cadmium	X	X	--
	Chromium	X	X	--
	Copper	X	X	--
	Cyanide	--	X	--
	Iron	X	--	X
	Lead	--	X	--
	Manganese	--	--	Q
	Mercury	X	Q	--
	Nickel	X	X	--
	Selenium	--	--	X
	Silver	X	X	X
	Vanadium	X	--	--
	Zinc	X	--	--
	Nitrate	Q	Q	--
	Sulfate	--	--	Q
	Sulfide	--	--	X
PCB	Aroclor-1254	--	Q	--
SVOCs	2,6-Dinitrotoluene	--	X	--
	Anthracene	--	X	--
	Benz(a)anthracene	--	X	--
	Benzo(a)pyrene	--	X	--
	Benzo(ghi)perylene	--	X	--
	Benzo(k)fluoranthene	--	X	--
	Chrysene	--	X	--
	Fluoranthene	--	X	--
	Indeno(1,2,3-cd)pyrene	--	X	--
	Phenanthrene	--	X	--
	Pyrene	--	X	--
	Total PAHs	--	X	--
VOCs	Acetone	--	--	Q
	Chloromethane	--	--	Q
Explosives	2,4,6-Trinitrotoluene	--	Q	--
	Nitrocellulose	Q	Q	--

Adapted from Tables 7-1, 7-2, and 7-3 from the Phase II Remedial Investigation Report for Upper and Lower Cobbs Ponds (MKM 2005)

COPEC = Chemical of potential ecological concern.

PCB = Polychlorinated biphenyl.

SVOC = Semi-volatile organic compound.

VOC = Volatile organic compound.

-- = Chemical not identified as a COPEC in this data set.

Q = Qualitative COPEC; persistent, bioaccumulative, and toxic chemical; or no ecological screening value (ESV).

X = Quantitative COPEC, exceeds ESV.

Table 7–12. Wetlands Associated with the Upper and Lower Cobbs Ponds AOC

Wetland ID	Wetland Type[1]	Total Wetland Size	ORAM Score	ORAM Category
Wetland 1[2]	PFO1E	0.34 acres (0.17 acres inside AOC)	34	2
Wetland 2[3]	PUBH/PEM1F/PSS1F/PFO1E	4.75 acres (3.60 acres inside AOC)	55	2
Wetland 3[4]	PUBH/PABH/PEM1F/PSS1F/PFO1E	4.62 acres (3.90 acres inside AOC)	61	3

[1] Cowardin Classification: PUBH = palustrine, unconsolidated bottom, permanently flooded; PABH = palustrine, aquatic bed, permanently flooded; PEM1E = palustrine persistent emergent, seasonally flooded/saturated; PEM1F = palustrine persistent emergent, semi-permanently flooded; PSS1E = palustrine, broad-leaved deciduous, scrub-shrub, seasonally flooded/saturated; PSS1F = palustrine, broad-leaved deciduous, scrub-shrub, semi-permanently flooded; PFO1E = palustrine, broad –leaved deciduous, forested, seasonally flooded/saturated.

[2] Solitary wetland.

[3] Wetland complex between Track 33 and Track FA.

[4] Wetland complex south of Track FA.

AOC = Area of concern.

ID = Identification.

ORAM = Ohio Rapid Assessment Method.

Table 7–13. Survey of Proximity to the AOC of Various Ecological Resources

Natural Resource	Inside Habitat Area	Near the AOC	Distances to Nearest Resources and Comments[a]
Wetlands (planning level survey and jurisdictional)	No jurisdictional wetlands in AOC. Several small- to moderate-size planning level wetlands associated with Lower Cobbs Pond spillway, shoreline fringe, and shallow embayments and shoreline fringe of Backwater Area	Jurisdictional and planning level wetlands along northern, eastern, southern, and western border. ORAM Category 2 wetland complex on Load Line 12 drainage ditch, southwest of AOC	Numerous other wetlands are in vicinity of AOC (Figure 7-2)
State-listed or federally-listed species[b]	Least Bittern in Backwater Area	Yellow-bellied Sapsucker and Butternut[b]	<500 ft to the south-southwest and ~1,700 ft to the north-northwest (Yellow-bellied Sapsucker) ~2,200 ft to the north (Butternut)
Beaver dams	One at Track FA culvert in Backwater Area	Two: one on ditch from Load Line 12 and one west of Paris-Windham Road	<200 ft west and <700 ft southwest
100-year floodplain	Floodplain along unnamed tributaries to the south and west	Sand Creek floodplain to the northwest	100-year floodplain to Sand Creek located within 1,400 ft of AOC
Stream sampling[c]	None	Stream sampling station <900 ft to the northwest on unnamed tributary to Sand Creek (S-8)	Additional stream sampling station approximately 4,000 ft upstream of the AOC (S-9)
Pond sampling[c]	Upper Cobbs Pond and Lower Cobbs Pond	None	None

[a] Measurements of distance and direction are taken from the nearest boundary of the AOC to the resource being measured.

[b] The butternut is a federal species of concern, which is not an officially listed status with legal protection.

[c] Stream and pond sampling refers to *Facility-wide Biological and Water Quality Study* (USACE 2005a).

AOC = Area of concern.

FA = Functional area.

ft = Feet.

ORAM = Ohio Rapid Assessment Method.

Table 7–14. Summary of Integrated COPECs for Surface Soil

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	19200	50	384	Highest ratio at 384x
Arsenic	28.4	18	1.58	None
Cadmium	0.49	0.36	1.36	None
Cobalt	16.4	13	1.26	None
Lead	31.3	11	2.85	None
Mercury	0.074	0.00051	145.10	Second highest ratio at about 145x, PBT compound
Vanadium	35.3	7.8	4.53	None
Zinc	121	46	2.63	None
Nitrate/Nitrite	1.4	No ESV	--	None
Nitrocellulose	1.5	No ESV	--	None
Benzoic acid	17	No ESV	--	None
beta-BHC	0.0035	0.00398	0.88	PBT compound

Table excludes nutrients.
BHC = Hexachlorocyclohexane.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.
-- = No ratio could be calculated because there is no ESV.

Table 7–15. Summary of Integrated COPECs for Sediment at the Backwater Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Antimony	2.1	No ESV	--	Exceeded SRV
Beryllium	1.1	No ESV	--	Exceeded SRV
Cadmium	2.3	0.99	2.32	None
Chromium	56.5	43.4	1.30	None
Copper	62.3	31.6	1.97	Exceeded ESV and SRV
Cyanide	0.55	0.0001	5500	Highest ratio at 5500x
Lead	57.9	35.8	1.62	Exceeded ESV and SRV
Mercury	0.11	0.18	0.61	PBT Compound
Nickel	35.5	22.7	1.56	Exceeded ESV and SRV
Selenium	2.7	No ESV	--	None
Silver	23	0.5	46	Second highest ratio at 46x
Nitrate/Nitrite	2.2	No ESV	--	None
TNT	0.32	No ESV	--	None
2,6-Dinitrotoluene	0.16	0.0398	4.02	None
Nitrocellulose	10.4	No ESV	--	None
Tetryl	0.024	No ESV	--	None
Anthracene	0.22	0.0572	3.85	None
Benz(a)anthracene	0.83	0.108	7.69	None
Benzo(a)pyrene	0.89	0.15	5.93	None
Benzo(ghi)perylene	0.49	0.17	2.88	None
Benzo(k)fluoranthene	0.8	0.24	3.33	None
Chrysene	0.93	0.166	5.60	None
Dibenz(a,h)anthracene	0.066	0.033	2	None
Fluoranthene	1.8	0.423	4.26	None
Indeno(1,2,3-cd)pyrene	0.48	0.2	2.40	None
Phenanthrene	0.91	0.204	4.46	None
Pyrene	1.9	0.195	9.74	None
PCB-1254	0.047	0.0598	0.79	PBT Compound
2-Butanone	0.055	0.0424	1.30	None
Acetone	0.19	0.0099	19.19	None

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
SRV = Sediment reference value.
TNT = 2,4,6-Trinitrotoluene.
x = Multiplier.
-- = No ratio could be calculated because there is no ESV.

Table 7–16. Summary of Integrated COPECs for Sediment at Upper Cobbs Pond

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Discrete Sediment				
Antimony	1.9	No ESV	--	Exceeded SRV
Beryllium	1.3	No ESV	--	Exceeded SRV
Cadmium	2.3	0.99	2.32	None
Chromium	91.6	43.4	2.11	None
Chromium, hexavalent	10.6	No ESV	--	None
Copper	106	31.6	3.35	Exceeded ESV and SRV
Lead	52.4	35.8	1.46	Exceeded ESV and SRV
Mercury	0.15	0.18	0.83	PBT Compound
Nickel	41.1	22.7	1.81	Exceeded ESV and SRV
Selenium	2.9	No ESV	--	None
Silver	11	0.5	22	Highest ratio at 22x
1,3-Dinitrobenzene	0.036	0.00861	4.18	None
2,4,6-Trinitrotoluene	0.15	No ESV	--	None
4-Amino-2,6-Dinitrotoluene	0.12	No ESV	--	None
HMX	0.083	No ESV	--	None
Nitrocellulose	5.7	No ESV	--	None
Tetryl	0.019	No ESV	--	None
PCB-1254	0.032	0.0598	0.54	PBT Compound
Acetone	0.091	0.0099	9.19	Second highest ratio at about 9x
ISM Sediment				
Mercury	0.048	0.18	0.27	PBT Compound
Silver	1.1	0.5	2.2	None
Nitrate/Nitrite	5.3	No ESV	--	None
Ammonia	69	No ESV	--	None
Total Phosphorous	270	No ESV	--	None
Bis(2-ethylhexyl)phthalate	0.84	0.182	4.62	None
Di-n-butyl phthalate	2.7	1.114	2.42	None

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ISM = Incremental sampling methodology.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
SRV = Sediment reference value.
x = Multiplier.
-- = No ratio could be calculated because there is no ESV.

Table 7–17. Summary of Integrated COPECs for Sediment at Lower Cobbs Pond

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Discrete Sediment				
Antimony	1.4	No ESV	--	Exceeded SRV
Arsenic	34.3	9.79	3.50	Exceeded ESV and SRV
Beryllium	0.93	No ESV	--	Exceeded SRV
Cadmium	1.5	0.99	1.52	None
Chromium	150	43.4	3.46	None
Chromium, hexavalent	5.7	No ESV	--	None
Copper	149	31.6	4.72	Exceeded ESV and SRV
Cyanide	0.4	0.0001	4000	Highest ratio at 4000x
Lead	60.4	35.8	1.69	Exceeded ESV and SRV
Mercury	0.093	0.18	0.52	PBT Compound
Selenium	2.2	No ESV	--	None
Silver	2.4	0.5	4.80	None
HMX	0.017	No ESV	--	None
Nitrocellulose	7.8	No ESV	--	None
Tetryl	0.022	No ESV	--	None
2-Butanone	0.047	0.0424	1.11	None
Acetone	0.17	0.0099	17.17	Second highest ratio at about 17x
ISM Sediment				
Beryllium	0.83	No ESV	--	Exceeded SRV
Cadmium	1.2	0.99	1.21	None
Chromium	121	43.4	2.79	None
Mercury	0.1	0.18	0.56	PBT Compound
Silver	1.5	0.5	3.00	None
Nitrate/Nitrite	8.5	No ESV	--	None
Ammonia	61	No ESV	--	None
Total Phosphorous	360	No ESV	--	None

Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ISM = Incremental sampling methodology.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
PBT = Persistent, bioaccumulative, and toxic.
SRV = Sediment reference value.
x = Multiplier.
-- = No ratio could be calculated because there is no ESV.

Table 7–18. Summary of Integrated COPECs for Surface Water at the Backwater Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Barium	0.382	0.22[a]	1.7	Ratio is MDC/OMZA (MDC/OMZM<1)
Manganese	15.8	0.12[b]	131.7	ESV is Tier II
Selenium	0.0104	0.005	2.1	ESV is OMZA (no OMZM available)
Silver	0.0017	0.0016/0.0013[c]	1.1/1.3	Ratios are MDC/OMZM and MDC/OMZA
Sulfate	29	No ESV	--	None
Sulfide	2.3	0.002	1150	ESV is NAWQC
Chloromethane	0.0007	No ESV	--	None

[a] ESV shown is OMZA. The analyte is not a COPEC when screened against OMZM (MDC<OMZM). See Appendix H, Table H-23 for OMZM screening of this analyte.

[b] No Ohio Environmental Protection Agency Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.

[c] ESVs shown are OMZM/OMZA.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
NAWQC = National ambient water quality criteria.
OMZA = Outside mixing zone average.
OMZM = Outside mixing zone maximum.
-- = No ratio could be calculated because there is no ESV.

Table 7–19. Summary of Integrated COPECs for Surface Water at Upper Cobbs Pond

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Manganese	0.528	0.12[a]	4.4	ESV is Tier II
Nitrate/Nitrite	0.18	No ESV	--	None
Sulfate	13	No ESV	--	None
Sulfide	0.7	0.002[a]	350	ESV is NAWQC

[a] No Ohio Environmental Protection Agency Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
NAWQC = National ambient water quality criteria.
-- = No ratio could be calculated because there is no ESV.

Table 7–20. Summary of Integrated COPECs for Surface Water at Lower Cobbs Pond

COPEC	MDC(mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Manganese	0.654	0.12[a]	5.45	ESV is Tier II
Nitrate/Nitrite	0.13	No ESV	--	None
Sulfate	19	No ESV	--	None
Sulfide	0.7	0.002[a]	350	ESV is NAWQC

[a] No Ohio Environmental Protection Agency Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
mg/kg= Milligrams per kilogram.
NAWQC = National ambient water quality criteria.
-- = No ratio could be calculated because there is no ESV.

Table 7–21. Application and Decisions of Selected Evaluation Factors to Integrated COPECs for Surface Soil from Level II

Action	Condition for Decision to Dismiss or Retain COPEC	Outcome
Compare mean concentration to ESV	(A) Mean concentration smaller than or equal to the ESV	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than the ESV	Continue evaluation of chemical.
Compare mean concentration above ESV to background concentration	(A) Mean concentration smaller than the background concentration	COPEC is not a candidate to be a final COPEC. Evaluation ceased.
	(B) Mean concentration larger than background concentration	Continue evaluation of chemical.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.

Table 7–22. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at the AOC

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Arsenic	11.1	18	No	15.4	No	Yes	2/24	4/24	No
Cadmium	0.135	0.36	No	0	Yes	Yes	1/19	19/19	No
Cobalt	8.9	13	No	10.4	No	Yes	2/24	8/24	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration									
Aluminum	11900	50	Yes	17,700	No	No	24/24	2/24	No
Lead	18.7	11	Yes	26.1	No	No	23/24	3/24	No
Vanadium	20.9	7.8	Yes	31.1	No	No	24/24	1/24	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Mercury	0.043	0.00051	Yes	0.036	Yes	No	21/21	10/21	Yes
Zinc	63.9	46	Yes	61.8	Yes	No	24/24	10/24	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

AOC = Area of concern.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg= Milligrams per kilogram.

Table 7–23. Summary of Mean Concentrations and Background Concentrations of Remaining Integrated Soil COPECs in the Refinement Factors

COPEC	Mean Concentration (mg/kg)	Background Concentration (mg/kg)	Ratio of Mean Concentration to Background Concentration	Qualitative Assessment of Mean to Background Concentration
Surface Soil				
Mercury	0.043	0.036	1.19	Concentrations are similar
Zinc	63.9	61.8	1.03	Concentrations are similar

COPEC = Chemical of potential ecological concern.
mg/kg= Milligrams per kilogram.

Table 7–24. Comparison of Alternative ESV to Mean Concentration for Remaining Integrated Soil COPECs

COPEC	AOC Mean Concentration (mg/kg)	Background Concentration (mg/kg)	Preferred ESV (mg/kg)	Alternative ESV[a] (mg/kg)	Ratio of Mean Concentration to Preferred ESV	Ratio of Mean Concentration to Alternative ESV
Mercury	0.043	0.036	0.00051	0.1	84	0.43
Zinc	63.9	61.8	46	79	1.4	0.81

[a] The Alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration.
AOC = Area of concern.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/kg= Milligrams per kilogram.

Table 7–25. Summary of Data for Step 3A Refinement of Integrated COPECs in Sediment at the Backwater Area

COPEC	Mean Concentration (mg/kg)	ESV or (SRV) (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Cadmium	0.972	0.99	No	0	Yes	Yes	5/14	14/14	No
Chromium	23.3	43.4	No	18.1	Yes	Yes	1/14	9/14	No
Copper	28.2	31.6	No	27.6	Yes	Yes	4/14 (4)	4/14	No
Lead	29.6	35.8	No	27.4	Yes	Yes	4/14 (1)	7/14	No
Nickel	20.5	22.7	No	17.7	Yes	Yes	6/14 (1)	8/14	No
Indeno(1,2,3-cd)pyrene	0.192	0.2	Yes	0	Yes	Yes	2/3	3/3	No
2-Butanone	0.0256	0.0424	No	0	Yes	Yes	1/3	3/3	No
COPEC with Mean Concentration < Background or SRV									
Antimony	0.607	(1.3)	<SRV	0	Yes	--	(2<SRV)	11/11	No
Beryllium	0.782	(0.8)	<SRV	0.38	Yes	--	(8<SRV)	13/14	No
Selenium	0.5	(1.7)	<SRV	1.7	No	--	(7<SRV)	1/14	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Cyanide	0.224	0.0001	Yes	0	Yes	Yes	3/3	3/3	No
Silver	5.7	0.5	Yes	0	Yes	Yes	13/13	13/13	Yes
2,6-Dinitrotoluene	0.0483	0.0398	Yes	0	Yes	Yes	1/1	1/1	No
Anthracene	0.0956	0.0572	Yes	0	Yes	Yes	2/2	2/2	No
Benz(a)anthracene	0.274	0.108	Yes	0	Yes	Yes	2/3	3/3	Yes
Benzo(a)pyrene	0.323	0.15	Yes	0	Yes	Yes	3/4	4/4	Yes
Benzo(ghi)pyrene	0.22	0.17	Yes	0	Yes	Yes	2/3	3/3	No
Benzo(k)fluoranthene	0.265	0.24	Yes	0	Yes	Yes	2/3	3/3	No
Chrysene	0.338	0.166	Yes	0	Yes	Yes	3/4	4/4	Yes
Dibenz(a,h)anthracene	0.095	0.033	Yes	0	Yes	Yes	1/1	1/1	No
Fluoranthene	0.61	0.423	Yes	0	Yes	Yes	2/3	3/3	No
Phenanthrene	0.285	0.204	Yes	0	Yes	Yes	2/3	3/3	No
Pyrene	0.604	0.195	Yes	0	Yes	Yes	2/3	3/3	Yes
Acetone	0.0145	0.0099	Yes	0	Yes	Yes	5/5	5/5	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg= Milligrams per kilogram.

SRV = Sediment reference value.

-- = No value available.

Table 7–26. Summary of Data for Step 3A Refinement of Integrated COPECs in Discrete Sediment at Upper Cobbs Pond

COPEC	Mean Concentration (mg/kg)	ESV (SRV) (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Cadmium	0.95	0.99	No	0	Yes	Yes	2/3	3/3	No
Lead	27.7	35.8	No	27.4	Yes	Yes	2/5	2/5	No
COPEC with Mean Concentration < Background or SRV									
Antimony	0.78	(1.3)	(<SRV)	0	Yes	Yes (SRV)	(1>SRV)	5/5	No
Beryllium	0.842	(0.8)	(>SRV)	0.38	Yes	Yes (SRV)	(2>SRV)	5/5	No
Nickel	28.7	22.7 (33)	Yes (<SRV)	17.7	Yes	Yes (<SRV)	4/5 (2>SRV)	4/5	No
Selenium	0.839	(1.7)	(<SRV)	1.7	No	No (SRV)	(1>SRV)	1/5	No
COPEC with Mean Concentration > ESV (or >SRV) and Mean Concentration > Background Concentration									
Chromium	50.8	43.4	Yes	18.1	Yes	Yes	3/6	6/6	No
Copper	57.1	31.6	Yes	27.6	Yes	Yes	3/5	4/5	No
Silver	3.81	0.5	Yes	0	Yes	Yes	3/3	3/3	Yes
1,3-Dinitrobenzene	0.0144	0.00861	Yes	0	Yes	Yes	1/1	1/1	No
Acetone	0.0895	0.0099	Yes	0	Yes	Yes	2/2	2/2	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/kg= Milligrams per kilogram.
SRV = Sediment reference value.

Table 7–27. Summary of Data for Step 3A Refinement of Integrated COPECs in Discrete Sediment at Lower Cobbs Pond

COPEC	Mean Concentration (mg/kg)	ESV (SRV) (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV (or <SRV)									
Antimony	0.328	(1.3)	No (<SRV)	0	Yes	Yes (SRV)	(1>SRV)	1/1	No
Arsenic	14.9	9.79 (25)	Yes (<SRV)	19.5	Yes	No	5/8 (1>SRV)	2/8	No
Beryllium	0.679	(0.8)	No (<SRV)	0.38	Yes	Yes (SRV)	(2>SRV)	8/8	No
Cadmium	0.536	0.99	No	0	Yes	Yes	2/6	6/6	No
Lead	29.4	35.8	No	27.4	Yes	Yes	3/8	4/8	No
Selenium	0.72	(1.7)	No (<SRV)	1.7	No	No (SRV)	(1>SRV)	1/4	No
2-Butanone	0.036	0.0424	No	0	Yes	Yes	1/2	2/2	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Chromium	59	43.4	Yes	18.1	Yes	Yes	3/8	5/8	No
Copper	56.6	31.6 (32)	Yes	27.6	Yes	Yes	4/8 (3>SRV)	4/8	No
Cyanide	0.225	0.0001	Yes	0	Yes	Yes	1/1	1/1	No
Silver	0.852	0.5	Yes	0	Yes	Yes	3/5	5/5	No
Acetone	0.123	0.0099	Yes	0	Yes	Yes	2/2	2/2	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
mg/kg= Milligrams per kilogram.
SRV = Sediment reference value.

Table 7–28. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Water at the Backwater Area

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV									
Barium	0.141	0.22	No	0.0475	Yes	Yes	1/4	2/4	No
Selenium	0.00335	0.005	No	0	Yes	Yes	1/3	3/3	No
Silver	0.000603	0.0016	No	0	Yes	Yes	1/1	1/1	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Manganese	6.16	0.12	Yes	0.391	Yes	No	4/4	2/4	Yes
Sulfide	1.28	0.002	Yes	0	Yes	Yes	1/1	1/1	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg= Milligrams per kilogram.

Table 7–29. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Water at Upper Cobbs Pond

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < Background Concentration									
Manganese	0.216	0.12	Yes	0.391	No	No	3/5	1/5	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Sulfide	0.7	0.002	Yes	0	Yes	Yes	2/2	2/2	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg= Milligrams per kilogram.

Table 7–30. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Water at Lower Cobbs Pond

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	Mean Concentration > Background Concentration? (Yes/No)	ESV > Background Concentration? (Yes/No)	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < Background Concentration									
Manganese	0.215	0.12	Yes	0.391	No	No	4/7	1/7	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration									
Sulfide	0.4	0.002	Yes	0	Yes	Yes	1/1	1/1	Yes

[a] Frequency of detection refers to the subset of detections relative to ESV or background concentration as opposed to the standard frequency of detections of total samples taken.

COPEC = Chemical of potential ecological concern.

ESV = Ecological screening value.

mg/kg= Milligrams per kilogram.

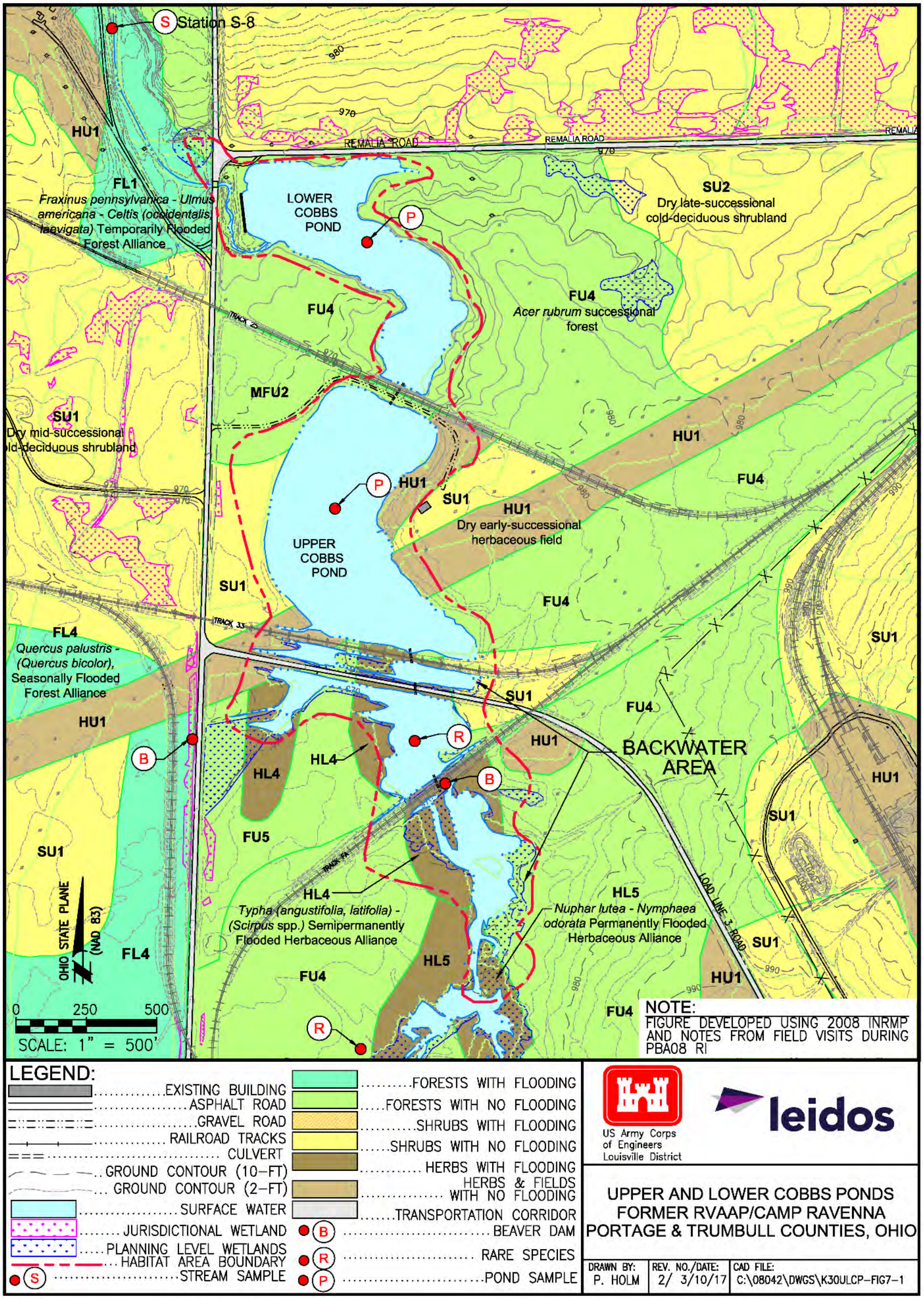


Figure 7–1. Natural Resources Inside and Near Habitat Area at the Upper and Lower Cobbs Ponds

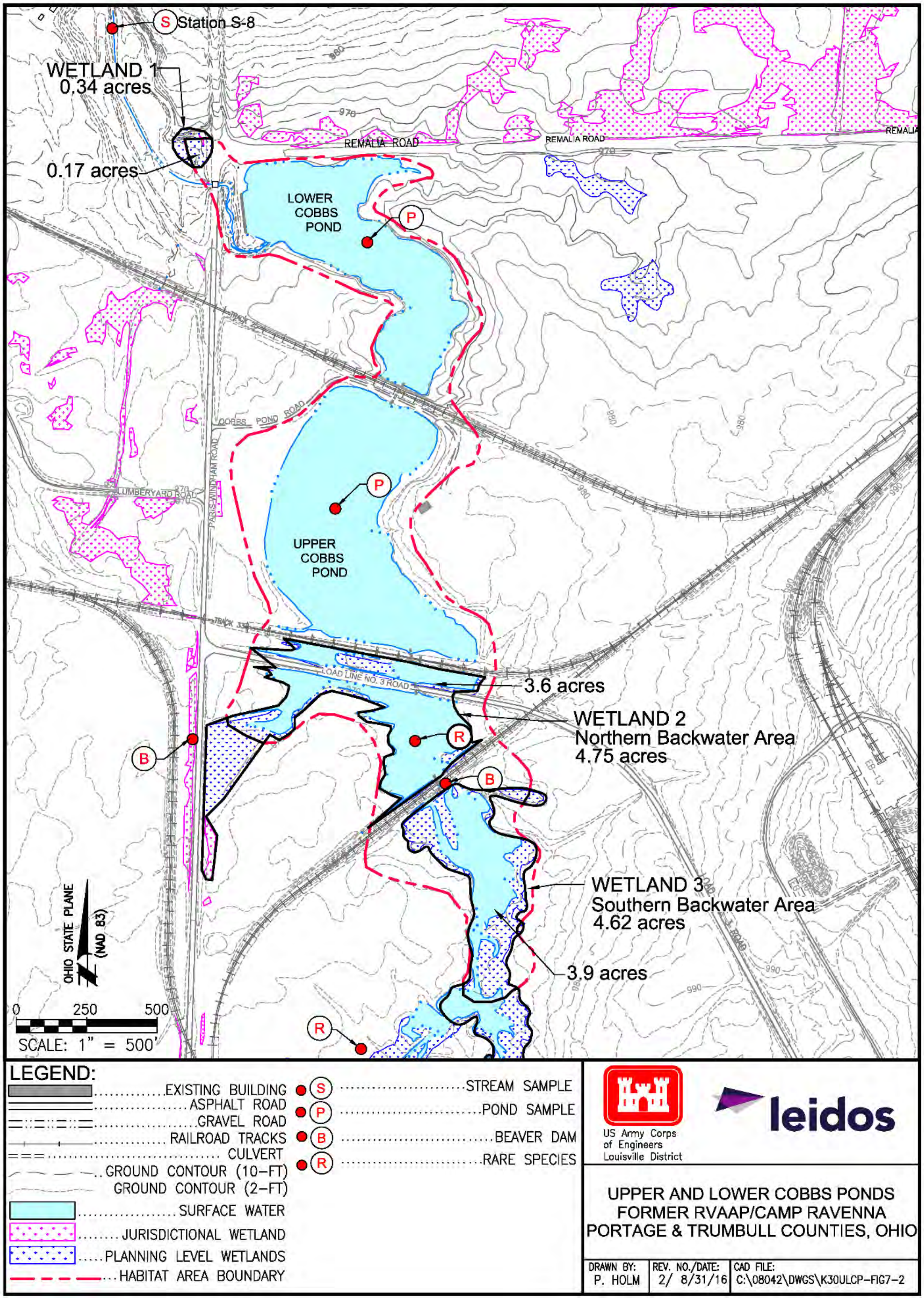


Figure 7–2. Wetland and Aquatic Resources Inside and Near Habitat Area at the Upper and Lower Cobbs Ponds

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8.0 REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This Phase III RI Report for the Upper and Lower Cobbs Ponds AOC presents a detailed analysis of historical and newly acquired environmental data. The following sections summarize the major findings of the nature and extent of contamination, modeling of contaminant fate and transport, HHRA, and ERA. A CSM incorporating all available information is also presented to integrate results of prior investigations and the PBA08 RI. The CSM denotes, based on available data where source areas occur, the mechanisms for contaminant migration from source areas to receptor media (e.g., surface water and groundwater), exit pathways from the AOC, and if COCs occur that may require further evaluation in an FS. This section presents the need for any further characterization of the media evaluated under the RI phase of work and whether to proceed to the FS phase of the CERCLA RI/FS process.

8.2 SUMMARY OF DATA USED IN THE REMEDIAL INVESTIGATION

Quality-assured sample data from the RIs (1996 Phase I RI, 2001 Phase II RI, and 2010 PBA08 RI) and the 2003 FWBWQS were used to evaluate nature and extent of contamination at the Upper and Lower Cobbs Ponds AOC. All available sample data collected at the locations were evaluated to determine suitability for use in various key RI data screens and evaluations (i.e., nature and extent, fate and transport, and risk assessment). Evaluating data suitability for use in the PBA08 RI involved two primary considerations: (1) whether the data represented current AOC conditions, and (2) sample collection methods (e.g., discrete vs. ISM).

Data collected during the RIs (1996 Phase I RI, 2001 Phase II RI, and 2010 PBA08 RI) and the 2003 FWBWQS were deemed usable for this report. Pond Bank surface soil data collected during the Phase II RI and PBA08 RI (with exception of field duplicate samples) were included in data screening to identify SRCs, contaminant nature and extent, contaminant fate and transport, and risk assessments. For subsurface soil, only PBA08 RI sample data are available for evaluations performed in this report. For sediment, Phase II RI, 2003 FWBWQS, and PBA08 RI samples were deemed most representative of current AOC conditions and were used for SRCs screening, fate and transport evaluation, and risk assessment. Surface water data collected during the Phase II RI, 2003 FWBWQS, and the PBA08 RI were deemed representative of current AOC conditions and were used to screen for SRCs and for risk assessment. All available historical and current sediment and surface water are included in contaminant nature and extent to evaluate temporal trends for identified SRCs and the potential for off-AOC transport of contaminants via the surface water migration pathway.

8.3 SUMMARY AND CONCLUSIONS OF NATURE AND EXTENT OF CONTAMINATION

Nature and extent of contamination in surface soil (0–1 ft bgs), subsurface soil (greater than 1 ft bgs), sediment, and surface water was evaluated in the RI. Data from the RIs (1996 Phase I RI, 2001 Phase

II RI, and 2010 PBA08 RI) and the 2003 FWBWQS effectively characterized the nature and extent of the contamination at the AOC. To support the evaluation of nature and extent of contamination, SRC concentrations were compared to SLs corresponding to the lowest FWCUG for the Resident Receptor (Adult and Child) and National Guard Trainee at a target HQ of 0.1 or TR of 1E-06, as presented in the FWCUG Report. It can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate the Upper and Lower Cobbs Ponds AOC.

8.3.1 Surface Soil

The predominant SRCs for surface soil at the Pond Bank were inorganic chemicals and SVOCs; the majority of which were PAHs. A total of 18 inorganic chemicals (16 metals, cyanide, and nitrate/nitrite) were identified as SRCs in surface soil. Elevated inorganic chemical concentrations above background concentrations were observed in surface soil throughout the Pond Bank, and only 1 of 24 surface soil samples collected exhibited no inorganic chemicals above background concentrations (ULCPss-009). However, the majority of elevated inorganic chemical concentrations occurred at levels marginally in excess of background concentrations, as all but two concentrations occurred at magnitudes less than twice their respective background concentrations. As such, no apparent spatial trend is evident in the distribution of inorganic chemicals throughout the surface soil in the Pond Bank.

Sixteen SVOCs, predominantly PAHs, were identified as SRCs in surface soil at the Pond Bank. The highest frequency and magnitudes of detection were observed at CPCsb-035, located on the western bank of Upper Cobbs Pond, immediately south of Cobbs Pond Road. The pesticide beta-BHC and propellant nitrocellulose were also identified as SRCs in surface soil at the Pond Bank. PAH concentrations are an order of magnitude higher in sediment than those observed in the adjacent Pond Bank surface soil.

One propellant (nitrocellulose) and one pesticide (BHC) were identified as SRCs in surface soil at the Pond Bank. Neither exceeded their respective SLs. No explosives, VOCs, or PCBs were detected or identified as SRCs in Pond Bank surface soil.

8.3.2 Subsurface Soil

Four inorganic chemicals (cadmium, lead, selenium, and silver) were identified as SRCs in subsurface soil samples at the Pond Bank. Lead and selenium were detected above background concentrations at only one sample location. Selenium was detected at 1.6 mg/kg, slightly above the background concentration of 1.5 mg/kg, and lead was detected at 23.3 mg/kg above the background concentration of 19.1 mg/kg. As such, no apparent spatial trend in the distribution of inorganic chemicals throughout the subsurface soil in the Pond Bank is evident.

A total of 13 SVOCs, 12 of which were PAHs, were detected and identified as SRCs in subsurface soil at the Pond Bank. Of the 13 SVOCs, 12 were detected from the 1–4 ft bgs interval at CPCsb-035; the majority of which were observed at low, estimated concentrations below laboratory reporting limits. Sample location CPCsb-035 is on the western bank of Upper Cobbs Pond and near Cobbs

Pond Road. PAH concentrations in the subsurface soil samples were generally comparable to those observed in the corresponding surface soil sample (i.e., within the same order of magnitude). One propellant (nitrocellulose) was identified as an SRC in subsurface soil at the Pond Bank. No explosives, VOCs, PCBs, or pesticides were detected or identified as SRCs in Pond Bank subsurface soil.

8.3.3 Sediment

8.3.3.1 Backwater Area

The Backwater Area was evaluated using 14 surface sediment samples and 2 subsurface sediment samples. Three explosives (TNT; 2,6-DNT; and tetryl) and one propellant (nitrocellulose) were detected in surface sediment. All of the detected concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in subsurface sediment in the Backwater Area. In surface sediment, aluminum, cobalt, and cyanide concentrations exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only the cobalt concentration exceeded a TR of 1E-06, HQ of 0.1 in subsurface sediment in one subsurface soil location, but not at a TR of 1E-05, HQ of 1. Five PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] exceeded their respective SLs in surface sediment. Four of the five PAHs were detected at their maximum concentrations in the Phase II RI sample ULCPsd-015. The detected concentrations in the adjacent PBA08 RI sample CPCsd-047 indicate that concentrations have declined since the 2001 Phase II RI sampling event. Benzo(a)pyrene concentrations at ULCPsd-006, ULCPsd-015, and CPCsd-047 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Only benzo(a)pyrene was detected above its respective SL (0.022 mg/kg) at PBA08 RI sample location CPCsd-047 in the 0.5–2 ft bgs interval. The concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, methylene chloride, and 2-butanone) were detected below their respective SLs in surface and subsurface sediment, respectively. PCB-1254 also was detected in the Phase II RI surface sediment samples ULCPsd-006 and ULCPsd-011; however, it was not detected in the PBA08 RI samples. No pesticides were detected in surface sediment. Pesticides and PCBs were not detected in the Backwater Area subsurface sediment.

8.3.3.2 Upper Cobbs Pond

Five surface discrete sediment samples, one surface ISM sample, and one subsurface sediment sample were used to evaluate Upper Cobbs Pond. Five explosives (1,3-dinitrobenzene; TNT; 4-amino-2,6-DNT; HMX; and tetryl) and one propellant (nitrocellulose) were detected in surface sediment at PBA08 RI sample location CPCsd-046. All detected concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No explosives or propellants were detected in subsurface sediment. In surface sediment, concentrations of aluminum, hexavalent chromium, and cobalt exceeded a TR of 1E-06, HQ of 0.1, but not a TR of 1E-05, HQ of 1. Only the cobalt concentration exceeded a TR of 1E-06, HQ of 0.1 in subsurface sediment, but not at a TR of 1E-05, HQ of 1. Ten SVOCs were detected in surface and subsurface sediment at PBA08 RI sample location CPCsd-046. Two additional SVOCs (acenaphthylene and anthracene) were detected in subsurface sediment. The 10 SVOCs occurred at higher concentrations in surface sediment than in the corresponding subsurface sediment sample. Benzo(a)pyrene was detected above its respective SL in surface and subsurface sediment at CPCsd-046; however, the concentrations were below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Two VOCs (acetone and 2-butanone) were detected in surface sediment below their respective SLs, both were detected at their maximum concentrations at PBA08 RI location CPCsd-046. These VOCs also were detected at the 2001 Phase II RI sample location ULCPsd-020 at lower concentrations than CPCsd-046. PCB-1254 also was detected in surface sediment at Upper Cobbs Pond in ULCPsd-020 below its respective SL. PCB-1254 was not detected in the PBA08 RI sample. Pesticides were not detected in surface sediment at Upper Cobbs Pond. The VOC 2-butanone was detected in subsurface sediment below the TR of 1E-05, HQ of 1. The pesticide delta-BHC does not have an SL. PCBs were not detected in subsurface sediment.

8.3.3.3 Lower Cobbs Pond

Lower Cobbs Pond was evaluated using eight discrete surface sediment samples, one surface ISM sample, and one subsurface sediment sample. Two explosives (HMX and tetryl) and one propellant (nitrocellulose) were detected in surface sediment, and the explosive HMX and propellant nitrocellulose were detected in subsurface sediment at Lower Cobbs Pond. The concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. In surface sediment, aluminum, arsenic, hexavalent chromium, cobalt, and cyanide concentrations exceeded a TR of 1E-06, HQ of 0.1, but only arsenic exceeded a TR of 1E-05, HQ of 1. Only the cobalt concentrations exceeded a TR of 1E-06, HQ of 0.1 in the subsurface sediment, but not at a TR of 1E-05, HQ of 1. A total of 11 SVOCs were detected in surface sediment in Lower Cobbs Pond and 18 SVOCs were detected in subsurface sediment. The 11 SVOC SRCs that were identified for surface sediment also were observed in subsurface sediment and occurred at their highest concentrations in the PBA08 RI subsurface sediment sample CPCsd-045. The benzo(a)pyrene concentration exceeded its respective SL in surface and subsurface sediment at CPCsd-045; however, only the subsurface sediment concentration exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (2-butanone, acetone, and carbon disulfide) were detected in surface sediment at Lower Cobbs Pond. All three VOCs were detected at PBA08 RI location CPCsd-045, with 2-butanone and carbon disulfide observed at their maximum concentrations in this sample location. 2-Butanone also was detected in the subsurface sediment. All of the VOCs detected in surface and subsurface soil were below their respective SLs. No PCBs or pesticides were detected in surface or subsurface sediment in Lower Cobbs Pond.

8.3.4 Surface Water

8.3.4.1 Backwater Area

Four surface water samples were used to evaluate the Backwater Area. One explosive (4-amino-2,6-DNT) was detected in surface water at a low, estimated concentration below laboratory reporting limits. No propellants were detected in the Backwater Area surface water. Four inorganic chemical concentrations (arsenic, cobalt, manganese, and selenium) exceeded the RSL at a TR of 1E-06, HQ of

0.1. Manganese concentrations at Phase II RI sample locations ULCPsw-001 and ULCPsw-002 and cobalt at ULCPsw-001 exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Three VOCs (acetone, chloromethane, and toluene) were detected in surface water for the Backwater Area, all of which were detected in ULCPsw-002. No propellants, SVOCs, PCBs, or pesticides were detected in surface water at the Backwater Area. Elevated inorganic chemical concentrations and 4-amino-2,6-DNT are likely attributable to continuing upstream sources as these constituents are observed in the PBA08 RI locations immediately downstream of the confluence of the drainage channels from Load Lines 3 and 12.

8.3.4.2 Upper Cobbs Pond

Surface water in Upper Cobbs Pond was evaluated using five surface water samples. One explosive (4-amino-2,6-DNT) was detected at a low, estimated concentration in two surface water samples. The concentrations were below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No surface water concentrations for inorganic chemicals in Upper Cobbs Pond exceeded the SL at a TR of 1E-06, HQ of 0.1. The SVOCs bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected at low, estimated concentrations below the laboratory reporting limit at PBA08 RI sample location CPCsw-046 and the August 2003 FWBWQS location, respectively. No VOCs, PCBs, or pesticides were detected in surface water at Upper Cobbs Pond.

8.3.4.3 Lower Cobbs Pond

Lower Cobbs Pond surface water was evaluated using seven surface water samples. The explosive 4-amino-2,6-DNT was identified as an SRC in surface water at Lower Cobbs Pond. 4-Amino-2,6-DNT was detected in the August 2003 sample from the FWBWQS Lower Cobbs Pond station (0.00029J mg/L). 4-Amino-2,6-DNT was not detected in the subsequent PBA08 RI samples taken at CPCsw-044 and CPCsw-045 in 2010. No propellants were detected. Only manganese was detected at a concentration which exceeded the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1 at one sample location. Two SVOCs (benzenemethanol and butyl benzyl phthalate) were detected at low, estimated concentrations at PBA08 RI location CPCsw-045, located at the center of the aggregate. No VOCs, PCBs, or pesticides were detected in surface water in Lower Cobbs Pond.

8.4 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in surface soil, subsurface soil, and sediment at the Upper and Lower Cobbs Ponds AOC were evaluated through the stepwise contaminant fate and transport evaluation. The evaluation included analyzing leaching and migration from soil and sediment to groundwater and determining whether contamination present in soil and sediment may potentially impact groundwater quality at the site.

Maximum SRC concentrations identified in surface and subsurface soil were evaluated using a series of generic screening steps to identify initial CMCOPCs. Initial CMCOPCs for soil were further evaluated using the SESOIL model to predict leaching concentrations and identify final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria among USEPA MCLs, USEPA tap water RSLs, or RVAAP groundwater FWCUGs for the Resident Receptor Adult. These final CMCOPCs were evaluated using the AT123D model to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., Cobbs Ponds) and identify CMCOCs.

A sediment screening analysis was performed for sediment samples at the AOC. Chemical-specific DAFs were calculated using co-located surface water and sediment concentrations for identified sediment SRCs. These DAFs were used in the sediment screening analysis to identify the initial CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. The initial CMCOPCs for sediment were further evaluated by comparing their maximum detected surface water concentrations against their respective MCL/RSLs to identify the final sediment CMCOPCs.

The modeling results identified the following CMCOCs for soil and final CMCOPCs for sediment:

- Arsenic, nickel, selenium, and thallium in soil were predicted to exceed the screening criteria in groundwater beneath the source area, and only arsenic was predicted to exceed the screening criteria in groundwater at the downgradient receptor location.
- Hexavalent chromium in Upper Cobbs Pond and Lower Cobbs Pond sediment was predicted to exceed the screening criteria in groundwater beneath the source areas.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any soil CMCOCs may impact the groundwater beneath the source or at the downstream receptor location (Cobbs Ponds) or if any CMCOPCs in sediment may impact groundwater beneath Cobbs Ponds. This qualitative assessment concluded that the remaining soil CMCOCs and sediment CMCOPCs are not expected to adversely impact groundwater at the AOC. No further action is required of soil and sediment at the Upper and Lower Cobbs Ponds AOC for the protection of groundwater.

8.5 SUMMARY AND CONCLUSIONS OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA identified COCs and conducted risk management analysis to determine if COCs pose unacceptable risk to the Resident Receptor. If there is no unacceptable risk to the Resident Receptor, it can be concluded that there is no unacceptable risk to the National Guard Trainee and Industrial Receptor.

Media of concern at the Upper and Lower Cobbs Ponds AOC are surface soil, subsurface soil, surface water, and sediment. Soil data were aggregated into surface and subsurface soil. Surface water and sediment data were aggregated into three EUs (Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond).

No COCs were identified in soil. Several PAHs were identified as COCs in sediment at the backwater area. The MDC of benzo(a)pyrene (0.89 mg/kg) at the Backwater Area exceeds the FWCUG (0.221

mg/kg). The MDC is at ULCPsd-015 collected in 2001. Sample ULCPsd-047 was collected at approximately the same location in 2010 and showed a benzo(a)pyrene concentration of 0.39 mg/kg. Detected benzo(a)pyrene concentrations in the other Backwater Area samples ranged from 0.063–0.23 mg/kg. Three additional PAHs, present below FWCUGs, were identified as COCs based on the SOR analysis. Benzo(a)pyrene, and by association the other PAHs, were not identified as COCs to be carried forward for potential remediation because the elevated PAH concentrations are located near a culvert between Load Line 3 Road and Track 33. The source of the PAHs in sediment is most likely runoff from the road and railroad bed. The FWCUGs for exposure to sediment are the same as the FWCUGs for soil (i.e., exposure is assumed to be the same for soil in a residential yard and sediment in a pond). However, the MDC at the backwater area (0.89 mg/kg) is below a more realistic (but still conservative) calculated RSL of 9 mg/kg.

The EPC of arsenic in sediment at Lower Cobbs Pond (26.9 mg/kg) exceeds the FWCUG for the Resident Receptor Adult of 4.25 mg/kg, the facility-wide background concentration of 19.5 mg/kg, and the Ohio EPA SRV of 25 mg/kg. The MDC of arsenic (34.3 mg/kg) at ULCPsd-026, collected in 2001, is the only sample concentration greater than the facility-wide background concentration and Ohio EPA SRV. Reported arsenic concentrations in the other Lower Cobbs Pond samples ranged from 5.1–20.2 mg/kg. Arsenic was not identified as a COC for potential remediation because the reported concentrations appear to represent naturally occurring levels in sediment.

The EPC of cobalt (0.01 mg/L) is less than two times the tap water RSL of 0.006 mg/L. The Backwater Area is a shallow pond created through beaver dam construction activity upstream of Upper Cobbs Pond. This limited shallow surface water is not a potential source of residential drinking water; therefore, this low exceedance of the tap water RSL does not warrant potential remediation in this EU.

The EPC of manganese in surface water at the Backwater Area EU exceeds the FWCUG for the Resident Receptor (Adult and Child) of 6.326 mg/L. The EPC is strongly influenced by the elevated concentration reported in a single sample collected in 2001. The manganese concentrations in all samples collected in 2010 are below the facility-wide background concentration of 0.391 mg/L. Because recent sample data indicate manganese is present at naturally occurring background concentrations, manganese does not warrant potential remediation in this EU.

Based on the risk management analysis, no COCs were identified to be carried forth in an FS for the Resident Receptor (Adult and Child) in any of the media of concern at the Upper and Lower Cobbs Pond AOC; therefore, no other receptors were evaluated and no further action is recommended from a human health risk perspective.

8.6 SUMMARY AND CONCLUSIONS OF THE ECOLOGICAL RISK ASSESSMENT

The Level I ERA presents important ecological resources on or near the AOC and evaluates the potential for current contamination to impact ecological resources. There is chemical contamination present in surface soil, sediment, and surface water at Upper and Lower Cobbs Ponds AOC. This contamination was identified using historical and PBA08 RI data and data from the 2003 FWBWQS.

Although the ponds constitute much of the AOC, red maple successional forest (dominant vegetation type), dry, mid-successional, cold-deciduous shrubland, three types of herbaceous communities, and three additional types of forests were observed on the 39 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, a state-listed threatened species (Least Bittern) and its habitat, wetlands, and surface water (i.e., ponds) are present and near contamination. These findings invoked a requirement of a Level II ERA.

The Level II ERA evaluated integrated COPECs in soil, sediment, and surface water. Integrated COPECs are identified by screening PBA08 RI, FWBWQS, and historical data sets against ESVs. Twelve integrated COPECs were identified for soil. Forty integrated COPECs were identified for sediment. Eight integrated COPECs were identified for surface water. The integrated soil, sediment, and surface water COPECs were further evaluated with technical and refinement factors in Step 3A. The factors in Step 3A showed there are no integrated COPECs that are of ecological concern requiring remediation or further evaluation. Consequently, the Level II Screening ERA for the Upper and Lower Cobbs Ponds AOC concludes with a recommendation that no further action is required to be protective of important ecological resources.

8.7 UPDATED CONCEPTUAL SITE MODEL

The CSM is presented in this section to incorporate results of this RI. Elements of the CSM include:

- Primary and secondary contaminant sources and release mechanisms,
- Contaminant migration pathways and discharge or exit points,
- Potential receptors with unacceptable risk, and
- Data gaps and uncertainties.

The following sections describe each of the above elements of the CSM for the Upper and Lower Cobbs Ponds AOC, and the CSM is presented on Figure 8-1. In addition, figures contained in earlier sections of the report that illustrate AOC features, topography, groundwater and surface water flow directions, and nature and extent of SRCs are cited to assist in visualizing key summary points of the revised CSM.

8.7.1 Primary and Secondary Contaminant Sources and Release Mechanisms

No primary contaminant sources (e.g., operational facilities) were located at the AOC. The ponds themselves functioned as sedimentation basins receiving storm water runoff and effluent discharges during historical operations at Load Line 3 and Load Line 12. The Installation Assessment identified the pink wastewater and washout of residue, dusts, and spills at Load Lines 3 and 12, which were discharged through surface drainage channels towards the AOC (USATHAMA 1978). Remnant contamination in Pond Bank soil and sediment within the AOC is considered as a secondary source of contamination.

A fish kill occurred on November 15, 1966 at Lower Cobbs Pond as a result of improper handling of aluminum chloride during manufacturing operations. The bulk of the aluminum chloride at Load Line

12 was removed and disposed in Ramsdell Quarry. The pond was settled and drained, and the contaminants were moved to Ramsdell Quarry.

In soil collected from the pond banks and surface water, contamination is not evident. Remnant contamination in sediment within the AOC is considered a secondary source of contamination. RI evaluations indicate sediment contamination is present in the Backwater Area, Upper Cobbs Pond, and Lower Cobbs Pond. Shallow sediment (0–0.5 ft bgs) in the Backwater Area and Upper Cobbs Pond contained generally higher chemical concentrations than the deeper sediment interval (0.5–2 ft bgs).

The primary mechanisms for release of contaminants from secondary sources at the AOC include:

- Eroding soil matrices with sorbed contaminants and mobilization in overland surface water storm runoff during heavy rainfall conditions,
- Dissolving soluble contaminants and transport in perennial surface water conveyances and intermittent surface water runoff,
- Re-suspending contaminated sediment during periods of high flow with downstream transport within the surface water system, and
- Leaching contaminants leaching to groundwater.

8.7.2 Contaminant Migration Pathways and Exit Points

8.7.2.1 Surface Water Pathways

Contaminant migration from soil sources via surface water occurs primarily through: (1) particle-bound contaminants moving in surface water runoff, and (2) dissolved constituents being transported in surface water. Upon reaching portions of surface water conveyances where flow velocities decrease, particle-bound contaminants will settle out as sediment accumulation. Bank soil data indicate few SRCs and minimal dispersal of contaminants from secondary sources into the AOC via this pathway. Sediment-bound contaminants may become re-suspended and migrate during storm events or may partition to dissolved phase in surface water. As noted in Section 3.0, surface water flows into the AOC via drainage conveyances from Load Line 3, Load Line 12, and miscellaneous small ditches alongside roads and railroad trackbeds. Flow through the surface water system is constrained at four culverts beneath several railroad trackbeds and Load Line No. 3 Road (Figure 3-1). Surface water exits the system via a stand pipe and overflow spillway at the north end of Lower Cobbs Pond and discharges into a tributary to Sand Creek. The culverts and Lower Cobbs Pond dam serve to decrease flow velocities at multiple points within the system and promote deposition of any suspended sediment. Beaver dams and heavy aquatic vegetation within the upper reaches of the system also promote deposition of sediment, sorption of dissolved phase contaminants into the sediment zone, and decay of organic biomass and bio-uptake.

8.7.2.2 Groundwater Pathways

The estimated direction of groundwater flow at the AOC is from southeast to northwest. This reflects the January 2010 facility-wide potentiometric data presented in the *Facility-wide Groundwater Monitoring Program Report on the January 2010 Sampling Event* (EQM 2010a). Water level elevations at the AOC range from 957.38–973.40 ft amsl. Potentiometric data indicate the groundwater table occurs within unconsolidated zone throughout the AOC. Groundwater discharge to surface water features (e.g., via base flow to the ponds) occur within the AOC boundary. Surface water exits Lower Cobbs Pond via a dam overflow spillway, which leaves the AOC and flows into an unnamed tributary to Sand Creek.

The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. Between 2009–2013, several sampling events under the FWGWMP collected groundwater data at the Upper and Lower Cobbs Ponds AOC.

Contaminant leaching pathways from soil to the water table are through unconsolidated soil representing silty loam with low permeability. The overall average hydraulic conductivity of the unconsolidated soil is approximately 5.64E-06 cm/s. Conservative transport modeling indicated four chemicals (arsenic, nickel, selenium, and thallium) may leach from soil and migrate to the groundwater table at concentrations exceeding MCLs/RSLs beneath their respective sources; however, only arsenic was predicted to exceed the screening criteria in groundwater at the downgradient receptor location. None of these chemicals except arsenic (which is determined to be background related) were detected in AOC groundwater samples collected from 2009–2013 above their respective groundwater criteria; therefore, this evaluation concludes that the model-predicted concentrations are conservative. For sediment, the screening indicated that hexavalent chromium may be a leachability concern; however, this assessment was conservative because hexavalent chromium was not analyzed in surface water or groundwater and did not allow for a chemical-specific DAF to be calculated. A qualitative assessment of the sample results was performed and the limitations and assumptions of the models were considered to identify if any CMCOCs are present in soil or sediment at the Upper and Lower Cobbs Ponds AOC that may potentially impact groundwater. This qualitative assessment concluded that CMCOCs are not adversely impacting groundwater quality based on current data and are not predicted to have future impacts. No further action is required of soil or sediment to be protective of groundwater.

8.7.3 Potential Human Receptors and Ecological Resources

In February 2014, the Army and Ohio EPA amended the risk assessment process to address changes in the RVAAP restoration program. The Technical Memorandum identified three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process.

These three Land Uses and Representative Receptors are presented below.

1. Unrestricted (Residential) Land Use – Resident Receptor (Adult and Child) (formerly called Resident Farmer).
2. Military Training Land Use – National Guard Trainee.
3. Commercial/Industrial Land Use – Industrial Receptor (USEPA Composite Worker).

Unrestricted (Residential) Land Use is considered protective for all three Land Uses at Camp Ravenna. Therefore, if an AOC meets the requirements for Unrestricted (Residential) Land Use, then the AOC is also considered to have met the requirements of the other Land Uses (i.e., Commercial/Industrial and Military Training), and the other Land Uses do not require evaluation. The HHRA did not identify Resident Receptor COCs to be carried forward for potential remediation; therefore, the Upper and Lower Cobbs Ponds AOC is considered protective for all potential human health receptors.

Camp Ravenna has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas. An abundance of wildlife is present on the facility: 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified. Ecological resources at the Upper and Lower Cobbs Ponds AOC were compared to the list of important ecological places and resources. The ponds and wetlands are important/significant ecological resources. In addition, the Least Bittern (*Ixobrychus exilis*), a state of Ohio threatened species, has been observed at the AOC.

8.7.4 Uncertainties

Uncertainties are inherent in the CSM depending on the density and availability of data. The CSM for the Upper and Lower Cobbs Ponds AOC is overall well defined using existing data, and major data gaps do not remain to be resolved. However, some uncertainties for the CSM include the following:

- The potential for a continuing flux of contamination from sources in the Upper Cobbs Pond and Lower Cobbs Pond drainage basin headwater areas – from Load Line 3 in particular. Remedial actions for portions of Load Line 3 soil (outside of building footprints) have been completed, and Load Line 3 building demolition actions have been conducted. Disturbed portions of the Load Line 3 were re-vegetated following building demolition, and the vegetation is in early stages of recovery. Soil remediation actions at Load Line 12 were also completed 2010, and Load Line 12 building demolition actions were completed in 1999.
- A fish kill occurred on November 15, 1966 at Lower Cobbs Pond as a result of improper handling of aluminum chloride during manufacturing operations. The bulk of the aluminum chloride at Load Line 12 was removed and disposed in Ramsdell Quarry. The pond was settled and drained, and the contaminants were moved to Ramsdell Quarry. Documentation of this fish kill and subsequent cleanup is limited.

- The lack of established RVAAP-specific background concentrations for identifying SRCs for PAHs is a source of uncertainty. Evaluating potential former RVAAP process-related sources and other common anthropogenic sources using available PAH environmental data minimizes the impact of this uncertainty on the conclusions of the RI.
- While this RI addresses soil, sediment, and surface water, additional ongoing investigations are being conducted for the Facility-wide Groundwater AOC.

8.8 RECOMMENDATION OF THE REMEDIAL INVESTIGATION

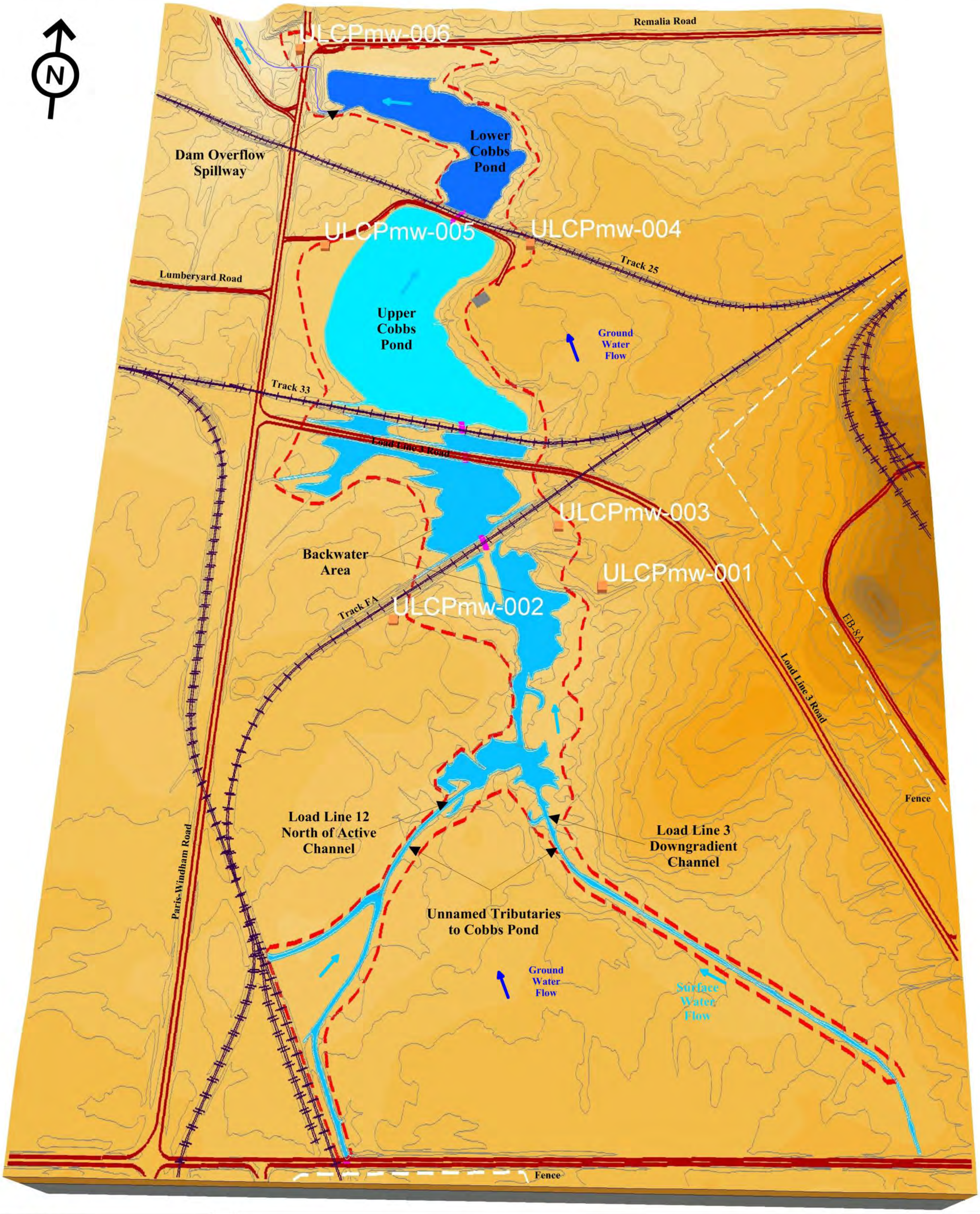
Based on the investigation results, the Upper and Lower Cobbs Ponds AOC has been adequately characterized and the recommended path forward is no further action for soil, sediment, and surface water to attain Unrestricted (Residential) Land Use. Further investigation is not warranted at this AOC for the following reasons: (1) the current nature and extent of impacted media has been sufficiently characterized; (2) the fate and transport modeling did not identify soil CMCOCs requiring further evaluation or remediation to protect groundwater; (3) there are no CERCLA release-related human health COCs identified in soil, sediment, or surface water requiring further evaluation in an FS or additional remediation; and (4) remedial actions to protect ecological resources are not warranted.

The next step in the CERCLA process is to prepare a PP to solicit public input with respect to no further action for soil, sediment, and surface water. The PP will briefly summarize the history, characteristics, risks, and the basis for no further action. Comments on the PP received from state and federal agencies and the public will be considered in preparing a ROD to document the final remedy. The ROD will also include a responsiveness summary addressing comments received on the PP.

Groundwater:
Potentiometric data indicate the groundwater flow direction is to the northwest with an average hydraulic gradient of 0.011 ft/ft. The water table in the unconsolidated bank soil occurs at approximately 5 ft bgs (ranging from 1 ft bgs to greater than 13 ft bgs) or around 965 ft amsl as observed in subsurface borings installed during the PBA08 RI.

Sewers: There are no storm or sanitary sewers present in the Upper and Lower Cobbs Ponds AOC.

Surface Water:
The topography at the AOC is dominated by the ponds and their associated drainage conveyances. Perennial surface water is present within Upper Cobbs Pond, Lower Cobbs Pond, and the Backwater Area. Surface water flows south to north and is received at the Upper and Lower Cobbs Ponds AOC from the Load Line 12 North of Active Area Channel and Load Line 3 Dowgradient Channel. Surface water then flows through the Backwater Area to Upper Cobbs Pond then to Lower Cobbs Pond, ultimately exiting the AOC through a dam overflow spillway located near the intersection of Remalia and Paris-Windham Roads. Surface water then enters an unnamed tributary that discharges into Sand Creek, northwest of the AOC.



LEGEND

AOC Boundary	▬ ▬
Existing Buildings	■
Monitoring Well	⬢
Roads	—
Rail Road	########
Fence	– –
Culvert	·····
Lower Cobbs Pond	●
Upper Cobbs Pond	●
Backwater Area	●
Groundwater Flow	→
Surface Water Flow	→

Sediment And Surface Water:	Inorganic chemicals in sediment and surface water and SVOCs in sediment were identified as COPCs. However, no COCs were identified in sediment or surface water that require remediation for Unrestricted (Residential) Land Use.
Surface & Subsurface Soil:	Soil at the Pond Banks was characterized during the Remedial Investigations. Inorganic chemicals and SVOCs were identified as COPCs in the Pond Bank; however, no chemicals were identified as a risk to human health that warranted a remedial action.
Groundwater:	All SRCs were evaluated to determine if soil or sediment may potentially impact groundwater quality through the stepwise fate and transport evaluation. Modeling results identified CMCOPCs, but based on current data, a qualitative assessment concluded that CMCOCs are not adversely impacting groundwater quality.
Ecological Risk:	There is chemical contamination present in soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. The terrestrial vegetation habitat at the AOC consists of four forest community types, one shrub community type, and three herbaceous community types. The dominant forest community at the AOC is the red maple (A. rubrum) successional forest. Upper Cobbs Pond, Lower Cobbs Pond, and the wetlands are important/significant ecological resources. In addition, the Least Bittern (Ixobrychus exilis), which is a state of Ohio threatened species, uses the AOC. The Level II assessment evaluated soil, sediment, and surface water and the factors in Step 3A showed there is no further evaluation necessary for integrated COPECs, and there is no ecological concern requiring remediation.

Figure 8–1. Upper and Lower Cobbs Ponds Conceptual Site Model

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9.0 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

The Army is the lead agency responsible for executing the CERCLA process and ultimately completing an approved ROD for soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. This section reviews actions that have been conducted and presents activities that are planned to ensure the regulatory agencies and members of the public have been provided with appropriate opportunities to stay informed of the progress of the environmental investigation, restoration efforts, and final selection of a remedy.

9.1 STATE ACCEPTANCE

State acceptance considers comments received from agencies of the state of Ohio on the proposed remedial alternatives. Ohio EPA is the lead regulatory agency for supporting the remedy for soil, sediment, and surface water at the Upper and Lower Cobbs Ponds AOC. This Phase III RI Report has been prepared in consultation with Ohio EPA.

Ohio EPA provided input during the ongoing investigation and report development to ensure the remedy ultimately selected is protective of human health and the environment and fulfills the requirements of the DFFO (Ohio EPA 2004). Ohio EPA will provide comments on this report and the subsequent PP and ROD. The Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for soil, sediment, and surface water at the AOC.

9.2 COMMUNITY ACCEPTANCE

Community acceptance considers comments provided by community members for each proposed remedial alternative. CERCLA 42 U.S.C. 9617(a) emphasizes early, constant, and responsive community relations. The Army has prepared a *Community Relations Plan for the Ravenna Army Ammunition Plant Restoration Program* (Vista 2016) to facilitate communication between the former RVAAP and the community surrounding Ravenna, Ohio, during environmental investigations and potential remedial action. The plan was developed to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board meetings with local officials, interest groups, and the general public.

CERCLA 42 U.S.C. 9617(a) requires an Administrative Record to be established "at or near the facility at issue." Relevant documents regarding the former RVAAP have been made available to the public for review and comment.

The Administrative Record for this project is available at the following location:

Camp Ravenna
Environmental Office
1438 State Route 534 SW
Newton Falls, OH 44444

Access to Camp Ravenna is restricted but can be obtained by contacting the environmental office at (614) 336-6136. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canal Street
Newton Falls, Ohio 44444-1694

Additionally, there is an online resource for restoration news and information. This website is available at: www.rvaap.org.

Comments will be received from the community upon issuing the PP. As required by the CERCLA regulatory process and Community Relations Plan (Vista 2016), the Army will hold a public meeting and request public comments on the PP for the Upper and Lower Cobbs Ponds AOC. These comments will be considered prior to the final selection of a remedy. Responses to these comments will be addressed in the responsiveness summary of the ROD.

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