Revised Draft

Phase II Remedial Investigation Report and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912QR-15-C-0046

Prepared for:

U.S. Army Corps of Engineers
Louisville District

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14. ABSTRACT

This Phase II Remedial Investigation Report and Feasibility Study for NACA Test Area presents physical characteristics, geology, and hydrogeology of NACA Test Area; compiles historical and newly acquired environmental data;summarizes nature and extent of contamination in soil;evaluates contaminant fate and transport; provides human health and ecological risk assessments;identifies response actions,screening of remedial technologies and process options;develops remedial alternatives to address chemicals of concern (COCs) presenting unacceptable risk; and presents a recommended alternative to meet the remedial action objective at this AOC. To achieve an Unrestricted (Residential)Land Use for soil, sediment, and surface water,this report recommends implementing “Alternative 5:Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal –Attain Unrestricted (Residential) Land Use."

15. SUBJECT TERMS

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CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Leidos has completed the Revised Draft Phase II Remedial Investigation Report and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area 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.

8/15/16

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

8/15/16

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.

8/15/16

Lisa Jones-Bateman
Senior Program Manager
Date

PLACEHOLDER FOR:

Documentation of Ohio EPA Approval of Final Document

(Documentation to be provided once approval is issued.)

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

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ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AT123D	Analytical Transient 1-, 2-, 3- Dimensional
bgs	Below Ground Surface
BHC	Hexachlorocyclohexane
CAIS	Chemical Agent Identification Sets
Camp Ravenna	Camp Ravenna Joint Military Training Center
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
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
CSM	Conceptual Site Model
CUG	Cleanup Goal
CWM	Chemical Warfare Material
DAF	Dilution Attenuation Factor
DERP	Defense Environmental Restoration Program
DERR	Division of Emergency and Remedial Response
DFFO	Director’s Final Findings and Orders
DNT	Dinitrotoluene
EcoSSL	Ecological Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERS	Ecological Risk Screening
ESL	Ecological Screening Level
ESV	Ecological Screening Value
EU	Exposure Unit
FCR	Field Change Request
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 Assessor Manual
FWSAP	Facility-wide Sampling and Analysis Plan
gpm	Gallons Per Minute

GRA	General Response Action
GSSL	Generic Soil Screening Level
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HHRS	Human Health Risk Screening
HLC	Henry’s Law Constant
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	Hazard Quotient
IBI	Index of Biotic Integrity
ILCR	Incremental Lifetime Cancer Risk
INRMP	Integrated Natural Resources Management Plan
IRIS	Integrated Risk Information System
ISM	Incremental Sampling Methodology
LDR	Land Disposal Restriction
LUC	Land Use Control
LUCRD	Land Use Control Remedial Design
MCL	Maximum Contaminant Level
MD	Munitions Debris
MDC	Maximum Detected Concentration
MDL	Method Detection Limit
MEC	Munitions and Explosives of Concern
MTR	Minimum Technical Requirement
NACA	National Advisory Committee on Aeronautics
NCP	National Contingency Plan
O&M	Operations and Maintenance
OAC	Ohio Administrative Code
ODA1	Open Demolition Area #1
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
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
PBR	Permit-by-Rule
PBT	Persistent, Bioaccumulative, and Toxic
PCB	Polychlorinated Biphenyl
PMP	Project Management Plan
PP	Proposed Plan
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
QA	Quality Assurance

QC	Quality Control
QHEI	Qualitative Habitat Evaluation Index
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
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
RM	River Mile
ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SESOIL	Seasonal Soil Compartment Model
Shaw	Shaw Environmental & Infrastructure, Inc.
SL	Screening Level
SLERA	Screening Level Ecological Risk Assessment
SMABS	Suspected Mustard Agent Burial Site
SOR	Sum-of-Ratios
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
TCLP	Toxicity Characteristic Leaching Procedure
TEC	Threshold Effect Concentration
TestAmerica	TestAmerica Laboratories, Inc.
TNB	Trinitrobenzene
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
UTS	Universal Treatment Standard
VEG©	Vapor Energy Generation

VOC	Volatile Organic Compound
WOE	Weight-of-Evidence
WQC	Water Quality Criteria
WQS	Water Quality Standard

EXECUTIVE SUMMARY

ES.1 INTRODUCTION AND SCOPE

This document has been revised by Leidos under the U.S. Army Corps of Engineers (USACE), Louisville District Contract Number W912QR-15-C-0046. This Phase II Remedial Investigation (RI) Report and Feasibility Study (FS) address soil, sediment, and surface water at National Advisory Committee on Aeronautics (NACA) Test Area 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 (NCP) to implement an RI to characterize the area of concern (AOC); develop an FS Report (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

NACA Test Area is located west of Greenleaf Road at the southern end of Demolition Road in the southwestern portion of Camp Ravenna. The AOC is approximately 47 acres, representing the limits of investigation of the Phase I RI and Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI), which encompassed all known or suspected former operations areas, excluding Open Demolition Area #1 (ODA1; designated as RVAAP-03).

This AOC was designed and used by NACA from 1947–1953 to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft (AGOH 1997; NACA 1953). During this time, 17 aircraft were crashed to develop and test explosion-proof fuel tanks and fuel (USACE 2001a). Seventeen excess aircraft were used during NACA Test Area operations. The planes were fueled and then propelled under their own power on a guide monorail. The planes were then crashed into a concrete barrier at speeds from 80–105 miles per hour. During the tests, high-speed films were made to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters.

Some aircraft were completely consumed by fire. Aircraft that were significantly damaged during testing were stripped of instrumentation and salvageable parts, and the majority of the aircraft were removed from the site. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area

(USACE 2001a). Explosives were burned and demolished in the ODA1, immediately south of the crash strip (Shaw 2013).

Since 1969, Ohio Army National Guard (OHARNG) has used NACA Test Area for training. The area is currently designated as Training Area 29 and is used as part of the land navigation course, to draw water from the wetland (outside the AOC boundary) for water purification training, and for helicopter "touch and go" training for hasty landing zones.

NACA Test Area consists of a crash strip approximately 1,625 ft long. The crash area was located at the east end of the strip. The total crash area is approximately 12 acres. A plane burial area is located east of the crash area. An unpaved access road circles the AOC. Many of the AOC features, including the crash barrier, utilities, and buildings (i.e., observation towers, fuel shack, storage sheds) have been removed. Remaining AOC features include the concrete crash strip and pad, a small man-made reservoir southeast of the former crash barrier, and an out-of-service water well and its associated concrete well pit northeast of the reservoir (USACE 2001a). Some plane debris can be observed on the surface of the plane burial area in the eastern portion of the AOC.

ES.1.2 Scope

The scope of this report is to perform a CERCLA evaluation of soil, sediment, and surface water at NACA Test Area. The media of concern associated with NACA Test Area 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, as it will be evaluated as an individual AOC for the entire facility. However, the potential for soil contaminants to leach to and migrate in groundwater is evaluated in this report to determine whether soil remedial actions to protect groundwater may be necessary. In addition, no storm or sanitary sewers are present at NACA Test Area.

ES.1.3 Evaluation of Future Use

In February 2014, the U.S. Department of the Army (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 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.

As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet Unrestricted (Residential) Land Use, then an FS will be completed that evaluates cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use]. Remedial alternatives for meeting each Land Use are to be evaluated per the current guidelines for selecting a remedy for the AOC. The preferred remedy is one that would meet Unrestricted (Residential) Land Use. RI/FS Reports in progress at the time of the Technical Memorandum's approval on February 11, 2014 will not be revised to include an evaluation of Commercial/Industrial Land Use as an Alternative if it achieves no further action for Unrestricted (Residential) Land Use.

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 environmental 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 1999 Phase I RI and 2010 PBA08 RI were used to evaluate nature and extent of contamination at NACA Test Area. These investigations used discrete sampling methods.

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 RI 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, such as ditches) 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 Phase I RI and 2010 PBA08 RI effectively characterized the nature and extent of 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 NACA Test Area.

ES.2.2.1 Surface and Subsurface Soil

Locations where explosives were identified as potential contaminants from previous site use were thoroughly evaluated across each exposure unit (EU). The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered chemicals of potential concern (COPCs), except one surface sample location at the Former Plane Refueling/Crash Strip Area. A concentration of 5.5 mg/kg of 2,4,6-trinitrotoluene (TNT) exceeded the SL of 3.65 mg/kg and was considered a COPC for the EU. TNT was not detected in the subsurface samples collected at the Former Plane Refueling/Crash Strip.

A total of 12 inorganic chemicals (arsenic, aluminum, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc) were identified as potential inorganic SRCs and as potentially related to previous AOC operations. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the regional screening level (RSL) of 400 mg/kg for lead), chromium, mercury, selenium, silver, and zinc concentrations were below their respective SLs; therefore, these chemicals were not considered COPCs at any of the EUs comprising NACA Test Area.

Aluminum, arsenic, and manganese were considered COPCs in surface soil at the Former Crash Area. Of these three inorganic chemicals, arsenic was the only COPC in subsurface soil in one PBA08 RI sample location (NTAsb-124, 4–7 ft bgs interval). Arsenic exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 in surface and subsurface soil with a maximum detected concentration (MDC) of 24.7J mg/kg at NTAsb-124 (in the 4–7 ft bgs interval). Arsenic was detected below the background concentration (13.9J mg/kg) in the next sample interval (from 7–13 ft bgs). Manganese exceeded the National Guard Trainee (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 in surface soil with an MDC of 4,500 mg/kg at NTA-034.

Barium and lead concentrations of 436 and 13,200 mg/kg, respectively, exceeded their respective SLs of 351 and 400 mg/kg in the one surface soil sample collected at the Former Crash Area Well Pit. Both inorganic chemicals were considered COPCs. Only lead exceeded the RSL, but barium was below the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1.

Five chemicals (aluminum, arsenic, cadmium, copper, and manganese) were considered COPCs in surface soil at the Former Plane Burial Area. In subsurface soil, cadmium and copper were considered COPCs. Although not identified as previously used during historical operations, antimony and cobalt also were considered COPCs in surface soil at the Former Plane Burial Area. Of the COPCs identified in surface and subsurface soil at the Former Plane Burial Area, only concentrations of arsenic and manganese in surface soil exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The MDC of arsenic and manganese was 23 mg/kg and 2,190 mg/kg, respectively, at Phase I RI sample location NTA-067.

Aluminum, arsenic, barium, and manganese were considered COPCs in surface soil at the Former Plane Refueling/Crash Strip Area. Although not identified as previously used during historical operations, cobalt and cyanide also were considered Phase II RI COPCs in surface soil. Arsenic and manganese exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The MDC of arsenic was 22.1 mg/kg at PBA08 RI sample location NTAss-128. Manganese was detected at a maximum concentration of 6,240J mg/kg at Phase I RI sample location NTA-084. No inorganic chemical COPCs were identified in subsurface soil.

Semi-volatile organic compounds (SVOCs) were not detected in surface soil at the Former Crash Area Well Pit. SVOCs were COPCs in surface and subsurface soil at the Former Plane Burial Area. Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected in Former Crash Area surface soil at Phase I RI sample location NTA-026, which exceeded the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The detected concentration of benzo(a)pyrene in the surface sample at Phase I RI sample location NTA-032 also exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1 at multiple surface soil sample locations at the Former Plane Refueling/Crash Strip Area. In subsurface soil, only benzo(a)pyrene exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 at one subsurface sample location. All other polycyclic aromatic hydrocarbon (PAH) concentrations detected in surface and subsurface soil at the Former Crash Area and Former Plane Refueling/Crash Strip Area were below the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1.

None of the detected concentrations of volatile organic compounds (VOCs) at NACA Test Area in surface or subsurface soil exceeded their respective SLs. Pesticides and polychlorinated biphenyls (PCBs) were not detected in any of the surface or subsurface samples collected for the four EUs comprising NACA Test Area except for the pesticide delta-hexachlorobenzene which was identified as an SRC in subsurface soil at the Former Crash Area.

ES.2.2.2 Sediment and Surface Water

The Tributary to Hinkley Creek was evaluated using two sediment and two surface water samples. No explosives or propellants were detected in the surface water samples and no propellants were detected in the sediment samples. One explosive [octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)] was detected at a low, estimated concentration in one sediment sample, but was not detected at the downstream sample. The concentration was below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for inorganic chemicals in the Tributary to Hinkley Creek exceeded the RSL at a TR of 1E-06, HQ of 0.1, except a sediment concentration of cobalt at NTAsd-145. One PAH, benzo(a)pyrene, exceeded its respective SL in sediment; however, the concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Bis(2-ethylhexyl)phthalate was detected above its respective SL in a surface water sample. No pesticides or PCBs were detected in sediment and no VOCs, pesticides, or PCBs were detected in surface water at the Tributary to Hinkley Creek. One VOC (2-butanone) was detected at NTAsd-143 below the SL.

One sediment and one surface water sample were used to evaluate the Wetland/Pond North of the Former Crash Area. No explosives or propellants were detected in sediment or surface water. All of the detected concentrations of inorganic chemicals in sediment and surface water were below the RSL at a TR of 1E-06, HQ of 0.1. In surface water, cobalt and manganese exceeded the SL at a TR of 1E-06, HQ of 0.1 but not at a TR of 1E-05, HQ of 1. SVOCs, pesticides, and PCBs were not detected in sediment or surface water samples at the Wetland/Pond North of the Former Crash Area. Three VOCs (2-butanone, ethylbenzene, and toluene) were detected in sediment and one VOC (toluene) was detected in surface water. The detected concentrations were below the SL at a TR of 1E-06, HQ of 0.1.

Sediment and surface water samples collected during the Phase I RI at the Former Crash Reservoir were used to evaluate the nature and extent for comparison purposes only. No explosives, propellants, SVOCs, pesticides, or PCBs were detected in sediment or surface water. In addition, no inorganic chemicals were identified as SRCs in sediment or surface water. Two VOCs (2-butanone and acetone) were detected in sediment at concentrations below the RSL at a TR of 1E-06, HQ of 0.1. VOCs were not detected in surface water for the Former Crash Area Reservoir.

One sediment and one surface water sample were collected during the Phase I RI at a drainage conveyance upstream of NACA Test Area. These samples were included in the nature and extent evaluation to provide data on off-AOC conditions for comparison purposes. No explosives were detected in sediment at the off-AOC Phase I RI sample location; however, the propellant nitrocellulose was detected at a concentration of 4.8 mg/kg. The explosive 2,4-dintrotoluene (DNT) was detected at Phase I RI off-AOC surface water station NTA-104 at a concentration of 0.000051J mg/L. This explosive was not detected in any of the other surface water samples collected at NACA Test Area. Eight inorganic chemicals (barium, beryllium, cadmium, cobalt, cyanide, manganese, nickel, and selenium) were detected above background concentrations in sediment. Barium, cobalt, cyanide, and manganese were detected at concentrations above their respective SLs in sediment. The concentrations detected at the upstream, off-AOC location were higher than those observed at either of the NACA Test Area sediment data EUs. VOCs were not detected in sediment, but acetone was detected in surface water below the RSL. SVOCs, pesticides, and PCBs were not detected in sediment and surface water at the off-AOC sample locations.

ES.2.3 Summary of Contaminant Fate and Transport

All SRCs identified in surface soil, subsurface soil, and sediment at NACA Test Area were evaluated through the stepwise contaminant fate and transport evaluation which 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 concentrations of SRCs 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 (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 maximum contaminant levels (MCLs), USEPA tap water RSLs, or RVAAP groundwater FWCUGs for the Resident Receptor Adult. 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 final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. Final CMCOPCs were evaluated using the Analytical Transient 1-, 2-, 3-Dimensional (AT123D) model to predict groundwater concentrations beneath source areas and at the nearest downgradient groundwater receptor to the AOC (e.g., stream).

The evaluation of modeling results with respect to current AOC groundwater data and model limitations did not identify CMCOPCs in sediment but identified the following CMCOPCs for soil:

- Antimony, arsenic, barium, cobalt, selenium, thallium, and naphthalene in the Former Crash Area;
- Antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium in the Former Plane Burial Area; and
- Selenium and 2,4-DNT in the Former Plane Refueling/Crash Strip Area.

These CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed the screening criteria in groundwater at the downgradient receptor location.

A qualitative assessment of the sample results and considerations of the limitations and assumptions of the models were performed to identify if any contaminant migration chemicals of concern (CMCOCs) are present in soil and sediment at NACA Test Area that may impact the groundwater at NACA Test Area beneath the source or at the downstream 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 downstream receptor location. No further action is required of soil and sediment at NACA Test Area 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. However, if unacceptable risk is identified for the Resident Receptor, the risk to the National Guard Trainee and Industrial Receptor is evaluated.

Media of concern at NACA Test Area are surface soil, subsurface soil, surface water, and sediment. Soil data associated with NACA Test Area were aggregated into surface and subsurface soil in each of three EUs (Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane Burial Area) and one potential hotspot area (Former Crash Area Well Pit). Surface water and sediment data associated with NACA Test Area were aggregated into three EUs [Wetland/Pond North of Former Crash Area, Tributary to Hinkley Creek, and Former Crash Area Reservoir (sediment only)].

No COCs were identified for any receptor at any EU in subsurface soil, sediment, or surface water. Additionally, there were no COCs identified for any receptor for surface soil in the Former Plane Burial Area. Lead and five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified in surface soil at one or more EUs as COCs to be carried forward for potential remediation.

Lead was identified as a COC in surface soil to be carried forward for potential remediation at the Former Crash Area Well Pit for all three Land Uses. Lead within the Former Crash Area Well Pit is likely attributable to lead-based paint on the metal cover and/or former equipment and piping that used to be in the pit. The elevated concentration of lead (13,200 mg/kg) in the well pit represents a hotspot of lead contamination.

The PAHs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were identified as COCs to be carried forward for potential remediation at the Former Plane Refueling/Crash Strip Area EU for Unrestricted (Residential) Land Use. Additionally, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs for remediation in this area to be carried forward for potential remediation for Commercial/Industrial Land Use. Activities in this area (i.e., crashing and burning planes and fuel) are a potential source of PAHs in this area. No COCs were identified for potential remediation in surface soil in this area for Military Training Land Use.

The PAHs benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs to be carried forward for potential remediation at the Former Crash Area for Unrestricted (Residential) Land Use. Concentrations of these PAHs at NTA-026 (located directly east of the crash strip where the crash strip terminated at a former concrete barrier structure) may be associated with site activities from use of the crash strip. No COCs were identified for potential remediation in surface soil for the Commercial/Industrial or Military Training Land Uses at the Former Crash Area EU. Table ES-1 summarizes COCs by receptor and EU.

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 NACA Test Area. This contamination was identified using historical and PBA08 RI data. Dry, early-successional, herbaceous field (dominant vegetation type), seasonally flooded herbaceous alliance, as well as dry and semi-permanently flooded shrublands and four types of forests were observed on the 47 acres in the AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., pond, streams) are present and near contamination. These findings invoked 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 and historical data sets against ecological screening values. A total of 28 integrated COPECs were identified for soil, 6 were identified for sediment, and 2 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 NACA Test Area 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, NACA Test Area has been adequately characterized and nature and extent has been defined. The fate and transport assessment concluded that chemicals in soil and sediment are not adversely impacting groundwater quality and are not predicted to have future impacts. The ERA concluded that there are no important or ecologically significant resources at the AOC; consequently, no further action is recommended from the ecological risk perspective.

The HHRA identified the following to be carried forward for potential remediation:

- PAHs as surface soil COCs in the Former Plane Refueling/Crash Strip Area to be protective of the Resident Receptor and Industrial Receptor.
- PAHs as surface soil COCs in the Former Crash Area to be protective of the Resident Receptor.
- Lead as a soil COC in the Former Crash Area Well Pit to be protective of the Resident Receptor, Industrial Receptor, and National Guard Trainee.

ES.3 SUMMARY AND RECOMMENDATION OF THE FEASIBILITY STUDY

To address COCs for potential remediation in the Former Crash Area, Former Plane Refueling/Crash Strip Area, and Former Crash Area Well Pit that are presented in Table ES-2, an FS was presented. This FS developed remedial action objectives (RAOs), identified appropriate cleanup goals (CUGs) for remedial actions, identified applicable and relevant or appropriate requirements (ARARs), screened potential remedial technologies and process options, and developed and evaluated remedial alternatives.

ES.3.1 Remedial Action Objective

Given the requirements for monitoring and the documentation that lists site usage by the National Guard Trainee, the Army has elected to evaluate only the Commercial/Industrial and Unrestricted (Residential) Land Use alternatives in this FS. Accordingly, the RAO for NACA Test Area is to prevent Industrial Receptor and Resident Receptor exposure to (1) lead in soil above the CUG at the Former

Crash Area Well Pit and (2) surface soil (0–1 ft bgs) with concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene above CUGs in the Former Plane Refueling/Crash Strip Area and the Former Crash Area. Figures ES-2 and ES-3 present the estimated extent of surface soil requiring remediation.

ES.3.2 Remedial Alternatives

Remedial technologies and process options were screened to identify potential remedial alternatives that can achieve the RAOs. The remedial alternatives developed are presented below:

- Alternative 1: No Action.
- Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and Land Use Controls (LUCs) – Attain Commercial/Industrial Land Use.
- Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.
- Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.

Alternative 1: No Action is required for evaluation under the NCP and provides the baseline against which other remedial alternatives are compared. This alternative assumes all current actions (e.g., access restrictions and environmental monitoring) are discontinued and that no future actions will take place to protect human receptors or the environment. COCs at the AOC are not removed or treated.

Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use involves removing 490 yd^3 (ex-situ) of surface soil (0–1 ft bgs) to achieve CUGs for the Industrial Receptor COCs at Area 1. The excavated area at Area 1 would be backfilled with approved, clean soil from a local commercial supplier. In addition, the soil in the Well Pit will be removed, and the former production well will be abandoned. Disturbed areas would be restored to grade and re-vegetated using an OHARNG-approved seed mixture and mulched. LUCs will be required as Unrestricted (Residential) Land Use is not attained.

Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use involves thermally treating the contaminated surface soil to achieve CUGs for the Industrial Receptor COCs at Area 1. The estimated 490 yd^3 (ex-situ) of soil would be excavated and placed into a thermal treatment system to remove COCs from soil. Once the treated soil is sampled and confirmed to be below CUGs, the treated soil will be placed back into the excavated area. In addition, the soil in the Well Pit will be removed, and the former production well will be abandoned. Disturbed areas will be restored to grade and re-vegetated using an OHARNG-approved seed mixture and mulched. LUCs will be required as Unrestricted (Residential) Land Use is not attained.

Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3, and Well Pit Removal – Attain Unrestricted (Residential) Land Use involves removing 1,140 yd^3 (ex-situ) of surface soil (0–1 ft bgs) to achieve CUGs for the Resident Receptor COCs at Areas 2 and 3. Excavations would be backfilled with approved, clean soil from a local commercial supplier. In addition, the soil in the Well Pit will be removed, and the former production well will be abandoned. Disturbed areas would be restored to grade and re-vegetated using an OHARNG-approved seed mixture and mulched. No LUCs or five-year reviews pursuant to CERCLA would be required because this alternative attains a level of protection for unrestricted use of the AOC.

Alternative 5 Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use involves thermally treating the contaminated surface soil to achieve CUGs for the Resident Receptor COCs at Areas 2 and 3. The estimated 1,140 yd^3 of soil would be excavated and placed into a thermal treatment system to remove the COCs from soil. Once the treated soil is sampled and confirmed to be below CUGs, the treated soil will be placed back into the excavated area. In addition, the soil in the Well Pit will be removed, and the former production well will be abandoned. Disturbed areas will be restored to grade and re-vegetated using an OHARNG-approved seed mixture and mulched. No LUCs or five-year reviews pursuant to CERCLA would be required because this alternative attains a level of protection for unrestricted use of the AOC.

The five alternatives were compared to CERCLA threshold and balancing criteria and a comparative analysis was completed to justify the selection of a recommended alternative for NACA Test Area. Table ES-3 summarizes the comparative analysis of the alternatives.

ES.3.3 Recommended Alternative

The recommended alternative for NACA Test Area is Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use. Alternative 5 meets the threshold and primary balancing criteria and is protective of the Resident Receptor by thermally treating PAH-contaminated soil and disposing the lead-contaminated soil offsite at an engineered landfill. The cost of Alternative 5 is $234,732 and has no operations and maintenance costs, as implementing the alternative results in attaining Unrestricted (Residential) Land Use. In addition, Alternative 5 is a green and highly sustainable alternative for on-site treatment and unrestricted reuse of soil and implements a treatment alternative to reduce the toxicity, mobility, and volume of contamination.

The selection of Alternative 5 as a recommended alternative is predicated on the on-site availability of the thermal treatment system. In the event that a thermal treatment system is not on site at the former RVAAP, Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use would be readily available and may be implemented. Excavation and off-site disposal alternatives have been implemented multiple times during restoration efforts at the former RVAAP. As with Alternative 5, Alternative 4 is effective in the long term and attains Unrestricted (Residential) Land Use. Alternative 4 reduces the mobility of contaminants by placing contamination in an engineered landfill.

The next step in the CERCLA process is to prepare a PP to solicit public input on the remedial alternatives. The PP will present these alternatives with the preferred remedial alternative for NACA Test Area. Comments on the PP provided by state and federal agencies and the public will be presented in the responsiveness summary of the NACA Test Area ROD. The ROD will provide a brief summary of the history, characteristics, and risks of the AOC and will document the selected remedy.

Table ES–1. Summary of COCs for NACA Test Area

Receptor(s)	Surface Soil (0–1 ft bgs)[a,b]	Deep Surface Soil (0–4 ft bgs)[a,b]	Subsurface Soil (4–7 and 1–13 ft bgs)[a,b]	Sediment	Surface Water
Former Plane Refueling/Crash Strip Area					
Resident Receptor (Adult and Child)	Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	—	None	None	None
Industrial	Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	—	None	None	None
National Guard Trainee	—	None	None	None	None
Former Crash Area					
Resident Receptor (Adult and Child)	Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	—	None	None	None
Industrial	None	—	None	None	None
National Guard Trainee	—	None	None	None	None
Former Crash Area Well Pit					
Resident Receptor (Adult and Child), Industrial, and National Guard Trainee	Lead	Lead	None	None	None
Former Plane Burial Area, Tributary to Hinkley Creek, Wetland/Pond North of the Former Crash Area, Former Crash Area Reservoir					
National Guard Trainee, Industrial, and Resident Receptor (Adult and Child)	None	None	None	None	None

[a] Surface soil (0–1 ft bgs) used to evaluate Resident Receptor and Industrial Receptor. Surface Soil (0–4 ft bgs) used to evaluate National Guard Trainee Receptor.

[b] Subsurface soil (1–13 ft bgs) used to evaluate Resident Receptor and Industrial Receptor. Subsurface soil (4–7 ft bgs) used to evaluate National Guard Trainee Receptor.

bgs = Below ground surface.
COC = Chemical of concern.
ft = Feet.
NACA = National Advisory Committee on Aeronautics.
— = Receptor not evaluated for that media.

Table ES–2. COCs for Potential Remediation and Cleanup Goals

Media	Chemical of Concern	Cleanup Goal (mg/kg)	
		Commercial/Industrial Land Use (Industrial Receptor)	**Unrestricted (Residential) Land Use (Resident Receptor)**
Former Crash Area			
Surface Soil (0–1 ft bgs)	Benzo(a)pyrene	NA	0.221
	Benzo(b)fluoranthene	NA	2.21
	Dibenz(a,h)anthracene	NA	0.221
Former Plane Refueling/Crash Strip Area			
Surface Soil (0–1 ft bgs)	Benz(a)anthracene	29	2.21
	Benzo(a)pyrene	2.9	0.221
	Benzo(b)fluoranthene	29	2.21
	Dibenz(a,h)anthracene	2.9	0.221
	Indeno(1,2,3-cd)pyrene	NA	2.21
Former Crash Area Well Pit			
Soil	Lead	800	400

Benz(a)anthracene is not a chemical of concern (COC) for potential remediation in the Former Crash Area, as the exposure point concentration (0.239 mg/kg) and maximum detected concentration (1.5 mg/kg) are below the Resident Receptor FWCUG (2.21 mg/kg).

There are no subsurface soil, sediment, or surface water COCs requiring remediation for Unrestricted (Residential) Land Use at National Advisory Committee on Aeronautics (NACA) Test Area.

There are no COCs in the following exposure units (EUs) within NACA Test Area: Former Plane Burial Area, Tributary to Hinkley Creek, Wetland/Pond North of the Former Crash Area, Former Crash Area Reservoir; and Off-Area of Concern.

bgs = Below ground surface.
ft = Feet.
mg/kg = Milligrams per kilogram.
NA = Not applicable. The COC does not require remediation for the receptor within the specified EU.

Table ES–3. Summary of Comparative Analysis of Remedial Alternatives

NCP Evaluation Criteria	**Alternative 1: No Action**	**Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use**	**Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use**	**Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal - Attain Unrestricted (Residential) Land Use**	**Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal - Attain Unrestricted (Residential) Land Use**
Threshold Criteria	***Result***	***Result***	***Result***	***Result***	***Result***
1. Overall Protectiveness of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective
2. Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant
Balancing Criteria	***Score***	***Score***	***Score***	***Score***	***Score***
3. Long-term Effectiveness and Permanence	Not applicable	1	1	3	3
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Not applicable	1	2	2	3
5. Short-term Effectiveness	Not applicable	3	3	2	2
6. Implementability	Not applicable	1	1	3	2
7. Cost	Not applicable ($0)	1 ($389,664)	2 ($345,530)	1 ($337,124)	3 ($234,732)
Balancing Criteria Score	*Not applicable*	*7*	*9*	*11*	*13*

Any alternative considered “not protective” for overall protectiveness of human health and the environment or “not compliant” for compliance with ARARs is not eligible for selection as the recommended alternative. Therefore, that alternative is not ranked as part of the balancing criteria evaluation.

Scoring for the balancing criteria is on a 3=most favorable, 1=least favorable basis. The alternative with the highest total balancing criteria score is considered the most feasible.

ARARs = Applicable and Relevant or Appropriate Requirements.

LUC = Land use control.

NCP = National Contingency Plan.

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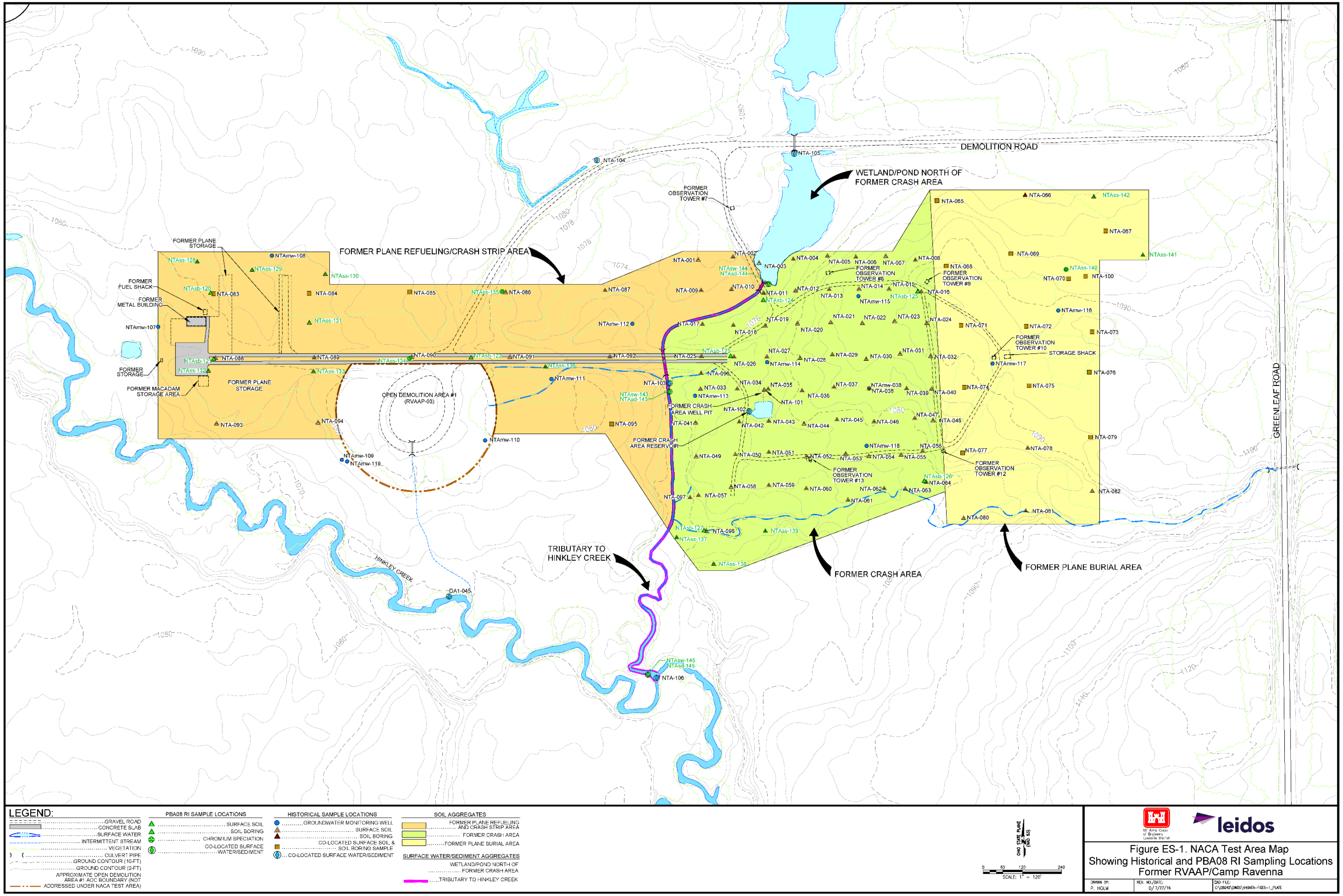
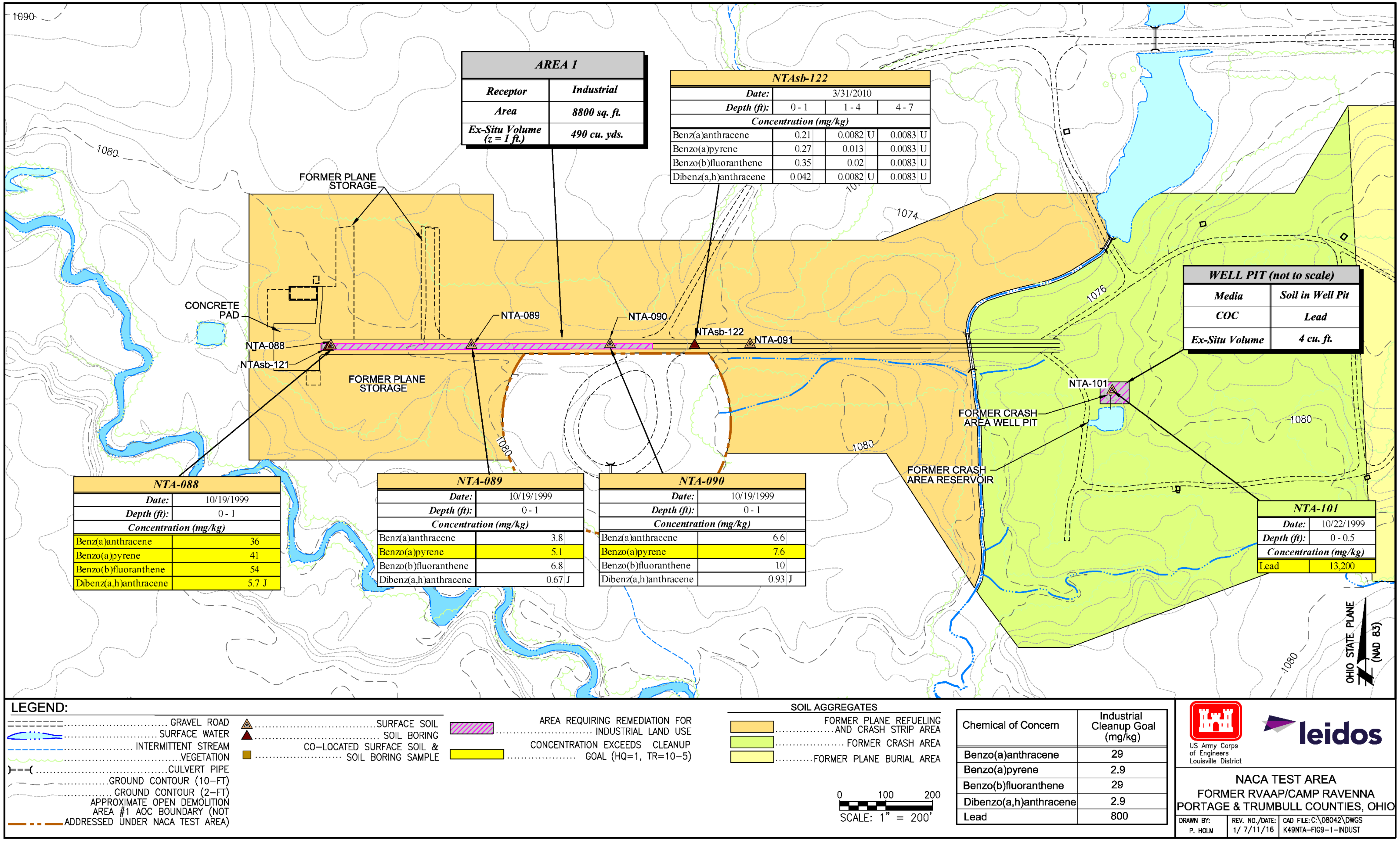


Figure ES–1. NACA Test Area Map Showing Sampling Locations - Former RVAAP/Camp Ravenna



AREA 1	
Receptor	Industrial
Area	8800 sq. ft.
Ex-Situ Volume (z = 1 ft.)	490 cu. yds.

NTAsb-122			
Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.21	0.0082 U	0.0083 U
Benzo(a)pyrene	0.27	0.013	0.0083 U
Benzo(b)fluoranthene	0.35	0.02	0.0083 U
Dibenz(a,h)anthracene	0.042	0.0082 U	0.0083 U

WELL PIT (not to scale)	
Media	Soil in Well Pit
COC	Lead
Ex-Situ Volume	4 cu. ft.

NTA-088	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	36
Benzo(a)pyrene	41
Benzo(b)fluoranthene	54
Dibenz(a,h)anthracene	5.7 J

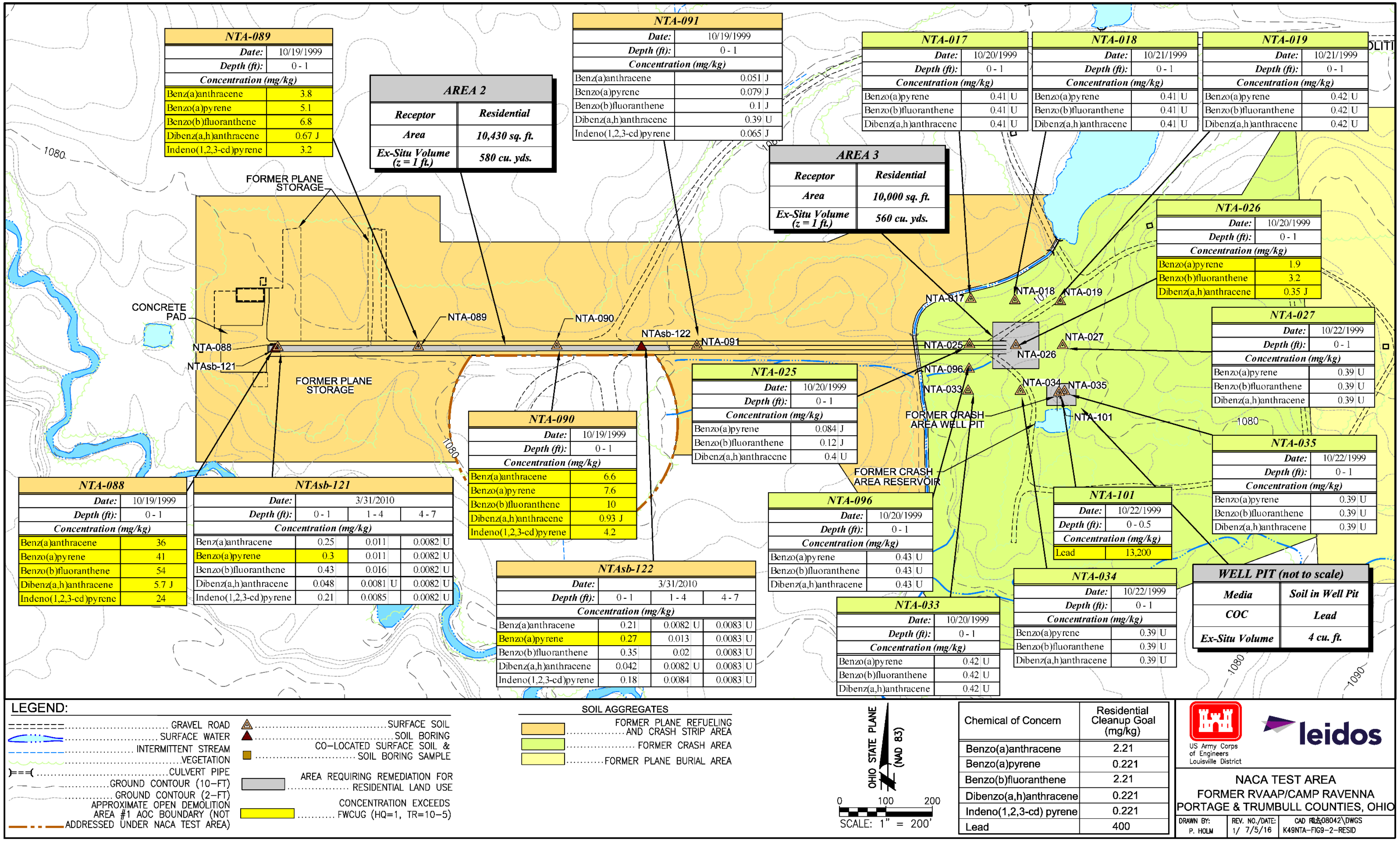
NTA-089	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	3.8
Benzo(a)pyrene	5.1
Benzo(b)fluoranthene	6.8
Dibenz(a,h)anthracene	0.67 J

NTA-090	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	6.6
Benzo(a)pyrene	7.6
Benzo(b)fluoranthene	10
Dibenz(a,h)anthracene	0.93 J

NTA-101	
Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Lead	13,200

Chemical of Concern	Industrial Cleanup Goal (mg/kg)
Benzo(a)anthracene	29
Benzo(a)pyrene	2.9
Benzo(b)fluoranthene	29
Dibenzo(a,h)anthracene	2.9
Lead	800

Figure ES–2. Estimated Extent of Soil Requiring Remediation to Attain Commercial/Industrial Land Use



NTA-089	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	3.8
Benzo(a)pyrene	5.1
Benzo(b)fluoranthene	6.8
Dibenz(a,h)anthracene	0.67 J
Indeno(1,2,3-cd)pyrene	3.2

AREA 2	
Receptor	**Residential**
Area	**10,430 sq. ft.**
Ex-Situ Volume (z = 1 ft.)	**580 cu. yds.**

NTA-091	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.051 J
Benzo(a)pyrene	0.079 J
Benzo(b)fluoranthene	0.1 J
Dibenz(a,h)anthracene	0.39 U
Indeno(1,2,3-cd)pyrene	0.065 J

NTA-017	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.41 U
Benzo(b)fluoranthene	0.41 U
Dibenz(a,h)anthracene	0.41 U

NTA-018	
Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.41 U
Benzo(b)fluoranthene	0.41 U
Dibenz(a,h)anthracene	0.41 U

NTA-019	
Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.42 U
Benzo(b)fluoranthene	0.42 U
Dibenz(a,h)anthracene	0.42 U

AREA 3	
Receptor	**Residential**
Area	**10,000 sq. ft.**
Ex-Situ Volume (z = 1 ft.)	**560 cu. yds.**

NTA-026	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	1.9
Benzo(b)fluoranthene	3.2
Dibenz(a,h)anthracene	0.35 J

NTA-027	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

NTA-025	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.084 J
Benzo(b)fluoranthene	0.12 J
Dibenz(a,h)anthracene	0.4 U

NTA-090	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	6.6
Benzo(a)pyrene	7.6
Benzo(b)fluoranthene	10
Dibenz(a,h)anthracene	0.93 J
Indeno(1,2,3-cd)pyrene	4.2

NTA-035	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

NTA-088	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	36
Benzo(a)pyrene	41
Benzo(b)fluoranthene	54
Dibenz(a,h)anthracene	5.7 J
Indeno(1,2,3-cd)pyrene	24

NTAsb-121			
Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.25	0.011	0.0082 U
Benzo(a)pyrene	0.3	0.011	0.0082 U
Benzo(b)fluoranthene	0.43	0.016	0.0082 U
Dibenz(a,h)anthracene	0.048	0.0081 U	0.0082 U
Indeno(1,2,3-cd)pyrene	0.21	0.0085	0.0082 U

NTA-096	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.43 U
Benzo(b)fluoranthene	0.43 U
Dibenz(a,h)anthracene	0.43 U

NTA-101	
Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Lead	13,200

NTAsb-122			
Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.21	0.0082 U	0.0083 U
Benzo(a)pyrene	0.27	0.013	0.0083 U
Benzo(b)fluoranthene	0.35	0.02	0.0083 U
Dibenz(a,h)anthracene	0.042	0.0082 U	0.0083 U
Indeno(1,2,3-cd)pyrene	0.18	0.0084	0.0083 U

NTA-034	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

WELL PIT (not to scale)	
Media	**Soil in Well Pit**
COC	**Lead**
Ex-Situ Volume	**4 cu. ft.**

NTA-033	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.42 U
Benzo(b)fluoranthene	0.42 U
Dibenz(a,h)anthracene	0.42 U

Chemical of Concern	Residential Cleanup Goal (mg/kg)
Benzo(a)anthracene	2.21
Benzo(a)pyrene	0.221
Benzo(b)fluoranthene	2.21
Dibenzo(a,h)anthracene	0.221
Indeno(1,2,3-cd) pyrene	0.221
Lead	400

Figure ES–3. Estimated Extent of Soil Requiring Remediation to Attain Unrestricted (Residential) Land Use

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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 II Remedial Investigation (RI) Report and Feasibility Study (FS) address soil, sediment, and surface water at the National Advisory Committee on Aeronautics (NACA) Test Area 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). NACA Test Area is designated as area of concern (AOC) RVAAP-38.

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 an FS Report (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:

- A description of the operational history and environmental setting for the AOC.
- A summary of all historical assessments and investigations at NACA Test Area.
- 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 II RI Report, including the identification and extent of COCs, which form the basis for conducting the FS.
- Identification of remedial action objectives (RAOs) for contaminated media at the AOC.
- Identification of applicable or relevant and appropriate requirements (ARARs).
- Identification of general response actions (GRAs) and screening of a range of remedial technologies to reduce risk to human health and the environment at the AOC from COCs identified in the Phase II RI Report.

- Development of remedial alternatives from appropriate GRAs and remedial technologies and evaluation of alternatives against criteria specified by CERCLA.
- Conclusions of the FS and a recommended alternative.

1.1 PURPOSE

The purpose of this report is to use available RI data, including that provided in the *Phase I Remedial Investigation Report for the NACA Test Area* (USACE 2001a) (herein referred to at the Phase I RI Report), 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 NACA Test Area. This report also provides a summary of the Performance-Based Acquisition 2008 Remedial Investigation (PBA08 RI) at NACA Test Area that was performed to supplement data from previous sampling events.

Depending on the results of the evaluations contained in the Phase II RI portion of 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. The purpose of the FS is to identify RAOs and appropriate cleanup goals (CUGs), screen remedial technologies, develop remedial alternatives to meet the RAOs and attain CUGs, and perform a detailed evaluation of remedial alternatives to identify a preferred remedy.

1.2 SCOPE

The scope of this report is to present a Phase II RI summarizing 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. Using the results of the Phase II RI, this report also includes an evaluation of remedial alternatives for meeting RAOs for any CERCLA-related COCs identified in the media at the AOC and a recommended alternative to present to the public in a PP. The recommended alternative will achieve required risk reductions to protect human health and the environment and attain all ARARs. In accordance with CERCLA, remedial alternatives are to be cost effective; use permanent solutions and alternative treatment technologies to the maximum extent practicable; and satisfy the preference for treatment that reduces volume, toxicity, or mobility to the maximum practical extent.

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 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 evaluation of remedial alternatives for these media. However, 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 NACA Test Area, including the geology, hydrogeology, climate, and receptor population.
- Section 4.0 summarizes previous assessments and investigations at the NACA Test Area, as well as the data used to support this Phase II 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 II RI.
- Section 9.0 outlines the development of RAOs for the chemicals and media of concern.
- Section 10.0 summarizes potential federal and state chemical-, location-, and action-specific ARARs for potential remedial actions.
- Section 11.0 presents GRAs and the identification and screening of technology types and process options considered for possible use in remediation.
- Section 12.0 develops remedial alternatives from technologies and process options that passed initial screening and presents an initial evaluation against effectiveness, implementability, and cost.
- Section 13.0 presents the detailed and comparative analyses of viable remedial action alternatives developed to address chemicals and media of concern using the seven criteria specified by CERCLA guidance.
- Section 14.0 presents the conclusions of the FS and the recommended remedial alternative.
- Section 15.0 summarizes the framework for conducting the necessary agency and public involvement activities.
- Section 16.0 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;
Appendix I: PBA08 RI Summary; and
Appendix J: Detailed Cost Estimates.

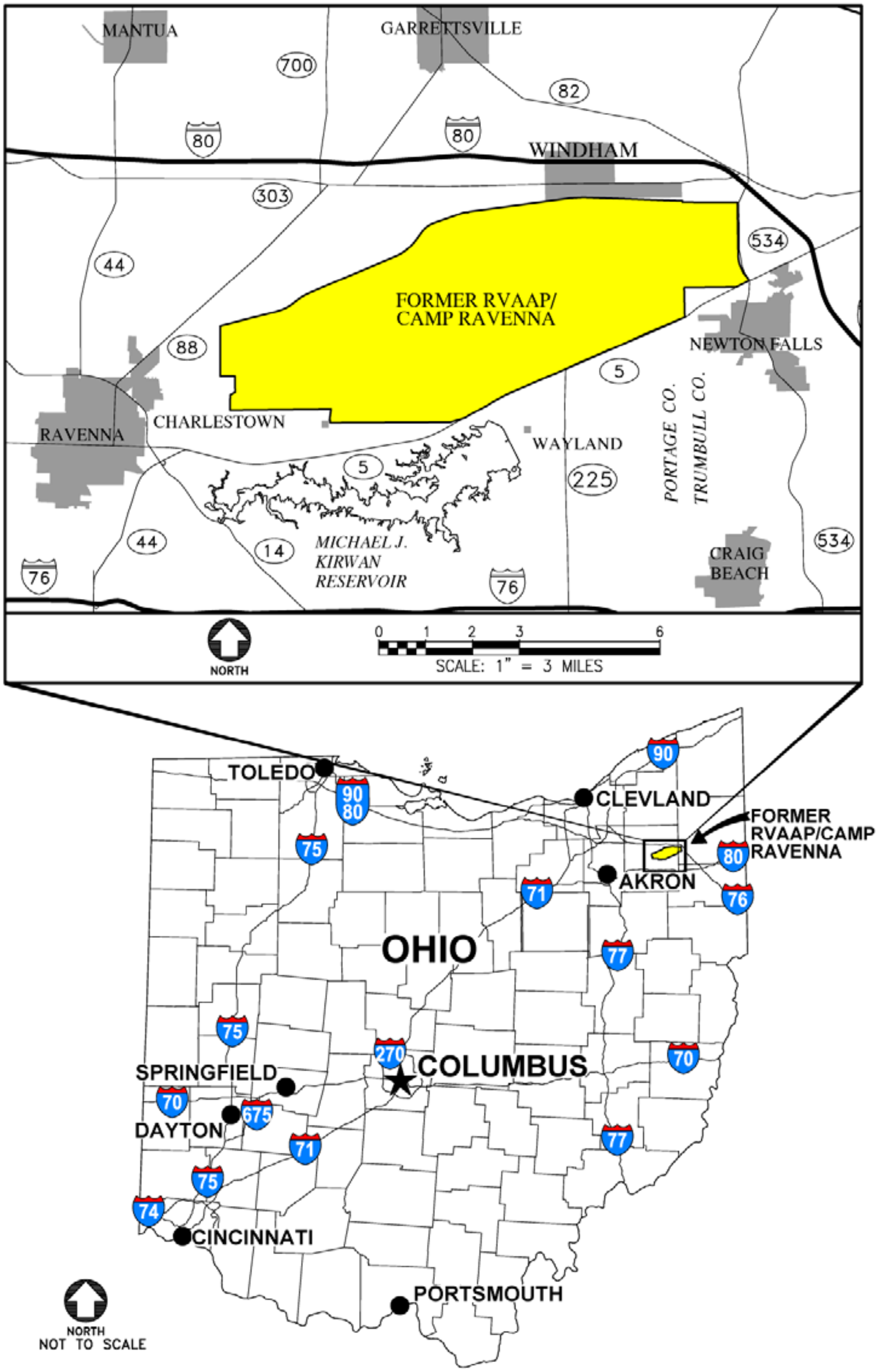

Figure 1–1. General Location and Orientation of Camp Ravenna

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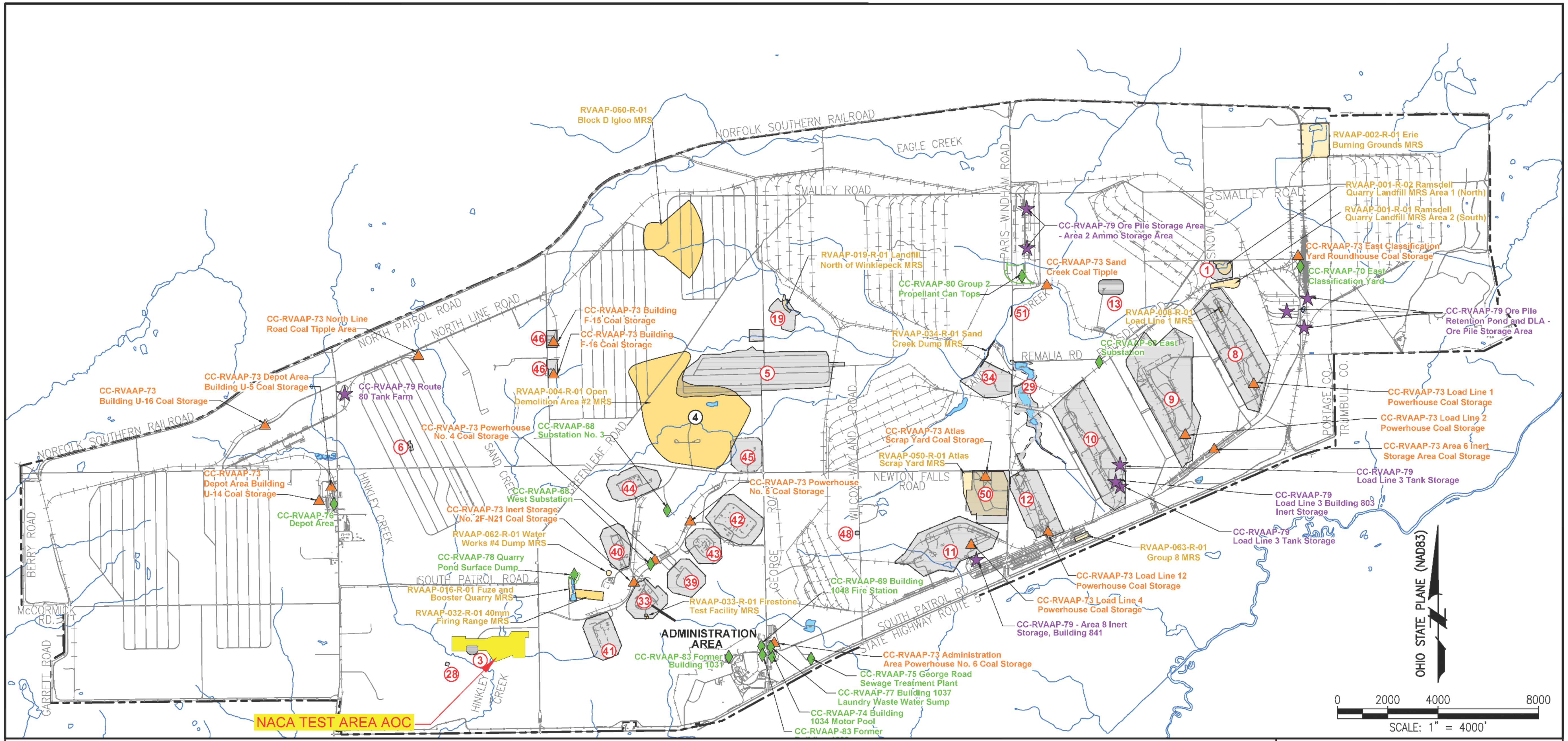

IRP SITES - CERCLA

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

COMPLIANCE RESTORATION SITES (13 SITES)

RVAAP-68	ELECTRIC SUBSTATIONS (E,W,NO.3)
RVAAP-69	BUILDING 1048 – FIRE STATION
RVAAP-70	EAST CLASSIFICATION YARD
RVAAP-72	FACILITY–WIDE USTs
RVAAP-73	FACILITY–WIDE COAL STORAGE
RVAAP-74	BUILDING 1034 MOTOR POOL HYDRAULIC LIFT
RVAAP-75	GEORGE ROAD SEWAGE TREATMENT PLANT
RVAAP-76	DEPOT AREA
RVAAP-77	BUILDING 1037 LAUNDRY WASTE WATER SUMP
RVAAP-78	QUARRY POND SURFACE DUMP
RVAAP-79	DLA ORE STORAGE SITES
RVAAP-80	GROUP 2 PROPELLANT CAN TOPS
RVAAP-83	FORMER BUILDINGS 1031 AND 1039

MMRP SITES (14 SITES)

RVAAP-001-R-02	RAMSDELL QUARRY LANDFILL AREA 1 (NORTH)
RVAAP-001-R-01	RAMSDELL QUARRY LANDFILL AREA 2 (SOUTH)
RVAAP-002-R-01	ERIE BURNING GROUNDS MRS
RVAAP-004-R-01	OPEN DEMOLITION AREA #2 MRS
RVAAP-008-R-01	LOAD LINE 1 MRS
RVAAP-016-R-01	FUZE AND BOOSTER QUARRY MRS
RVAAP-019-R-01	LANDFILL NORTH OF WINKLEPECK MRS
RVAAP-032-R-01	40MM FIRING RANGE MRS
RVAAP-033-R-01	FIRESTONE TEST FACILITY MRS
RVAAP-034-R-01	SAND CREEK DUMP MRS
RVAAP-050-R-01	ATLAS SCRAP YARD MRS
RVAAP-060-R-01	BLOCK D IGLOO MRS
RVAAP-061-R-01	BLOCK D IGLOO – TD MRS
RVAAP-062-R-01	WATER WORKS #4 DUMP MRS
RVAAP-063-R-01	GROUP 8 MRS

OTHER REGULATORY - RCRA

④RVAAP–04	OPEN DEMOLITION AREA #2

LEGEND:

◆	COMPLIANCE RESTORATION SITES – APPROVED
★	DLA ORE STORAGE AREAS (7 SITES)
▲	COAL STORAGE AREAS (17 SITES)
▭	AOC SITES
🟨	MMRP SITES
┼┼┼┼┼┼┼┼	RAILROAD TRACKS
–x–x–x–	FENCELINE
〜	STREAM OR CREEK

US Army Corps
of Engineers
Louisville District

leidos

FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV.2/05–05–16	08042/DWGS/K49NTA–FIG1–2

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 NACA Test Area's operational history, potential human health and ecological receptors, co-located or proximate sites, and potential site-related releases.

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 *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978). The assessment identified NACA Test Area only as an aircraft crash facility test site adjacent to the old demolition area [RVAAP-03 Open Demolition Area #1 (ODA1)].

The former RVAAP received bulk 2,4,6-trinitrotoluene (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 Army's 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, convoy training, maintaining equipment; C-130 aircraft drop zone operations, helicopter operations, and storing heavy equipment.

2.2 NACA TEST AREA BACKGROUND INFORMATION

2.2.1 Operational History

NACA Test Area is located west of Greenleaf Road at the southern end of Demolition Road in the southwestern portion of Camp Ravenna (Figures 1-2, 2-1, and 2-2). The Phase I RI Report indicated the AOC is 69 acres. However, the AOC is approximately 47 acres, which represents the limits of investigation of the Phase I RI and PBA08 RI. This AOC boundary encompasses all known or suspected former operations areas but now excludes ODA #1, which is now being evaluated as a separate AOC designated as RVAAP-03.

This AOC was designed and used by NACA from 1947–1953. The site was used to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft (AGOH 1997, NACA 1953). Excess airplanes were flown to the former RVAAP under their own power, taxied along installation roads, and staged at NACA Test Area. Seventeen excess aircraft were used during NACA Test Area operations. The planes were fueled and then propelled under their own power on a guide monorail. The planes were crashed into a concrete barrier at speeds from 80–105 miles per hour. During the tests, high-speed films were made to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters.

Combustible liquids involved in testing activities included 100/130 octane aviation fuels, low-volatility fuel, flame retardants, lubricating oil, coolant compounds, hydraulic fluids, alcohol, and brake fluid. Estimates of aviation fuel consumed are approximately 17,850 gal. However, the amounts of other liquids potentially released are not known (AGOH 1997). Fluids from the burning airplanes were generally found in a fan-shaped area beginning at the crash barrier and extending out in front of the airplane up to 400 ft.

Some aircraft were completely consumed by fire. Aircraft that were significantly damaged during testing were stripped of instrumentation and salvageable parts, and the majority of the aircraft were removed from the site. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area

(USACE 2001a). Explosives were burned and demolished in the ODA #1, immediately south of the crash strip (Shaw 2013).

Since 1969, OHARNG has used NACA Test Area for training. The area is currently designated as Training Area 29 and is used as part of the land navigation course, to draw water from the wetland (outside the AOC boundary) for water purification training, and for helicopter “touch and go” training for hasty landing zones.

Table 2-1 describes the various site features associated with NACA Test Area, which consists of an east-west trending runway or crash strip approximately 1,625 ft long. The crash area was located at the east end of the strip. The total crash area is approximately 12 acres. A plane burial area is located east of the crash area. An unpaved access road circles the AOC. Many of the AOC features, including the crash barrier, utilities, and buildings (i.e., observation towers, fuel shack, storage sheds) have been removed. Remaining AOC features include the concrete crash strip and pad, a small man-made reservoir southeast of the former crash barrier, and an out-of-service water well and associated concrete well pit northeast of the reservoir (USACE 2001a).

Currently, the AOC is forested around the perimeter. The interior of the AOC, which includes the crash strip and burial area, is relatively open and occasionally mowed. Hinkley Creek is located south/southwest of the AOC. A tributary to Hinkley Creek is located in the center of the AOC near the eastern end of the crash strip. The tributary flows from the northern wetlands south through the AOC toward Hinkley Creek (Figure 2-1).

2.2.2 Anticipated Primary Chemicals of Potential Concern

Using available process knowledge and previous investigation results, the Phase I RI Report established anticipated primary COPCs. These anticipated primary COPCs include inorganic chemicals (metals), semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs) and are shown in Table 2-2. These chemical groups are associated with burned or partly combusted fuels, deicing compounds, lubricants, hydraulic fluids, as well as fire extinguishing agents (specifically bromochloromethane) (AGOH 1997, NACA 1953).

Explosives, such as TNT and its associated degradation products, and propellants are not directly related to past operations. However, because of the proximity of ODA1, explosives and propellants are also considered to be potential contaminants, especially in the southern portion of the crash strip area.

2.2.3 AOC Boundary

NACA Test Area is in the southwest portion of RVAAP, at the southern end of Demolition Road, west of Greenleaf Road. No fences or perimeter boundaries exist at the AOC. However, the AOC boundary encompasses the limits of investigation of the 1999 Phase I RI and 2010 PBA08 RI, as presented in Figure 2-1.

The RVAAP Installation Action Plan (RVAAP 2013) and Phase I RI Report (USACE 2001a) state the AOC is approximately 69 acres; however, this area has not been defined in historical documents and likely includes outlying areas south to Hinkley Creek and north along Demolition Road. The acreage cited for NACA Test Area in the *Environmental Baseline Survey at the Ravenna Army Ammunition Plant* (Vista Technologies 1998) was approximately 40 acres.

The Phase I RI AOC boundary, as presented in Figure 1-4 of the Phase I RI Report, encompassed about 45 acres. This boundary included the entirety of ODA1, which is now being evaluated separately from NACA Test Area. The ODA1 AOC boundary, as presented in Figure 2-1 of the ODA Phase II RI Report, is approximately 3.6 acres. There are Seibert stakes demarcating the boundary of ODA1.

The investigation area of NACA Test Area expanded slightly during the 2010 PBA08 RI. The AOC boundary presented in this Phase II RI Report is approximately 47 acres (Figure 2-1).

2.2.4 Spatial Aggregates

The Phase I RI Report separated the AOC into eight functional areas to organize and track sampling efforts. These functional areas were based on site characteristics, operational data, available maps, and historical aerial photographs. This Phase II RI Report incorporated new information and reassessed separating varying areas within the AOC. This new assessment accommodated for additional samples collected beyond the Phase I RI sampling footprint. Accordingly, the NACA Test Area 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 Table 2-3 and Figure 2-3.

Soil aggregates for NACA Test Area include the (1) Former Crash Area, (2) Former Plane Burial Area, and (3) Former Plane Refueling/Crash Strip Area. In addition to these aggregates, the Crash Area Well Pit was evaluated as a potential hotspot because of its isolated nature and historical function as part of the fire suppression infrastructure.

Sediment and surface water were subdivided into four spatial aggregates for this report: (1) Tributary to Hinkley Creek, (2) Wetland/Pond North of the Former Crash Area, (3) Former Crash Area Reservoir, and (4) Off-AOC.

2.3 POTENTIAL RECEPTORS AT NACA TEST AREA

The following sections discuss potential human and ecological receptors at the NACA Test Area.

2.3.1 Human Receptors

Camp Ravenna is a controlled-access facility. NACA Test Area is located in the southwest portion of the facility (Figure 1-2). NACA Test Area is currently designated as Training Area 29 and is used as part of the land navigation course, to draw water from the wetland (outside the AOC boundary) for water purification training, and for helicopter “touch and go” training for hasty landing zones.

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 three Categorical Land Uses and Representative Receptors 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 (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.

As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential) Land Use, then an FS will be completed that evaluates cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use]. Remedial alternatives for meeting each Land Use are to be evaluated per the current guidelines for selecting a remedy for the AOC. The preferred remedy is one that would meet Unrestricted (Residential) Land Use. RI/FS Reports in progress at the time of the Technical Memorandum's approval on February 11, 2014 will not be revised to include an evaluation of Commercial/Industrial Land Use as an Alternative if it achieves no further action for Unrestricted (Residential) Land Use.

2.3.2 Ecological 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 (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 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 2-4. Currently, the AOC is forested around the perimeter. The interior of the AOC, which includes the crash strip and burial area, is relatively open and occasionally mowed. Hinkley Creek is located south/southwest of the AOC. A tributary to Hinkley Creek is located in the center of the AOC near the eastern end of the crash strip. The tributary flows from the northern wetlands south through the AOC toward Hinkley Creek (Figure 2-1). Additional information specific to ecological resources at NACA Test Area 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 NACA Test Area 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. The following summarizes wells sampled during the FWGWMP from 2005 to July 2014:

- 2008–2009 – A total of 12 groundwater monitoring wells (NTAmw-107 to NTAmw-118) installed in 2004 during the Characterization of 14 AOCs (MKM 2005) were sampled for 5 quarters.
    - Most chemical concentrations in the groundwater were below the maximum contaminant level (MCL) and regional screening level (RSL) [target risk (TR) of 1E-05, hazard quotient (HQ) of 1].
    - There were arsenic concentrations above the MCL (10 µg/L) at NTAmw-107, NTAmw-110, NTWmw-112, and NTWmw-113 µg/L. The maximum concentration was 41.2 µg/L collected in October 2009 at NTAmw-113.
    - There were manganese concentrations above the RSL (TR of 1E-05, HQ of 1) at NTAmw-112, NTAmw-113, NTAmw-114, and NTAmw-117. The maximum concentration was 1,070J µg/L at NTAmw-112.
    - NTAmw-113 also exceeded the lead and iron RSLs (TR of 1E-05, HQ of 1).
- January 2011 – Monitoring wells NTAmw-112 and NTAmw-113 were sampled for one quarter.
    - The concentration of arsenic in NTAmw-113 (10.7 µg/L) was only slightly above the MCL of 10 µg/L.
    - The concentration of manganese in NTAmw-112 (475 µg/L) was only slightly above the RSL (TR of 1E-05, HQ of 1) of 430 µg/L.
    - NTAmw-113 had non-detectable concentrations of lead and iron in the groundwater samples.
- 2012–2013 – Monitoring well NTWmw-109 was sampled for three quarters.
    - All chemical concentrations were below either the MCL or RSL (TR of 1E-05, HQ of 1).
- 2012–2014 – Monitoring well NTAmw-119 [installed in 2012 into the deeper unconsolidated aquifer zone and paired with well NTAmw-109 to assess the vertical extent of groundwater (EQM 2012)] was sampled for seven quarters.

- All chemical concentrations were below either the MCL or RSL (TR of 1E-05, HQ of 1) with the exception of naphthalene. Naphthalene was below the RSL in 5 of 7 quarters sampled. The final quarter sampled in July 2014 had non-detectable concentrations of naphthalene.

Facility-wide groundwater is currently at the RI phase of the CERCLA process. Any future decisions or actions respective to groundwater at NACA Test Area will be addressed as part of that facility-wide AOC.

2.4.3 Open Demolition Area #1 (RVAAP-03)

ODA1 is an AOC adjacent to and south of the crash strip at NACA Test Area. The AOC was in operation from 1941–1949 and was primarily used for the thermal destruction of munitions, explosives, and related materials by open burning and open detonation operations. During the late 1940s through the early 1950s, ODA1 was also used as a plane storage area for the NACA Test Area.

Previous environmental investigations at ODA1 were conducted in order to characterize the site. Upon completing the Relative Risk Site Evaluation (RRSE; USACHPPM 1996) and Water Quality Surveillance Program (USATHMA 1980–1992), the ODA1 Phase I RI was conducted in 1999 to assess the occurrence, distribution, and potential risks from contamination in soil (up to 8 ft bgs), sediment, surface water, and groundwater at ODA1. The *Phase I Remedial Investigation Report for Demolition Area 1* (USACE 2001b) identified site-related contamination (explosives and metals) in soil and determined that no significant impact to sediment, surface water, or groundwater as a result of past operations at ODA1 had occurred. The ODA1 Phase I RI concluded that based upon the future intended use of the site (military use), a human health risk remained from impacted soil and an HHRA and ERA should be conducted in order to facilitate remedial activities at ODA1.

In conjunction with the ODA1 Phase I RI, a munitions and explosives of concern (MEC) debris removal/Interim Removal Action was performed in 2000–2001 (MKM 2004). The objective of the removal action at ODA1 was to remove the MEC/munitions debris (MD), and the hazards associated with it, to a depth of 4 ft bgs, and eliminate the human health exposure to environmental COCs [explosives, such as TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)], DNT, and associated metals (i.e., cadmium, chromium, lead, and mercury) identified from the ODA1 Phase I RI (USACE 2001b).

To initiate Phase II RI activities, the *Final Data Quality Objectives for the RVAAP-03 Open Demolition Area #1 Version 1.0* (Shaw 2009) (herein known as the DQO Report) was developed to identify data gaps from past investigations and remedial activities where the extent of contamination was not adequately characterized or delineated for the purposes of environmental site closure. The DQO Report recommended that additional surface and subsurface soil sampling be performed to address identified data gaps to define the extent of contamination. The DQO Report (Shaw 2009) also recommended the AOC site boundary be confirmed. Based upon the need to address these data gaps mentioned above, additional sampling, a geophysical survey, a quantitative HHRA, and a screening level ecological risk assessment (SLERA) was performed.

The *Draft Phase II Remedial Investigation Study for RVAAP-03 Open Demolition Area #1* (USACE 2016) (herein referred to as the ODA1 Phase II RI Report) concluded that no further action is warranted for Unrestricted (Residential) Land Use for soil, sediment, and surface water. Although slightly elevated concentrations were detected in both discrete and ISM samples and the potential for localized ecological impacts cannot be completely discounted, the terrestrial area evaluated for ODA1 is less than one acre in size. Thus, the SLERA used highly conservative assumptions, and no further investigation or remedial action is considered necessary at ODA1 for ecological purposes.

ODA1 still has potential for MEC in areas that were not cleared in previously completed studies on the AOC. It is believed that little if any MEC remains, but this cannot be confirmed until a complete MEC clearance is conducted. Therefore, ODA1 will be properly managed and maintained according to Army policy (USACE 2016).

2.4.4 Suspected Mustard Agent Burial Site (RVAAP-28)

The Suspected Mustard Agent Burial Site (SMABS) AOC is located in the southwestern portion of the former RVAAP and consists of three investigation areas. A Site Investigation (USACE 2015) was conducted to evaluate the presence of sulfur mustard agent (dichlorodiethyl sulfide), which was suspected to have been buried at the SMABS after World War II and before 1950. Based on unconfirmed verbal evidence, this sulfur mustard may be in the form of Chemical Agent Identification Sets (CAIS).

The SMABS investigation areas are presented below and are shown on Figure 2-4:

- 1998 Geophysical Investigation Area – Wooded area approximately 1,000 ft southwest of NACA Test Area.
- 2006 Geophysical Investigation Area – Includes the 1969 Army Excavation Area.
- 2010 Geophysical Investigation Area – Investigation area surrounding the western portion of the crash strip and concrete test pad.

In 1969, the Army excavated a possible mustard agent burial site west of NACA Test Area. During this excavation, one 50-gal drum and seven small rusted cans were discovered. All recovered items were empty and no contamination was discovered (EQM 2008).

An unidentified and undocumented source reported that the 1969 Army Excavation Area was incorrectly identified, and the mustard agent was buried in the wooded area approximately 500 ft south of Hinkley Creek (approximately 1,000 ft southwest of NACA Test Area), along an abandoned power line right-of-way (USACE 1996). This second suspected site, measuring 270 square ft, was marked and fenced. However, only remnants of the fence existed in 2006, and the area has since been marked with Seibert stakes.

In July 2006, the Army conducted interviews with three local members of the public who formerly worked at RVAAP and claimed to have knowledge of SMABSs at the facility. One of the former workers interviewed identified a new area adjacent to the concrete pad at the west end of the NACA Test Area crash strip.

To date, investigations at the SMABS AOC have included performing one excavation, collecting surface soil samples, conducting geophysical mapping, and reviewing historical records. In addition, groundwater monitoring has been conducted in the vicinity of one of the SMABS AOC investigation areas as part of facility-wide activities.

No compounds related to mustard agents were detected in these surface soil and groundwater samples. The results of the geophysical investigations indicate that subsurface anomalies are present in the SMABS AOC. Many of the anomalies were identified as possible cultural and anthropogenic features based on location, size, length, position, and/or historical practices at the facility. The identified anomalies included former fencing/fence posts, subsurface utilities, and steel mill slag, and did not indicate the described mustard agent burial containers.

An Archive Search Report prepared for the former RVAAP in 2004 indicated that, “no records were found during the records search of any chemical warfare material (CWM) at this installation.” Furthermore, in a follow-up records review in 2012 of all documents available at the former RVAAP, there was no indication that any shipment of CWM had passed through the former RVAAP. However, historical documentation is most likely incomplete due to potential disposal of some archived documents over the years.

Although CAIS have been indicated to have been buried based on anecdotal interviews, the type and kind has not been clearly defined, and the investigation activities conducted to date have not confirmed the presence of metallic or glass CAIS containers. Based on the 2013 Probability Assessment (USAESC 2013), the possibility of encountering CWM or CAIS is “seldom” (meaning remotely possible). According to the geophysical data available, there are anomalies present which could be caused by metallic items the size of items of potential concern. This potentiality cannot be ruled out without an intrusive investigation of the anomalies.

2.4.5 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.

2.4.6 Compliance Restoration Sites

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

2.5 POTENTIAL SITE-RELATED RELEASES

Potential site-related releases at NACA Test Area involve activities performed to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft. Combustible liquids involved in testing activities included 100/130 octane aviation fuels, low-volatility fuel, flame retardants, lubricating oil, coolant compounds, hydraulic fluids, alcohol, and brake fluid. Estimates of aviation fuel consumed are approximately 17,850 gal. However, the amounts of other liquids potentially released are not known (AGOH 1997). Fluids from the burning airplanes were generally found in a fan-shaped area beginning at the crash barrier and extending out in front of the airplane up to 400 ft.

Some aircraft were completely consumed by fire, and the majority of the aircraft were removed from the site. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area (USACE 2001a).

Based on available process knowledge and previous investigation results, the anticipated primary COPCs include inorganic chemicals, SVOCs, and VOCs. Explosives, such as TNT, and its associated degradation products (e.g., 2,4-DNT) and propellants are not directly related to past operations, but they may exist along a portion of the crash strip due to previous operations at ODA1. Operational data suggest that the anticipated primary COPCs may include those shown in Table 2-2. These COPCs represent constituents encountered when burning fossil fuels and associated aircraft fluids and components.

Table 2–1. Descriptions of NACA Test Area Site Features

Site Features	Previous Use and/or Description
Former Plane Refueling Area	1947-1953: For refueling aircraft used in crash testing. Concrete pad, gravel area, and fuel shack.
Storage Area	1947-1953: Storage area on south side of concrete pad, constructed from macadam.
Former Fuel Shack	1947-1953: For refueling aircraft used in crash testing.
Corrugated Metal Building	1947-1953: Former operations building for the NACA Test Area
Former Observation Towers #8, 9, 10, 12, and 13	1947-1953: During the tests, high-speed films were made presumably from the observation towers to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters.
Storage Shacks near Observation Towers #10 and 13	1947-1953: Storage shacks presumably stored high-speed film materials and fire extinguishing agents.
Former Plane Storage	1947-1953: Multiple areas, including northeast of the concrete pad and within Open Demolition Area #1 south of the crash strip, utilized for aircraft staging for crash testing.
Former Crash Strip	1947-1953: Concrete crash strip approximately 1,625 ft long in which 17 excess aircraft traversed until they were crashed into a crash barrier by NACA to develop and test explosion-proof fuel tanks and fuel.
Former Crash Area	1947-1953: The crash area was located at the east end of the crash strip used by NACA. The total crash area is approximately 12 acres. Some crashed aircraft were completely consumed by fire. Those that were significantly damaged during testing were stripped of instrumentation and salvageable parts, and the majority were removed from the site. Fluids from the burning airplanes were generally found in a fan-shaped area beginning at the crash barrier and extending out in front of the airplane up to 400 ft.
Former Plane Burial Area	1947-1953: The majority of the crashed aircraft were removed from the site. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area.
Former Crash Area Well Pit	1947-1953: An out-of-service water well, enclosed in a concrete pit, is located immediately northeast of the reservoir, likely utilized as water source for the reservoir. The former steel-cased production well within the well pit was open at the time of the Phase I RI investigation. The depth of the well was estimated in the field at about 23.8 meters (78 ft); the depth to water was 3.35 meters (11 ft) below ground surface (bgs).
Former Crash Area Reservoir	1947-1953: A small reservoir was excavated for water, presumably for fire control, southeast of the former crash barrier.

AOC = Area of concern.
ft = Feet.
NACA = National Advisory Committee on Aeronautics.
RVAAP = Ravenna Army Ammunition Plant.

Table 2–2. Anticipated Primary COPCs at NACA Test Area per the Phase I RI

Chemical Group	Chemical	Rationale
Explosives	TNT	Munitions explosive
	DNT	Munitions explosive
	RDX	Munitions explosive
	HMX	Munitions explosive
	Trinitrobenzene	Associated with explosives
	Dinitrobenzene	Associated with explosives
	Nitrobenzene	Associated with explosives
	Nitrotoluene	Associated with explosives
Propellants	Nitroglycerine	Associated with explosives
	Nitroguanidine	Associated with explosives
	Nitrocellulose	Associated with explosives
Metals[a]	Arsenic	Previously detected
	Aluminum	Munitions booster cups; common fuze casings are made of aluminum
	Barium	Previously detected
	Cadmium	Previously detected; plating of many small metallic munitions components and all metallic shipping components for rust prevention
	Chromium	Common to munitions processing; previously detected
	Copper	Previously detected; common munitions (propellant) casings are made of brass (69% copper, 30% zinc)
	Lead	Common to munitions processing; previously detected at other AOCs
	Manganese	Previously detected at other AOCs
	Mercury	Previously detected at other AOCs
	Selenium	Previously detected at other AOCs
	Silver	Common to munitions processing
	Zinc	Previously detected
VOCs	---	Associated with aircraft releases; previously detected
	Bromochloromethane	Fire suppression agent
SVOCs	PAHs	Associated with aircraft releases; previously detected
PCBs	---	Associated with aircraft components
Pesticides	---	Associated with industrial processes

Source: Phase I Remedial Investigation Report for the NACA Test Area at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 2001a).

[a] Most common projectile casings are made of steel.

AOC = Area of concern.
DNT = Dinitrotoluene.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NACA = National Advisory Committee on Aeronautics.
PAH = Polycyclic aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
SVOC = Semi-volatile organic compound.
TNT = Trinitrotoluene.
VOC = Volatile organic compound.

Table 2–3. Phase II RI Aggregate Names and Description

Phase II RI Aggregate Name	Media	Description and Notes
Former Crash Area	Soil	Combination of Phase I RI Functional Area 1: Crash Area and Functional Area 4: Ditches Flowing from the Crash Strip. The samples identified as surface soil/dry sediment for the ditches flowing from the Crash Area in the Phase I RI Report have been incorporated into the surrounding Former Crash Area spatial aggregate.
Former Plane Burial Area	Soil	Same as Phase I RI Functional Area 2: Plane Burial Area.
Former Plane Refueling/Crash Strip Area	Soil	Same as Phase I RI Functional Area 3: Plane Refueling/Crash Strip Area.
Wetland/Pond North of Former Crash Area	Sediment, Surface Water	Wetland/pond north of NACA Test Area.
Tributary to Hinkley Creek	Sediment, Surface Water	Tributary traversing through the middle of NACA Test Area.
Former Crash Area Well Pit	Soil	Same as Phase I RI Functional Area 5: Crash Area Well Pit. Media reclassified as surface soil since this location is only intermittently wet.
Former Crash Area Reservoir	Sediment, Surface Water	Same as Phase I RI Functional Area 6: Crash Area Reservoir.
Off-AOC	Sediment, Surface Water	Evaluation of a drainage ditch sample collected during the Phase I RI upstream of NACA Test Area.

AOC = Area of concern.
NACA = National Advisory Committee on Aeronautics.
RI = Remedial investigation.

Table 2–4. 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*
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*

Table 2–4. Federal- and State-listed Species List (continued)

CAMP RAVENNA JOINT MILITARY TRAINING CENTER RARE SPECIES LIST

December 2014

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 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 Management Plan (OHARNG 2014) indicated that no federally listed species are known to reside at Camp Ravenna, and no critical habitat occurs. However, the northern long-eared bat exists and Camp Ravenna and was expected to be listed as an endangered species in mid-2015. It does exist at Camp Ravenna. Accordingly, this table indicates the northern long-eared bat is federally threatened (USFWS 2016) and state threatened (ODNR 2016).

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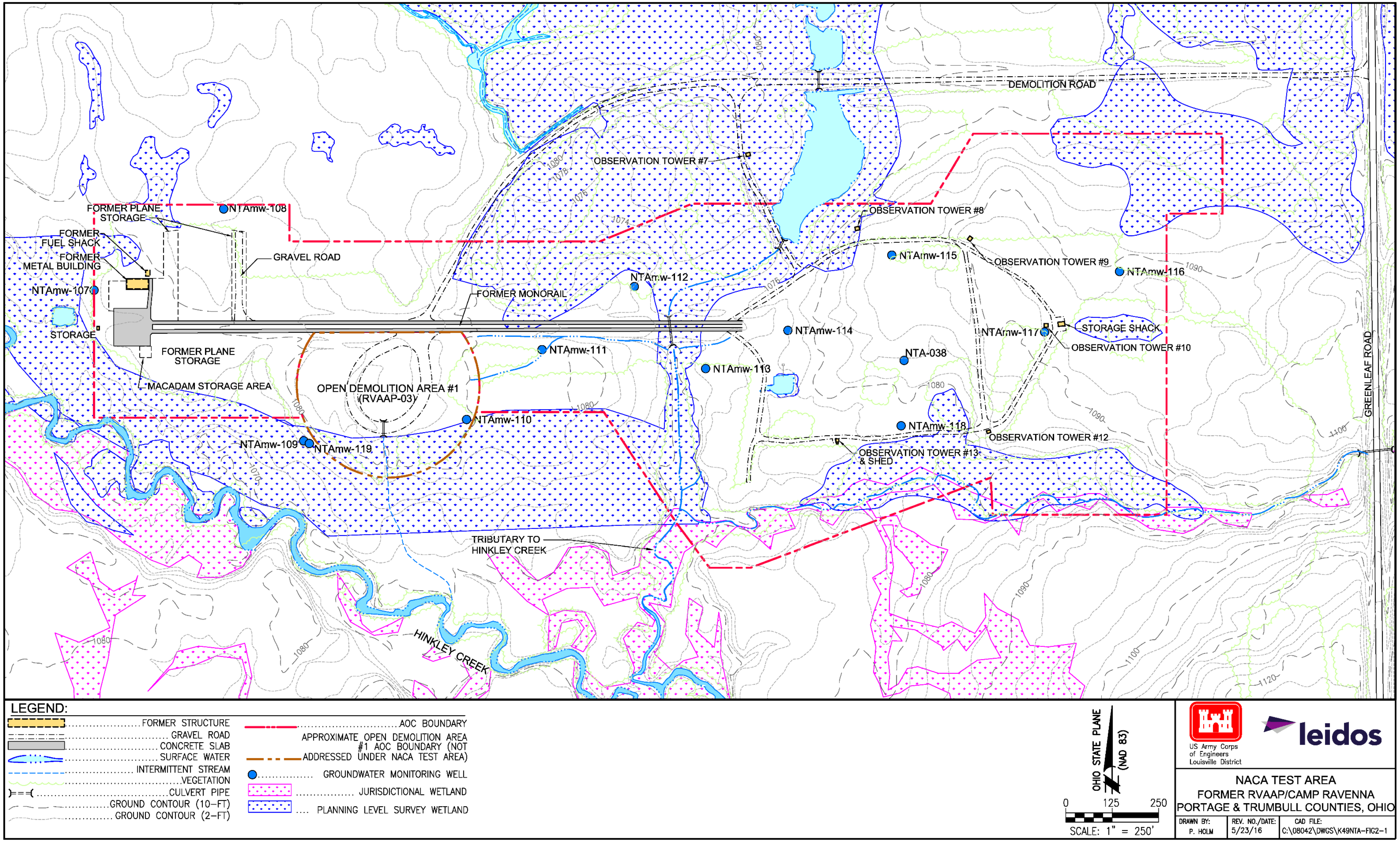

Figure 2–1. NACA Test Area Site Features

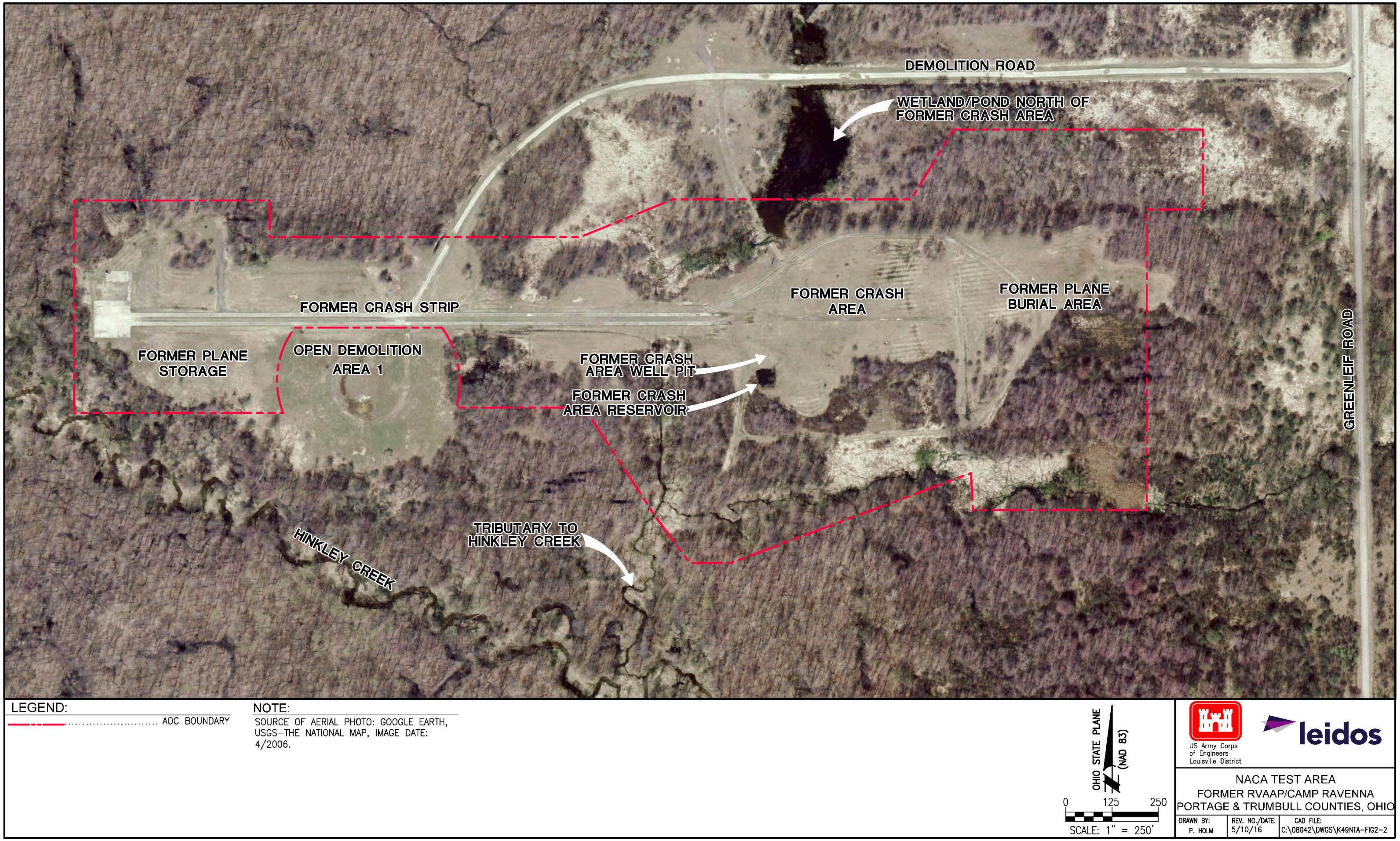

Figure 2–2. NACA Test Area Site Features (Aerial Photo dated 4/2006)

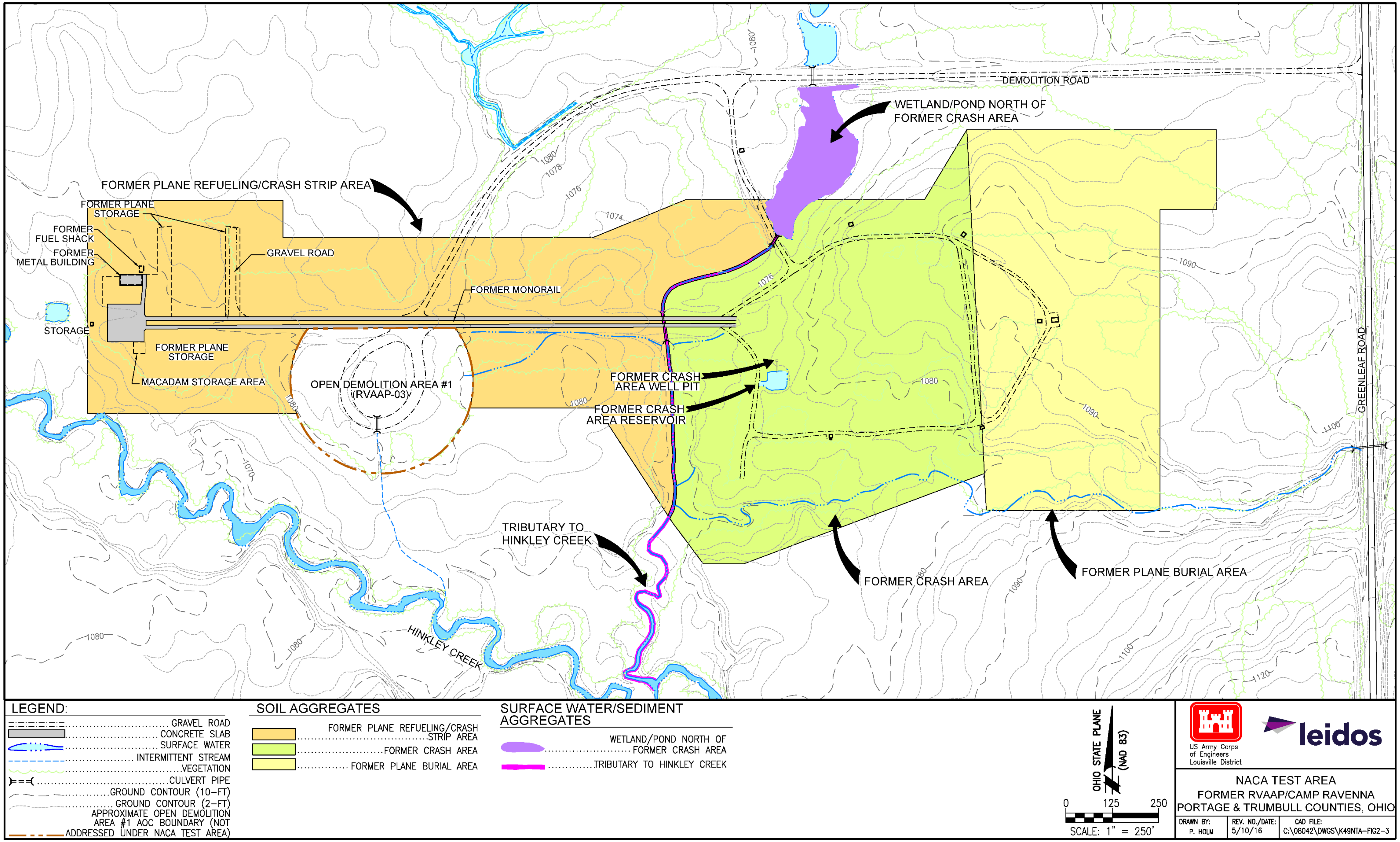

Figure 2–3. Location of Data Aggregates at NACA Test Area

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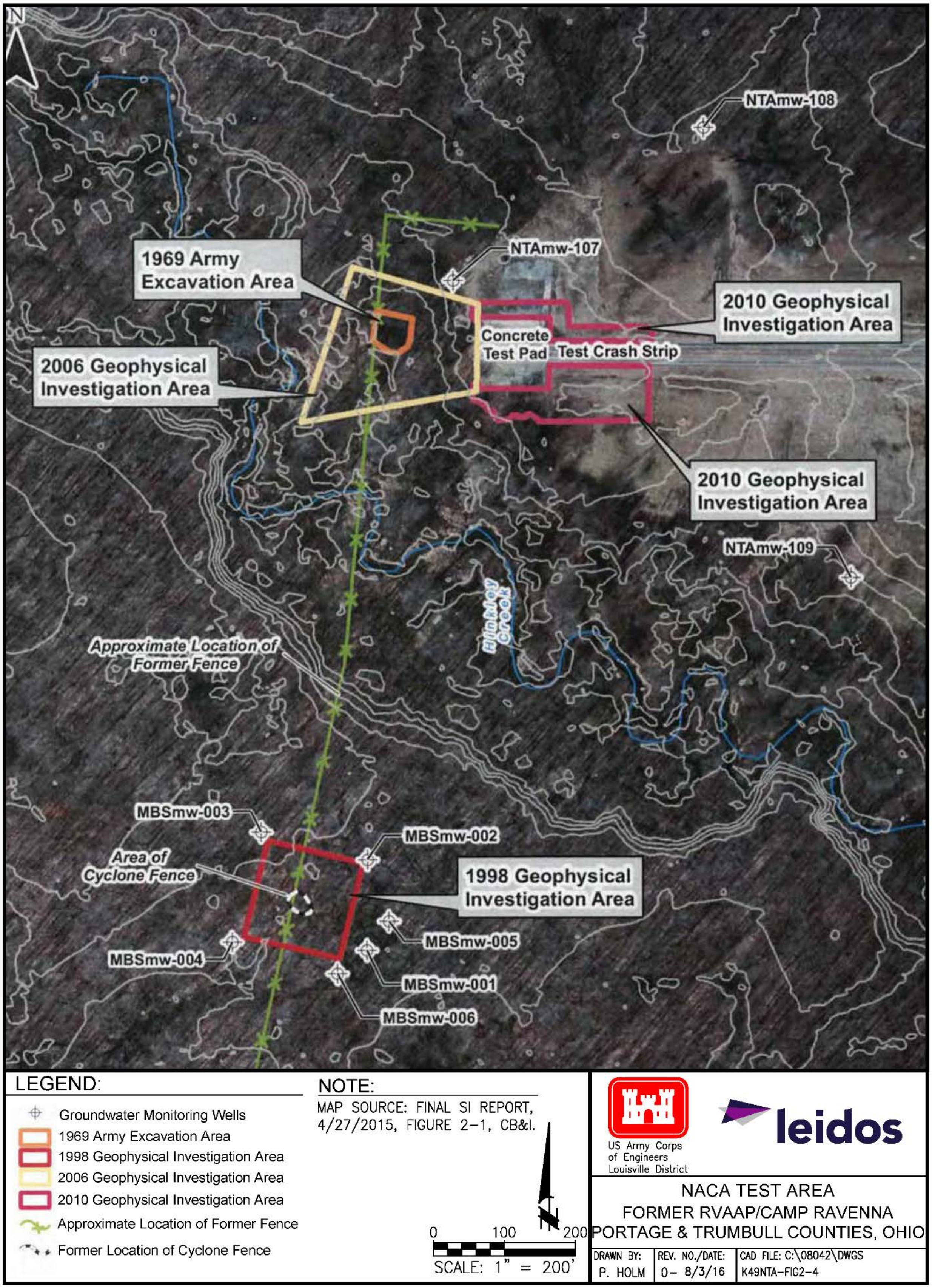

Figure 2–4. Suspected Mustard Agent Burial Sites

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3.0 ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of Camp Ravenna and NACA Test Area 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.

NACA Test Area is in the southwest portion of RVAAP, at the southern end of Demolition Road, west of Greenleaf Road. No fences or perimeter boundaries exist at the AOC. Ground elevations within NACA Test Area range from approximately 1,070-1,094 ft amsl (Figure 3-1). Topographic relief at NACA Test Area is low, with most of the relief occurring at the east end of the AOC. The area of the crash strip is level. Hinkley Creek is south of the AOC and a tributary to Hinkley Creek runs through the center of the AOC, west of the crash barrier.

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 NACA Test Area 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 2001c). 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 2001c).

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 NACA Test Area

Bedrock was not encountered at NACA Test Area during the PBA08 RI or previous characterization activities. The bedrock formation at NACA Test Area 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.

The absence of encountering bedrock less than 30 ft bgs may correlate with NACA Test Area being located in the suspected pre-glacial buried bedrock valley that trends northeast to southwest through the facility (Figure 3-3). The thickness of glacial deposits may exceed 150 ft in this area (Winslow et al. 1966).

NACA Test Area is located on the eastern boundary of the Lavery Till and the western boundary of the younger Hiram Till glacial deposits. The primary soil types found at NACA Test Area are the Mahoning silt loam (2-6% slopes) in the eastern half of the AOC and Fitchville silt loam series in the western half of the AOC. 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. The Fitchville silt loam series (0-2% and 2-6% slopes) is a somewhat poorly drained, gently sloping silt loam to silty clay loam formed from glaciolacustrine deposits (USDA 2010).

As observed in PBA08 RI soil borings, the composition of unconsolidated deposits at the AOC generally consist of yellowish-brown and brown to gray, medium dense, sand and clay-rich silt tills. Groundwater was observed from 2.5–12.75 ft bgs in unconsolidated borings. Small, saturated sand seams were also observed above the groundwater table from 3–5.2 ft bgs in several soil borings. PBA08 RI boring logs containing geologic descriptions of unconsolidated deposits at NACA Test Area 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 I RI and Characterization of 14 AOCs. Cross-sections of NACA Test Area subsurface were created from monitoring well lithology records to illustrate lateral distribution and variation of the discontinuous glacial sediment (MKM 2007).

Disturbed geotechnical samples were collected from six surface soil locations during the Phase I RI (USACE 2001a). Geotechnical results showed a narrow range of variation in moisture content and Atterberg limit results. Soil classifications for these samples were clays and silts, which indicated relatively consistent surface soil lithology across the AOC (USACE 2001a). Three undisturbed geotechnical samples were collected during the Characterization of 14 AOCs at groundwater monitoring well locations NTAmw-111 (4–6 ft bgs), NTAmw-112 (10–12 ft bgs), and NTAmw-113 (6–8 ft bgs). Soil classifications for these three samples ranged from sandy silt (10–12 ft bgs) to lean and silty clays. No geotechnical analyses were conducted as part of the PBA08 RI.

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). 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 2010).

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 2010). 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 NACA Test Area Hydrologic/Hydrogeologic Setting

Twelve groundwater monitoring wells were installed in 2004 at NACA Test Area during the Characterization of 14 AOCs and were screened in the unconsolidated overburden. Initial depths to groundwater encountered during well installation varied from 5.5–23 ft bgs. Monitoring wells at the AOC ranged in completion from 18–27 ft bgs. One additional well (NTAmw-119) was installed in 2012 into the deeper unconsolidated aquifer zone, paired with well NTAmw-109 to assess the vertical extent of groundwater (EQM 2012). All monitoring wells have groundwater elevations collected under the FWGWMP.

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 2010). Water level elevations at the AOC had a range of 1,067.38-1,090.10 ft amsl (0.33–15.66 ft bgs). The potentiometric surface shows the groundwater flow pattern to the southwest toward Hinkley Creek. The hydraulic gradient ranges from 0.00278 ft/ft in the western portion of the AOC to 0.0297 ft/ft in the eastern portion of the AOC.

Results of rising and falling head slug tests performed at the 12 monitoring wells during the Characterization of 14 AOCs indicate an average hydraulic conductivity of 4.12E-04 cm/s (MKM 2007). Table 3-1 presents the hydraulic conductivity result for each well at NACA Test Area.

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 Route 88 and State Route 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 south of the facility (USACE 2001c).

Approximately one-third of Camp Ravenna meets the regulatory definition of a wetland, with the majority of the wetland areas located in the eastern portion of the facility. 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 50 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 NACA Test Area Surface Water

Several perennial surface water features are present within the AOC or in the immediate vicinity (Figure 3-1). The main surface water features include a large pond at the north-central portion of the AOC, a tributary flowing north to south through the middle of the AOC to Hinkley Creek, and an approximate 40 by 45 ft reservoir located southeast of the former crash barrier was excavated for water, presumably for fire control during NACA operations from 1947–1953.

A water body west of the crash strip and concrete pad is a product of an Army excavation in 1969 to investigate a SMABS (USACE 2015). This activity was summarized in Section 2.4.4.

Surface water is the primary migration pathway for contamination to exit the AOC, flowing through ditches or surface water drainage features toward Hinkley Creek. Most surface runoff flows overland to the center of the AOC into the tributary to Hinkley Creek. Surface runoff in the western portion of the Former Plane Refueling/Crash Strip Area flows southwest and drains into Hinkley Creek (Figure 3-1). During the PBA08 RI, surface water was observed throughout the AOC flowing toward the tributary to Hinkley Creek. A storm sewer system is not present at NACA Test Area.

Several large planning and jurisdictional wetlands exist within the AOC boundary, which may receive overland surface water flow.

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)](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 Characterization of 14 AOCs

Monitoring Well ID	Screened Interval (ft bgs)	Geologic Material Adjacent to Screen	Hydraulic Conductivity (cm/s)
NTAmw-107	12 - 22	Sand, Clayey Silt	1.69E-03
NTAmw-108	12 -22	Sand, Sandy Silt	2.64E-04
NTAmw-109	8 -18	Sand, Silty Sand	1.01E-03
NTAmw-110	17 -27	Silt, Silty Sand	6.41E-05
NTAmw-111	9.5 – 19.5	Clayey Silt	2.30E-04
NTAmw-112	13.9 – 23.9	Sand, Sandy Silt	4.66E-04
NTAmw-113	17 -27	Sandy Silt	3.19E-04
NTAmw-114	9.5 – 19.5	Sand, Silt	2.13E-04
NTAmw-115	12.5 – 22.5	Clayey Silt	1.37E-04
NTAmw-116	10 – 20	Clayey Silt	2.76E-04
NTAmw-117	14.5 – 24.5	Sandy Silt	1.54E-04
NTAmw-118	12 – 22	Sand, Sandy Silt	1.37E-04

Source = MKM 2007. *Characterization of 14 AOCs at Ravenna Army Ammunition Plant.* March 2007.
AOC = Area of concern
bgs = Below ground surface.
cm/s = Centimeters per second.
ft= Feet.
ID = Identification.

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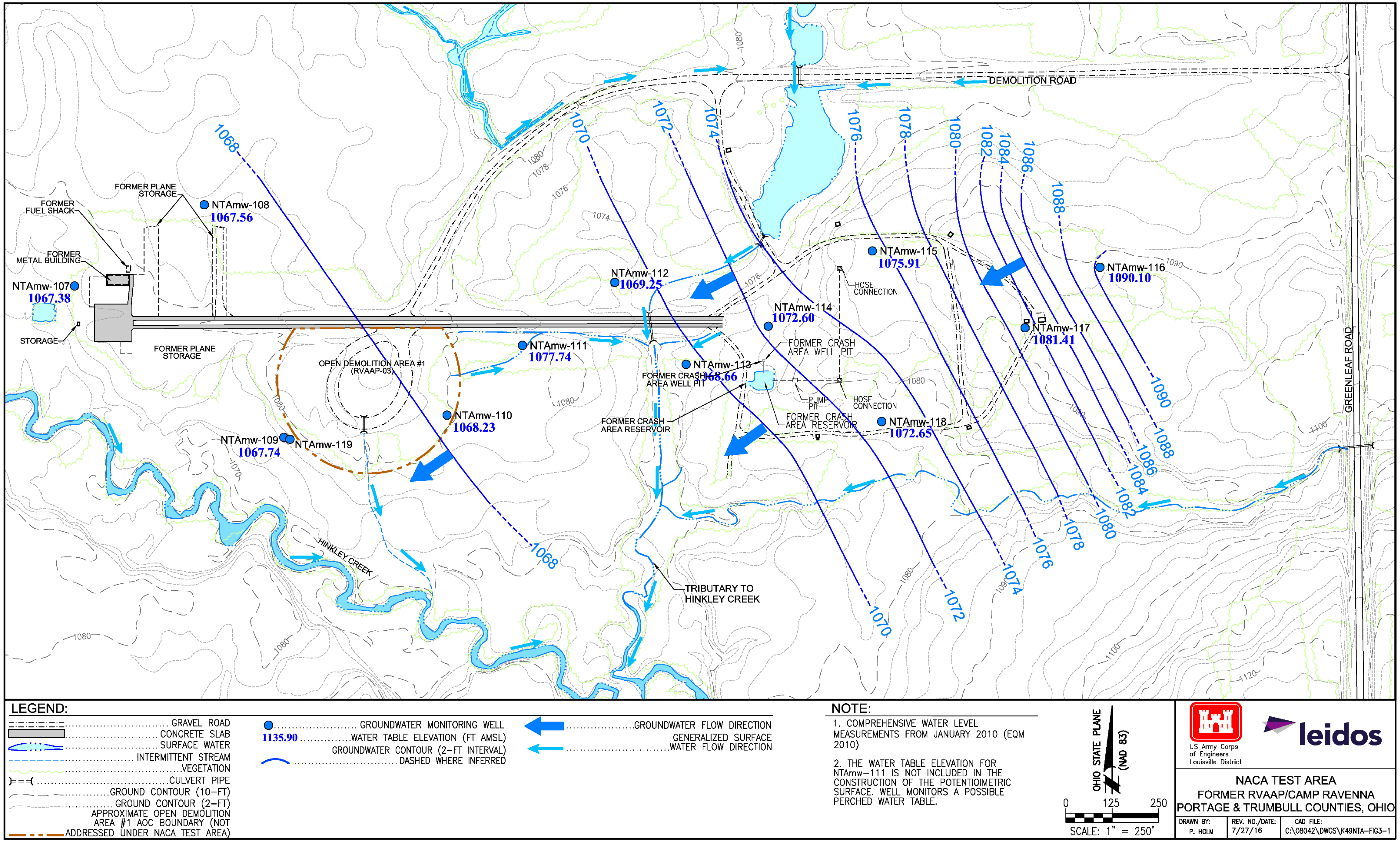

NOTE:

1. COMPREHENSIVE WATER LEVEL MEASUREMENTS FROM JANUARY 2010 (EQM 2010)

2. THE WATER TABLE ELEVATION FOR NTAmw-111 IS NOT INCLUDED IN THE CONSTRUCTION OF THE POTENTIOIMETRIC SURFACE. WELL MONITORS A POSSIBLE PERCHED WATER TABLE.

Figure 3–1. Topography, Groundwater Flow, and Surface Water Flow at NACA Test Area

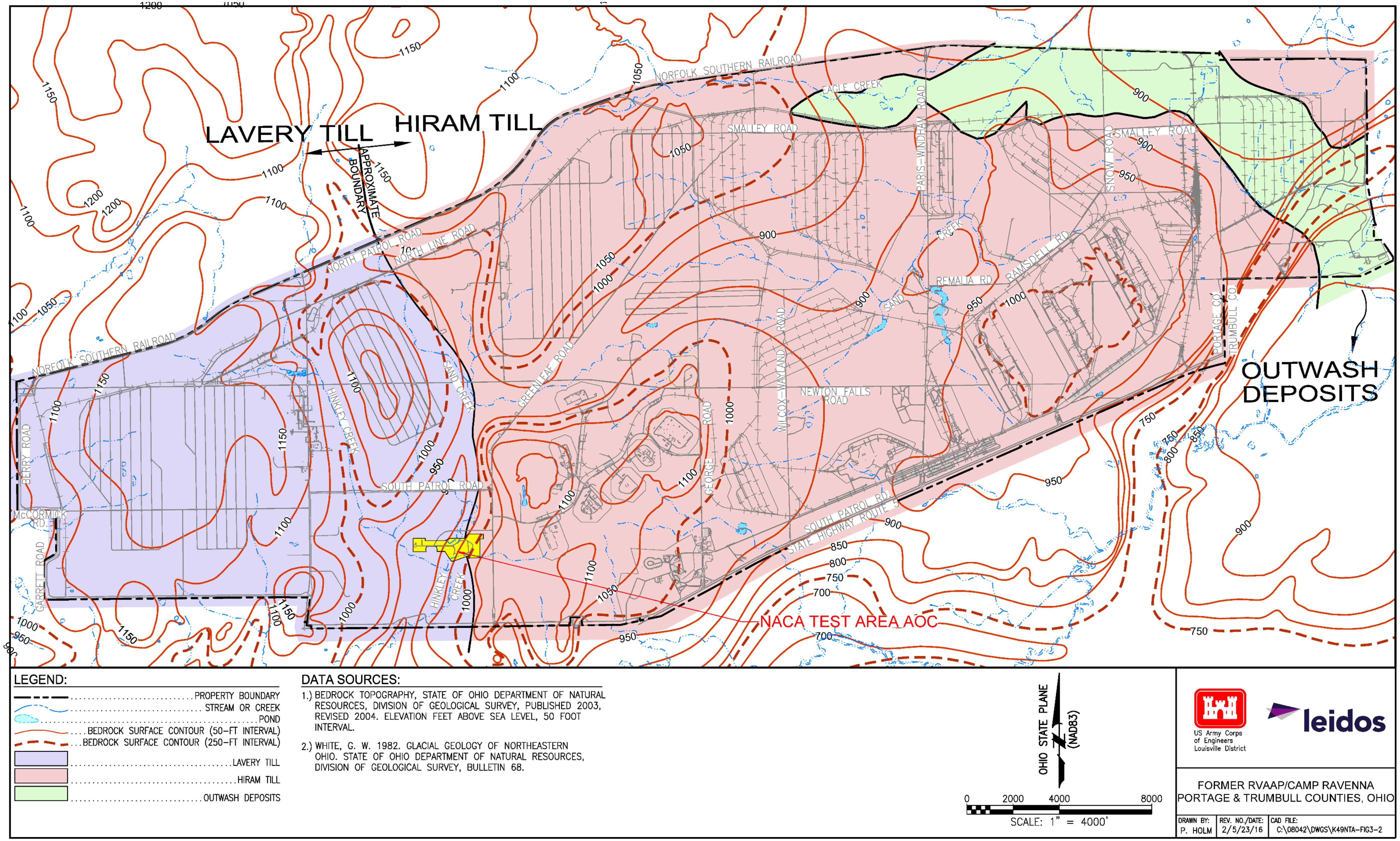

Figure 3–2. Geologic Map of Unconsolidated Deposits on Camp Ravenna

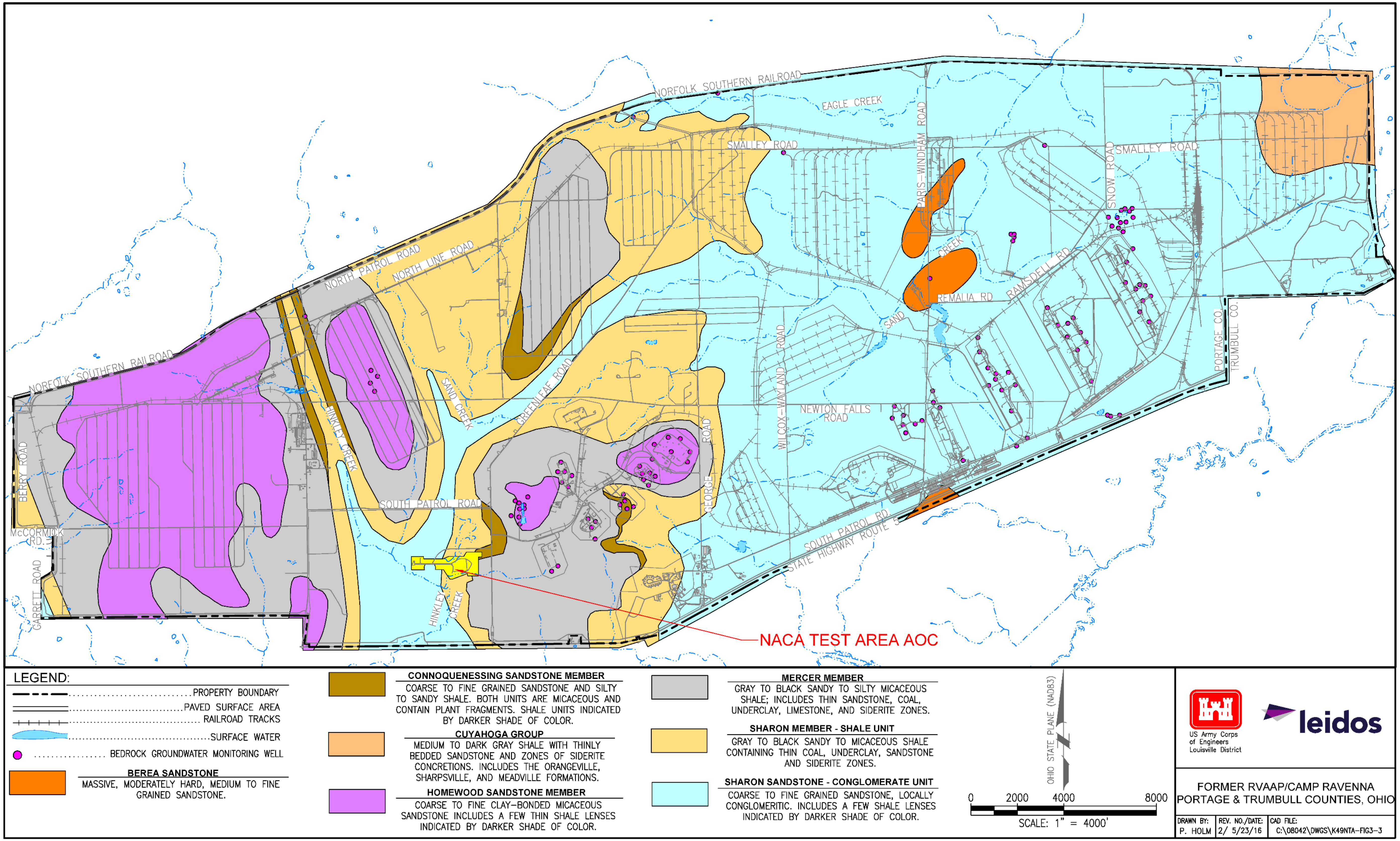

Figure 3-3. Geologic Bedrock Map and Stratigraphic Description of Units on Camp Ravenna

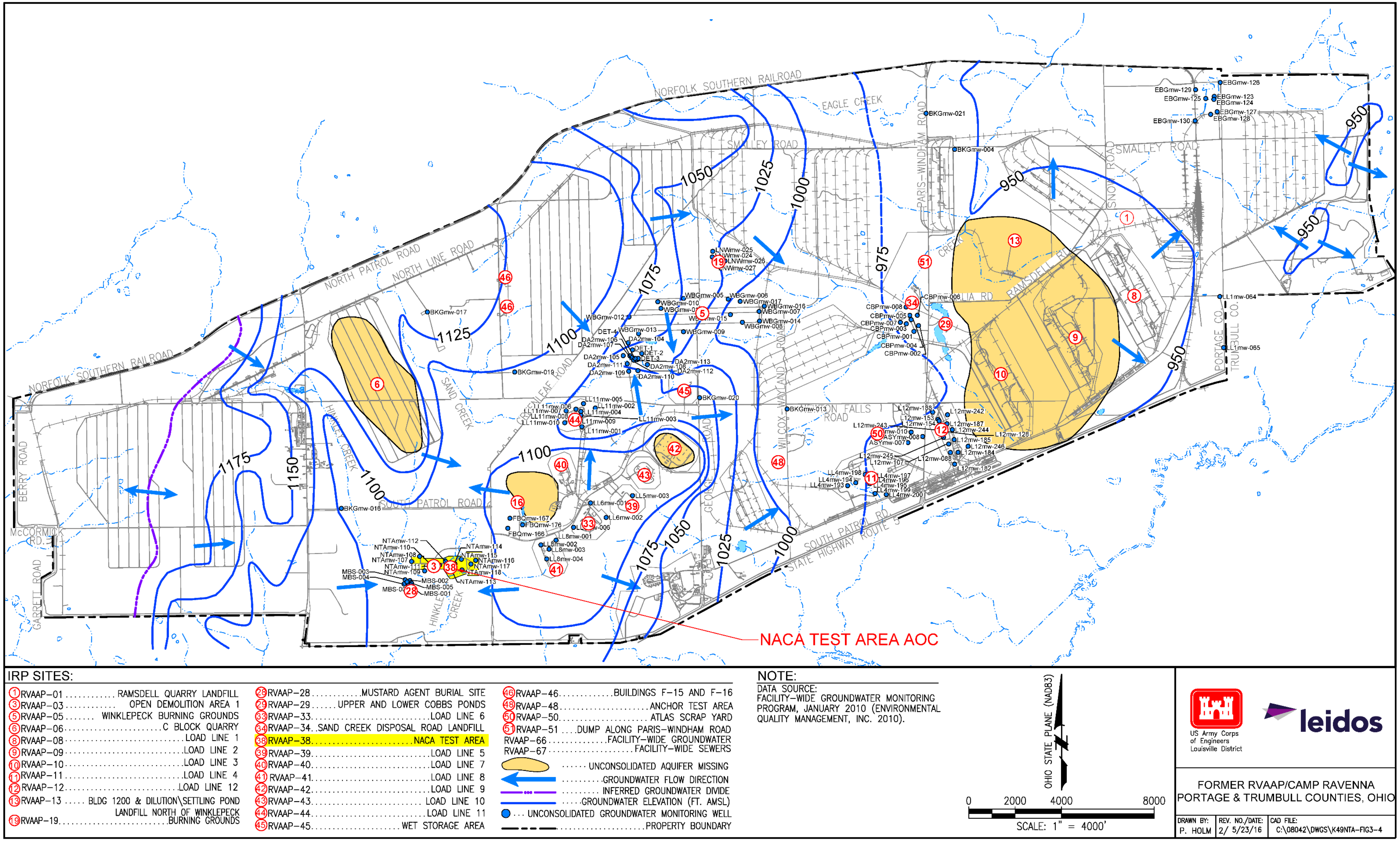

Figure 3-4. Potentiometric Surface of Unconsolidated Aquifer at Camp Ravenna

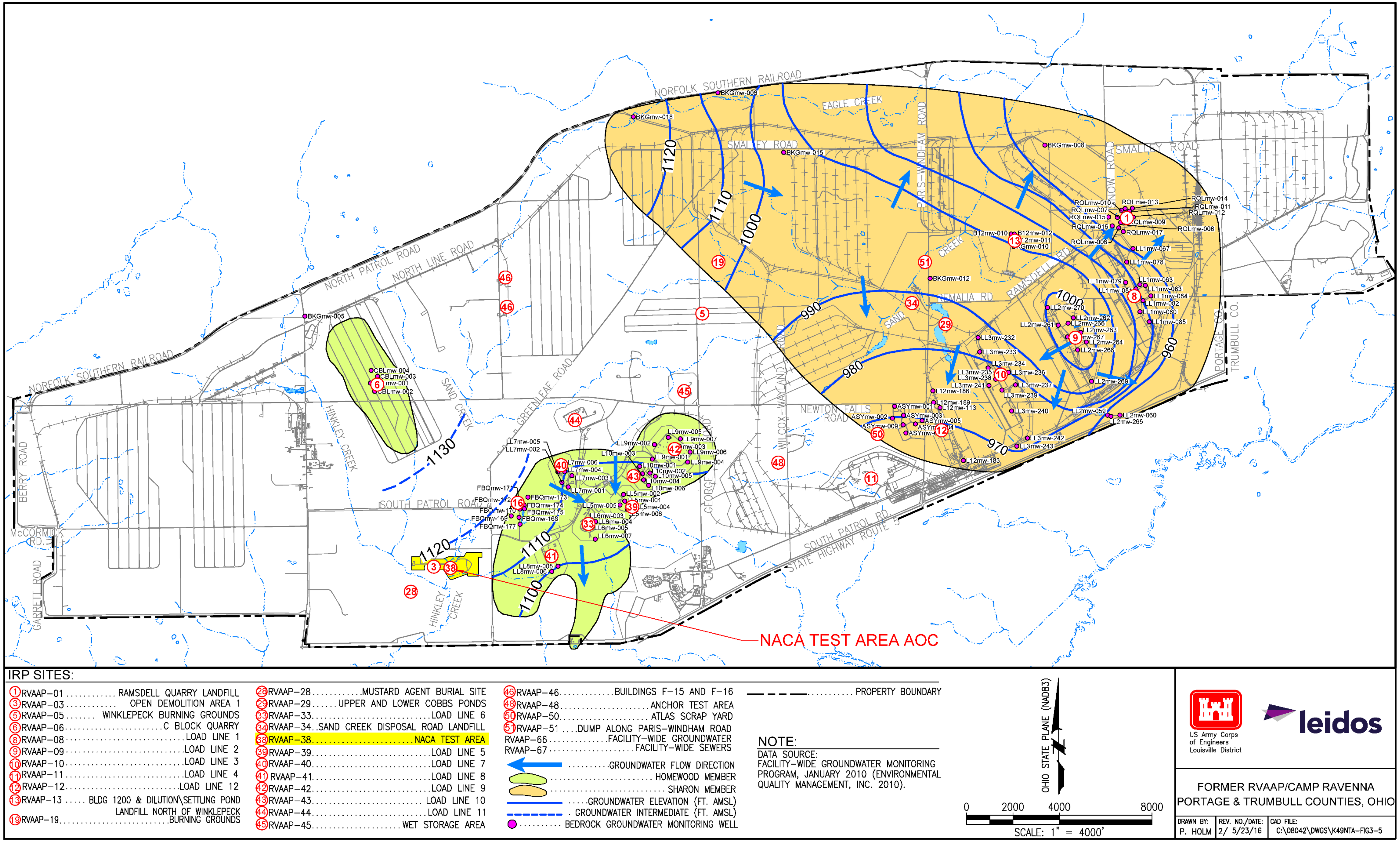

Figure 3-5. Potentiometric Surface of Bedrock Aquifers at Camp Ravenna

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4.0 SITE ASSESSMENTS, INVESTIGATIONS, AND DATA ASSEMBLY

This section summarizes all previous site assessments and investigations conducted at NACA Test Area. These previous activities included assessments to prioritize the AOC and investigations that collected data used in support of the RI.

4.1 NACA TEST AREA PREVIOUS ASSESSMENTS AND EVALUATIONS

This section summarizes previous assessments and evaluations conducted at NACA Test Area. These activities were generally performed to do 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 NACA Test Area as part of the assessment. The assessment identified NACA Test Area only as an aircraft crash facility test site adjacent to the old demolition area. No formal operational history of NACA Test Area was provided, and only a photograph of the test area was included in the assessment. As NACA Test Area is part of military training areas D and G, the assessment recommended that digging and excavation in the area be prohibited until the AOC can be certified as safe (USATHAMA 1978).

4.1.2 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 1996). This document also summarized available historical information associated with NACA Test Area. The report provided preliminary assessment scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a RRSE model.

The assessment provided the following general conclusions for RVAAP AOCs (all conclusions may not apply to NACA Test Area; rather, these are general conclusions for all AOCs):

- COPCs at RVAAP AOCs were identified as explosives [TNT, RDX, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), composition B, and lead azide] and heavy metals (lead and mercury).
- The primary sources of potential contamination were identified as wastewater effluent from the munitions assembly and demilitarization process, open burning and detonation of explosives, and landfill operations. Primary contaminant release mechanisms from load lines were process

effluent discharges to surface water (drainage ditches, settling ponds, and streams) and process building wastewater wash-out to surface soil. Media of concern were identified as soil, sediment, groundwater, and surface water.

- The greatest potential for release of contaminants from load lines to groundwater likely occurred from wastewater effluent discharge to unlined earthen settling ponds. Concrete settling tanks, open drainage ditches, and storm sewers were also identified as concerns relative to groundwater.
- Known releases of contamination to surface water and soil have occurred from load line (assembly and demilitarization) operations.

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. NACA Test Area was ranked as a low priority AOC, primarily due to inactive status and limited exposure pathways, specifically the potential for leaching fuels to groundwater.

4.1.3 Relative Risk Site Evaluation

In 1996, the U.S. Army Center for Health Promotion and Preventive Medicine conducted an RRSE at NACA Test Area. This evaluation was completed to prioritize future remedial or corrective activities at RVAAP. The RRSE does not provide any risk assessment for human health or ecology.

The RRSE also included collecting surface soil and sediment samples at NACA Test Area. The data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment." This section summarizes the samples collected as part of the RRSE data, the chemicals detected, and the associated prioritization recommendations, but the analytical results are not presented and are not used in subsequent evaluations in this RI Report.

The RRSE evaluated the soil pathway (human receptor endpoint) using data from five surface soil samples (RVAP-381 to RVAP-385, and field duplicate RVAP-386) collected at the AOC and analyzed the soil for target analyte list (TAL) metals, SVOCs, and VOCs. One sediment sample, RVAP-38B, was collected for TAL metals, SVOCs, and VOCs to evaluate the sediment pathway for human and ecological receptor endpoints. Subsurface soil and groundwater were not evaluated as part of the RRSE. No explosives were detected in the surface soil samples, but several inorganic chemicals and one VOC were detected in surface soil. Several inorganic chemicals, VOCs, SVOCs, and explosives were detected in the sediment. Detected analyte concentrations are presented in Appendix C of the RRSE (USACHPPM 1996).

The surface soil and sediment pathways were evaluated as follows:

1. Surface soil
    a. Contaminant Hazard Factor: Moderate.
    b. Migration Pathway Factor: Potential. There is no evidence that site contaminants are migrating. However, there are no physical barriers in place to prevent migration.
    c. Receptor Pathway Factor: Potential. This area is not used for production and is not populated with workers. However, access to the site is not restricted in any manner.
2. Sediment
    a. Contaminant Hazard Factor: Minimal.
    b. Migration Pathway Factor: Potential. There is no evidence that site contaminants are migrating. However, there are no physical barriers in place to prevent migration.
    c. Receptor Pathway Factor: Potential. This area is not used for production and is not populated with workers. However, access to the site is not restricted in any manner.

Human receptor endpoints were evaluated based on the available surface soil and sediment data. The RRSE scored NACA Test Area as a “medium-priority” AOC due to potentially contaminated surface soil and sediment potentially migrating and affecting human and ecological receptors (USACHPPM 1996).

4.1.4 Environmental Baseline Survey

The *Environmental Baseline Survey of Ravenna Army Ammunition Plant* (Vista Technologies 1998) provides a brief description and environmental categorization of AOCs, including NACA Test Area. This categorization is based on the American Society for Testing Materials Standard Classification of Environmental Condition of Property Types, D5746-95 definitions of environmental categories. NACA Test Area was assigned a parcel designation of seven, indicating a parcel of property that is unevaluated or requires additional evaluation. No further information about NACA Test Area was provided.

4.2 NACA TEST AREA REMEDIAL INVESTIGATIONS

This section summarizes previous investigations conducted at NACA Test Area. 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 identified anticipated primary COPCs at the onset of the investigation. These anticipated primary COPCs were identified based on available process knowledge and previous investigation results. In the risk evaluation conducted in the Phase I RI Report, SRCs and COPCs were identified 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 TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), SVOCs, VOCs, polychlorinated biphenyls (PCBs), and pesticides.

4.2.1 Phase I Remedial Investigation

In 1999, sampling was conducted at NACA Test Area in accordance with the *Sampling and Analysis Plan Addendum No. 1 for the Phase I Remedial Investigation of the NACA Test Area* (USACE 1999a) (herein referred to as the Phase I SAP Addendum). The primary objectives associated with the Phase I RI are presented below.

- Determine the potential types and sources of contamination using historical process information and previous sampling data to locate Phase I RI samples for soil, sediment, and surface water.
- Identify whether releases of contamination beyond the AOC boundary are occurring by collecting environmental samples (surface water and sediment) downstream of the AOC boundary within exit conveyances and using applicable historical information.
- Perform a screening risk evaluation to determine if additional investigation is warranted; the human health and ecological risk screening (ERS) will be used to determine the potential magnitude of risk associated with any contamination detected.
- Provide preliminary recommendations for additional investigations and/or actions.

Results of this Phase I RI are presented in the Phase I RI Report (USACE 2001a) 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 October-November 1999 at NACA Test Area to assess the potential impacts from former aircraft crash testing:

- Collected 99 discrete surface soil (0–1 ft bgs) samples,
- Collected 21 subsurface soil (1–3 and 3–5 ft bgs) samples,
- Collected 5 surface water samples,
- Collected 6 sediment samples, and
- Surveyed sampling locations.

One groundwater sample was collected from a piezometer. Groundwater sampling is pertinent to other co-located AOCs associated with NACA Test Area (e.g., Facility-wide Groundwater) and is not discussed in this section.

Surface and subsurface soil samples were analyzed for TAL metals, SVOCs, and VOCs; select locations were also analyzed for explosives or pesticides/PCBs. Additionally, a minimum of 10% of soil samples were analyzed for RVAAP full-suite analytes. Sediment and surface water samples were analyzed for 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. Tables 4-2 through 4-5 present 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 1996 version of the Phase I SAP Addendum. The 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

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

Surface Soil

- Sporadic detections of TNT, DNT, and nitrocellulose were identified in surface soil. No apparent pattern of distribution was noted for this class of SRCs.
- The principal inorganic SRCs in surface soil include barium, copper, mercury, and zinc, which exceeded background in 20% or more of the sample population. Inorganic chemicals above background occurred throughout the AOC, but the highest concentrations of metals occurred along the crash strip and in the northeast portion of the plane burial area in association with observed surface debris and suspected subsurface debris.
- Bis(2-ethylhexyl)phthalate and polycyclic aromatic hydrocarbon (PAH) compounds were detected in some combination in approximately one-third of all samples analyzed. Bis(2-ethylhexyl)phthalate was the most widespread SVOC, with detected values at 18 sample stations. The majority of the detected PAH values occurred within the Plane Refueling/Crash Strip Area. The maximum detected value for each of the PAHs occurred at station NTA-088 in the western-most portion of the Plane Refueling/Crash Strip Area.
- The VOCs dimethylbenzene, methylene chloride, and toluene were each detected in six to nine samples. VOCs were concentrated in the center of the crash area and on the perimeter of the plane burial area.
- PCBs were not detected in any surface soil samples.

Subsurface Soil

- Explosives, propellants, and PCBs were not detected in subsurface soil.
- Aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc were detected in all subsurface soil samples, but they only rarely exceeded their background criteria. Almost all exceedances of background occur in the northeastern

corner of the plane burial area in association with observed surface debris and suspected subsurface debris.

- Thirteen PAHs were detected in the sample from station NTA-083 in the Plane Refueling/Crash Strip Area. Bis(2-ethylhexyl)phthalate was detected at eight different stations scattered across the AOC. A total of 8 PAHs at station NTA-083 were retained as SRCs based on WOE evaluation, despite only being detected in 1of 21 samples.
- In general, the average and maximum detected concentrations (MDCs) for inorganic SRCs in subsurface soil were less than the corresponding values in surface soil.
- Three VOC compounds (methylene chloride, styrene, and toluene) were detected in more than 5% of the subsurface soil samples. The maximum detected values for these three VOCs occurred at stations NTA-067 and NTA-073 in the plane burial area.

Sediment

- Low levels of nitrocellulose and the maximum detected values for all of the inorganic sediment SRCs occurred at stations NTA-101 in the Crash Area Well Pit and NTA-104 north of NACA Test Area along Demolition Road. Because of the presence of paint chips and abundant rust fragments in the well pit at NTA-101 and the fact that NTA-104 is upgradient (upstream) of the NTA drainage area, these results do not reflect impacts related to former NACA Test Area operations. Concentrations of all detected inorganic chemicals decreased along the tributary to Hinkley Creek between stations NTA-103 and NTA-106. The consistency of the observed decrease among the inorganic chemicals suggests some observable impacts to the tributary from site runoff; however, background values are not exceeded at the confluence with Hinkley Creek.

Surface Water

- The majority of constituents above background levels in surface water occurred at the two stations located north and upgradient (upstream) of NACA Test Area (NTA-104 and NTA-105). No impacts to the tributary draining NACA Test Area or to Hinkley Creek can be ascertained. The water reservoir also does not appear to have been impacted by former NACA Test Area operations.

4.2.1.3 Human Health Risk Screening

A Human Health Risk Screening (HHRS) was included in the Phase I RI. The HHRS utilized the 2001 screening protocol to identify COPCs. A COPC was also retained if it was detected in the medium, but no risk-based screening value was available for comparison. The COPCs identified in the quantitative HHRS are summarized in Table 4-6. Inorganic chemicals, SVOCs, one explosive, and one propellant were identified as COPCs at NACA Test Area.

4.2.1.4 Ecological Risk Screening

An ERS was included in the Phase I RI. The ERS compared chemical concentrations detected in NACA Test Area environmental media to ecological screening values (ESVs). Ecological screening levels (ESLs) were selected based on the current (1998) USEPA Region 5 ecological data quality levels. Soil was not evaluated as no suitable screening value existed at the time of the evaluation (USACE 2001a). Table 4-7 presents those chemicals identified in the ERS as exceeding screening values for NACA Test Area.

4.2.1.5 Conclusions and Recommendations

Recommendations and conclusions of this Phase I RI included:

- Further investigate the surface water exposure unit (EU) to the confluence with Hinkley Creek,
- Investigate the northeastern quadrant to further characterize soil in the plane burial area,
- 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 within NACA Test Area,
- Complete a baseline HHRA for all environmental media, and
- Complete an ERA for all environmental media.

The Phase I RI identified site-related contamination in soil at NACA Test Area. Based on the human health and ecological screening risk evaluations, human health COPCs were identified for surface soil at NACA Test Area. The principal Phase I RI COPCs are inorganic chemicals. Subsurface soil COPCs were very limited in extent to a suspected burial site in the northeastern portion of the plane burial area. The potential exists for exposure of human receptors to debris and associated inorganic surface soil contaminants within the NACA Test Area. Therefore, site conditions during the Phase I RI did not support a no further action decision.

4.2.2 Characterization of 14 AOCs

From 2004–2005, well installation and groundwater sampling was conducted at NACA Test Area in accordance with the *Final Sampling and Analysis Plan Addendum for the Characterization of 14 RVAAP AOCs* (MKM 2004) (herein referred to as the Characterization of 14 AOCs SAP). Results of this characterization are presented in the *Characterization of 14 AOCs at the Ravenna Army Ammunition Plant* (MKM 2007) (herein referred to as the Characterization of 14 AOCs report) and are summarized below.

4.2.2.1 Field Activities

The following investigation field activities were conducted from August 2004-May 2005 to assess potential impacts to groundwater from former operations at NACA Test Area (MKM 2007):

- Excavating seven test trenches near groundwater monitoring well locations;
- Collecting geotechnical soil samples from monitoring well borings;
- Installing, developing, and sampling 12 groundwater monitoring wells;
- Completing in-situ permeability testing (slug tests); and
- Completing sampling location and monitoring well survey.

During test trench excavation, activities were concluded upon encountering groundwater. Saturated conditions were encountered from 9.5–13 ft bgs. Bedrock was not encountered during the test trench excavation. No visual evidence of contamination or MEC were encountered during trenching activities. Figure 2-1 presents the monitoring well locations installed and sampled under the Characterization of 14 AOCs.

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, the Characterization of 14 AOCs SAP (MKM 2004), and USACE Louisville Chemistry Guideline (USACE 2002). DQOs were established for the Characterization of 14 AOCs 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 (90% complete), was usable, and that it satisfied the DQOs for the project.

4.2.2.2 Results and Conclusions

Groundwater contaminants were detected above screening criteria as detailed below:

- Sixteen TAL metals were detected at the AOC above facility-wide background concentrations;
- Two TAL metals (lead and arsenic) were detected above Region 9 tap water preliminary remediation goal (PRG) screening values and facility-wide background concentrations;
- Six SVOCs were detected above screening criteria in two groundwater monitoring wells (NTAmw-113 and NTAmw-116);
- One estimated concentration of the propellant nitrocellulose was detected; and
- VOCs, PCBs, pesticides, and explosives were not detected above screening values.

The Characterization of 14 AOCs report stated that a full risk evaluation should be considered in the overall risk management decisions for the AOC.

4.2.3 PBA08 Remedial Investigation

In November 2008, Science Applications International Corporation (SAIC) scientists performed a site walk of NACA Test Area. The site walk was conducted to develop the *Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (herein referred to as the PBA08 SAP), which supplemented the Phase I RI and completed the RI phase of the CERCLA process. No physical changes occurred at NACA Test Area between the 1999 Phase I RI sampling and the development of the PBA08 SAP. The PBA08 SAP considered the prior investigations and changes in AOC conditions during development of the DQOs and sampling scheme for completing the NACA Test Area RI. Section 4.4.4 discusses the suitability and use of samples collected to support this 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 NACA Test Area 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 Facility-wide Human Health Risk Assessor Manual (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 and HQ of 1 to facilitate identifying potential source areas that may require additional sampling to refine the extent of contamination. Table 4-8 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, surface water using discrete sampling techniques, and sediment using the multi-aliquot composite technique. The results of the PBA08 RI sampling, combined with the results of the Phase I RI 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.

4.2.3.1 Surface Soil Sampling Rationale

Source Area Investigation

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., former crash and plane burial areas). Table 4-9 presents the specific rationale for each surface soil sample collected during the PBA08 RI. Table 4-10 presents the chromium speciation samples collected under PBA08 RI. Table 4-11 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.

A total of 15 surface soil samples were collected at NACA Test Area during the PBA08 RI to further delineate surface soil above screening criteria presented in Table 4-8 and to completely characterize the AOC (Figure 4-4). Of the 15 surface soil samples collected, 12 surface soil samples were collected to delineate the lateral extent of previously identified contamination where historical screening criteria exceedances were observed, and three discrete samples were collected to evaluate chromium speciation (Section 4.2.3.1). 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 2001c). An updated version of the FWSAP was developed in February 2011 and approved by the 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 PAHs; chromium speciation samples were analyzed for total and hexavalent chromium. Two samples (10% of the total number of samples collected) were analyzed for RVAAP full-suite analytes. Two QC field duplicates and two QA split samples were collected to satisfy the QA/QC requirement of 10% of the total samples collected.

Chromium Speciation

As part of the PBA08 RI, three discrete chromium speciation samples were collected to evaluate the potential contribution of hexavalent chromium to the total chromium concentrations in soil. Samples from 0–1 ft bgs were collected in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the FWSAP (USACE 2001c). Two samples were collected from areas previously identified as having elevated total chromium concentrations, and one sample was collected from an area previously identified as having a total chromium concentration near the background concentration. The rationale for the chromium speciation samples collected as part of the PBA08 RI is summarized in Table 4-10. The locations of these samples are presented in Figure 4-4 and results are presented in Table 4-11.

4.2.3.2 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:

- Borings at locations where previous surface soil sampling results exceeded screening criteria and vertical delineation was warranted.
- Borings at locations where previous surface soil sampling results only slightly exceeded screening criteria to confirm that contaminant concentrations did not increase with depth.
- Borings at locations not previously sampled to 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. 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 4-12 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI. Results of detected analytes are presented in Table 4-13.

To assess the depths of exposure of the Resident Receptor, each soil boring was attempted to be 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 interval 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:

1. One chemical had a concentration that exceeded screening criteria in the 4–7 ft bgs sample; or
2. To ensure at least 10% of all subsurface samples from 7–13 ft bgs were submitted for laboratory analysis 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 the 7–13 ft bgs interval (where achievable) was archived on site, while the 4–7 ft bgs interval sample was analyzed under an expedited five day turnaround time. One 7–13 ft bgs sample (NTAsb-124-5312-SO) was analyzed due to preliminary screening criteria exceedance for arsenic (24.7 mg/kg) within the 4–7 ft bgs sample interval (NTAsb-124-5311-SO). One sample (NTAsb-124-5312-SO) collected from the 7–13 ft bgs sample interval was submitted for laboratory analysis to adequately characterize the 7–13 ft bgs interval. All samples were analyzed for TAL metals, explosives, and PAHs; 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.

4.2.3.3 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). Three co-located surface water and sediment samples were collected during the PBA08 RI from the southern discharge point of the Wetland/Pond North of the Former Crash Area, the discharge point of the culvert outfall under the crash strip, and downstream of the AOC prior to the confluence of Hinkley Creek.

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). The sediment samples were collected in accordance with Section 4.2 of the PBA08 SAP. The samples consisted of a multi-aliquot composite with 10 aliquots selected randomly within a 5-ft radius of the identified sample location. Each aliquot was collected by a push probe to a maximum depth of 0.5 ft bgs. All sediment samples (and their associated QA/QC samples) were analyzed for RVAAP full-suite analytes. Table 4-14 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 Table 4-15 and Table 4-16 for surface water and sediment, respectively.

4.2.3.4 Changes from the Work Plan

Significant changes to the work plan are documented in field change requests (FCRs) (Appendix B). Changes made in the field based on site conditions are not documented on FCRs but on the field sampling logs (Appendix A). These changes are presented on Table 4-17. 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 2001d). These facility-wide background values 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 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 inorganic chemicals. 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 inorganic chemicals are presented in Table 4-18.

4.4 DATA EVALUATION METHOD

Data evaluation methods for NACA Test Area are consistent with those established in the FWCUG Report. These methods were specified in the PBA08 SAP (USACE 2009a). 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

NACA Test Area 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, 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 RVAAP human health risk EUs and guidance established in the FWHHRAM and FWCUG Report.

Data aggregates for evaluating the nature and extent of contamination at NACA Test Area are as follows:

- Surface Soil (0–1 ft bgs). Using the above data aggregation criteria, surface soil within the geographic area of NACA Test Area were subdivided into four spatial aggregates: (1) Former Crash Area, (2) Former Plane Burial Area, (3) Former Plane Refueling/Crash Strip Area, and (4) Former Crash Area Well Pit.
- Subsurface Soil (greater than 1 ft bgs). Includes data from discrete sample intervals 1–4, 4–7, and 7–13 ft bgs. This medium was subdivided into three spatial aggregates for this report: (1) Former Crash Area, (2) Former Plane Burial Area, and (3) Former Plane Refueling/Crash Strip Area, as shown in Figure 2-3. These three spatial aggregates correspond to the definitions for the surface soil aggregates. Under the Phase I RI report, the only subsurface soil aggregates defined were the Plane Burial Area and the Plane Refueling/Crash Strip Area, as no historical subsurface soil samples were collected within the Crash Area.
- Sediment. Sediment was subdivided into four spatial aggregates for this report: (1) Tributary to Hinkley Creek, (2) Wetland/Pond North of the Former Crash Area, (3) Former Crash Area Reservoir, and (4) Off-AOC.
- Surface Water. Similar to sediment, surface water was divided into four spatial aggregates for this report: (1) Tributary to Hinkley Creek, (2) Wetland/Pond North of the Former Crash Area, (3) Former Crash Area Reservoir; and (4) Off-AOC.

The soil data aggregates are further subdivided to define human health and ecological risk EUs in the risk assessments as discussed in Section 7.0 (e.g., shallow surface soil, deep surface soil, subsurface soil).

4.4.2 Data Verification, Reduction, and Screening

4.4.2.1 Data Verification

Data verification was performed on 52 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 (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., EPA 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 NACA Test Area 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 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 NACA Test Area. 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 4-19). 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 screening levels (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 Position Paper for Human Health CUGs) 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 was applied to the NACA Test Area surface soil data, as this data set 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 NACA Test Area are presented below for each media and spatial aggregate. Analytical results for SRCs are presented in Tables 4-20 through 4-23 for surface soil, Tables 4-24 through 4-26 for subsurface soil, Tables 4-27 and 4-29 for sediment, and Tables 4-30 and 4-31 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 NACA Test Area have sample identifications beginning with “NTA.” Each table in Appendix D presents the results for each sampling location for a specific medium aggregate (e.g., surface soil, subsurface soil, sediment, and surface water), spatial aggregate (i.e., Former Crash Area, Former Crash Area Well Pit, Former Plane Burial Area, Former Plane Refueling/Crash Strip Area, Tributary to Hinkley Creek, Wetland/Pond North of the Former Crash Area, Former Crash Area Reservoir, and Off-AOC), 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 1999 Phase I RI 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 (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. Pesticides were thoroughly evaluated at NACA Test Area. However, based on operational history and process knowledge, pesticides were not evaluated in the Former Crash Area Well Pit, Former Plane Burial Area, Former Crash Area Reservoir, and Off-AOC sample locations, in accordance with the Phase I RI and PBA08 SAP. Table 4-32 presents the designated use for all available NACA Test Area samples.

4.4.4.1 Soil

Surface and subsurface soil samples at NACA Test Area were collected during the 1999 Phase I RI and the PBA08 RI. Samples from the 1999 (Phase I RI) were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the PBA08 RI activities. Physical conditions at the AOC did not change substantially during the time between the Phase I RI and PBA08 RI. However, training activities have periodically been conducted on portions of the AOC and adjacent areas. The historical surface soil and subsurface soil results were retained for SRC screening purposes, as these results are considered representative of current conditions.

The RRSE samples RVAP-381 to RVAP-386 were not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment."

No surface or subsurface soil samples from the PBA08 RI data set were eliminated from the SRC screening process, with the exception of samples excluded as not representative of current conditions. The samples identified as surface soil/dry sediment for the ditches flowing from the Crash Area in the Phase I RI report have been incorporated into the surrounding Former Crash Area spatial aggregate. The Crash Area Well Pit was identified as a sediment data aggregate under the Phase I RI report but has been reclassified as surface soil in this report because this location is predominantly dry and does not meet the current definition of sediment.

4.4.4.2 Sediment and Surface Water

For sediment and surface water data, if a PBA08 RI sample was obtained from a historical (1999 Phase I 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.

As noted above, the Crash Area Well Pit was identified as a sediment data aggregate under the Phase I RI Report but has been reclassified as surface soil in this report because this location is predominantly dry and does not meet the current definition of sediment.

The RRSE sediment sample RVAP-38B was not included in this RI evaluation, as the RRSE data collected at the site "…are minimal Level III data, as defined by U.S. EPA, and are not intended to be used as definitive evidence of contamination presence or absence or to support health risk assessment."

Table 4–1. Phase I RI Sampling Locations

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
NTA-001	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-002	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-003	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-004	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-005	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-006	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-007	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-008	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-009	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-010	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-011	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-012	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-013	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-014	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-015	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-016	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-017	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-018	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-019	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-020	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-021	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-022	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-023	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-024	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-025	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-026	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-027	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-028	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-029	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-030	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-031	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-032	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-033	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-034	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-035	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-036	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-037	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-038	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures. Geoprobe station – converted to a piezometer	None	Metals, VOCs, PAHs
	1–3	Geotech	Residual contaminants from aircraft impact/fuel tank ruptures	Possible residual contaminants from aircraft impact/fuel tank ruptures. Geotech only.		None
NTA-039	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-040	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-041	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-042	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
NTA-043	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-044	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-045	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-046	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-047	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-048	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-049	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-050	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-051	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-052	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-053	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-054	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-055	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-056	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-057	0–1	Full suite	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-058	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
	1–3	Geotech	Residual contaminants from aircraft impact/fuel tank ruptures	Possible residual contaminants from aircraft impact/fuel tank ruptures. Geotechnical sample only.	None	None
NTA-059	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures. Wetland Area	None	Metals, VOCs, PAHs
NTA-060	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-061	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-062	0–1	Full suite	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-063	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-064	0–1	Metals, VOCs, SVOCs	Grid station inside of crash area/Wetland Area	Possible residual contaminants from aircraft impact/fuel tank ruptures	None	Metals, VOCs, PAHs
NTA-065	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-066	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-067	0–1	Full suite	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-068	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-069	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
	1–3	Geotech		Geotechnical sample.		None
NTA-070	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Surface debris noted at station.	None	Metals, VOCs, PAHs
	1–3					
	3–5					
NTA-071	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-072	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-073	0–1	Full suite	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Surface debris noted at station.	None	Metals, VOCs, PAHs
	1–3					
	3–5	Metals, VOCs, SVOCs				
NTA-074	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-075	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
NTA-076	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1-3					
NTA-077	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
	1–3					
NTA-078	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Old service road	None	Metals, VOCs, PAHs
NTA-079	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Old service road	None	Metals, VOCs, PAHs
NTA-080	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
NTA-081	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
NTA-082	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris	None	Metals, VOCs, PAHs
NTA-100	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Old service road. Surface debris noted at station	None	Metals, VOCs, PAHs
	1–3					
NTA-083	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-084	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-085	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-086	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-087	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-088	0–1	Metals, VOCs, Pesticides, PCBs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills. Slag present at surface.	None	Metals, VOCs, PAHs
NTA-089	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills. Slag present at surface.	None	Metals, VOCs, PAHs
NTA-090	0–1	Metals, Explosives, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills. Slag present at surface.	None	Metals, VOCs, PAHs
NTA-091	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills. Slag present at surface.	None	Metals, VOCs, PAHs
NTA-092	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills. Slag present at surface.	None	Metals, VOCs, PAHs
NTA-093	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-094	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-095	0–1	Metals, VOCs, SVOCs	Grid station inside of plane refueling/crash strip area	Possible residual contaminants from aircraft fluid leaks/spills.	None	Metals, VOCs, PAHs
NTA-096	0–1	Metals, VOCs, Pesticides, PCBs, SVOCs	Dry ditch near former impact barrier	Sediment accumulation area near impact barrier. Classified as surface soil.	None	Metals, VOCs, PAHs
NTA-097	0–1	Metals, Explosives, VOCs, SVOCs	Dry ditch at southwest corner of former crash area	Sediment accumulation area from crash area. Classified as surface soil.	None	Metals, VOCs, PAHs
NTA-098	0–1	Metals, VOCs, SVOCs	Dry ditch at southwest corner of former crash area	Sediment accumulation area from crash area. Classified as surface soil.	None	Metals, VOCs, PAHs
NTA-100	0–1	Metals, VOCs, SVOCs	Grid station inside of plane burial area	Possible source area due to buried and surface debris. Old service road. Surface debris noted at station	None	Metals, VOCs, PAHs
NTA-101	0–0.5	Full suite	Former Crash Area Well Pit	Former water supply well, concrete-lined well pit. Accumulation point for sediment/runoff from former crash area. No water sample since water pit was dry.	None	Metals, VOCs, PAHs
NTA-102 (SD)	0–0.5	Full suite	Former Crash Area Reservoir	Former fire water supply surface impoundment. Accumulation point for sediment/runoff from former crash area.	None	Metals, VOCs, PAHs
NTA-103 (SD/SW)	0–0.5	Full suite	Tributary to Hinkley Creek	Tributary headwaters represents principal exit pathway from NACA Test Area.	None	Metals, VOCs, PAHs
	NA	Full suite plus dissolved metals				
	0–0.5	Full suite	Drainage Ditch north of Demolition Road	Drainage ditch north of NACA Test Area represents ambient surface water.	None	None

Table 4–1. Phase I RI Sampling Locations (continued)

Phase I RI Sample Location	Sample Depth (ft bgs)	Analytes	Potential Sources or Areas for Investigation	Previous Use and/or Description	Documented Release	Potential Contaminants from Use
NTA-104 (SD/SW)	NA	Full suite plus dissolved metals				
NTA-105 (SD/SW)	0–0.5	Full suite	Inlet to wetland north of former crash area	Inlet to wetland represents ambient surface water.	None	None
	NA	Full suite plus dissolved metals				
NTA-106 (SD/SW)	0–0.5	Full suite	Tributary at junction with Hinkley Creek	Tributary represents principal exit pathway from NACA Test Area	None	Metals, VOCs, PAHs
	NA	Full suite plus dissolved metals				

bgs = Below ground surface.
ft = Feet.
NA = Not applicable.
NACA = National Advisory Committee on Aeronautics.
PAH = Polycyclic aromatic hydrocarbons.
PCB = Polychlorinated biphenyl.
RI = Remedial investigation.
SVOC = Semi-volatile organic compounds.
VOC = Volatile organic compound.

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-004**	**NTA-005**	**NTA-006**	**NTA-007**	**NTA-008**	**NTA-011**	**NTA-012**	**NTA-013**	**NTA-014**	**NTA-015**
Sample ID		**NTAss-004-0004-SO**	**NTAss-005-0005-SO**	**NTAss-006-0006-SO**	**NTAss-007-0007-SO**	**NTAss-008-0008-SO**	**NTAss-011-0011-SO**	**NTAss-012-0012-SO**	**NTAss-013-0013-SO**	**NTAss-014-0014-SO**	**NTAss-015-0015-SO**
Date		**10/21/99**	**10/21/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/21/99**	**10/21/99**	**10/21/99**	**10/22/99**	**10/24/99**
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 **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	11100	10600	11600	7680	7220	**20900***	10100	10600	9590	12500
Antimony	0.96	<1.2UJ	0.92J	<1.2UJ	<1.2UJ	<1.2UJ	0.66J	0.53J	0.8J	<1.2UJ	<1.3UJ
Arsenic	15.4	5.5	11.1	12.5	8.2	7.5	9.9	7.3	10.3	11.1	9.3
Barium	88.4	35.1	68.9	35.4	36.2	26.3	**205***	56.5	43	48.2	73.2
Beryllium	0.88	<0.16U	<0.46U	0.24J	<0.2U	<0.15U	**1.4***	<0.32U	<0.14U	<0.2U	<0.25U
Cadmium	0	<0.6U	<0.62U	<0.61U	<0.59U	<0.6U	<0.6U	<0.59U	<0.56U	<0.59U	<0.63U
Calcium	15800	349J	735	<209UJ	<148UJ	<182UJ	**63400***	1150	558J	3520J	1740J
Chromium	17.4	12.3	13.4	14.9	9.3	8.2	16.4	12.1	13.1	11.4	14.2
Cobalt	10.4	3.8J	**16.7***	5.9J	5.4J	4.1J	7.3	9.4	5.8	6.5	6.5
Copper	17.7	6.4	11.9	12.3J	6.9J	8.1J	13.7	7.5	13.6	9.3J	10.2J
Cyanide	0	<0.6U	<0.62U	<0.61U	<0.59U	<0.6U	<0.6U	<0.59U	<0.56U	<0.59U	<0.63U
Iron	23100	18200	**28700***	**23600***	15700	13400	21300	19000	22500	18800	18100
Lead	26.1	8.2	18.4	11.2	15.1	14.7	11.2	17.6	14	15.9	17.2
Magnesium	3030	1560	2150	2270	1230	982	**10200***	1730	1720	2120	1730
Manganese	1450	55.4	1370	206	256	97.5	**2280***	721	224	392	496
Mercury	0.036	0.023J	0.024J	<0.12U	<0.03U	<0.032U	0.023J	0.013J	**0.038J***	<0.022U	<0.059U
Nickel	21.1	9.7	15.4	14.9	8.9	7.7	16.2	11	12.2	10.5	10.6
Potassium	927	652	703	847	450J	315J	**1800***	683	510J	634	**1270***
Selenium	1.4	0.55J	0.55J	0.82	0.56J	0.83	1.1	0.72	0.91	0.76	<0.63U
Silver	0	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.1U	<1.2U	<1.3U
Sodium	123	<45.3U	<57.9U	<113U	<107U	<123U	**393J***	<50U	<50.8U	<114U	<113U
Thallium	0	**0.27J***	**0.3J***	**0.32J***	**0.26J***	**0.25J***	<0.6U	**0.22J***	**0.29J***	**0.3J***	**0.31J***
Vanadium	31.1	16.9	20	20.1	16.2	13.9	18.3	18.5	22.3	20.1	24
Zinc	61.8	37.8	52.1	46.6	38.6	36.6	48.7	45.2	41.1	41.9	50.7
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	<0.25U	NR	NR	NR	NR	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	<0.25U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	**3.5***	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Acenaphthylene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Anthracene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Benz(a)anthracene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Benzo(a)pyrene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Benzo(b)fluoranthene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Benzo(*ghi*)perylene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Benzo(k)fluoranthene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Bis(2-ethylhexyl)phthalate	None	<0.39U	<0.41U	<0.4U	**6.6***	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Carbazole	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Chrysene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Di-n-butyl phthalate	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Dibenz(a,h)anthracene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-004**	**NTA-005**	**NTA-006**	**NTA-007**	**NTA-008**	**NTA-011**	**NTA-012**	**NTA-013**	**NTA-014**	**NTA-015**
Sample ID		**NTAss-004-0004-SO**	**NTAss-005-0005-SO**	**NTAss-006-0006-SO**	**NTAss-007-0007-SO**	**NTAss-008-0008-SO**	**NTAss-011-0011-SO**	**NTAss-012-0012-SO**	**NTAss-013-0013-SO**	**NTAss-014-0014-SO**	**NTAss-015-0015-SO**
Date		**10/21/99**	**10/21/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/21/99**	**10/21/99**	**10/21/99**	**10/22/99**	**10/24/99**
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 **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Dibenzofuran	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Fluoranthene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Fluorene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Indeno(1,2,3-cd)pyrene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Naphthalene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Phenanthrene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Phenol	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
Pyrene	None	<0.39U	<0.41U	<0.4U	<0.78U	<0.4U	<0.4U	<0.39U	<0.37U	<0.39U	<0.41U
VOCs (mg/kg)											
Acetone	None	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.011UJ	<0.012UJ	<0.013UJ
Dimethylbenzene	None	<0.006U	<0.0062U	<0.0061U	<0.0059U	**0.0016J***	<0.006U	<0.0059U	<0.0056U	<0.0059U	<0.0063U
Methylene chloride	None	<0.006U	<0.0072U	<0.0061U	<0.0059U	<0.006U	<0.0075U	<0.0059U	<0.0056U	**0.0028J***	<0.0063U
Styrene	None	<0.006U	<0.0062U	<0.0061UJ	<0.0059U	<0.006U	<0.006U	<0.0059U	<0.0056U	<0.0059UJ	<0.0063U
Toluene	None	<0.006U	<0.0062U	<0.0061U	<0.0059U	<0.006U	<0.006U	**0.0028J***	<0.0056U	<0.0059U	<0.0063U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-016**	**NTA-017**	**NTA-018**	**NTA-019**	**NTA-020**	**NTA-021**	**NTA-022**	**NTA-023**	**NTA-024**	**NTA-025**
Sample ID		**NTAss-016-0016-SO**	**NTAss-017-0017-SO**	**NTAss-018-0018-SO**	**NTAss-019-0019-SO**	**NTAss-020-0020-SO**	**NTAss-021-0021-SO**	**NTAss-022-0022-SO**	**NTAss-023-0023-SO**	**NTAss-024-0024-SO**	**NTAss-025-0025-SO**
Date		**10/24/99**	**10/20/99**	**10/21/99**	**10/21/99**	**10/21/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/20/99**
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 Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Metals (mg/kg)											
Aluminum	17700	**19200***	12600	15300	11300	14500	6130	5860	6600	6680	**25400***
Antimony	0.96	<1.2R	0.85J	**1.1J***	0.64J	0.68J	<1.1UJ	<1.2UJ	<1.2R	<1.2R	0.95J
Arsenic	15.4	5.1J	9.7	10.2	5.1	10.2	8.3	7.1	9.6J	10.3J	4
Barium	88.4	**250J***	38.4	56.7	**102***	66.2	21.5J	48.9	48.1J	49.8J	**254J***
Beryllium	0.88	**1.7J***	<0.21U	<0.28U	<0.56U	<0.44U	0.25J	<0.18U	0.22J	<0.18UJ	**1.4***
Cadmium	0	<0.59UJ	<0.63U	<0.62U	<0.64U	<0.6U	<0.57U	<0.58U	<0.61UJ	<0.6UJ	<0.61U
Calcium	15800	**93700***	1010	1690	13500	2120	371J	834J	1150	3290	**111000***
Chromium	17.4	8.9J	**17.5***	**20.7***	11	17.3	8.1	8.3	9.6J	10.3J	16.5J
Cobalt	10.4	3J	6J	3.9J	4.3J	8.6	6.3	5.5J	6.5J	5.9J	3.6J
Copper	17.7	5.8J	14.4	13.6	9.4	16.5	16.8J	15.8J	13.7J	7J	9
Cyanide	0	<0.59U	<0.63U	**0.68***	<0.64U	<0.6U	<0.57U	<0.58U	<0.61U	<0.6U	**1.3***
Iron	23100	6520	**29400***	**32800***	15200	**24200***	15400	13600	19200	15200	7810
Lead	26.1	8.8J	14.9	12.8	15	20.1	10.3	16.6	21.3J	21.1J	17
Magnesium	3030	**13400J***	2700	1620	**3290***	2610	1530	1240	1170J	1270J	**16000***
Manganese	1450	**2480***	94.1	86.7	810	331	303	364	384	594	**2850***
Mercury	0.036	0.033J	0.018J	**0.043J***	**0.044J***	0.019J	<0.029U	<0.051U	**0.042J***	**0.041J***	<0.0078U
Nickel	21.1	4.9J	18.6	9.2	9.1	18.4	13.1	10	10J	7.4J	6.2
Potassium	927	**1000J***	622J	677	626J	**1630***	702	414J	436J	332J	**1950J***
Selenium	1.4	**1.7J***	0.65	1.2	0.97	0.63	<0.57U	0.46J	0.94J	1.4J	**1.5***
Silver	0	<1.2U	<1.3U	<1.2U	<1.3U	<1.2U	<1.1U	<1.2U	<1.2U	<1.2U	<1.2U
Sodium	123	**364J***	<73.2U	<52.1U	<122U	<94.4U	<122U	<118U	<86.8UJ	<66.2UJ	**694***
Thallium	0	**0.27J***	**0.28J***	**0.32J***	**0.23J***	**0.25J***	**0.16J***	**0.28J***	**0.37J***	**0.36J***	**0.19J***
Vanadium	31.1	11.2J	21.3	30	15.6	23.1	11.1	12.3	14.8J	18.3J	17.6
Zinc	61.8	26.7	46.8	38.2	42.6	61.5	45.1	38.9	41.7	31	41.3J
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	<2.4U	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Acenaphthylene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Anthracene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Benz(a)anthracene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	**0.064J***
Benzo(a)pyrene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	**0.084J***
Benzo(b)fluoranthene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	**0.05J***	<0.4U	<0.4U	**0.12J***
Benzo(ghi)perylene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	**0.15J***	<0.39U	<0.4U	<0.4U	**0.066J***
Benzo(k)fluoranthene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	**0.05J***
Bis(2-ethylhexyl)phthalate	None	**0.059J***	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Carbazole	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Chrysene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	**0.05J***	<0.4U	<0.4U	**0.096J***
Di-n-butyl phthalate	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Dibenz(a,h)anthracene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	**0.14J***	<0.39U	<0.4U	<0.4U	<0.4U

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

Aggregate	**Background Criteria**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-016**	**NTA-017**	**NTA-018**	**NTA-019**	**NTA-020**	**NTA-021**	**NTA-022**	**NTA-023**	**NTA-024**	**NTA-025**
Sample ID		**NTAss-016-0016-SO**	**NTAss-017-0017-SO**	**NTAss-018-0018-SO**	**NTAss-019-0019-SO**	**NTAss-020-0020-SO**	**NTAss-021-0021-SO**	**NTAss-022-0022-SO**	**NTAss-023-0023-SO**	**NTAss-024-0024-SO**	**NTAss-025-0025-SO**
Date		**10/24/99**	**10/20/99**	**10/21/99**	**10/21/99**	**10/21/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/20/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Dibenzofuran	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Fluoranthene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	**0.13J***
Fluorene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Indeno(1,2,3-cd)pyrene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	**0.12J***	<0.39U	<0.4U	<0.4U	**0.068J***
Naphthalene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Phenanthrene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	**0.06J***
Phenol	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	<0.39U	<0.4U	<0.4U	<0.4U
Pyrene	None	<0.39U	<0.41U	<0.41U	<0.42U	<0.4U	<0.37U	**0.039J***	<0.4U	<0.4U	**0.14J***
VOCs (mg/kg)											
Acetone	None	<0.012UJ	<0.013UJ	<0.012UJ	<0.013UJ	<0.012UJ	<0.011UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ
Dimethylbenzene	None	**0.0014J***	<0.0063U	<0.0062U	<0.0064UJ	<0.006U	<0.0057U	<0.0058U	**0.002J***	**0.0023J***	<0.0061U
Methylene chloride	None	<0.0059U	<0.0063U	<0.0067U	<0.0085UJ	<0.006U	**0.0028J***	**0.0028J***	<0.0061U	<0.006U	<0.0061U
Styrene	None	<0.0059U	<0.0063U	<0.0062U	<0.0064UJ	<0.006U	<0.0057UJ	<0.0058UJ	<0.0061U	<0.006U	<0.0061U
Toluene	None	<0.0059U	<0.0063U	<0.0062U	<0.0064UJ	<0.006U	<0.0057U	<0.0058U	<0.0061U	<0.006U	<0.0061U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-026**	**NTA-027**	**NTA-028**	**NTA-029**	**NTA-030**	**NTA-031**	**NTA-032**	**NTA-032**	**NTA-033**	**NTA-034**
Sample ID		**NTAss-026-0026-SO**	**NTAss-027-0027-SO**	**NTAss-028-0028-SO**	**NTAss-029-0029-SO**	**NTAss-030-0030-SO**	**NTAss-031-0031-SO**	**NTAss-032-0139-SO**	**NTAss-032-0032-SO**	**NTAss-033-0033-SO**	**NTAss-034-0034-SO**
Date		**10/20/99**	**10/22/99**	**10/22/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/20/99**	**10/22/99**
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 **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	14300	13300	11800	8270	9650	10900	10400	9270	11100	8510
Antimony	0.96	0.55J	<1.2UJ	<1.2UJ	<1.2UJ	<1.2UJ	<1.2R	<1.2R	<1.2R	<1.3UJ	<1.2UJ
Arsenic	15.4	13.6	12.2	13.2	9.1	8.5	10J	8.5J	7.2J	4.8	**17.4***
Barium	88.4	**95.2***	63.8	**96.9***	40.9	55.1	58.4J	70.2J	73J	50.1J	**93.9***
Beryllium	0.88	0.75	0.41J	0.39J	<0.23U	0.28J	0.31J	0.26J	0.25J	<0.64U	0.72
Cadmium	0	**0.59J***	<0.58U	<0.58U	<0.59U	**1.3***	**0.28J***	<0.62UJ	<0.61UJ	<0.64U	<0.59U
Calcium	15800	**19500***	5810J	10100J	1840J	1820J	1530	13700	13300	338J	981J
Chromium	17.4	16.4	**17.8***	16.9	10.9	12.4	14.5J	11.9J	11.2J	13J	12.4
Cobalt	10.4	9.4	8.9	**14.3J***	6.8	7.1	7.8J	4.9J	4.6J	5.4J	**38.2***
Copper	17.7	**19.3***	17.1J	**20.3J***	14.5J	**55.6J***	**25.4J***	11.9J	10.2J	6.2	5.9J
Cyanide	0	<0.6U	<0.58U	<0.58U	<0.59U	<0.59U	<0.6U	<0.62U	<0.61U	<0.64U	<0.59U
Iron	23100	**25800J***	22800	**27000***	17900	17000	22200	14400	15200	13900	**38700***
Lead	26.1	20.1	18.1	22.6	18.8	**34***	23.4J	15J	17.4J	15.8	**27.5***
Magnesium	3030	**4880***	**3590***	**4140***	2180	1990	2190J	**3640J***	**3280J***	1500	1180
Manganese	1450	737	288	1110	307	305	354	619	694	155	**4500***
Mercury	0.036	**0.058J***	<0.023U	<0.033U	<0.034U	<0.025U	0.033J	<0.022U	0.03J	**0.061J***	<0.037U
Nickel	21.1	20.6	**21.6***	**26.6***	15.9	14.2	15.9J	9.7J	8.6J	9.1	10.4
Potassium	927	**1140***	**2270***	**1360***	801	741	**930J***	575J	546J	746J	494J
Selenium	1.4	0.84	<0.58U	<0.58U	0.46J	0.7	0.68J	1.2J	1.3J	0.89	**2.6***
Silver	0	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U	<1.3U	<2.4U
Sodium	123	<157U	<135U	<107U	<120U	<113U	<115UJ	<130UJ	<172UJ	<95U	<80.6U
Thallium	0	**0.26J***	**0.34J***	**0.3J***	**0.3J***	**0.35J***	**0.36J***	**0.37J***	**0.35J***	**0.46J***	**0.3J***
Vanadium	31.1	20.2	23.3	20.9	14.1	16.1	20.6J	20.1J	16.7J	20.1	29
Zinc	61.8	**67J***	58	**62.4***	46.4	**62.2***	54.9	38.9	38	45.8J	47.9
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	<0.25U	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	<0.25U	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	<2.4U	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Acenaphthylene	None	**0.33J***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Anthracene	None	**0.33J***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	**0.17J***	<0.42U	<0.39U
Benz(a)anthracene	None	**1.5***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.12J***	**0.46***	<0.42U	<0.39U
Benzo(a)pyrene	None	**1.9***	<0.39U	<0.39U	**0.06J***	<0.39U	<0.39U	**0.14J***	**0.43***	<0.42U	<0.39U
Benzo(b)fluoranthene	None	**3.2***	<0.39U	<0.39U	**0.079J***	<0.39U	<0.39U	**0.2J***	**0.61***	<0.42U	<0.39U
Benzo(ghi)perylene	None	**1***	<0.39U	<0.39U	**0.073J***	<0.39U	<0.39U	**0.11J***	**0.27J***	<0.42U	<0.39U
Benzo(k)fluoranthene	None	**1.2***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.073J***	**0.23J***	<0.42U	<0.39U
Bis(2-ethylhexyl)phthalate	None	<0.53U	<0.39U	**0.093J***	<0.39U	**0.099J***	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Carbazole	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Chrysene	None	**2.7***	<0.39U	<0.39U	**0.059J***	<0.39U	<0.39U	**0.16J***	**0.46***	<0.42U	<0.39U
Di-n-butyl phthalate	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Dibenz(a,h)anthracene	None	**0.35J***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	**0.075J***	<0.42U	<0.39U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-026**	**NTA-027**	**NTA-028**	**NTA-029**	**NTA-030**	**NTA-031**	**NTA-032**	**NTA-032**	**NTA-033**	**NTA-034**
Sample ID		**NTAss-026-0026-SO**	**NTAss-027-0027-SO**	**NTAss-028-0028-SO**	**NTAss-029-0029-SO**	**NTAss-030-0030-SO**	**NTAss-031-0031-SO**	**NTAss-032-0139-SO**	**NTAss-032-0032-SO**	**NTAss-033-0033-SO**	**NTAss-034-0034-SO**
Date		**10/20/99**	**10/22/99**	**10/22/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/20/99**	**10/22/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Dibenzofuran	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Fluoranthene	None	**1.7***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.23J***	**0.81***	<0.42U	<0.39U
Fluorene	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Indeno(1,2,3-cd)pyrene	None	**1.2***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.12J***	**0.34J***	<0.42U	<0.39U
Naphthalene	None	<0.53U	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Phenanthrene	None	**0.34J***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.14J***	**0.27J***	<0.42U	<0.39U
Phenol	None	<0.53UJ	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	<0.41U	<0.4U	<0.42U	<0.39U
Pyrene	None	**1.8***	<0.39U	<0.39U	<0.39U	<0.39U	<0.39U	**0.22J***	**0.65***	<0.42U	<0.39U
VOCs (mg/kg)											
Acetone	None	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.013UJ	<0.012UJ
Dimethylbenzene	None	<0.006U	**0.0021J***	<0.0058U	<0.0059U	**0.0019J***	**0.0019J***	<0.0062U	<0.0061U	<0.0064U	<0.0059U
Methylene chloride	None	<0.006U	<0.0058U	**0.0046J***	**0.0039J***	<0.0059U	<0.006U	<0.0062U	<0.0061U	<0.0064U	<0.0059U
Styrene	None	<0.006U	<0.0058U	<0.0058UJ	<0.0059UJ	<0.0059U	<0.006U	<0.0062U	<0.0061U	<0.0064U	<0.0059U
Toluene	None	<0.006U	**0.0017J***	<0.0058U	<0.0059U	<0.0059U	<0.006U	<0.0062U	<0.0061U	<0.0064U	<0.0059U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-035**	**NTA-036**	**NTA-037**	**NTA-038**	**NTA-039**	**NTA-040**	**NTA-041**	**NTA-042**	**NTA-043**	**NTA-043**
Sample ID		**NTAss-035-0035-SO**	**NTAss-036-0036-SO**	**NTAss-037-0037-SO**	**NTAss-038-0038-SO**	**NTAss-039-0040-SO**	**NTAss-040-0041-SO**	**NTAss-041-0042-SO**	**NTAss-042-0043-SO**	**NTAss-043-0140-SO**	**NTAss-043-0044-SO**
Date		**10/22/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**
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 Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Metals (mg/kg)											
Aluminum	17700	9560	5400	6820	7570	10400	7740	8640	8950	7660	6290
Antimony	0.96	<1.2UJ	<1.1UJ	<1.2UJ	<1.3R	<1.3R	<1.2R	<1.2UJ	<1.2UJ	<1.2UJ	<1.2UJ
Arsenic	15.4	11.3	6.9	6.7	6.9J	9.7J	9.4J	3.8	6.1	4.9	4.9
Barium	88.4	54.7	18J	36.6	43.6J	51.2J	35.4J	45.6J	33	35.8	30.4
Beryllium	0.88	0.29J	<0.14U	0.24J	<0.19UJ	0.23J	<0.16UJ	<0.61U	<0.29U	<0.26U	<0.28U
Cadmium	0	<0.59U	<0.55U	<0.6U	<0.63UJ	<0.64UJ	<0.61UJ	<0.61U	<0.6UJ	<0.61UJ	<0.61UJ
Calcium	15800	3880J	389J	182J	862	803	1290	351J	1840	<289U	<279U
Chromium	17.4	13.8	6.6	7.7	8.9J	12.3J	10.2J	10J	10.3J	7.4J	6.3J
Cobalt	10.4	8.2	4.5J	8.1	4.3J	8.2J	5.5J	5.9J	4.4J	3.1J	3.1J
Copper	17.7	**25J***	8.6J	6.2J	12J	9.4J	7.6J	5.1	8J	13.2J	7.9J
Cyanide	0	<0.59U	<0.55U	<0.6U	<0.63U	<0.64U	<0.61U	<0.61U	<0.6U	<0.61U	<0.61U
Iron	23100	21400	12600	17700	20500	18600	**23600***	22500	15100	11200	11400
Lead	26.1	**32.9***	6.9	20.7	14.5J	17.3J	17.8J	13.8	12.7J	13J	13J
Magnesium	3030	2950	1040	1330	1230J	1600J	1320J	1170	1670J	956J	884J
Manganese	1450	258	109	625	180	456	198	317	125	94	103
Mercury	0.036	<0.028U	<0.015U	<0.043U	**0.047J***	**0.06J***	**0.04J***	0.036J	0.017J	0.031J	0.026J
Nickel	21.1	19.9	10.8	8.7	9.8J	11.4J	9.5J	7.3	11.6	7.2	7
Potassium	927	**1180***	371J	468J	460J	716J	575J	698J	606	455J	338J
Selenium	1.4	0.61	0.46J	<0.6U	0.63J	1.4J	1.2J	0.54J	<0.6U	<0.61U	<0.61U
Silver	0	<1.2U	<1.1U	<1.2U	<1.3U	<1.3U	<1.2U	<1.2U	<1.2U	<1.2U	<1.2U
Sodium	123	<127U	<102U	<61.7U	<55.2UJ	<78.8UJ	<58.4UJ	<87.1U	<97.2U	<76.3U	<104U
Thallium	0	**0.31J***	**0.2J***	**0.29J***	**0.33J***	**0.39J***	**0.32J***	**0.26J***	**0.27J***	**0.23J***	**0.23J***
Vanadium	31.1	17	8.7	15.2	14.5J	21.4J	15.9J	15.5	14.6	11.9	10.4
Zinc	61.8	57.8	28.7	38.1	40.1	**67.7***	39.9	38.6J	44.1J	38.5J	33.7J
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	**0.15J***	NR	NR	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	NR	NR	<0.25U	NR	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	<2.4U	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Acenaphthylene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Anthracene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Benz(a)anthracene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Benzo(a)pyrene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U
Benzo(b)fluoranthene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U
Benzo(ghi)perylene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U
Benzo(k)fluoranthene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U
Bis(2-ethylhexyl)phthalate	None	<0.39U	<0.36UJ	<0.39U	<0.41U	**0.048J***	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Carbazole	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Chrysene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Di-n-butyl phthalate	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Dibenz(a,h)anthracene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-035**	**NTA-036**	**NTA-037**	**NTA-038**	**NTA-039**	**NTA-040**	**NTA-041**	**NTA-042**	**NTA-043**	**NTA-043**
Sample ID		**NTAss-035-0035-SO**	**NTAss-036-0036-SO**	**NTAss-037-0037-SO**	**NTAss-038-0038-SO**	**NTAss-039-0040-SO**	**NTAss-040-0041-SO**	**NTAss-041-0042-SO**	**NTAss-042-0043-SO**	**NTAss-043-0140-SO**	**NTAss-043-0044-SO**
Date		**10/22/99**	**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Dibenzofuran	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Fluoranthene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Fluorene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Indeno(1,2,3-cd)pyrene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39U	<0.4U	<0.4U
Naphthalene	None	<0.39UJ	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Phenanthrene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Phenol	None	<0.39U	<0.36U	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
Pyrene	None	<0.39U	<0.36UJ	<0.39U	<0.41U	<0.42U	<0.4U	<0.4U	<0.39UJ	<0.4U	<0.4U
VOCs (mg/kg)											
Acetone	None	<0.012UJ	<0.011UJ	<0.012UJ	<0.013UJ	<0.013UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ
Dimethylbenzene	None	<0.0059U	**0.0018J***	<0.006U	<0.0063U	<0.0064U	<0.0061U	<0.0061U	<0.006U	<0.0061U	<0.0061U
Methylene chloride	None	<0.0059U	<0.0055U	**0.0041J***	<0.0063U	<0.0064U	<0.0061U	<0.0061U	<0.006U	<0.0061U	<0.0061U
Styrene	None	<0.0059U	<0.0055U	<0.006UJ	<0.0063U	<0.0064U	<0.0061U	<0.0061U	<0.006U	<0.0061UJ	<0.0061U
Toluene	None	<0.0059U	<0.0055U	<0.006U	<0.0063U	<0.0064U	<0.0061U	<0.0061U	<0.006U	<0.0061U	<0.0061U

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

Aggregate	**Background Criteria**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-044**	**NTA-045**	**NTA-046**	**NTA-047**	**NTA-048**	**NTA-049**	**NTA-050**	**NTA-051**	**NTA-052**	**NTA-053**
Sample ID		**NTAss-044-0045-SO**	**NTAss-045-0046-SO**	**NTAss-046-0047-SO**	**NTAss-047-0048-SO**	**NTAss-048-0049-SO**	**NTAss-049-0050-SO**	**NTAss-050-0051-SO**	**NTAss-051-0052-SO**	**NTAss-052-0053-SO**	**NTAss-053-0054-SO**
Date		**10/25/99**	**10/26/99**	**10/26/99**	**10/26/99**	**10/24/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**	**10/25/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Metals (mg/kg)											
Aluminum	17700	8920	6870	7230	8040	6230	11300	10100	10100	14000	12300
Antimony	0.96	<1.2UJ	<1.2UJ	<1.3UJ	<1.2UJ	<1.2R	<1.2UJ	<1.3UJ	<1.3UJ	<1.3UJ	<1.2UJ
Arsenic	15.4	9.8	5.5	6.1	4.9	8.7J	3.7	3.3	4	9.7	12.7
Barium	88.4	45.1	28.5	48.7	36.7	36.6J	41.3J	68.1	30.1	59.8	53
Beryllium	0.88	<0.41U	<0.6U	<0.16U	<0.61U	0.24J	<0.62U	<0.52U	<0.3U	<0.49U	<0.45U
Cadmium	0	<0.61UJ	<0.6U	<0.63U	<0.61U	<0.58UJ	<0.62U	<0.63UJ	<0.65UJ	<0.64UJ	<0.6UJ
Calcium	15800	3380	290J	1010	358J	1160	<180U	8150	<152U	1760	1680
Chromium	17.4	12.2J	7.9	8.3	8.8	7.8J	12.7J	9.2J	9.8J	15.8J	16.1J
Cobalt	10.4	7.6	3J	4.6J	2.7J	7J	4.4J	3.7J	3.1J	6.2J	**12.7***
Copper	17.7	16.8J	6.3J	7.9J	6.2J	7.9J	6.7	3.9J	5.2J	10.5J	**17.9J***
Cyanide	0	<0.61U	<0.6U	<0.63U	<0.61U	<0.58U	<0.62U	<0.63UJ	<0.65U	<0.64U	<0.6U
Iron	23100	19800	11100	14600	10900	14500	13200	12200	12600	19600	**27100***
Lead	26.1	16.1J	13.7	14.7	12.2	15J	9.9	12.3J	11.3J	16.4J	13.7J
Magnesium	3030	2430J	980	1180	1060	1100J	1730	2260J	1320J	2420J	2980J
Manganese	1450	280	78.3	196	49	374	129	367	52.5	193	466
Mercury	0.036	0.036J	**0.049J***	0.032J	0.036J	<0.0085U	<0.032U	0.032J	0.026J	**0.037J***	0.036J
Nickel	21.1	17.1	7	9.2	7.2	9.7J	10.9	7.7	9	14	**22.2***
Potassium	927	**975***	478J	520J	726	425J	872J	623J	507J	**1280***	**986***
Selenium	1.4	<0.61U	1.1	0.9	<0.61U	0.8J	0.57J	<0.63U	<0.65U	<0.64U	<0.6U
Silver	0	<1.2U	<1.2U	<1.3U	<1.2U	<1.2U	<1.2U	<1.3U	<1.3U	<1.3U	<1.2U
Sodium	123	<91U	<63.5U	<87.9U	<62.3U	<81UJ	<71.8U	<127U	<107U	<112U	<124U
Thallium	0	**0.24J***	<0.4U	<0.26U	<0.17U	**0.23J***	**0.36J***	**0.25J***	**0.3J***	**0.37J***	**0.29J***
Vanadium	31.1	15.4	13.5	13.2	15.6	15.1J	19.3	13.8	14.7	22.1	18.5
Zinc	61.8	53.2J	35.4	**77.7***	34.5	42.3	51.5J	43.5J	40.8J	**64.3J***	57.7J
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	<2.6U	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Acenaphthylene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Anthracene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Benz(a)anthracene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Benzo(a)pyrene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Benzo(b)fluoranthene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Benzo(ghi)perylene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Benzo(k)fluoranthene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Bis(2-ethylhexyl)phthalate	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Carbazole	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Chrysene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Di-n-butyl phthalate	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Dibenz(a,h)anthracene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U

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

Aggregate	**Background Criteria**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-044**	**NTA-045**	**NTA-046**	**NTA-047**	**NTA-048**	**NTA-049**	**NTA-050**	**NTA-051**	**NTA-052**	**NTA-053**
Sample ID		**NTAss-044-0045-SO**	**NTAss-045-0046-SO**	**NTAss-046-0047-SO**	**NTAss-047-0048-SO**	**NTAss-048-0049-SO**	**NTAss-049-0050-SO**	**NTAss-050-0051-SO**	**NTAss-051-0052-SO**	**NTAss-052-0053-SO**	**NTAss-053-0054-SO**
Date		**10/25/99**	**10/26/99**	**10/26/99**	**10/26/99**	**10/24/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**	**10/25/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Dibenzofuran	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Fluoranthene	None	<0.4U	**0.042J***	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Fluorene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Indeno(1,2,3-cd)pyrene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Naphthalene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Phenanthrene	None	<0.4U	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
Phenol	None	**0.27J***	<0.4U	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	**0.11J***
Pyrene	None	<0.4U	**0.04J***	<0.41U	<0.4U	<0.38U	<0.41U	<0.42U	<0.43U	<0.42U	<0.39U
						VOCs (mg/kg)					
Acetone	None	<0.012UJ	<0.012U	<0.013U	<0.012U	<0.012UJ	<0.012UJ	<0.013UJ	<0.013UJ	<0.013UJ	<0.012UJ
Dimethylbenzene	None	<0.0061U	<0.006U	<0.0063U	<0.0061U	**0.0012J***	<0.0062U	<0.0063U	<0.0065U	<0.0064U	<0.006U
Methylene chloride	None	<0.0061U	<0.006U	<0.0063U	<0.0061U	<0.0058U	<0.0062U	<0.0063U	<0.0065U	<0.0064U	<0.006U
Styrene	None	<0.0061U	<0.006U	<0.0063U	<0.0061U	<0.0058U	<0.0062U	<0.0063U	<0.0065U	<0.0064U	<0.006U
Toluene	None	<0.0061U	<0.006U	<0.0063U	<0.0061U	<0.0058U	<0.0062U	<0.0063U	<0.0065U	<0.0064U	<0.006U
Acetone	None	<0.012UJ	<0.012U	<0.013U	<0.012U	<0.012UJ	<0.012UJ	<0.013UJ	<0.013UJ	<0.013UJ	<0.012UJ

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

Aggregate	**Background Criteria**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-054**	**NTA-055**	**NTA-055**	**NTA-056**	**NTA-057**	**NTA-058**	**NTA-058**	**NTA-059**	**NTA-060**	**NTA-061**
Sample ID		**NTAss-054-0055-SO**	**NTAss-055-0141-SO**	**NTAss-055-0056-SO**	**NTAss-056-0057-SO**	**NTAss-057-0058-SO**	**NTAss-058-0137-SO**	**NTAss-058-0060-SO**	**NTAss-059-0061-SO**	**NTAss-060-0062-SO**	**NTAss-061-0063-SO**
Date		**10/26/99**	**10/26/99**	**10/26/99**	**10/26/99**	**10/20/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**	**10/25/99**
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 **Analyte**		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	11700	8090	8980	15000	10300	10600	10600	10700	7020	12900
Antimony	0.96	<1.3UJ	<1.2UJ	<1.2UJ	<1.4UJ	<1.2UJ	0.73J	<1.3R	<1.2UJ	<1.2UJ	<1.5UJ
Arsenic	15.4	12.4	10	8.5	8.8	6.2	5.8	5.2J	5.2	6.4	10.8
Barium	88.4	75.9	52.9	**109***	**127***	42	39.5	68.9J	35.2	42.3	**113***
Beryllium	0.88	0.41J	0.25J	0.27J	0.58J	<0.62U	<0.62U	0.34J	<0.3U	<0.32U	<0.71U
Cadmium	0	<0.66U	<0.6U	<0.61U	**1.1***	<0.62U	<0.62U	<0.64UJ	<0.6UJ	<0.61UJ	<0.74UJ
Calcium	15800	2240	2150	12200	2140	380J	355J	5010	<287U	1140	2310
Chromium	17.4	17	10.5	9.8	**17.7***	14	13.8	12.1J	11.1J	9.1J	16J
Cobalt	10.4	**10.5***	8	6.4	8.3	5.8J	5.2J	5.5J	3.9J	8.4	10
Copper	17.7	**20.6J***	16.7J	13.1J	15.1J	7.3	7.4	8.5J	7J	5.6J	17.7J
Cyanide	0	<0.66U	<0.6U	<0.61U	<0.7U	<0.62U	<0.62U	<0.64U	<0.6U	<0.61U	<0.74U
Iron	23100	**30600***	20300	17700	17100	16900J	19600J	20000	13800	14100	**25100***
Lead	26.1	19.6	12.9	12.2	**27.4***	13.3	12.5	14.4J	9.6J	13.8J	22.8J
Magnesium	3030	**3430***	1990	**3440***	2560	2090	2040	2650J	1620J	1320J	2490J
Manganese	1450	385	344	560	151	130	110	368	79.7	493	946
Mercury	0.036	0.029J	0.027J	0.021J	**0.064J***	**0.039J***	0.036J	**0.043J***	0.032J	**0.046J***	**0.072J***
Nickel	21.1	**25.2***	14.8	11.1	20.8	12.6	12.3	13.2J	10.7	9.7	**22.3***
Potassium	927	**984***	588J	592J	**1410***	869	857	662J	534J	411J	**1570***
Selenium	1.4	1.1	0.99	0.82	0.63J	0.91	0.75	0.76J	<0.6U	<0.61U	<0.74U
Silver	0	<1.3U	<1.2U	<1.2U	<1.4U	<1.2U	<1.2U	<1.3U	<1.2U	<1.2U	<1.5U
Sodium	123	<49.7U	<49.8U	<90.6U	<98.8U	<88.8U	<92.5U	<102UJ	<217U	<165U	<93U
Thallium	0	<0.47U	<0.31U	<0.22U	<0.63U	**0.35J***	**0.27J***	**0.43J***	**0.24J***	**0.28J***	**0.3J***
Vanadium	31.1	19.1	13.9	12.4	24.9	19	18.4	16.1J	16.6	12.9	20.6
Zinc	61.8	**75.8***	42.8	35.6	**150***	51.5J	52.4J	47.4	44.4J	52.6J	**168J***
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	<0.25U	<0.25U	NR	NR	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	<0.25U	<0.25U	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	<2.5U	**2.8***	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Acenaphthylene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Anthracene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Benz(a)anthracene	None	<0.43U	<0.4U	<0.4U	**0.05J***	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Benzo(a)pyrene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Benzo(b)fluoranthene	None	<0.43U	<0.4U	<0.4U	**0.058J***	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Benzo(ghi)perylene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Benzo(k)fluoranthene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Bis(2-ethylhexyl)phthalate	None	<0.43U	<0.4U	<0.4U	**0.062J***	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Carbazole	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Chrysene	None	<0.43U	<0.4U	<0.4U	**0.06J***	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Di-n-butyl phthalate	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Dibenz(a,h)anthracene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTA-054**	**NTA-055**	**NTA-055**	**NTA-056**	**NTA-057**	**NTA-058**	**NTA-058**	**NTA-059**	**NTA-060**	**NTA-061**
Sample ID		**NTAss-054-0055-SO**	**NTAss-055-0141-SO**	**NTAss-055-0056-SO**	**NTAss-056-0057-SO**	**NTAss-057-0058-SO**	**NTAss-058-0137-SO**	**NTAss-058-0060-SO**	**NTAss-059-0061-SO**	**NTAss-060-0062-SO**	**NTAss-061-0063-SO**
Date		**10/26/99**	**10/26/99**	**10/26/99**	**10/26/99**	**10/20/99**	**10/20/99**	**10/25/99**	**10/25/99**	**10/25/99**	**10/25/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Dibenzofuran	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Fluoranthene	None	<0.43U	<0.4U	<0.4U	**0.076J***	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Fluorene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Indeno(1,2,3-cd)pyrene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Naphthalene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Phenanthrene	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
Phenol	None	<0.43U	<0.4U	<0.4U	<0.46U	<0.41U	<0.41U	<0.42U	<0.39U	<0.4U	<0.49U
Pyrene	None	<0.43U	<0.4U	<0.4U	0.068J*	<0.41U	<0.41U	<0.42U	<0.39U	<0.4UJ	<0.49U
VOCs (mg/kg)											
Acetone	None	<0.013U	<0.012UJ	<0.012UJ	<0.014U	<0.012UJ	<0.012UJ	<0.013UJ	<0.012UJ	<0.012UJ	<0.015UJ
Dimethylbenzene	None	<0.0066U	<0.006U	<0.0061U	<0.007U	<0.0062U	<0.0062U	<0.0064U	<0.006U	<0.0061U	<0.0074U
Methylene chloride	None	<0.0066U	<0.006U	<0.0061U	<0.007U	<0.0062U	<0.0062U	<0.0064U	<0.006U	<0.0061U	<0.0074U
Styrene	None	<0.0066U	<0.006U	<0.0061U	<0.007U	<0.0062U	<0.0062U	<0.0064U	<0.006U	<0.0061U	<0.0074U
Toluene	None	<0.0066U	<0.006U	<0.0061U	<0.007U	<0.0062U	<0.0062U	<0.0064U	<0.006U	<0.0061U	<0.0074U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area Well Pit**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-062**	**NTA-063**	**NTA-064**	**NTA-096**	**NTA-097**	**NTA-098**	**NTA-098**	**NTA-101**	**NTA-065**	**NTA-066**
Sample ID		**NTAss-062-0064-SO**	**NTAss-063-0065-SO**	**NTAss-064-0066-SO**	**NTAss-096-0117-SO**	**NTAss-097-0118-SO**	**NTAss-098-0145-SO**	**NTAss-098-0119-SO**	**NTAsd-101-0124-SD**	**NTAss-065-0067-SO**	**NTAss-066-0069-SO**
Date		**10/26/99**	**10/26/99**	**10/26/99**	**10/20/99**	**10/20/99**	**10/20/99**	**10/20/99**	**10/22/99**	**11/02/99**	**11/02/99**
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 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	8020	8650	11900	**22500***	17200	8620	9290	8730	9430J	16500J
Antimony	0.96	<1.9UJ	<1.3UJ	<1.4UJ	<1.3UJ	0.7J	<1.2UJ	0.88J	<1.5UJ	<1.3UJ	<1.3UJ
Arsenic	15.4	12.3	7.2	**19***	4.8	13	6	**18.3***	12.4	7.4	11.6
Barium	88.4	**89.1***	61	**95.1***	**99.8J***	**104***	44.2	62.9	**436***	35.6J	70.2J
Beryllium	0.88	0.51J	0.3J	0.47J	<0.44U	<0.52U	<0.44U	<0.37U	<0.21U	0.28J	0.49J
Cadmium	0	**0.56J***	<0.63U	<0.71U	<0.65U	**0.32J***	<0.61U	<0.61U	**5***	<0.65U	<0.65U
Calcium	15800	2070	1180	1880	3650	2690	901	1180	**20400J***	180J	560J
Chromium	17.4	12	10.5	16	**25.2J***	**22.4***	11.6	12.7	**24.6***	12.6J	**22.3J***
Cobalt	10.4	10.3	6.8	8.9	9.3	**11.6***	5.5J	9	8.4	6.3J	7
Copper	17.7	**24.8J***	8.8J	**23.5J***	**19.3***	**20.4***	7.3	14.6	**155J***	6.1J	13.4J
Cyanide	0	**1.1***	<0.63U	<0.71U	<0.65U	<0.65U	<0.61U	<0.61U	<0.74U	<0.65U	<0.65U
Iron	23100	18600	20900	**33000***	**28300***	**32500J***	15900J	**31200***	**58700***	18200	**28900***
Lead	26.1	**29.6***	14.5	17.9	11.7	16.9	10	10.6	**13200***	15.2	13.8
Magnesium	3030	1720	1640	2670	**4090***	**4080***	1580	2130	2200	1990	**3640***
Manganese	1450	674	188	507	101	352	261	372	1310	229J	142J
Mercury	0.036	**0.1J***	**0.043J***	**0.054J***	<0.037U	**0.041J***	0.025J	0.0093J	<0.069U	**0.042J***	0.033J
Nickel	21.1	**21.3***	12.4	**21.6***	**26.3***	**29.2***	14.2	**21.2***	**23.9***	12.4	**21.6***
Potassium	927	**951J***	767	**1510***	**1740J***	**1710***	904	**1060***	**1850***	809	**1960***
Selenium	1.4	**1.7***	1.1	0.86	0.53J	0.94	<0.61U	0.9	1	<0.65U	<0.65U
Silver	0	<1.9U	<1.3U	<1.4U	<1.3U	<1.3U	<1.2U	<1.2U	**0.5J***	<1.3U	<1.3U
Sodium	123	<130U	<92.5U	<111U	<138U	<125U	<45.9U	<73U	<414U	<36.8U	<43.5U
Thallium	0	<0.52U	<0.25U	<0.33U	**0.57J***	<0.65U	**0.3J***	**0.29J***	**0.35J***	**0.33J***	**0.44J***
Vanadium	31.1	16.2	15.6	21.2	27.9	27.5	15.3	14.5	16.9	16.1	27.5
Zinc	61.8	**231***	**73***	**116***	**82.2J***	**84.8J***	46.1J	55.3	**631***	43.1	**65.3***
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	<0.25U	NR	NR	NR	<0.25U	NR	NR	<0.25U	NR	NR
2,4-Dinitrotoluene	None	<0.25U	NR	NR	NR	<0.25U	NR	NR	<0.25U	NR	NR
Nitrocellulose	None	**45.4***	NR	NR	NR	<2.6U	NR	NR	**11***	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Acenaphthylene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Anthracene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Benz(a)anthracene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Benzo(a)pyrene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Benzo(b)fluoranthene	None	**0.092J***	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Benzo(ghi)perylene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Benzo(k)fluoranthene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Bis(2-ethylhexyl)phthalate	None	<0.63U	**0.07J***	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Carbazole	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Chrysene	None	**0.089J***	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Di-n-butyl phthalate	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area Well Pit**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-062**	**NTA-063**	**NTA-064**	**NTA-096**	**NTA-097**	**NTA-098**	**NTA-098**	**NTA-101**	**NTA-065**	**NTA-066**
Sample ID		**NTAss-062-0064-SO**	**NTAss-063-0065-SO**	**NTAss-064-0066-SO**	**NTAss-096-0117-SO**	**NTAss-097-0118-SO**	**NTAss-098-0145-SO**	**NTAss-098-0119-SO**	**NTAsd-101-0124-SD**	**NTAss-065-0067-SO**	**NTAss-066-0069-SO**
Date		**10/26/99**	**10/26/99**	**10/26/99**	**10/20/99**	**10/20/99**	**10/20/99**	**10/20/99**	**10/22/99**	**11/02/99**	**11/02/99**
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 - 0.5**	**0.0 - 1.0**	**0.0 - 1.0**
Parameters Analyzed		**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Dibenz(a,h)anthracene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Dibenzofuran	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Fluoranthene	None	**0.17J***	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Fluorene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Indeno(1,2,3-cd)pyrene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Naphthalene	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Phenanthrene	None	**0.13J***	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Phenol	None	<0.63U	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
Pyrene	None	**0.15J***	<0.42U	<0.47U	<0.43U	<0.43U	<0.4U	<0.4U	<0.49U	<0.43U	<0.43U
VOCs (mg/kg)											
Acetone	None	<0.019U	<0.013UJ	**0.0091J***	<0.013UJ	<0.013UJ	<0.012UJ	<0.012UJ	<0.015UJ	<0.013UJ	<0.013UJ
Dimethylbenzene	None	<0.0096U	<0.0063U	<0.0071U	<0.0065U	<0.0065U	<0.0061U	<0.0061U	**0.003J***	<0.0065U	<0.0065U
Methylene chloride	None	<0.0096U	<0.0063U	<0.0071U	<0.0065U	<0.0065U	<0.0079U	<0.0061U	<0.0074U	<0.0065U	<0.0066U
Styrene	None	<0.0096U	<0.0063U	<0.0071U	<0.0065U	<0.0065U	<0.0061U	<0.0061U	<0.0074U	**0.0012J***	**0.00095J***
Toluene	None	<0.0096U	<0.0063U	<0.0071U	<0.0065U	<0.0065U	<0.0061U	<0.0061U	<0.0074U	**0.0012J***	<0.0065U

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

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-067**	**NTA-068**	**NTA-069**	**NTA-069**	**NTA-070**	**NTA-071**	**NTA-072**	**NTA-073**	**NTA-074**	**NTA-075**
Sample ID		**NTAss-067-0071-SO**	**NTAss-068-0073-SO**	**NTAss-069-0142-SO**	**NTAss-069-0075-SO**	**NTAss-070-0078-SO**	**NTAss-071-0080-SO**	**NTAss-072-0082-SO**	**NTAss-073-0084-SO**	**NTAss-074-0086-SO**	**NTAss-075-0088-SO**
Date		**11/03/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**10/27/99**	**10/27/99**	**11/02/99**	**10/27/99**	**10/27/99**
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 **Analyte**	**Background Criteria**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
						Metals (mg/kg)					
Aluminum	17700	17400	7750	9270	9520	**31200***	12000	11700	5090	6850	7080
Antimony	0.96	<1.4UJ	<1.2UJ	<1.3UJ	<1.3U	**2.9***	<1.2UJ	<1.1UJ	<1.1UJ	<1.2UJ	<1.2UJ
Arsenic	15.4	**23***	8.8	9.2	9.9	8.3	12.3	8.6	7.2	7.6	4.5
Barium	88.4	**253J***	31J	63J	67.6J	**109J***	80.2	56.1	36.8J	46.3	46.7
Beryllium	0.88	**0.94***	0.22J	0.39J	0.41J	0.36J	0.42J	<0.15U	0.23J	<0.58U	<0.61U
Cadmium	0	<0.72U	<0.58U	<0.64U	<0.64U	**14.5***	<0.6U	**0.74***	**1.6***	<0.58U	<0.61U
Calcium	15800	3660	134J	339J	304J	511J	2190	518J	144J	213J	217J
Chromium	17.4	**23.5J***	9.1J	10.9J	11.3J	**54.2J***	16.7	14	7J	8.4	7.9
Cobalt	10.4	**10.6***	5.9	6.4	8.6	5.9J	10	7.8	4.4J	5.5J	3.4J
Copper	17.7	**19.2J***	8.6J	7.1J	7J	**1760J***	16J	**27.2J***	**19.6J***	8.2J	5.2J
Cyanide	0	<0.72U	<0.58U	<0.64U	<0.64U	<0.63U	<0.6U	<0.57U	<0.56U	<0.58U	<0.61U
Iron	23100	**31700***	14200	17000	18500	15500	23000	15300	13000	14300	13500
Lead	26.1	22.2	11.5	18.5	18	**149***	25.1	17.7	**29.7***	12.3	13.6
Magnesium	3030	**3950***	1430	1300	1330	1530	2430	2140	944	1120	760
Manganese	1450	**2190***	350J	1040J	**1500J***	804J	658	392	265J	296	358
Mercury	0.036	**0.061J***	**0.046J***	**0.066J***	**0.068J***	**0.038J***	0.022J	0.031J	**0.038J***	**0.049J***	0.035J
Nickel	21.1	**33.2***	11.6	9.6	9.9	**41.4***	17.2	15.3	8.5	8.9	5.5
Potassium	927	**1700***	496J	579J	575J	281J	**1270***	726	248J	427J	550J
Selenium	1.4	<0.72U	<0.58U	<0.64U	<0.64U	<0.63U	0.74	0.73	<0.56U	0.54J	<0.61U
Silver	0	<1.4U	<1.2U	<1.3U	<1.3U	**1.5***	<1.2U	<1.1U	<1.1U	<1.2U	<1.2U
Sodium	123	<68.7U	<33.3U	<35.7U	<43.2U	<72.8U	<72.2U	<50.3U	<51.1U	<48U	<58.3U
Thallium	0	**0.52J***	**0.22J***	**0.33J***	**0.33J***	**0.33J***	<0.48U	<0.39U	**0.18J***	<0.36U	<0.46U
Vanadium	31.1	**36.6***	13.7	18.5	19.8	14.9	23.8	20.8	9.6	14.4	11.4
Zinc	61.8	**97.1***	44	54.8	51.3	**603***	**75.5***	**64.4***	43	37.3	41
						Explosives (mg/kg)					
2,4,6-Trinitrotoluene	None	**0.11J***	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
2,4-Dinitrotoluene	None	<0.25U	NR	NR	NR	NR	NR	NR	<0.25U	NR	NR
Nitrocellulose	None	<2U	NR	NR	NR	NR	NR	NR	<2U	NR	NR
						SVOCs (mg/kg)					
Acenaphthene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Acenaphthylene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Anthracene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Benz(a)anthracene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.19J***	<0.38U	<1.5U	<0.38U	<0.4U
Benzo(a)pyrene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.18J***	<0.38U	<1.5U	<0.38U	<0.4U
Benzo(b)fluoranthene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.21J***	<0.38U	<1.5U	<0.38U	<0.4U
Benzo(ghi)perylene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.13J***	<0.38U	<1.5U	<0.38U	<0.4U
Benzo(k)fluoranthene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.096J***	<0.38U	<1.5U	<0.38U	<0.4U
Bis(2-ethylhexyl)phthalate	None	<0.48U	<0.39U	**0.054J***	<0.42U	**0.49J***	**0.045J***	**0.063J***	**0.4J***	**0.043J***	<0.4U
Carbazole	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Chrysene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.2J***	<0.38U	<1.5U	**0.045J***	<0.4U
Di-n-butyl phthalate	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	**0.075J***	<1.5U	**0.04J***	<0.4U
Dibenz(a,h)anthracene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U

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

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-067**	**NTA-068**	**NTA-069**	**NTA-069**	**NTA-070**	**NTA-071**	**NTA-072**	**NTA-073**	**NTA-074**	**NTA-075**
Sample ID		**NTAss-067-0071-SO**	**NTAss-068-0073-SO**	**NTAss-069-0142-SO**	**NTAss-069-0075-SO**	**NTAss-070-0078-SO**	**NTAss-071-0080-SO**	**NTAss-072-0082-SO**	**NTAss-073-0084-SO**	**NTAss-074-0086-SO**	**NTAss-075-0088-SO**
Date		**11/03/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**10/27/99**	**10/27/99**	**11/02/99**	**10/27/99**	**10/27/99**
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 Criteria**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte											
Dibenzofuran	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Fluoranthene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.3J***	<0.38U	<1.5U	**0.053J***	<0.4U
Fluorene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Indeno(1,2,3-cd)pyrene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.15J***	<0.38U	<1.5U	<0.38U	<0.4U
Naphthalene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Phenanthrene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.086J***	<0.38U	<1.5U	<0.38U	<0.4U
Phenol	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	<0.39U	<0.38U	<1.5U	<0.38U	<0.4U
Pyrene	None	<0.48U	<0.39U	<0.42U	<0.42U	<0.41U	**0.27J***	<0.38U	<1.5U	**0.051J***	<0.4U
VOCs (mg/kg)											
Acetone	None	**0.0049J***	<0.014UJ	<0.013UJ	<0.013UJ	<0.013UJ	<0.012UJ	<0.011U	<0.011UJ	<0.012U	<0.012U
Dimethylbenzene	None	<0.0072U	<0.0058U	<0.0064U	<0.0064U	<0.0063U	<0.006U	<0.0057U	<0.0056U	<0.0058U	<0.0061U
Methylene chloride	None	**0.00086J***	<0.0058U	<0.0064U	<0.0064U	<0.0063U	<0.006U	<0.0057U	<0.0056U	<0.0058U	<0.0061U
Styrene	None	<0.0072U	<0.0058U	**0.00077J***	<0.0064U	**0.00088J***	<0.006U	<0.0057U	**0.0015J***	<0.0058U	<0.0061U
Toluene	None	<0.0072U	<0.0058U	<0.0064U	<0.0064U	<0.0063U	<0.006U	<0.0057U	<0.0056U	<0.0058U	<0.0061U

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

Aggregate		Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Burial Area	Former Plane Refueling/Crash Strip Area	Former Plane Refueling/Crash Strip Area
Station		**NTA-076**	**NTA-077**	**NTA-078**	**NTA-079**	**NTA-080**	**NTA-081**	**NTA-082**	**NTA-100**	**NTA-001**	**NTA-002**
Sample ID		**NTAss-076-0090-SO**	**NTAss-077-0092-SO**	**NTAss-078-0094-SO**	**NTAss-079-0095-SO**	**NTAss-080-0097-SO**	**NTAss-081-0098-SO**	**NTAss-082-0099-SO**	**NTAss-100-0122-SO**	**NTAss-001-0001-SO**	**NTAss-002-0002-SO**
Date		**11/03/99**	**11/01/99**	**11/03/99**	**11/03/99**	**11/01/99**	**11/03/99**	**11/03/99**	**11/04/99**	**10/20/99**	**10/21/99**
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 **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	7350	8720	8800	8360	9470	7210	10200	9560	13400	12900
Antimony	0.96	<1.2UJ	<1.2UJ	<1.2UJ	<1.2UJ	<1.4UJ	<1.4UJ	<1.4UJ	<1.3UJ	0.59J	0.8J
Arsenic	15.4	6.2	7.9	10.9	8.3	7.9	11.5	8.8	8	6.2	5.7
Barium	88.4	48.1J	30.9J	63.4J	42.3J	81.5J	73.3J	77.4J	75.6J	57.1	38.3
Beryllium	0.88	<0.17U	0.23J	<0.26U	<0.61U	0.48J	0.36J	<0.32U	<0.31U	<0.19U	<0.31U
Cadmium	0	<0.61U	<0.6U	<0.6U	<0.61U	<0.71U	<0.7U	<0.71U	**2.4***	<0.66U	<0.63U
Calcium	15800	<227U	241J	<265U	<226U	1530	1940	<677U	<331U	345J	214J
Chromium	17.4	8.6J	10.6J	11.4J	10.5J	12.1J	10.4J	12.5J	11.9J	**17.6***	14.7
Cobalt	10.4	4.6J	4.6J	**12***	5.1J	6.2J	7.8	6J	8.5	6.5J	6.4
Copper	17.7	5.7J	7.8J	9.8J	7.7J	10.1J	12.2J	10.7J	**24.4J***	10.7	10.3
Cyanide	0	<0.61U	<0.6U	<0.6U	<0.61U	<0.71U	<0.7U	<0.71U	<0.64U	<0.66U	<0.63U
Iron	23100	11500	16000	19300	16000	16700	22000	17300	15100	20900J	22600
Lead	26.1	9.8	12.1	14.3	10.6	17.8	17.7	22.5	24.2	18.3	11.3
Magnesium	3030	944	1600	1550	1340	1740	1640	1800	1360	2640	2090
Manganese	1450	201	112J	946	218	183J	527	246	1140	137	154
Mercury	0.036	0.032J	0.035J	**0.038J***	0.032J	**0.047J***	**0.046J***	**0.073J***	**0.073J***	**0.04J***	0.025J
Nickel	21.1	6.7	11.4	12.4	9.6	13.9	14.7	13.2	10.7	18.2	16
Potassium	927	375J	572J	634	552J	710	873	**958***	561J	**1230***	692
Selenium	1.4	<0.61U	<0.6U	0.68	0.85	0.87	0.75	0.61J	<0.64U	0.88	1
Silver	0	<1.2U	<1.2U	<1.2U	<1.2U	<1.4U	<1.4U	<1.4U	<1.3U	<1.3U	<1.3U
Sodium	123	<59U	<45U	<48.9U	<70.4U	<116U	<74.5U	<77.9U	<68.3U	<74.5U	<45.6U
Thallium	0	**0.27J***	**0.23J***	**0.25J***	**0.28J***	**0.35J***	**0.27J***	**0.31J***	**0.32J***	**0.31J***	**0.31J***
Vanadium	31.1	14.9	14.7	17.7	16.3	18.5	14	17.9	18.4	22.2	19.5
Zinc	61.8	28.4	41.7	41.7	44.3	**93.2***	**67.8***	**62.5***	38.3	**63.2***	48.3
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Acenaphthylene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Anthracene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Benz(a)anthracene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Benzo(a)pyrene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Benzo(b)fluoranthene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	**0.057J***	<0.47U	<0.42U	<0.43U	<0.41U
Benzo(ghi)perylene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Benzo(k)fluoranthene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Bis(2-ethylhexyl)phthalate	None	<0.4U	**0.058J***	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	**0.23J***	<0.43U	<0.41U
Carbazole	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Chrysene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Di-n-butyl phthalate	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U

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

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-076**	**NTA-077**	**NTA-078**	**NTA-079**	**NTA-080**	**NTA-081**	**NTA-082**	**NTA-100**	**NTA-001**	**NTA-002**
Sample ID		**NTAss-076-0090-SO**	**NTAss-077-0092-SO**	**NTAss-078-0094-SO**	**NTAss-079-0095-SO**	**NTAss-080-0097-SO**	**NTAss-081-0098-SO**	**NTAss-082-0099-SO**	**NTAss-100-0122-SO**	**NTAss-001-0001-SO**	**NTAss-002-0002-SO**
Date		**11/03/99**	**11/01/99**	**11/03/99**	**11/03/99**	**11/01/99**	**11/03/99**	**11/03/99**	**11/04/99**	**10/20/99**	**10/21/99**
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 **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Dibenz(a,h)anthracene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Dibenzofuran	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Fluoranthene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	**0.06J***	<0.47U	<0.42U	<0.43U	<0.41U
Fluorene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Indeno(1,2,3-cd)pyrene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Naphthalene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Phenanthrene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Phenol	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	<0.46U	<0.47U	<0.42U	<0.43U	<0.41U
Pyrene	None	<0.4U	<0.39U	<0.4U	<0.4U	<0.47U	**0.056J***	<0.47U	<0.42U	<0.43U	<0.41U
VOCs (mg/kg)											
Acetone	None	<0.012U	<0.012UJ	<0.012UJ	<0.012U	<0.014UJ	**0.0079J***	<0.014U	<0.013U	<0.013UJ	<0.013UJ
Dimethylbenzene	None	<0.0061U	<0.006U	<0.006U	<0.0061U	<0.0071UJ	<0.007U	<0.0071U	<0.0064U	<0.0066U	<0.0063U
Methylene chloride	None	<0.0061U	<0.006U	**0.0007J***	<0.0061U	<0.0071U	**0.0015J***	<0.0071U	<0.0064U	<0.0066U	<0.0069U
Styrene	None	<0.0061U	<0.006U	<0.006U	<0.0061U	<0.0071UJ	<0.007U	<0.0071U	<0.0064U	<0.0066U	<0.0063U
Toluene	None	**0.0042J***	<0.006U	**0.00078J***	<0.0061U	<0.0071U	**0.0017J***	<0.0071U	<0.0064U	<0.0066U	<0.0063U

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

Aggregate		**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-003**	**NTA-009**	**NTA-010**	**NTA-083**	**NTA-084**	**NTA-085**	**NTA-086**	**NTA-087**	**NTA-088**	**NTA-089**
Sample ID		**NTAss-003-0003-SO**	**NTAss-009-0009-SO**	**NTAss-010-0010-SO**	**NTAss-083-0100-SO**	**NTAss-084-0102-SO**	**NTAss-085-0104-SO**	**NTAss-086-0106-SO**	**NTAss-087-0107-SO**	**NTAss-088-0108-SO**	**NTAss-089-0109-SO**
Date		**10/21/99**	**10/20/99**	**10/21/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
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 **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	17700	8760	16500	7830	12400J	14400J	10300J	17500J	12800J	11700J	12500J
Antimony	0.96	<1.3UJ	<1.2UJ	<1.3UJ	<1.2U	<1.2U	<1.2U	<1.2U	<1.3U	<1.2U	<1.2U
Arsenic	15.4	3.5	4.9	3.9	5.2J	8J	10.1J	13.8J	3J	4.3J	4.7J
Barium	88.4	59.1	53.5	42	**130J***	**181J***	37.8J	59.8J	57.9J	**111J***	**90.7J***
Beryllium	0.88	<0.26U	<0.33U	<0.2U	**1.2***	<0.86U	<0.25U	<0.4U	<0.21U	<1U	<0.81U
Cadmium	0	<0.66U	<0.61U	<0.64U	**5.2***	**0.67***	<0.6U	<0.62U	<0.64U	<0.59U	<0.58U
Calcium	15800	1160	641	911	**35000J***	1140J	169J	418J	813J	**39100J***	**34000J***
Chromium	17.4	11.1	**18.3***	10.2	8	14.7	12.6	**21.9***	14.7	9.6	8.5
Cobalt	10.4	6.1J	6.4	4.2J	4.7J	**27.5***	5.2J	8.1	6.6	2J	3.8J
Copper	17.7	7.1	13.2	7	8.8J	10.8J	10.1J	14.2J	5.1J	4.5J	5.6J
Cyanide	0	<0.66U	<0.61U	<0.64U	<0.59U	**0.77***	<0.6U	<0.62U	<0.64U	**0.98***	<0.58U
Iron	23100	15500	19900	13500	10400J	16500J	20500J	**30500J***	12500J	9210J	10100J
Lead	26.1	14.2	15	12.8	**56.6J***	22.6J	19.9J	15J	10.9J	11.1J	10.2
Magnesium	3030	1670	2410	1580	**5770J***	1750J	1790J	**3350J***	2250J	**5990J***	**6120J***
Manganese	1450	281	171	139	1310J	**6240J***	185J	205J	187J	**1570J***	1030J
Mercury	0.036	**0.038J***	**0.046J***	**0.057J***	0.013J	**0.073J***	**0.05J***	**0.053J***	0.028J	**0.066J***	**0.038J***
Nickel	21.1	11.8	15.3	10.6	9	**24.2***	11.8	20	13.3	4.6J	5.7
Potassium	927	584J	1150*	419J	788	**1070***	638	**1540***	**1290***	724	647
Selenium	1.4	0.64J	<0.61U	<0.64U	1.4	**1.7***	<0.6U	0.67	0.75	<0.59U	<0.58U
Silver	0	<1.3U	<1.2U	<1.3U	<1.2U	<2.5U	**1.3***	<1.2U	<1.3U	<1.2U	<1.2U
Sodium	123	<84.7U	<53.6U	<76.1U	**238J***	<622UJ	<604UJ	<618UJ	<635UJ	**267J***	<580UJ
Thallium	0	**0.32J***	**0.27J***	**0.24J***	**0.17J***	**0.4J***	**0.34J***	**0.33J***	**0.29J***	**0.16J***	<0.58UJ
Vanadium	31.1	15	25.3	13.6	9.8	21.6	20	29.2	22.6	10.9	13.9
Zinc	61.8	43.4	59.6	39.5	41.8J	**158J***	46.3J	**63.2J***	57.2J	24.9J	31.4J
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**2.1J***	<1.5U
Acenaphthylene	None	<0.44U	<0.4U	<0.42U	**0.89J***	<0.41U	<0.4U	<0.41U	<0.42U	**7.9J***	**1.2J***
Anthracene	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**9.6J***	**0.54J***
Benz(a)anthracene	None	<0.44U	<0.4U	<0.42U	**2.4J***	**0.086J***	<0.4U	<0.41U	<0.42U	**36***	**3.8***
Benzo(a)pyrene	None	<0.44U	<0.4U	<0.42U	**3.5J***	**0.1J***	<0.4U	<0.41U	<0.42U	**41***	**5.1***
Benzo(b)fluoranthene	None	<0.44U	<0.4U	<0.42U	**4.7***	**0.13J***	<0.4U	<0.41U	<0.42U	**54***	**6.8***
Benzo(ghi)perylene	None	<0.44U	<0.4U	<0.42U	**3.1J***	**0.082J***	<0.4U	<0.41U	<0.42U	**24***	**3.4***
Benzo(k)fluoranthene	None	<0.44U	<0.4U	<0.42U	**1.6J***	**0.055J***	<0.4U	<0.41U	<0.42U	**19***	**2.5***
Bis(2-ethylhexyl)phthalate	None	<0.44U	<0.4U	<0.42U	<3.9U	**0.075J***	<0.4U	<0.41U	**0.13J***	<16U	<1.5U
Carbazole	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**4.9J***	**0.21J***
Chrysene	None	<0.44U	<0.4U	<0.42U	**3.2J***	**0.12J***	<0.4U	<0.41U	<0.42U	**46***	**5.4***

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

Aggregate		**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-003**	**NTA-009**	**NTA-010**	**NTA-083**	**NTA-084**	**NTA-085**	**NTA-086**	**NTA-087**	**NTA-088**	**NTA-089**
Sample ID		**NTAss-003-0003-SO**	**NTAss-009-0009-SO**	**NTAss-010-0010-SO**	**NTAss-083-0100-SO**	**NTAss-084-0102-SO**	**NTAss-085-0104-SO**	**NTAss-086-0106-SO**	**NTAss-087-0107-SO**	**NTAss-088-0108-SO**	**NTAss-089-0109-SO**
Date		**10/21/99**	**10/20/99**	**10/21/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
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		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, Pesticides/PCBs, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Di-n-butyl phthalate	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	<16U	<1.5U
Dibenz(a,h)anthracene	None	<0.44U	<0.4U	<0.42U	**0.65J***	<0.41U	<0.4U	<0.41U	<0.42U	**5.7J***	**0.67J***
Dibenzofuran	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**1.9J***	<1.5U
Fluoranthene	None	<0.44U	<0.4U	<0.42U	**4.7***	**0.21J***	<0.4U	<0.41U	<0.42U	**98***	**7.8***
Fluorene	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**7.9J***	**0.21J***
Indeno(1,2,3-cd)pyrene	None	<0.44U	<0.4U	<0.42U	**2.7J***	**0.082J***	<0.4U	<0.41U	<0.42U	**24***	**3.2***
Naphthalene	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	**2.8J***	**0.18J***
Phenanthrene	None	<0.44U	<0.4U	<0.42U	**1.5J***	**0.1J***	<0.4U	<0.41U	<0.42U	**83***	**3.8***
Phenol	None	<0.44U	<0.4U	<0.42U	<3.9U	<0.41U	<0.4U	<0.41U	<0.42U	<16U	<1.5U
Pyrene	None	<0.44U	<0.4U	<0.42U	**5.3***	**0.18J***	<0.4U	<0.41U	<0.42U	**93***	**9.5***
VOCs (mg/kg)											
Acetone	None	<0.013UJ	<0.012UJ	<0.013UJ	<0.012UJ	<0.012UJ	<0.012UJ	**0.0078J***	<0.013UJ	<0.012UJ	<0.012UJ
Dimethylbenzene	None	<0.0066U	<0.0061U	<0.0064U	<0.0059U	<0.0062U	<0.006U	<0.0062U	<0.0064UJ	<0.0059U	<0.0058U
Methylene chloride	None	<0.0094U	<0.0061U	<0.0064U	<0.0059U	<0.0062U	<0.006U	<0.0062U	<0.0064U	<0.0059U	<0.0058U
Styrene	None	<0.0066U	<0.0061U	<0.0064U	<0.0059U	<0.0062U	<0.006U	<0.0062U	<0.0064UJ	<0.0059U	<0.0058U
Toluene	None	<0.0066U	<0.0061U	<0.0064U	<0.0059U	<0.0062U	<0.006U	<0.0062U	<0.0064U	<0.0059U	<0.0058U

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

Aggregate		**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-090**	**NTA-091**	**NTA-091**	**NTA-092**	**NTA-093**	**NTA-094**	**NTA-095**
Sample ID		**NTAss-090-0110-SO**	**NTAss-091-0144-SO**	**NTAss-091-0111-SO**	**NTAss-092-0112-SO**	**NTAss-093-0113-SO**	**NTAss-094-0114-SO**	**NTAss-095-0115-SO**
Date		**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
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**
Parameters Analyzed		**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**							
				Metals (mg/kg)				
Aluminum	17700	**22800J***	**26800J***	**26100J***	**33900J***	12800J	12900J	6380J
Antimony	0.96	<1.3U	<1.2U	<1.2U	<1.2U	<1.2U	<1.3U	<1.2U
Arsenic	15.4	6.1J	3J	3.4J	2.2J	11.1J	12.3J	5J
Barium	88.4	**253J***	**325J***	**301J***	**359J***	57.4J	71J	30.4J
Beryllium	0.88	**2.3***	**3.3***	**3.3***	**3.8***	<0.32U	<0.4U	<0.17U
Cadmium	0	<0.64U	<0.59U	<0.6U	<0.61U	<0.62U	<0.64U	<0.58U
Calcium	15800	**100000J***	**169000J***	**152000J***	**195000J***	588J	769J	298J
Chromium	17.4	13.5	11.3	8.2	11.6	16.2	**17.9***	7.1
Cobalt	10.4	4.9J	2.3J	3.1J	1.5J	7.2	**10.8***	3.3J
Copper	17.7	6.7J	4J	5.2J	2.6J	10.6J	**30.3J***	6.3J
Cyanide	0	<0.64U	**1.5***	**1.2***	**1.6***	<0.62U	<0.64U	<0.58U
Iron	23100	13800J	8850J	6680J	4570J	22200J	**27200J***	10000J
Lead	26.1	10.8J	10.4J	12.5J	11.4J	15.1J	18.2J	9.1
Magnesium	3030	**13800J***	**21600J***	**19300J***	**25100J***	2420J	**3400J***	1070J
Manganese	1450	**3410J***	**3930J***	**3370J***	**6080J***	297J	424J	88.2J
Mercury	0.036	**0.04J***	0.011J	0.032J	0.033J	0.036J	**0.056J***	**0.037J***
Nickel	21.1	7.4	3J	4.3J	2.1J	16.6	**23.3***	8.6
Potassium	927	**1420***	**2210***	**2020***	**2120***	**1300***	**1050***	489J
Selenium	1.4	1.4	**2.4***	**2.2***	**2.8***	<0.62U	0.84	<0.58U
Silver	0	<1.3U	<1.2U	<1.2U	<2.5U	<1.2U	<1.3U	<1.2U
Sodium	123	**506J***	**831J***	**695J***	**780J***	<621UJ	<636UJ	<576UJ
Thallium	0	**0.18J***	<0.59UJ	<0.6UJ	<1.2UJ	**0.36J***	**0.31J***	**0.25J***
Vanadium	31.1	13	11.9	10.1	8.9	21.7	19.9	11
Zinc	61.8	28.7J	21.9J	26.8J	17.4J	**63.7J***	**91.4J***	30.7J
				Explosives (mg/kg)				
2,4,6-Trinitrotoluene	None	<0.25U	NR	NR	NR	NR	NR	NR
2,4-Dinitrotoluene	None	**0.048J***	NR	NR	NR	NR	NR	NR
Nitrocellulose	None	**3.5***	NR	NR	NR	NR	NR	NR
				SVOCs (mg/kg)				
Acenaphthene	None	**0.29J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Acenaphthylene	None	**1.5J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Anthracene	None	**1.2J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Benz(a)anthracene	None	**6.6***	<0.39U	**0.051J***	<0.41U	<0.41U	<0.42U	<0.38UJ
Benzo(a)pyrene	None	**7.6***	**0.052J***	**0.079J***	**0.052J***	<0.41U	<0.42U	**0.053J***
Benzo(b)fluoranthene	None	**10***	**0.076J***	**0.1J***	**0.06J***	<0.41U	<0.42U	**0.051J***
Benzo(ghi)perylene	None	**4.2***	<0.39U	**0.067J***	<0.41U	<0.41U	<0.42U	<0.38UJ
Benzo(k)fluoranthene	None	**3.4***	<0.39U	**0.057J***	<0.41U	<0.41U	<0.42U	**0.056J***
Bis(2-ethylhexyl)phthalate	None	<2.8U	**0.065J***	<0.39U	<0.41U	**0.12J***	**0.1J***	<0.38UJ
Carbazole	None	**0.58J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Chrysene	None	**9***	**0.065J***	**0.09J***	**0.044J***	<0.41U	<0.42U	<0.38UJ
Di-n-butyl phthalate	None	<2.8U	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Dibenz(a,h)anthracene	None	**0.93J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Dibenzofuran	None	**0.28J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ

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

Aggregate		**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-090**	**NTA-091**	**NTA-091**	**NTA-092**	**NTA-093**	**NTA-094**	**NTA-095**
Sample ID		**NTAss-090-0110-SO**	**NTAss-091-0144-SO**	**NTAss-091-0111-SO**	**NTAss-092-0112-SO**	**NTAss-093-0113-SO**	**NTAss-094-0114-SO**	**NTAss-095-0115-SO**
Date		**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
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**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals, Explosives, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Fluoranthene	None	**16***	**0.091J***	**0.12J***	**0.059J***	<0.41U	<0.42U	<0.38UJ
Fluorene	None	**0.89J***	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Indeno(1,2,3-cd)pyrene	None	**4.2***	<0.39U	**0.065J***	<0.41U	<0.41U	<0.42U	<0.38UJ
Naphthalene	None	<2.8U	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Phenanthrene	None	**12***	<0.39U	**0.056J***	<0.41U	<0.41U	<0.42U	<0.38UJ
Phenol	None	<2.8U	<0.39U	<0.39U	<0.41U	<0.41U	<0.42U	<0.38UJ
Pyrene	None	**18***	**0.084J***	**0.13J***	**0.069J***	<0.41U	<0.42U	<0.38UJ
				VOCs (mg/kg)				
Acetone	None	<0.013UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.012UJ	<0.013UJ	<0.012UJ
Dimethylbenzene	None	<0.0064U	<0.0059U	<0.006U	<0.0061U	<0.0062U	<0.0064U	<0.0058U
Methylene chloride	None	<0.0064U	<0.0059U	<0.006U	<0.0061U	<0.0062U	<0.0064U	<0.0058U
Styrene	None	<0.0064U	<0.0059U	<0.006U	<0.0061U	<0.0062U	<0.0064U	<0.0058U
Toluene	None	<0.0064U	<0.0059U	<0.006U	<0.0061U	<0.0062U	<0.0064U	<0.0058U

ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
NR = Not reported/not analyzed.
R = Rejected result.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = 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.

Table 4–3. Analytes Detected in Phase I RI Subsurface Soil Samples

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-065**	**NTA-066**	**NTA-067**	**NTA-068**	**NTA-069**	**NTA-069**	**NTA-070**	**NTA-070**	**NTA-070**	**NTA-071**
Sample ID		**NTAso-065-0068-SO**	**NTAso-066-0070-SO**	**NTAso-067-0072-SO**	**NTAso-068-0074-SO**	**NTAss-069-0143-SO**	**NTAso-069-0076-SO**	**NTAso-070-0079-SO**	**NTAss-070-0147-SO**	**NTAss-070-0120-SO**	**NTAso-071-0081-SO**
Date		**11/02/99**	**11/02/99**	**11/03/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**10/27/99**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**3.0 - 5.0**	**3.0 - 5.0**	**1.0 - 3.0**
Parameters Analyzed		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	17100J	7240J	9470	10200	12300J	9580J	11600	11100	8640	12000
Arsenic	19.8	11.7	5.2	18.3	7.2	9.1	9.7	10.3	11.6	10.5	11.9
Barium	124	114J	45.6J	**196J***	47J	62.2J	57.3J	59.1J	72.4J	60.8J	35.1
Beryllium	0.88	0.83	0.32J	0.33J	<0.58U	0.24J	0.27J	0.29J	0.5J	0.38J	<0.58U
Cadmium	0	<0.63U	<0.56U	<0.63U	<0.58U	<0.59U	<0.59U	<0.57U	<0.56U	<0.56U	<0.58U
Calcium	35500	2100	507J	2370	123J	799	761J	509J	953	687	702
Chromium	27.2	24.3J	10.6J	14.1J	10.8J	14.8J	12.6J	15J	15.5J	13.1J	14.6
Cobalt	23.2	12	6.1	8.8	11.6	5.5J	4.9J	7.3	10.2	7.2	3.8J
Copper	32.3	17.6J	12.2J	21.4J	7.3J	12.9J	13.6J	**55.8J***	**47.3J***	**34.9J***	15.3J
Iron	35200	30800	15600	22800	15800	20100	19700	20400	24900	22300	21900
Lead	19.1	12.9	8.4	14.2	10.9	12.5	11.4	16.1	15.3	14.3	11.5
Magnesium	8790	4960	1860	2780	1540	2470	1840	1920	2470	2030	1910
Manganese	3030	296J	100J	1790	532J	407J	251J	413J	216J	152J	90.9
Mercury	0.044	0.032J	0.027J	0.028J	0.035J	**0.047J***	0.041J	0.036J	0.028J	0.022J	0.018J
Nickel	60.7	35.1	14.4	23.1	12	12.3	12.6	13.4	20.8	18	11.6
Potassium	3350	2380	736	1370	519J	1240	715	1030	1520	1010	996
Selenium	1.5	<0.63U	<0.56U	<0.63U	<0.58U	<0.59U	<0.59U	<0.57U	<0.56U	<0.56U	0.58
Thallium	0.91	0.34J	0.25J	0.34J	0.22J	0.25J	0.34J	0.28J	0.28J	0.4J	<0.49U
Vanadium	37.6	26.1	13.2	19.5	19.2	24.4	19.6	23.1	21.1	16.6	24.4
Zinc	93.3	71.1	45.7	55.9	44.9	49.6	45.5	67.3	76.1	59.5	41.1
SVOCs (mg/kg)											
Acenaphthylene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Anthracene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Benz(a)anthracene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Benzo(a)pyrene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Benzo(b)fluoranthene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Benzo(ghi)perylene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Benzo(k)fluoranthene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Bis(2-ethylhexyl)phthalate	None	<0.41U	<0.37U	<0.41U	<0.39U	**0.14J***	**0.094J***	<0.37U	<0.37U	<0.37U	**0.051J***
Chrysene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Dibenz(a,h)anthracene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Fluoranthene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Indeno(1,2,3-cd)pyrene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Phenanthrene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
Pyrene	None	<0.41U	<0.37U	<0.41U	<0.39U	<0.39U	<0.39U	<0.37U	<0.37U	<0.37U	<0.38U
VOCs (mg/kg)											
Dimethylbenzene	None	<0.0063U	<0.0056U	<0.0063U	<0.0058U	<0.0059U	<0.0059U	<0.0057U	<0.0056U	<0.0056U	<0.0058U
Methylene chloride	None	<0.0063U	<0.0056U	**0.0016J***	<0.0058U	<0.0059U	<0.0059U	<0.0057U	<0.0056U	<0.0056U	<0.0058U
Styrene	None	**0.00082J***	<0.0056U	**0.00097J***	<0.0058U	**0.00071J***	**0.001J***	<0.0057U	**0.0027J***	**0.0027J***	<0.0058U
Toluene	None	**0.00063J***	<0.0056U	**0.0053J***	<0.0058U	<0.0059U	<0.0059U	<0.0057U	**0.00095J***	**0.0011J***	<0.0058U

Table 4–3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**
Station		**NTA-072**	**NTA-073**	**NTA-073**	**NTA-073**	**NTA-073**	**NTA-074**	**NTA-075**	**NTA-076**	**NTA-077**	**NTA-079**
Sample ID		**NTAso-072-0083-SO**	**NTAss-073-0138-SO**	**NTAso-073-0085-SO**	**NTAss-073-0146-SO**	**NTAso-073-0121-SO**	**NTAso-074-0087-SO**	**NTAso-075-0089-SO**	**NTAso-076-0091-SO**	**NTAso-077-0093-SO**	**NTAso-079-0096-SO**
Date		**10/27/99**	**11/02/99**	**11/02/99**	**11/02/99**	**11/02/99**	**10/27/99**	**10/27/99**	**11/03/99**	**11/01/99**	**11/03/99**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**3.0 - 5.0**	**3.0 - 5.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Metals (mg/kg)											
Aluminum	19500	7590	**24400***	18500	7150	10000	9120	9090	7200	11900	11200
Arsenic	19.8	10.3	9.1	11.2	11.3	10.9	10.4	17.5	11.3	13.7	13.7
Barium	124	35.1	66.3J	74J	41.6J	48.7J	32.5	39.2	38.4J	58.7J	48.3J
Beryllium	0.88	0.35J	0.22J	0.45J	0.25J	0.24J	<0.16U	0.51J	<0.27U	0.36J	<0.32U
Cadmium	0	<0.56U	**29.5***	**30***	**0.64***	**0.62***	<0.55U	<0.56U	<0.58U	<0.58U	<0.59U
Calcium	35500	564	392J	359J	463J	490J	425J	310J	<327U	<742U	<543U
Chromium	27.2	9.9	15.4J	13.7J	8.3J	12J	10.7	14.2	9.7J	16.5J	15.9J
Cobalt	23.2	7.1	6.3	12.6	8	7.1	15.2	9.1	8.1	8.2	7.5
Copper	32.3	19.3J	**733J***	**400J***	23.7J	28.6J	16.2J	9.7J	10.8J	16.7J	17.3J
Iron	35200	22100	15900	22000	18300	18500	18600	32600	20200	25600	26200
Lead	19.1	11.5	**151***	**151***	**33.6***	**29.6***	12.9	17.1	12.8	10.2	11.6J
Magnesium	8790	1950	1720	2110	1500	1840	1800	1650	1340	2840	2520
Manganese	3030	405	328J	631J	559J	296J	607	761	644	148J	174
Mercury	0.044	0.036J	0.022J	0.042J	0.041J	0.025J	0.034J	0.021J	0.02J	0.019J	0.036J
Nickel	60.7	15.9	14.3	17.7	14.4	14.2	14.7	13.5	9.9	20	18.2
Potassium	3350	766	587J	528J	537J	712	777	852	398J	969	1040
Selenium	1.5	<0.56U	<0.59U	<0.58U	<0.57U	<0.56U	0.73	1.1	0.49J	<0.58U	<0.59U
Thallium	0.91	<0.4U	0.22J	0.29J	0.21J	0.26J	<0.29U	<0.47U	0.27J	0.34J	0.32J
Vanadium	37.6	13.9	16.8	16.6	12.2	17.9	14.9	24.4	17.1	18.7	19.4
Zinc	93.3	58.7	**119***	**132***	47.4	52.4	45.5	60	38.4	60.3	47.3
SVOCs (mg/kg)											
Acenaphthylene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Anthracene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Benz(a)anthracene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Benzo(a)pyrene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Benzo(b)fluoranthene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Benzo(ghi)perylene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Benzo(k)fluoranthene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Bis(2-ethylhexyl)phthalate	None	**0.15J***	**0.25J***	**0.17J***	**0.047J***	**0.43J***	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Chrysene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Dibenz(a,h)anthracene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Fluoranthene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Indeno(1,2,3-cd)pyrene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Phenanthrene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
Pyrene	None	<0.37U	<0.39U	<0.38U	<0.38U	<0.37U	<0.36U	<0.37U	<0.39U	<0.38U	<0.39U
VOCs (mg/kg)											
Dimethylbenzene	None	<0.0056U	<0.0059U	<0.0058U	<0.0057U	<0.0056U	<0.0055U	<0.0056U	<0.0058U	<0.0058U	<0.0059U
Methylene chloride	None	<0.0056U	<0.0059U	<0.0058U	<0.0057U	<0.0056U	<0.0055U	<0.0056U	**0.0012J***	<0.0058U	<0.0059U
Styrene	None	<0.0056U	**0.0016J***	**0.0014J***	<0.0057U	**0.0011J***	<0.0055U	<0.0056U	<0.0058U	<0.0058U	<0.0059U
Toluene	None	<0.0056U	<0.0059U	<0.0058U	<0.0057U	<0.0056U	<0.0055U	<0.0056U	<0.0058U	<0.0058U	<0.0059U

Table 4–3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**Former Plane Burial Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-100**	**NTA-083**	**NTA-084**	**NTA-085**	**NTA-095**
Sample ID		**NTAso-100-0123-SO**	**NTAso-083-0101-SO**	**NTAso-084-0103-SO**	**NTAso-085-0105-SO**	**NTAso-095-0116-SO**
Date		**11/04/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed		**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
Analyte	**Background Criteria**					
Metals (mg/kg)						
Aluminum	19500	12100	12300J	11400J	13100J	5340J
Arsenic	19.8	12.6	15J	5.2J	15.5J	3.8J
Barium	124	78.8J	52.5J	93.7J	92.4J	15.6J
Beryllium	0.88	<0.39U	<0.4U	<0.36U	<0.57U	<0.53U
Cadmium	0	<0.59U	**0.44J***	<0.57U	<0.57U	<0.53U
Calcium	35500	<600U	6240J	720J	1930J	<116U
Chromium	27.2	14.9J	15.2	14.1	19.1	6.7
Cobalt	23.2	19.3	7.6	10.4	12.8	3.1J
Copper	32.3	12.2J	16.1J	7.6J	19.6J	6.9J
Iron	35200	25700	25900J	16500J	29100J	9550J
Lead	19.1	18.2	16.7J	14.7J	12.5J	6.6J
Magnesium	8790	1960	3260J	1900J	4030J	1060J
Manganese	3030	1490	471J	1310J	385J	51.4J
Mercury	0.044	0.038J	0.02J	**0.05J***	0.03J	0.025J
Nickel	60.7	12.6	17	14.9	31.7	9
Potassium	3350	833	986	1100	1790	358J
Selenium	1.5	<0.59U	0.63	0.65	<0.57U	<0.53U
Thallium	0.91	0.39J	0.28J	0.27J	0.31J	0.17J
Vanadium	37.6	27.7	18.7	19.9	20.9	9.3
Zinc	93.3	58.1	49.6J	65.5J	62.4J	24.8J
SVOCs (mg/kg)						
Acenaphthylene	None	<0.39U	**0.23J***	<0.38U	<0.37U	<0.35U
Anthracene	None	<0.39U	**0.09J***	<0.38U	<0.37U	<0.35U
Benz(a)anthracene	None	<0.39U	**0.46***	<0.38U	<0.37U	<0.35U
Benzo(a)pyrene	None	<0.39U	**0.7***	<0.38U	<0.37U	<0.35U
Benzo(b)fluoranthene	None	<0.39U	**1***	<0.38U	<0.37U	<0.35U
Benzo(ghi)perylene	None	<0.39U	**0.65***	<0.38U	<0.37U	<0.35U
Benzo(k)fluoranthene	None	<0.39U	**0.23J***	<0.38U	<0.37U	<0.35U
Bis(2-ethylhexyl)phthalate	None	<0.39U	**0.063J***	**0.14J***	<0.37U	**0.056J***
Chrysene	None	<0.39U	**0.62***	<0.38U	<0.37U	<0.35U
Dibenz(a,h)anthracene	None	<0.39U	**0.11J***	<0.38U	<0.37U	<0.35U
Fluoranthene	None	<0.39U	**1***	<0.38U	<0.37U	<0.35U
Indeno(1,2,3-cd)pyrene	None	<0.39U	**0.52***	<0.38U	<0.37U	<0.35U
Phenanthrene	None	<0.39U	0.33J*	<0.38U	<0.37U	<0.35U
Pyrene	None	<0.39U	**1***	<0.38U	<0.37U	<0.35U

Table 4–3. Analytes Detected in Phase I RI Subsurface Soil Samples (continued)

Aggregate		**Former Plane Burial Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTA-100**	**NTA-083**	**NTA-084**	**NTA-085**	**NTA-095**
Sample ID		**NTAso-100-0123-SO**	**NTAso-083-0101-SO**	**NTAso-084-0103-SO**	**NTAso-085-0105-SO**	**NTAso-095-0116-SO**
Date		**11/04/99**	**10/19/99**	**10/19/99**	**10/19/99**	**10/19/99**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Parameters Analyzed **Analyte**	**Background Criteria**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**	**TAL Metals, SVOCs, VOCs**
			VOCs (mg/kg)			
Dimethylbenzene	None	**0.002J***	<0.006U	<0.0057U	<0.0057U	<0.0053U
Methylene chloride	None	<0.0059U	<0.006U	<0.0057U	<0.0057U	<0.0053U
Styrene	None	<0.0059U	<0.006U	<0.0057U	<0.0057U	<0.0053U
Toluene	None	<0.0059U	<0.006U	<0.0057U	<0.0057U	<0.0053U

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

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

Aggregate		**Former Crash Area Reservoir**	**Former Crash Area Reservoir**	**Off AOC**	**Off AOC**	**Off AOC**	**Off AOC**
Station		**NTA-102**	**NTA-102**	**NTA-104**	**NTA-104**	**NTA-104**	**NTA-104**
Sample ID		**NTAsw-102-0131-SW**	**NTAsw-102-0131-SW**	**NTAsw-104-0149-SW**	**NTAsw-104-0149-SW**	**NTAsw-104-0133-SW**	**NTAsw-104-0133-SW**
Date		**10/22/99**	**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/24/99**
Depth (ft)		**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**RVAAP Full-suite analytes**
Parameters Analyzed							
Analyte	**Background Criteria**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Metals (mg/kg)							
Aluminum	3.37	<0.2U	0.26	0.14J	2.2	0.2	0.92
Antimony	0	**0.0017J***	<0.005U	<0.005U	<0.005U	<0.005U	<0.005U
Barium	0.0475	0.011J	0.017J	0.03J	**0.06J***	0.032J	0.047J
Cadmium	0	<0.005U	<0.005U	<0.005U	<0.005U	<0.005U	<0.005U
Calcium	41.4	23.4	25.5	35.1	37.3	34.5	35.5
Cobalt	0	<0.05U	<0.05U	<0.05U	<0.05U	<0.05U	<0.05U
Iron	2.56	<0.1U	0.83	0.17	2	0.24	0.96
Lead	0	<0.003U	<0.003U	<0.003U	**0.0027J***	<0.003U	**0.0024J***
Magnesium	10.8	5	5.4	5.1	5.8	5.1	5.4
Manganese	0.391	0.023	0.08	0.37	**0.79***	**0.4***	**0.65***
Nickel	0	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U	<0.04U
Potassium	3.17	0.98J	1.2J	**4.7J***	**5.3***	**4.7J***	**4.7J***
Sodium	21.3	1.1J	1.2J	1.7J	1.8J	1.6J	1.7J
Zinc	0.042	<0.016U	<0.02U	0.015J	**0.06***	0.023	**0.044***
Explosives (mg/kg)							
2,4-Dinitrotoluene	None	NR	<0.00013U	NR	<0.00013U	NR	**0.00005J***
SVOCs (mg/kg)							
Bis(2-ethylhexyl)phthalate	N one	NR	<0.01U	NR	<0.01U	NR	<0.01U
VOCs (mg/kg)							
Acetone	None	NR	<0.01U	NR	**0.0039J***	NR	**0.0042J***

Table 4–4. Analytes Detected in Phase I RI Surface Water Samples (continued)

Aggregate	**Background Criteria**	**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Wetland/Pond North of Former Crash Area**	**Wetland/Pond North of Former Crash Area**
Station		**NTA-103**	**NTA-103**	**NTA-106**	**NTA-106**	**NTA-105**	**NTA-105**
Sample ID		**NTAsw-103-0132-SW**	**NTAsw-103-0132-SW**	**NTAsw-106-0135-SW**	**NTAsw-106-0135-SW**	**NTAsw-105-0134-SW**	**NTAsw-105-0134-SW**
Date		**10/24/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/22/99**	**10/22/99**
Depth (ft)		**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**RVAAP Full-suite analytes**	**TAL Metals**	**RVAAP Full-suite analytes**
Parameters Analyzed		**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**
Analyte							
Metals (mg/kg)							
Aluminum	3.37	<0.2U	0.58	1	0.19J	0.86	1.4
Antimony	0	<0.005U	<0.005U	**0.0018J***	**0.0019J***	**0.0024J***	<0.005U
Barium	0.0475	0.017J	0.023J	**0.062J***	**0.088J***	**0.11J***	**0.11J***
Cadmium	0	<0.005U	<0.005U	<0.005U	<0.005U	<0.005U	**0.0032J***
Calcium	41.4	22	23.7	**54.2***	**53.2***	**170***	**170***
Cobalt	0	<0.05U	<0.05U	<0.05U	<0.05U	**0.06***	**0.062***
Iron	2.56	0.25	0.92	0.16	0.42	0.092J	**3.4***
Lead	0	<0.003U	<0.003U	<0.003U	<0.003U	**0.002J***	**0.0043***
Magnesium	10.8	4.4J	4.8J	**11.9***	**12.8***	**30.9***	**31.4***
Manganese	0.391	0.056	0.18	0.028	0.18	**12.7***	**12.8***
Nickel	0	<0.04U	<0.04U	<0.04U	<0.04U	**0.052***	**0.054***
Potassium	3.17	2.5J	2.9J	**3.9J***	**4.3J***	3J	**3.3J***
Sodium	21.3	1.7J	1.8J	17	17.2	9.8	9.8
Zinc	0.042	<0.02U	0.019J	<0.02U	**0.11***	**1***	**1.1***
Explosives (mg/kg)							
2,4-Dinitrotoluene	None	NR	<0.00013U	NR	<0.00013U	NR	<0.00013U
SVOCs (mg/kg)							
Bis(2-ethylhexyl)phthalate	None	NR	**0.0032J***	NR	<0.01U	NR	<0.01UJ
VOCs (mg/kg)							
Acetone	None	NR	<0.01U	NR	<0.01U	NR	**0.0056J***

AOC = Area of concern.
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.
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.

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

Aggregate		**Former Crash Area Reservoir**	**Off AOC**	**Off AOC**	**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Wetland/Pond North of Former Crash Area**
Station		**NTA-102**	**NTA-104**	**NTA-104**	**NTA-103**	**NTA-106**	**NTA-105**
Sample ID		**NTAsd-102-0125-SD**	**NTAsd-104-0148-SD**	**NTAsd-104-0127-SD**	**NTAsd-103-0126-SD**	**NTAsd-106-0129-SD**	**NTAsd-105-0128-SD**
Date		**10/22/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/24/99**	**10/22/99**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**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**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Metals (mg/kg)							
Aluminum	13900	8800	12900	11500	9230	6320	8240
Arsenic	19.5	5.4	12.4J	19.2J	9.5J	4.4J	4.9
Barium	123	48.3	**126J***	**398J***	76.1J	65.8J	59.1
Beryllium	0.38	<0.31U	**0.61J***	**0.9J***	**0.52J***	0.26J	<1.1U
Cadmium	0	<0.97U	**0.45J***	**1.1J***	<0.74UJ	<0.69UJ	<1.1U
Calcium	5510	2150J	**14200***	**6060***	1110	1190	2500J
Chromium	18.1	11.1	**18.5J***	14.1J	15J	8.8J	12.2
Cobalt	9.1	7.5J	**19.7J***	**29.9J***	**14.2J***	5.4J	5.8J
Copper	27.6	14.1J	19.6J	15.4J	19.3J	7.9J	14J
Cyanide	0	<0.97U	<0.83U	**0.74***	<0.74U	<0.69U	<1.1U
Iron	28200	15900	**30500***	24900	**40000***	21000	12900
Lead	27.4	16.7	19.4J	22.1J	13.2J	9.6J	19.4
Magnesium	2760	1730	**4930J***	**2960J***	2640J	1650J	1730
Manganese	1950	164	1530	**9440***	629	247	235
Mercury	0.059	<0.014U	<0.17U	0.035 R	0.036J	0.025 R	<0.029U
Nickel	17.7	14.2	**36.5J***	**34.9J***	**23.5J***	11.6J	12.5
Potassium	1950	914J	**2260J***	1340J	1410J	452J	1100J
Selenium	1.7	<0.97U	0.72J	**2.9J***	1J	<0.69UJ	<1.1U
Thallium	0.89	0.27J	0.5J	0.44J	0.43J	0.33J	0.31J
Vanadium	26.1	15.4	23J	19.9J	17.8J	10.7J	15.8
Zinc	532	52.4	121	158	68.6	44	73.9
Explosives (mg/kg)							
Nitrocellulose	None	<3.9U	**4***	**4.8***	<3U	<2.8U	<4.5U
VOCs (mg/kg)							
2-Butanone	None	**0.016J***	<0.017UJ	<0.015UJ	<0.015UJ	<0.014U	<0.022UJ
Acetone	None	**0.061J***	<0.017UJ	<0.015UJ	**0.027J***	<0.014UJ	**0.013J***
Methylene chloride	None	<0.0097U	<0.0083U	<0.0074U	<0.0074U	<0.0069U	**0.0079J***

AOC = Area of concern.
ft = Feet.
ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = 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 4–6. Human Health COPCs per the Phase I RI

Surface Soil	Subsurface Soil	Sediment	Surface Water
Aluminum Arsenic Cadmium Chromium Copper Lead Manganese Acenaphthylene Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Benzo(k)fluoranthene Bis(2-ethylhexyl)phthalate Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene Nitrocellulose	Cadmium Copper Lead Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(ghi)perylene Indeno(1,2,3-cd)pyrene	Cadmium Chromium Lead Manganese Nitrocellulose	Antimony Cadmium Lead Manganese Zinc Bis(2-ethylhexyl)phthalate 2,4-Dinitrotoluene

Source: *Phase I Remedial Investigation Report for the NACA Test Area* (USACE 2001a).
COPC = Chemical of potential concern.
RI = Remedial investigation.

Table 4–7. Chemicals Exceeding ESVs per the Phase I RI

Soil	Sediment	Surface Water
Media not evaluated	Barium Beryllium Cadmium Calcium Copper Cyanide Iron Lead Magnesium Manganese Nickel Selenium Zinc Nitrocellulose	Barium Cadmium Calcium Cobalt Iron Lead Magnesium Manganese Nickel Potassium Zinc Bis(2-ethylhexyl)phthalate

Source: *Phase I Remedial Investigation Report for the NACA Test Area* (USACE 2001a)
RI = Remedial Investigation.

Table 4–8. Chemicals Detected at Concentrations above Screening Criteria in Previous Investigations

Surface Soil	Subsurface Soil	Sediment	Surface Water
Aluminum Antimony Arsenic Barium Cadmium Chromium Cobalt Copper Lead Manganese Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Chrysene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Aluminum Cadmium Copper Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Barium Chromium Manganese	Manganese

Source: *Phase I Remedial Investigation Report for the NACA Test Area* (USACE 2001a).
Information from the Phase I Remedial Investigation Report for High-Priority Areas of Concern (USACE 1998).
RI = Remedial investigation.

Table 4–9. PBA08 RI Surface Soil Samples and Rationales

PBA08 RI Location	Targeted Area	Purpose	Analyses Performed				
			Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
NTAss-128	North of Former Plane Refueling/Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-083.	Y	Y	N	N	PAH
NTAss-129	North of Former Plane Refueling/Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-083. Analyzed for RVAAP full-suite analytes	Y	Y	Y	Y	Y
NTAss-130	North of Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-084.	Y	Y	N	N	PAH
		QA/QC.	Y	Y	N	N	PAH
			Y	Y	N	N	PAH
NTAss-131	North of Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-084 and NTA-089.	Y	Y	N	N	PAH
NTAss-132	Concrete Pad/Former Plane Refueling/Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-088.	Y	Y	N	N	PAH
NTAss-133	Former Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-089.	Y	Y	N	N	PAH
NTAss-136	Former Crash Strip Area	Delineate lateral extent of previously identified contamination at NTA-091 and NTA-092.	Y	Y	N	N	PAH
NTAss-137	Former Crash Area	Delineate lateral extent of previously identified contamination at NTA-098.	Y	Y	N	N	PAH
		QA/QC.	Y	Y	N	N	PAH
			Y	Y	N	N	PAH
NTAss-138	Former Crash Area	Delineate lateral extent of previously identified contamination at NTA-098.	Y	Y	N	N	PAH
NTAss-139	Former Crash Area	Delineate lateral extent of previously identified contamination at NTA-098 Analyzed for RVAAP full-suite analytes	Y	Y	Y	Y	Y
NTAss-141	Former Plane Burial Area	Delineate lateral extent of previously identified contamination at NTA-067.	Y	Y	N	N	PAH
NTAss-142	Former Plane Burial Area	Delineate lateral extent of previously identified contamination.	Y	Y	N	N	PAH

AOC = Area of concern.
Hg = Mercury
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA/QC = Quality assurance/quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

Table 4–10. Chromium Speciation Samples under PBA08 RI

PBA08 RI Location	Rationale for Sample Selection
NTAss-134	Discrete sample collected to assess chromium speciation. Previous chromium result represents near background chromium concentration (13.5 mg/kg at NTA-090)
NTAss-135	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (21.9 mg/kg at NTA-086)
NTAss-140	Discrete sample collected to assess chromium speciation. Previous chromium result represents elevated chromium concentration (54.2 mg/kg at NTA-070)

mg/kg = Milligrams per kilogram.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples

Aggregate	**Background Criteria**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTAsb-123**	**NTAsb-124**	**NTAsb-124**	**NTAsb-125**	**NTAsb-126**	**NTAsb-127**	**NTAss-137**	**NTAss-137**	**NTAss-138**	**NTAss-139**
Sample ID		**NTAsb-123-5305-SO**	**NTAsb-124-6134-FD**	**NTAsb-124-5309-SO**	**NTAsb-125-5313-SO**	**NTAsb-126-5317-SO**	**NTAsb-127-5321-SO**	**NTAss-137-6107-FD**	**NTAss-137-5334-SO**	**NTAss-138-5335-SO**	**NTAss-139-5336-SO**
Date		**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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		**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**
Analyte											
Metals (mg/kg)											
Aluminum	17700	11900	**17900***	16900	7590	10900	6760	7910	9030	11800	15200
Antimony	0.96	0.4J	<0.67UJ	<0.66UJ	<0.66UJ	0.11J	0.086J	<0.69UJ	<0.69UJ	<0.64UJ	<0.71UJ
Arsenic	15.4	9.5J	5.9J	4.5J	6.6J	12.7	10.8	7.7	8.2	6.3	6.7
Barium	88.4	**100J***	62.5J	59.3J	36.4J	75.7	80.9	63.8	65.3	45.1	**119***
Beryllium	0.88	**1***	0.45	0.39	0.35	0.62	0.52	0.5	0.59	0.4	0.75
Cadmium	0	**0.51***	<0.042UJ	<0.052UJ	**0.23J***	**0.23J***	**0.23J***	**0.15J***	**0.087J***	**0.069J***	**0.18J***
Calcium	15800	13300J	1100J	1540J	1470J	1430J	1900	1060J	1000	<2560U	2250
Chromium	17.4	**20.3***	**20.4***	**18.6***	8.1	14J	10J	10.2J	11J	13.4J	15.8J
Cobalt	10.4	7.1	4.8	5.2	3.7	10.4	**11.4J***	6.5	6.5	6.4	6.6
Copper	17.7	16.5	13	12.8	8.5	15.1	11.8	10	9.7	10.1	10.6
Iron	23100	22500	22100	18700	13400	**31800***	20700	16200	17300	20300	17300
Lead	26.1	**29***	13	11.8	12.3	13.7J	**50.9***	14.9J	**47.7J***	11.6J	14.1J
Magnesium	3030	**4370J***	2740J	2950J	1130J	2490J	1920J	1760J	1760J	2150J	2500J
Manganese	1450	1100	76.8	103	123	567	1100	426	438	142	283
Mercury	0.036	0.029J	0.027J	<0.13U	**0.056J***	0.024J	<0.14U	0.028J	0.021J	<0.13U	0.03J
Nickel	21.1	16.6	12.9	14.5	8.4	19.6	18.1	13.7	13.9	13.5	17.3
Potassium	927	**967***	**1080***	839	315	**1010J***	705	563J	743	546J	**996***
Selenium	1.4	**1.4J***	0.72J	0.67J	0.95J	0.88	0.64J	0.74	0.77	0.61J	1.2
Silver	0	<0.039UJ	**0.054J***	<0.045UJ	<0.021UJ	<0.031UJ	<0.032UJ	<0.041UJ	<0.041UJ	<0.025UJ	**0.056J***
Sodium	123	109J	48.6J	42.9J	26.7J	67J	50.8J	39.2J	36.2J	32.5J	69J
Thallium	0	**0.14J***	**0.22J***	**0.19J***	**0.11J***	**0.14J***	**0.12J***	**0.12J***	**0.12J***	**0.14J***	**0.2J***
Vanadium	31.1	17	27.7	22.2	12.9	18.6	15J	15.2	17.2	19.5	21.5
Zinc	61.8	60.4J	50.2J	48.4J	34.8J	**87.3***	58.7	50.9	54	42	**72.2***
Explosives (mg/kg)											
1,3,5-Trinitrobenzene	None	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U
2,4,6-Trinitrotoluene	None	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U
2,4-Dinitrotoluene	None	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U
HMX	None	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U
Nitrocellulose	None	**52.2***	NR	NR	NR	NR	NR	NR	NR	NR	**1.4J***
SVOCs (mg/kg)											
Acenaphthene	None	<0.069U	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Acenaphthylene	None	**0.02J***	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Anthracene	None	**0.019J***	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Benz(a)anthracene	None	**0.091***	**0.0092***	<0.0089U	**0.011***	**0.017***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Benzo(a)pyrene	None	**0.12***	<0.0089U	<0.0089U	**0.014***	**0.017***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Benzo(b)fluoranthene	None	**0.17***	**0.013***	**0.014***	**0.017***	**0.029***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Benzo(ghi)perylene	None	**0.096***	<0.0089U	<0.0089U	**0.011***	**0.014***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Benzo(k)fluoranthene	None	**0.093***	<0.0089U	<0.0089U	**0.0091***	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Chrysene	None	**0.12***	<0.0089U	**0.0091***	**0.015***	**0.018***	<0.0091U	**0.0099***	<0.0093U	<0.0085U	<0.071U
Dibenz(a,h)anthracene	None	**0.021J***	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Fluoranthene	None	**0.12***	**0.015***	**0.014***	**0.027***	**0.034***	**0.014***	**0.016***	**0.017***	**0.0086***	<0.071U

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Crash Area**
Station		**NTAsb-123**	**NTAsb-124**	**NTAsb-124**	**NTAsb-125**	**NTAsb-126**	**NTAsb-127**	**NTAss-137**	**NTAss-137**	**NTAss-138**	**NTAss-139**
Sample ID		**NTAsb-123-5305-SO**	**NTAsb-124-6134-FD**	**NTAsb-124-5309-SO**	**NTAsb-125-5313-SO**	**NTAsb-126-5317-SO**	**NTAsb-127-5321-SO**	**NTAss-137-6107-FD**	**NTAss-137-5334-SO**	**NTAss-138-5335-SO**	**NTAss-139-5336-SO**
Date		**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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		**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**
Analyte	**Background Criteria**										
Fluorene	None	<0.069U	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Indeno(1,2,3-cd)pyrene	None	**0.072***	<0.0089U	<0.0089U	<0.0089U	**0.011***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Naphthalene	None	<0.069U	<0.0089U	<0.0089U	<0.0089U	<0.01U	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Phenanthrene	None	**0.028J***	<0.0089U	<0.0089U	**0.015***	**0.013***	<0.0091U	<0.0092U	<0.0093U	<0.0085U	<0.071U
Pyrene	None	**0.11***	**0.012***	**0.012***	**0.021***	**0.029***	**0.01***	**0.012***	**0.012***	<0.0085U	<0.071U
VOCs (mg/kg)											
2-Butanone	None	<0.028U	NR	NR	NR	NR	NR	NR	NR	NR	<0.028U

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate	**Background Criteria**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAss-140**	**NTAss-141**	**NTAss-142**	**NTAsb-120**	**NTAsb-121**	**NTAsb-122**	**NTAss-128**	**NTAss-129**	**NTAss-130**	**NTAss-130**
Sample ID		**NTAss-140-5337-SO**	**NTAss-141-5338-SO**	**NTAss-142-5339-SO**	**NTAsb-120-5293-SO**	**NTAsb-121-5297-SO**	**NTAsb-122-5301-SO**	**NTAss-128-5325-SO**	**NTAss-129-5326-SO**	**NTAss-130-6105-FD**	**NTAss-130-5327-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**03/31/10**	**03/31/10**	**03/31/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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		**Chromium Speciation**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte											
Metals (mg/kg)											
Aluminum	17700	NR	**19300***	12600	7540	**18000***	11500	13000	8320	13000	13700
Antimony	0.96	NR	0.13J	<0.71UJ	<0.63UJ	0.18J	0.11J	0.13J	<0.62UJ	0.11J	0.1J
Arsenic	15.4	NR	11.6	11	7.1J	**21.8J***	5.5J	**22.1***	6.2	11.4	11.9
Barium	88.4	NR	**175***	**102***	43.2J	**204J***	**97.4J***	54.4	31.5	52.6	53.9
Beryllium	0.88	NR	**1.1***	0.68	0.4	**2.3***	**1.1***	**1.1***	0.35	0.45	0.46
Cadmium	0	NR	**0.54***	**0.15J***	**0.2J***	**0.16J***	**0.25***	**0.048J***	**0.16J***	**0.059J***	**0.06J***
Calcium	15800	NR	1520J	1330J	1390J	**78700J***	**25000J***	267J	<2470U	<2510U	<2570U
Chromium	17.4	12.2	**21.6J***	15.2J	7.5	**149***	13.1	**17.8J***	9.2J	15.1J	16.2J
Cobalt	10.4	NR	**11***	8.7	5	5.7	3.5	**21.7***	5.9	5.4	6
Copper	17.7	NR	14.5	8.3	6.4	13.2	7.5	9	8	9.9	8.9
Iron	23100	NR	**29800***	**23900***	14200	14600	12700	**43600***	13300	21800	22900
Lead	26.1	NR	24.5J	17.2J	11.2	10.4	21.7	23.2J	10.6J	10.2J	9.9J
Magnesium	3030	NR	2840J	2130J	1180J	**13600J***	**5280J***	1510J	1250J	2080J	2240J
Manganese	1450	NR	1070	762	354	**3230***	971	919	268	314	369
Mercury	0.036	NR	**0.049J***	**0.045J***	0.023J	0.026J	0.02J	0.034J	0.021J	<0.13U	0.022J
Nickel	21.1	NR	21.1	13.7	8.6	**64.7***	8.4	12.3	9.7	12.8	13.7
Potassium	927	NR	**1530J***	733J	276	**1160***	737	627	318J	729J	812J
Selenium	1.4	NR	**1.4***	1.1	0.59J	**1.9J***	1.2J	1.3	0.61J	0.72	0.76
Silver	0	NR	**0.097J***	**0.085J***	**0.023J***	**0.025J***	**0.02J***	**0.059J***	<0.022UJ	<0.034UJ	<0.027UJ
Sodium	123	NR	62.1J	41.8J	30J	**511***	**161***	34.6J	38.1J	32.1J	35.7J
Thallium	0	NR	**0.3J***	**0.16J***	**0.13J***	**0.11J***	**0.094J***	**0.19J***	**0.13J***	**0.15J***	**0.16J***
Vanadium	31.1	NR	**36.9***	26.7	15.8	14	13.7	**34.6***	14.8	24.4	26.5
Zinc	61.8	NR	**102***	49.4	30.8J	27.2J	**85.8J***	58.1	40.1	43.9	46.3
Explosives (mg/kg)											
1,3,5-Trinitrobenzene	None	NR	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U	<0.24U	<0.24U	<0.25U	<0.24U
2,4,6-Trinitrotoluene	None	NR	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U	<0.24U	<0.24U	<0.25U	<0.24U
2,4-Dinitrotoluene	None	NR	<0.24U	<0.24U	<0.24U	<0.24U	<0.25U	<0.24U	<0.24U	<0.25U	<0.24U
HMX	None	NR	<0.24U	<0.24U	**0.017J***	**0.014J***	<0.25U	<0.24U	<0.24U	<0.25U	<0.24U
Nitrocellulose	None	NR	NR	NR	NR	NR	NR	NR	<6.2U	NR	NR
SVOCs (mg/kg)											
Acenaphthene	None	NR	<0.012U	<0.0095U	**0.018***	**0.017***	**0.011***	<0.0093U	**0.011J***	<0.0084U	<0.0086U
Acenaphthylene	None	NR	<0.012U	<0.0095U	**0.17***	**0.17***	**0.11***	<0.0093U	**0.086***	<0.0084U	<0.0086U
Anthracene	None	NR	<0.012U	<0.0095U	**0.11***	**0.097***	**0.073***	<0.0093U	**0.066***	<0.0084U	<0.0086U
Benz(a)anthracene	None	NR	<0.012U	<0.0095U	**0.53J***	**0.25***	**0.21***	**0.012***	**0.29***	<0.0084U	<0.0086U
Benzo(a)pyrene	None	NR	<0.012U	<0.0095U	**0.62J***	**0.3***	**0.27***	**0.014***	**0.35***	<0.0084U	<0.0086U
Benzo(b)fluoranthene	None	NR	<0.012U	<0.0095U	**0.79J***	**0.43***	**0.35***	**0.02***	**0.48***	<0.0084U	<0.0086U
Benzo(ghi)perylene	None	NR	<0.012U	<0.0095U	**0.33J***	**0.29***	**0.24***	**0.011***	**0.23***	<0.0084U	<0.0086U
Benzo(k)fluoranthene	None	NR	<0.012U	<0.0095U	**0.35***	**0.15***	**0.18***	<0.0093U	**0.17***	<0.0084U	<0.0086U
Chrysene	None	NR	<0.012U	<0.0095U	**0.65J***	**0.29***	**0.3***	**0.014***	**0.36***	<0.0084U	<0.0086U
Dibenz(a,h)anthracene	None	NR	<0.012U	<0.0095U	**0.083***	**0.048***	**0.042***	<0.0093U	**0.054J***	<0.0084U	<0.0086U
Fluoranthene	None	NR	**0.018***	<0.0095U	**1.2J***	**0.45***	**0.53***	**0.019***	**0.72***	**0.011***	**0.011***

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Burial Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAss-140**	**NTAss-141**	**NTAss-142**	**NTAsb-120**	**NTAsb-121**	**NTAsb-122**	**NTAss-128**	**NTAss-129**	**NTAss-130**	**NTAss-130**
Sample ID		**NTAss-140-5337-SO**	**NTAss-141-5338-SO**	**NTAss-142-5339-SO**	**NTAsb-120-5293-SO**	**NTAsb-121-5297-SO**	**NTAsb-122-5301-SO**	**NTAss-128-5325-SO**	**NTAss-129-5326-SO**	**NTAss-130-6105-FD**	**NTAss-130-5327-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**03/31/10**	**03/31/10**	**03/31/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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		**Chromium Speciation**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte	**Background Criteria**										
Fluorene	None	NR	<0.012U	<0.0095U	**0.034***	**0.014***	**0.017***	<0.0093U	**0.022J***	<0.0084U	<0.0086U
Indeno(1,2,3-cd)pyrene	None	NR	<0.012U	<0.0095U	**0.28***	**0.21***	**0.18***	**0.0087J***	**0.2***	<0.0084U	<0.0086U
Naphthalene	None	NR	<0.012U	<0.0095U	**0.014***	**0.018***	**0.012***	<0.0093U	<0.062U	<0.0084U	<0.0086U
Phenanthrene	None	NR	<0.012U	<0.0095U	**0.48J***	**0.17***	**0.24***	<0.0093U	**0.3***	<0.0084U	<0.0086U
Pyrene	None	NR	**0.014***	<0.0095U	**1.2J***	**0.5***	**0.56***	**0.02***	**0.76***	**0.0092***	**0.01***
VOCs (mg/kg)											
2-Butanone	None	NR	NR	NR	NR	NR	NR	NR	**0.0018J***	NR	NR

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate		**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAss-131**	**NTAss-132**	**NTAss-133**	**NTAss-134**	**NTAss-135**	**NTAss-136**
Sample ID		**NTAss-131-5328-SO**	**NTAss-132-5329-SO**	**NTAss-133-5330-SO**	**NTAss-134-5331-SO**	**NTAss-135-5332-SO**	**NTAss-136-5333-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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**
Parameters Analyzed	**Background Criteria**						
Analyte		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**TAL Metals, Explosives, SVOCs**
Metals (mg/kg)							
Aluminum	17700	11500	12900	15500	NR	NR	11700
Antimony	0.96	0.099J	0.093J	0.12J	NR	NR	0.11J
Arsenic	15.4	9.8	14	11.4	NR	NR	12.1
Barium	88.4	83.6	46	**126***	NR	NR	72.3
Beryllium	0.88	0.57	0.61	**0.92***	NR	NR	0.62
Cadmium	0	**0.26J***	**0.074J***	**0.27***	NR	NR	**0.26J***
Calcium	15800	1040J	1390J	2380J	NR	NR	1960J
Chromium	17.4	12.2J	17.2J	15.8J	**47.2***	**17.9***	**19.9J***
Cobalt	10.4	**11***	**11.2***	**17.8***	NR	NR	**13.4***
Copper	17.7	8.8	24.4*	10	NR	NR	16.8
Iron	23100	17700	**28300***	22900	NR	NR	**24900***
Lead	26.1	14.8J	14.2J	22.2J	NR	NR	17.8J
Magnesium	3030	1830J	**3650J***	2900J	NR	NR	2760J
Manganese	1450	1020	246	**1830***	NR	NR	718
Mercury	0.036	0.033J	0.019J	**0.038J***	NR	NR	<0.14U
Nickel	21.1	13.3	**26.4***	17.6	NR	NR	20.9
Potassium	927	578J	**1040J***	872J	NR	NR	910J
Selenium	1.4	1.1J	0.8	1.1	NR	NR	0.78
Silver	0	**0.045J***	<0.016UJ	**0.06J***	NR	NR	<0.032UJ
Sodium	123	<1310U	<1200U	<1330U	NR	NR	49.2J
Thallium	0	**0.18J***	**0.16J***	**0.22J***	NR	NR	**0.18J***
Vanadium	31.1	19.9	19.6	24.9	NR	NR	21.2
Zinc	61.8	**62.6***	**67.3***	**78.7***	NR	NR	59
Explosives (mg/kg)							
1,3,5-Trinitrobenzene	None	<0.23U	<0.23U	<0.25U	NR	NR	**0.02J***
2,4,6-Trinitrotoluene	None	<0.23U	<0.23U	<0.25U	NR	NR	**5.5***
2,4-Dinitrotoluene	None	<0.23U	<0.23U	**0.22J***	NR	NR	**0.014J***
HMX	None	**0.012J***	<0.23U	<0.25U	NR	NR	<0.24U
Nitrocellulose	None	NR	NR	NR	NR	NR	NR
SVOCs (mg/kg)							
Acenaphthene	None	<0.0087U	<0.008U	<0.0089U	NR	NR	<0.0092U
Acenaphthylene	None	**0.023***	**0.045***	<0.0089U	NR	NR	<0.0092U
Anthracene	None	**0.018***	**0.034***	<0.0089U	NR	NR	<0.0092U
Benz(a)anthracene	None	**0.048***	**0.082***	<0.0089U	NR	NR	<0.0092U
Benzo(a)pyrene	None	**0.058***	**0.093***	**0.011***	NR	NR	**0.0097***
Benzo(b)fluoranthene	None	**0.083***	**0.11***	<0.0089U	NR	NR	<0.0092U
Benzo(ghi)perylene	None	**0.05***	**0.077***	**0.0096***	NR	NR	<0.0092U
Benzo(k)fluoranthene	None	**0.034***	**0.063***	<0.0089U	NR	NR	<0.0092U
Chrysene	None	**0.058***	**0.099***	**0.013***	NR	NR	**0.013***
Dibenz(a,h)anthracene	None	<0.0087U	<0.008U	<0.0089U	NR	NR	<0.0092U
Fluoranthene	None	**0.12***	**0.19***	**0.021***	NR	NR	**0.022***
Fluorene	None	<0.0087U	**0.011***	<0.0089U	NR	NR	<0.0092U
Indeno(1,2,3-cd)pyrene	None	**0.038***	**0.058***	<0.0089U	NR	NR	<0.0092U

Table 4–11. Analytes Detected in PBA08 RI Discrete Surface Soil Samples (continued)

Aggregate	**Background Criteria**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAss-131**	**NTAss-132**	**NTAss-133**	**NTAss-134**	**NTAss-135**	**NTAss-136**
Sample ID		**NTAss-131-5328-SO**	**NTAss-132-5329-SO**	**NTAss-133-5330-SO**	**NTAss-134-5331-SO**	**NTAss-135-5332-SO**	**NTAss-136-5333-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**	**04/08/10**
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**
Parameters Analyzed		**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**Chromium Speciation**	**Chromium Speciation**	**TAL Metals, Explosives, SVOCs**
Analyte							
Naphthalene	None	<0.0087U	<0.008U	**0.011***	NR	NR	<0.0092U
Phenanthrene	None	**0.056***	**0.11***	**0.014***	NR	NR	**0.01***
Pyrene	None	**0.11***	**0.21***	**0.019***	NR	NR	**0.021***
				VOCs (mg/kg)			
2-Butanone	None	NR	NR	NR	NR	NR	NR

[a] Only detected analytes are presented in the table.

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

ft = Feet.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane.
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 = Non-detectable concentration.
UJ = Non-detectable concentration and reporting limit estimated.
VOC = Volatile organic compound.
* = Result exceeds background concentration.
< = Less than.

Table 4–12. 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
NTAsb-120	Delineate vertical extent of previously identified contamination at NTA-083 (north of concrete pad and western end of former crash strip).	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		NA	7–13	N	N	N	N	N
NTAsb-121	Delineate vertical extent of previously identified contamination at NTA-088 (western end of former crash strip and adjacent to concrete pad).	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		NA	7–13	N	N	N	N	N
NTAsb-122	Delineate vertical extent of previously identified contamination at NTA-90 and NTA-091 (midpoint of former crash strip).	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		NA	7–13	N	N	N	N	N
NTAsb-123	Delineate vertical extent of previously identified contamination at NTA-026 (end of former crash strip). 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	1–4	Y	Y	Y	Y	Y
		Discrete	1–4	Y	Y	Y	Y	Y
NTAsb-124	Delineate vertical extent of previously identified contamination NTA-011 (northern portion of former crash area).	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		Discrete[a]	7–13	Y	Y	N	N	PAH
	QA/QC	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	0–1	Y	Y	N	N	PAH
NTAsb-125	Delineate vertical extent of previously identified contamination at NTA-016 (north-eastern portion of former crash area).	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		Discrete[b]	7–13	Y	Y	N	N	PAH
NTAsb-126	Delineate vertical extent of previously identified contamination at NTA-064 (southeastern portion of former crash area); hand auger refusal at 5 ft bgs	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–5	Y	Y	N	N	PAH
		NS	7–13	N	N	N	N	N

Table 4–12. PBA08 RI Subsurface Soil Rationale and Analyses (continued)

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed	Explosives	VOCs	Pesticides/ PCBs	SVOC
NTAsb-127	Delineate vertical extent of previously identified contamination at NTA-098 (southwestern portion of former crash area); hand auger refusal at 7 ft bgs	Discrete	0–1	Y	Y	N	N	PAH
		Discrete	1–4	Y	Y	N	N	PAH
		Discrete	4–7	Y	Y	N	N	PAH
		NS	7–13	N	N	N	N	N

[a] Sample analyzed by the laboratory based on exceedance of preliminary screening criteria of the 4–7 ft sample interval.
[b] One sample (10%) from 7–13 ft bgs was submitted for laboratory analysis to characterize subsurface soil to 13 ft bgs.
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.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-Based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
QA/QC = Quality assurance/quality control.
RVAAP = Ravenna Army and Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

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

Aggregate		Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area	Former Crash Area
Station		**NTAsb-123**	**NTAsb-123**	**NTAsb-123**	**NTAsb-124**	**NTAsb-124**	**NTAsb-124**	**NTAsb-125**	**NTAsb-125**	**NTAsb-125**	**NTAsb-126**
Sample ID		**NTAsb-123-6132-FD**	**NTAsb-123-5306-SO**	**NTAsb-123-5307-SO**	**NTAsb-124-5310-SO**	**NTAsb-124-5311-SO**	**NTAsb-124-5312-SO**	**NTAsb-125-5314-SO**	**NTAsb-125-5315-SO**	**NTAsb-125-5316-SO**	**NTAsb-126-5318-SO**
Date		**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**04/08/10**
Depth (ft)		**1.0 - 4.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**7.0 - 13.0**	**1.0 - 4.0**	**4.0 - 7.0**	**7.0 - 13.0**	**1.0 - 4.0**
Parameters Analyzed		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	12500	13500	9380J	16200	7770J	5760	5690	7670J	8080	8690
Antimony	0.96	0.079J	0.099J	0.079J	0.085J	0.09J	0.08J	<0.6UJ	0.084J	<0.6 R	<0.65UJ
Arsenic	19.8	9.2J	10.8J	13.2J	6.7J	**24.7J***	13.9J	7.8J	10.2J	10.8J	6.3
Barium	124	72.9J	78.5J	51.1	**137J***	32.4	25.7J	16J	40.9	40.7	60.8
Beryllium	0.88	0.66	0.71	0.53J	**1.1***	0.45J	0.34	0.3	0.4J	0.38	0.61
Cadmium	0	**0.072J***	**0.098J***	**0.033J***	**0.066J***	**0.047J***	<0.034UJ	**0.075J***	**0.055J***	**0.043J***	**0.06J***
Calcium	35500	**40000J***	**47800J***	18100	3710J	7890	6870J	549J	1090	20100	843J
Chromium	27.2	18.6	19.2	15.9J	22.2	12.9J	8.9	6.5	10.9J	12.7J	10.6J
Cobalt	23.2	10.3	11.3	10.7J	9.7	8.6J	7	5.1	7.9J	9.3J	5.8J
Copper	32.3	18.2	18.5	17.3	20.3	17.3	15.2	13	16.6	17.1	8.3
Iron	35200	27600	28200	26000	25100	24400	19200	13500	19900	22500	15500
Lead	19.1	11.3	12.1	11.7J	15.3	10J	8.7	6.9	8.9J	10	11.3J
Magnesium	8790	7120J	6780J	5820	5380J	4750	3970J	1220J	2470	7080J	1870J
Manganese	3030	355	429	299	169	264	313	253	320	343	212
Mercury	0.044	<0.12U	<0.12U	<0.12UJ	0.02J	<0.12UJ	0.019J	<0.12U	<0.12UJ	<0.12U	<0.13U
Nickel	60.7	26.3	26.4	23.9J	29.1	21.3J	16.9	10.2	17.9J	21.4	14.9
Potassium	3350	1930	2260	1590J	1200	1350J	1140	458	1370J	1610	773J
Selenium	1.5	0.66J	0.76J	0.8J	1.4J	0.77J	0.66J	0.74J	0.91J	0.47J	0.71
Silver	0	<0.026UJ	<0.031UJ	<0.02UJ	**0.057J***	<0.029UJ	<0.025UJ	<0.01UJ	<0.018UJ	<0.028UJ	<0.031UJ
Sodium	145	94.7J	104J	81.5J	66.5J	67.2J	56.7J	22.2J	49.9J	102J	86.6J
Thallium	0.91	0.16J	0.18J	0.16J	0.19J	0.12J	0.099J	0.078J	0.14J	0.14J	0.11J
Vanadium	37.6	20.8	23.2	17.4J	27.2	13.7J	10.1	8.9	13.8J	13.9J	16.1
Zinc	93.3	55.1J	76.3J	53.8	66.7J	60.3	45.5J	30.4J	45.3	46	50.8J
SVOCs (mg/kg)											
Benz(a)anthracene	None	<0.062U	**0.013J***	<0.058U	<0.0084U	<0.0079U	<0.0076U	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Benzo(a)pyrene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	**0.0081***	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Benzo(b)fluoranthene	None	**0.0092J***	**0.023J***	<0.058U	<0.0084U	<0.0079U	**0.013***	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Benzo(ghi)perylene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	**0.031***	<0.0081U	<0.0083U	**0.011***	<0.0087U
Benzo(k)fluoranthene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	<0.0076U	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Bis(2-ethylhexyl)phthalate	None	**0.038J***	**0.097J***	<0.38U	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	**0.01J***	**0.023J***	<0.058U	<0.0084U	<0.0079U	**0.015***	<0.0081U	<0.0083U	**0.0094***	<0.0087U
Fluoranthene	None	**0.015J***	**0.033J***	<0.058U	<0.0084U	<0.0079U	**0.01***	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Indeno(1,2,3-cd)pyrene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	<0.0076U	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Naphthalene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	**0.02***	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Phenanthrene	None	<0.062U	<0.062U	<0.058U	<0.0084U	<0.0079U	**0.028***	<0.0081U	<0.0083U	**0.012***	<0.0087U
Pyrene	None	<0.062U	**0.013J***	<0.058U	<0.0084U	<0.0079U	<0.0076U	<0.0081U	<0.0083U	<0.0081U	<0.0087U
Pesticide/PCB (mg/kg)											
delta-BHC	None	<0.0049U	**0.0044J***	<0.0046U	NR	NR	NR	NR	NR	NR	NR

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAsb-126**	**NTAsb-127**	**NTAsb-127**	**NTAsb-120**	**NTAsb-120**	**NTAsb-121**	**NTAsb-121**	**NTAsb-121**	**NTAsb-122**	**NTAsb-122**
Sample ID		**NTAsb-126-5319-SO**	**NTAsb-127-5322-SO**	**NTAsb-127-5323-SO**	**NTAsb-120-5294-SO**	**NTAsb-120-5295-SO**	**NTAsb-121-5298-SO**	**NTAsb-121-6133-FD**	**NTAsb-121-5299-SO**	**NTAsb-122-5302-SO**	**NTAsb-122-5303-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**
Depth (ft)		**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**4.0 - 7.0**	**1.0 - 4.0**	**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**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte	**Background Criteria**										
Metals (mg/kg)											
Aluminum	19500	15600	8130	11200	8940	8970J	11000	11900	10600J	9920	10300J
Antimony	0.96	0.089J	0.092J	<0.64 R	0.14J	0.082J	0.1J	0.089J	0.087J	0.087J	0.08J
Arsenic	19.8	6	11.7J	6.3J	14.4J	13.7J	16.1J	16J	15.3J	10.7J	16.2J
Barium	124	69.7	59.9	54	54.7J	58	76.4J	75.9J	57.7	62.9J	58.9
Beryllium	0.88	0.81	0.53	0.57	0.58	0.5J	0.67	0.62	0.53J	0.65	0.55J
Cadmium	0	**0.14J***	**0.11J***	**0.079J***	**0.1J***	**0.067J***	**0.083J***	**0.075J***	**0.056J***	**0.075J***	**0.062J***
Calcium	35500	17300	1930	26700	1060J	3750	2270J	18400J	18400	4670J	2410
Chromium	27.2	20.8J	13.1J	19.8J	12.4	15J	17.1	18	17.6J	14.5	17.5J
Cobalt	23.2	10.7	12.1J	10.9J	14	10.4J	13.1	13.2	10.4J	8.7	11.6J
Copper	32.3	16.7	17	20.1	22.4	20.4	20.7	20.4	20	14.8	21.5
Iron	35200	24500	25200	25700	30000	25800	29800	31900	29500	24300	31300
Lead	19.1	12.5J	13	11.6	14.9	11.6J	12.6	13.7	12.2J	12.8	12.3J
Magnesium	8790	6470J	2990J	8460J	2440J	3900	3770J	6390J	6030	3190J	4060
Manganese	3030	361	530	408	589	352	417	524	386	376	360
Mercury	0.044	<0.14U	<0.13U	<0.13U	<0.12U	<0.12UJ	<0.12U	<0.13U	<0.12UJ	<0.12U	<0.12UJ
Nickel	60.7	27.5	24.3	28	21.5	26.7J	28.8	29.7	27.3J	21.1	30J
Potassium	3350	2800	1190	2170	854	1170J	1200	1630	1570J	982	1330J
Selenium	1.5	0.71	0.83J	0.63J	0.85J	0.87J	0.95J	0.86J	0.91J	0.95J	1J
Silver	0	<0.041UJ	**0.038J***	**0.037J***	**0.015J***	<0.024UJ	**0.019J***	<0.034UJ	<0.027UJ	**0.018J***	<0.029UJ
Sodium	145	**416***	74.1J	**166***	32.3J	57.4J	50.1J	75.1J	89.5J	53.9J	56.2J
Thallium	0.91	0.19J	0.15J	0.2J	0.21J	0.18J	0.18J	0.19J	0.16J	0.13J	0.19J
Vanadium	37.6	24.5	17.7J	19.8J	17.1	16.3J	18.9	20	18.7J	16.7	17.6J
Zinc	93.3	69.4	49.1	57.3	64.2J	56.1	58.2J	59.1J	61.7	52.2J	62.2
SVOCs (mg/kg)											
Benz(a)anthracene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	**0.011***	<0.0085U	<0.0082U	<0.0082U	<0.0083U
Benzo(a)pyrene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	**0.011***	<0.0085U	<0.0082U	**0.013***	<0.0083U
Benzo(b)fluoranthene	None	<0.0093U	<0.0088U	**0.0093***	<0.008U	<0.0083U	**0.016***	<0.0085U	<0.0082U	**0.02***	<0.0083U
Benzo(ghi)perylene	None	<0.0093U	<0.0088U	**0.017***	<0.008U	<0.0083U	**0.012***	<0.0085U	<0.0082U	**0.011***	<0.0083U
Benzo(k)fluoranthene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	<0.0081U	<0.0085U	<0.0082U	**0.0089***	<0.0083U
Bis(2-ethylhexyl)phthalate	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Chrysene	None	<0.0093U	**0.01***	**0.016***	<0.008U	<0.0083U	**0.012***	<0.0085U	<0.0082U	**0.02***	<0.0083U
Fluoranthene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	**0.022***	<0.0085U	<0.0082U	**0.022***	<0.0083U
Indeno(1,2,3-cd)pyrene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	**0.0085***	<0.0085U	<0.0082U	**0.0084***	<0.0083U
Naphthalene	None	<0.0093U	<0.0088U	<0.0085U	<0.008U	<0.0083U	<0.0081U	<0.0085U	<0.0082U	<0.0082U	<0.0083U
Phenanthrene	None	**0.011***	<0.0088U	**0.012***	<0.008U	<0.0083U	**0.0098***	<0.0085U	<0.0082U	**0.0095***	<0.0083U
Pyrene	None	<0.0093U	<0.0088U	**0.015***	<0.008U	<0.0083U	**0.02***	<0.0085U	<0.0082U	**0.023***	<0.0083U

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

Aggregate		**Former Crash Area**	**Former Crash Area**	**Former Crash Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**	**Former Plane Refueling/Crash Strip Area**
Station		**NTAsb-126**	**NTAsb-127**	**NTAsb-127**	**NTAsb-120**	**NTAsb-120**	**NTAsb-121**	**NTAsb-121**	**NTAsb-121**	**NTAsb-122**	**NTAsb-122**
Sample ID		**NTAsb-126-5319-SO**	**NTAsb-127-5322-SO**	**NTAsb-127-5323-SO**	**NTAsb-120-5294-SO**	**NTAsb-120-5295-SO**	**NTAsb-121-5298-SO**	**NTAsb-121-6133-FD**	**NTAsb-121-5299-SO**	**NTAsb-122-5302-SO**	**NTAsb-122-5303-SO**
Date		**04/08/10**	**04/08/10**	**04/08/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**	**03/31/10**
Depth (ft)		**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**1.0 - 4.0**	**4.0 - 7.0**	**4.0 - 7.0**	**1.0 - 4.0**	**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**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**	**TAL Metals, Explosives, SVOCs**
Analyte	**Background Criteria**										
Pesticide/PCB (mg/kg)											
delta-BHC	None	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

[a]Only detected analytes are presented in the table.
[b]Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001d).
BHC = Hexachlorocyclohexane.
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.
PCB = Polychlorinated biphenyl.
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 4–14. 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
NTAsw-143	Tributary to Hinkley Creek	Characterize current conditions at culvert outfall under crash strip.	Grab	NA	Y	Y	Y	Y	Y
NTAsd-143			Composite	0–0.5	Y	Y	Y	Y	Y
NTAsw-144	Wetland/Pond north of Former Crash Area	Characterize current conditions at lower end of wetland prior to Tributary to Hinkley Creek	Grab	NA	Y	Y	Y	Y	Y
NTAsd-144			Composite	0–0.5	Y	Y	Y	Y	Y
NTAsw-145	Tributary to Hinkley Creek	Characterize current conditions downstream of AOC prior to confluence with Hinkley Creek	Grab	NA	Y	Y	Y	Y	Y
NTAsd-145			Composite	0-0.5	Y	Y	Y	Y	Y

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

Table 4–15. Analytes Detected in PBA08 RI Surface Water Samples

Aggregate		**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Wetland/Pond North of Former Crash Area**
Sample location		**NTAsw-143**	**NTAsw-145**	**NTAsw-144**
Sample ID		**NTAsw-143-5340-SW**	**NTAsw-145-5342-SW**	**NTAsw-144-5341-SW**
Date		**03/09/10**	**02/25/10**	**03/09/10**
Parameters Analyzed[a]		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte	**Background Criteria[b]**			
Metals (mg/L)				
Aluminum	3.37	0.241	0.441	0.225
Antimony	0	<0.005UJ	**0.00026J***	<0.005UJ
Arsenic	0.0032	0.00065J	0.00067J	0.00072J
Barium	0.0475	0.0179J	0.0244	0.0188J
Cadmium	0	<0.002U	**0.00005J***	<0.002U
Calcium	41.4	12.7J	22.5	14.3J
Chromium	0	<0.005U	**0.00061J***	<0.005U
Cobalt	0	**0.00046J***	**0.00027J***	**0.00063J***
Copper	0.0079	<0.005U	0.0024J	<0.005U
Iron	2.56	2.36	0.874	**3.75***
Lead	0	**0.00023J***	**0.00052J***	**0.0002J***
Magnesium	10.8	3.82	5.54	4.67
Manganese	0.391	**0.509***	0.13	**0.737***
Nickel	0	**0.00086J***	**0.0013J***	**0.00098J***
Potassium	3.17	1.43	1.79	1.57
Selenium	0	<0.005UJ	**0.00037J***	<0.005UJ
Sodium	21.3	1.84	**21.8***	2.28
Thallium	0	<0.002U	<0.002U	**0.00037J***
Vanadium	0	**0.00052J***	**0.00067J***	<0.01U
SVOCs (mg/kg)				
Bis(2-ethylhexyl)phthalate	None	<0.01UJ	**0.021***	<0.01UJ
VOCs (mg/kg)				
Toluene	None	<0.001U	<0.001U	**0.00035J***

[a] Only detected analytes are presented in the table.

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

ID = Identification.
J = Estimated value less than reporting limits.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
PBA08 RI = Performance Based Acquisition 2008 Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.
U= Non-detectable concentration.
UJ = Non-detectable concentration and reporting limit estimated.
*** = Result exceeds background criteria or no background criteria was available.**

Table 4–16. Analytes Detected in PBA08 RI Sediment Samples

Aggregate	**Background Criteria**[b]	**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Wetland/Pond North of Former Crash Area**
Sample location		**NTAsd-143**	**NTAsd-145**	**NTAsd-144**
Sample ID		**NTAsd-143-5343-SD**	**NTAsd-145-5345-SD**	**NTAsd-144-5344-SD**
Date		**03/09/10**	**02/25/10**	**03/09/10**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Parameters Analyzed[a]		**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte				
Metals (mg/kg)				
Aluminum	13900	7580	13500	12000
Arsenic	19.5	4	10.6	4.3
Barium	123	64.3J	65.5	57.5J
Beryllium	0.38	**0.49***	**0.67***	**0.4***
Cadmium	0	**0.33***	<0.053UJ	**0.1J***
Calcium	5510	1120J	4930J	1520J
Chromium	18.1	10.3	**19.2***	14.6
Cobalt	9.1	6.5	**14.4***	5.5
Copper	27.6	10.3	19.1	9.6
Iron	28200	12800	**32600***	14800
Lead	27.4	14.4	10.9	12.3
Magnesium	2760	1870	**6480***	2440
Manganese	1950	292	708	157
Mercury	0.059	0.032J	<0.13U	0.023J
Nickel	17.7	13.3	**33.6***	12.7
Potassium	1950	580	1820J	758
Selenium	1.7	0.68J	1.2	0.52J
Silver	0	**0.031J***	<0.032UJ	**0.031J***
Sodium	112	<32.1UJ	91.4J	<40.8UJ
Thallium	0.89	0.1J	0.18J	0.14J
Vanadium	26.1	13.3	19.4	20.6
Zinc	532	56	60.3	46.2
Explosives and Propellants (mg/kg)				
HMX	None	**0.013J***	<0.25U	<0.25UJ
SVOCs (mg/kg)				
Acenaphthene	None	**0.012J***	<0.065U	<0.072UJ
Anthracene	None	**0.026J***	<0.065U	<0.072UJ
Benz(a)anthracene	None	**0.059J***	**0.01J***	<0.072UJ
Benzo(a)pyrene	None	**0.066J***	<0.065U	<0.072UJ
Benzo(b)fluoranthene	None	**0.083J***	**0.012J***	<0.072UJ

Table 4–16. Analytes Detected in PBA08 RI Sediment Samples (continued)

Aggregate		**Tributary to Hinkley Creek**	**Tributary to Hinkley Creek**	**Wetland/Pond North of Former Crash Area**
Sample location		**NTAsd-143**	**NTAsd-145**	**NTAsd-144**
Sample ID		**NTAsd-143-5343-SD**	**NTAsd-145-5345-SD**	**NTAsd-144-5344-SD**
Date		**03/09/10**	**02/25/10**	**03/09/10**
Depth (ft)		**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Parameters Analyzed[a]	**Background Criteria**[b]	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**	**RVAAP Full-suite analytes**
Analyte				
SVOCs (mg/kg) continued				
Benzo(ghi)perylene	None	**0.041J***	**0.012J***	<0.072UJ
Benzo(k)fluoranthene	None	**0.036J***	<0.065U	<0.072UJ
Bis(2-ethylhexyl)phthalate	None	<0.47UJ	**0.35J***	<0.47UJ
Chrysene	None	**0.069J***	**0.01J***	<0.072UJ
Dibenz(a,h)anthracene	None	**0.011J***	<0.065U	<0.072UJ
Fluoranthene	None	**0.1J***	<0.065U	<0.072UJ
Fluorene	None	**0.012J***	<0.065U	<0.072UJ
Indeno(1,2,3-cd)pyrene	None	**0.037J***	<0.065U	<0.072UJ
Phenanthrene	None	**0.07J***	<0.065U	<0.072UJ
Pyrene	None	**0.082J***	**0.015J***	<0.072UJ
VOCs (mg/kg)				
2-Butanone	None	**0.0064J***	<0.026UJ	**0.0044J***
Ethylbenzene	None	<0.0071UJ	<0.0065UJ	**0.0015J***
Toluene	None	<0.0071UJ	<0.0065UJ	**0.17J***

[a] Only detected analytes are presented in the table.

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

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.
PBA08 RI = Performance Based Acquisition 2008 Remedial Investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
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.

Table 4–17. Changes from the PBA08 Sample and Analysis Plan

Location	Affected Sample	Date Sampled	Change/Rationale
NTAsb-123	NTASB-123-5306-SO	3/31/2010	Poor recovery in 1–4 ft bgs interval due to presence of fill material. Two extra boreholes drilled to obtain necessary recovery.
	NTASB-123-6132-FD	3/31/2010	
	NTASB-123-6135-QA	3/31/2010	
NTAsb-125	NTASB-125-5313-SO	3/31/2010	Sample location moved to the bottom of a ditch.
	NTASB-125-5314-SO	3/31/2010	
	NTASB-125-5315-SO	3/31/2010	
	NTASB-125-5316-SO	3/31/2010	
NTAss-140	NTASS-140-5337-SO	4/8/2010	Sample point was relocated approximately 30 ft northeast of original location.
NTAsw-143	NTASW-143-5340-SW	3/9/2010	Original location was not in a stream; sample point was relocated.

bgs = Below ground surface.
ft = Feet.
PBA08 = Performance-Based Acquisition 2008 Sampling and Analysis Plan.

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Table 4–18. 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

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 4–19. RDA/RDI 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

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

[b] Adequate intake value.

mg/d = Milligram per day.
RDA = Recommended daily allowance.
RDI = Recommended daily intake.
µg/d = Micrograms per day.
USDA = U.S. Department of Agriculture.
Source = Values were obtained from http://fnic.nal.usda.gov charts.

Table 4–20. SRC Screening Summary for Former Crash Area Surface Soil

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**	**70/ 70**	**5400**	**25400**	**10800**	**17700**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**15/ 60**	**0.086**	**1.1**	**0.61**	**0.96**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**70/ 70**	**3.3**	**19**	**8.65**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**70/ 70**	**18**	**254**	**67.1**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**32/ 70**	**0.22**	**1.7**	**0.338**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**13/ 70**	**0.069**	**1.3**	**0.327**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	62/ 70	182	111000	6370	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**70/ 70**	**6.3**	**25.2**	**12.7**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**70/ 70**	**2.7**	**38.2**	**7.24**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**70/ 70**	**3.9**	**55.6**	**12.5**	**17.7**	**Yes**	**Exceeds background**
Cyanide	57-12-5	3/ 62	0.68	1.3	0.342	0	No	<5% Detected
Iron	7439-89-6	70/ 70	6520	38700	19700	23100	No	Essential Nutrient
Lead	**7439-92-1**	**70/ 70**	**6.9**	**50.9**	**17.3**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	70/ 70	884	16000	2590	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**70/ 70**	**49**	**4500**	**522**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**48/ 70**	**0.0093**	**0.1**	**0.0334**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**70/ 70**	**4.9**	**29.2**	**13.7**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	70/ 70	315	2270	843	927	No	Essential Nutrient
Selenium	**7782-49-2**	**54/ 70**	**0.46**	**2.6**	**0.775**	**1.4**	**Yes**	**Exceeds background**
Silver	7440-22-4	1/ 70	0.056	0.056	0.561	0	No	<5% Detected
Sodium	7440-23-5	11/ 70	26.7	694	68.9	123	No	Essential Nutrient
Thallium	**7440-28-0**	**59/ 70**	**0.11**	**0.57**	**0.268**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	70/ 70	8.7	30	17.8	31.1	No	Below background
Zinc	**7440-66-6**	**70/ 70**	**26.7**	**231**	**56.4**	**61.8**	**Yes**	**Exceeds background**
Explosives and Propellants								
2,4,6-Trinitrotoluene	**118-96-7**	**1/ 16**	**0.15**	**0.15**	**0.124**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**4/ 10**	**1.4**	**52.2**	**11**	**None**	**Yes**	**Detected organic**

Table 4–20. SRC Screening Summary for Former Crash Area Surface Soil (continued)

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
SVOCs								
Acenaphthylene	208-96-8	2/ 70	0.02	0.33	0.187	None	No	<5% Detected
Anthracene	120-12-7	3/ 70	0.019	0.33	0.186	None	No	<5% Detected
Benz(a)anthracene	**56-55-3**	**7/ 70**	**0.011**	**1.5**	**0.204**	None	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**7/ 70**	**0.014**	**1.9**	**0.21**	None	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**11/ 70**	**0.014**	**3.2**	**0.226**	None	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**8/ 70**	**0.011**	**1**	**0.194**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**5/ 70**	**0.0091**	**1.2**	**0.198**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**7/ 64**	**0.048**	**6.6**	**0.293**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**11/ 70**	**0.0091**	**2.7**	**0.215**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**4/ 70**	**0.021**	**0.35**	**0.184**	None	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**13/ 70**	**0.0086**	**1.7**	**0.21**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**6/ 70**	**0.011**	**1.2**	**0.199**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**7/ 70**	**0.013**	**0.34**	**0.183**	**None**	**Yes**	**Detected organic**
Phenol	108-95-2	2/ 64	0.11	0.27	0.209	None	No	<5% Detected
Pyrene	**129-00-0**	**13/ 70**	**0.01**	**1.8**	**0.206**	**None**	**Yes**	**Detected organic**
VOCs								
Acetone	67-64-1	1/ 64	0.0091	0.0091	0.00649	None	No	<5% Detected
Dimethylbenzene	**1330-20-7**	**9/ 64**	**0.0012**	**0.0023**	**0.00306**	**None**	**Yes**	**Detected organic**
Methylene chloride	**75-09-2**	**6/ 64**	**0.0028**	**0.0046**	**0.0032**	**None**	**Yes**	**Detected organic**
Toluene	108-88-3	2/ 64	0.0017	0.0028	0.00309	None	No	<5% Detected

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

CAS = Chemical Abstract Service.

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 4–21. SRC Screening Summary for Former Crash Area Well Pit Surface Soil

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	8730	8730	8730	17700	No	Below background
Arsenic	7440-38-2	1/ 1	12.4	12.4	12.4	15.4	No	Below background
Barium	**7440-39-3**	**1/ 1**	**436**	**436**	**436**	**88.4**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**5**	**5**	**5**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	20400	20400	20400	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 1**	**24.6**	**24.6**	**24.6**	**17.4**	**Yes**	**Exceeds background**
Cobalt	7440-48-4	1/ 1	8.4	8.4	8.4	10.4	No	Below background
Copper	**7440-50-8**	**1/ 1**	**155**	**155**	**155**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	1/ 1	58700	58700	58700	23100	No	Essential Nutrient
Lead	**7439-92-1**	**1/ 1**	**13200**	**13200**	**13200**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/ 1	2200	2200	2200	3030	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	1310	1310	1310	1450	No	Below background
Nickel	**7440-02-0**	**1/ 1**	**23.9**	**23.9**	**23.9**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	1850	1850	1850	927	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	1	1	1	1.4	No	Below background
Silver	**7440-22-4**	**1/ 1**	**0.5**	**0.5**	**0.5**	**0**	**Yes**	**Exceeds background**
Thallium	**7440-28-0**	**1/ 1**	**0.35**	**0.35**	**0.35**	**0**	**Yes**	**Exceeds background**
Vanadium	7440-62-2	1/ 1	16.9	16.9	16.9	31.1	No	Below background
Zinc	**7440-66-6**	**1/ 1**	**631**	**631**	**631**	**61.8**	**Yes**	**Exceeds background**
Explosives and Propellants								
Nitrocellulose	**9004-70-0**	**1/ 1**	**11**	**11**	**11**	**None**	**Yes**	**Detected organic**
VOCs								
Dimethylbenzene	**1330-20-7**	**1/ 1**	**0.003**	**0.003**	**0.003**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–22. SRC Screening Summary for Former Plane Burial Area Surface Soil

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**	**21/ 21**	**5090**	**31200**	**11200**	**17700**	**Yes**	**Exceeds background**
Antimony	**7440-36-0**	**2/ 21**	**0.13**	**2.9**	**0.699**	**0.96**	**Yes**	**Exceeds background**
Arsenic	**7440-38-2**	**21/ 21**	**4.5**	**23**	**9.59**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**21/ 21**	**30.9**	**253**	**76.3**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**13/ 21**	**0.22**	**1.1**	**0.367**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**6/ 21**	**0.15**	**14.5**	**1.18**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	16/ 21	134	3660	765	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**21/ 21**	**7**	**54.2**	**14.8**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**21/ 21**	**3.4**	**12**	**7.14**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**21/ 21**	**5.2**	**1760**	**95.3**	**17.7**	**Yes**	**Exceeds background**
Iron	7439-89-6	21/ 21	11500	31700	18700	23100	No	Essential Nutrient
Lead	**7439-92-1**	**21/ 21**	**9.8**	**149**	**23.8**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	21/ 21	760	3950	1820	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**21/ 21**	**112**	**2190**	**599**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**21/ 21**	**0.022**	**0.073**	**0.0444**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**21/ 21**	**5.5**	**41.4**	**14.9**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	21/ 21	248	1960	788	927	No	Essential Nutrient
Selenium	**7782-49-2**	**10/ 21**	**0.54**	**1.4**	**0.558**	**1.4**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**3/ 21**	**0.085**	**1.5**	**0.618**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	2/ 21	41.8	62.1	32	123	No	Essential Nutrient
Thallium	**7440-28-0**	**17/ 21**	**0.16**	**0.52**	**0.283**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**21/ 21**	**9.6**	**36.9**	**19.3**	**31.1**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**21/ 21**	**28.4**	**603**	**82.6**	**61.8**	**Yes**	**Exceeds background**

.

Table 4–22. SRC Screening Summary for Former Plane Burial Area Surface Soil (continued)

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
Explosives								
2,4,6-Trinitrotoluene	**118-96-7**	**1/ 4**	**0.11**	**0.11**	**0.119**	**None**	**Yes**	**Detected organic**
SVOCs								
Benz(a)anthracene	56-55-3	1/ 21	0.19	0.19	0.215	None	No	<5% Detected
Benzo(a)pyrene	50-32-8	1/ 21	0.18	0.18	0.215	None	No	<5% Detected
Benzo(b)fluoranthene	**205-99-2**	**2/ 21**	**0.057**	**0.21**	**0.208**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	191-24-2	1/ 21	0.13	0.13	0.212	None	No	<5% Detected
Benzo(k)fluoranthene	207-08-9	1/ 21	0.096	0.096	0.211	None	No	<5% Detected
Bis(2-ethylhexyl)phthalate	**117-81-7**	**7/ 19**	**0.043**	**0.49**	**0.205**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**2/ 21**	**0.045**	**0.2**	**0.209**	**None**	**Yes**	**Detected organic**
Di-n-butyl phthalate	**84-74-2**	**2/ 19**	**0.04**	**0.075**	**0.223**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**4/ 21**	**0.018**	**0.3**	**0.206**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	193-39-5	1/ 21	0.15	0.15	0.213	None	No	<5% Detected
Phenanthrene	85-01-8	1/ 21	0.086	0.086	0.21	None	No	<5% Detected
Pyrene	**129-00-0**	**4/ 21**	**0.014**	**0.27**	**0.204**	**None**	**Yes**	**Detected organic**
VOCs								
Acetone	**67-64-1**	**2/ 19**	**0.0049**	**0.0079**	**0.00628**	**None**	**Yes**	**Detected organic**
Methylene chloride	**75-09-2**	**3/ 19**	**0.0007**	**0.0015**	**0.00278**	**None**	**Yes**	**Detected organic**
Styrene	**100-42-5**	**4/ 19**	**0.00088**	**0.0015**	**0.00273**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**4/ 19**	**0.00078**	**0.0042**	**0.00289**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SVOC = Semi-volatile organic compound.

VOC = Volatile organic compound.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–23. SRC Screening Summary for Former Plane Refueling/Crash Strip Area Surface Soil

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**	**28/ 28**	**6380**	**33900**	**13900**	**17700**	**Yes**	**Exceeds background**
Antimony	7440-36-0	10/ 28	0.093	0.8	0.457	0.96	No	Below background
Arsenic	**7440-38-2**	**28/ 28**	**2.2**	**22.1**	**8.4**	**15.4**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**28/ 28**	**30.4**	**359**	**100**	**88.4**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**14/ 28**	**0.35**	**3.8**	**0.782**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**12/ 28**	**0.048**	**5.2**	**0.449**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	26/ 28	169	195000	24200	15800	No	Essential Nutrient
Chromium	**7440-47-3**	**28/ 28**	**7.1**	**149**	**18.4**	**17.4**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**28/ 28**	**1.5**	**27.5**	**7.84**	**10.4**	**Yes**	**Exceeds background**
Copper	**7440-50-8**	**28/ 28**	**2.6**	**30.3**	**10.1**	**17.7**	**Yes**	**Exceeds background**
Cyanide	**57-12-5**	**4/ 18**	**0.77**	**1.6**	**0.495**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	28/ 28	4570	43600	17900	23100	No	Essential Nutrient
Lead	**7439-92-1**	**28/ 28**	**9.1**	**56.6**	**16.1**	**26.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	28/ 28	1070	25100	4950	3030	No	Essential Nutrient
Manganese	**7439-96-5**	**28/ 28**	**88.2**	**6240**	**1260**	**1450**	**Yes**	**Exceeds background**
Mercury	**7439-97-6**	**27/ 28**	**0.013**	**0.073**	**0.0381**	**0.036**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**28/ 28**	**2.1**	**64.7**	**14.9**	**21.1**	**Yes**	**Exceeds background**
Potassium	7440-09-7	28/ 28	276	2120	946	927	No	Essential Nutrient
Selenium	**7782-49-2**	**21/ 28**	**0.59**	**2.8**	**0.948**	**1.4**	**Yes**	**Exceeds background**
Silver	**7440-22-4**	**7/ 28**	**0.02**	**1.3**	**0.48**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	12/ 28	30	780	281	123	No	Essential Nutrient
Thallium	**7440-28-0**	**25/ 28**	**0.094**	**0.4**	**0.249**	**0**	**Yes**	**Exceeds background**
Vanadium	**7440-62-2**	**28/ 28**	**8.9**	**34.6**	**18.3**	**31.1**	**Yes**	**Exceeds background**
Zinc	**7440-66-6**	**28/ 28**	**17.4**	**158**	**53.3**	**61.8**	**Yes**	**Exceeds background**
Explosives and Propellants								
1,3,5-Trinitrobenzene	**99-35-4**	**1/ 11**	**0.02**	**0.02**	**0.111**	**None**	**Yes**	**Detected organic**
2,4,6-Trinitrotoluene	**118-96-7**	**1/ 11**	**5.5**	**5.5**	**0.61**	None	**Yes**	**Detected organic**

Table 4–23. SRC Screening Summary for Former Plane Refueling/Crash Strip Area Surface Soil (continued)

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
Explosives and Propellants (Continued)								
2,4-Dinitrotoluene	**121-14-2**	**3/ 11**	**0.014**	**0.22**	**0.112**	**None**	**Yes**	**Detected organic**
HMX	**2691-41-0**	**3/ 11**	**0.012**	**0.017**	**0.103**	**None**	**Yes**	**Detected organic**
Nitrocellulose	**9004-70-0**	**1/ 2**	**3.5**	**3.5**	**3.3**	**None**	**Yes**	**Detected organic**
SVOCs								
Acenaphthene	**83-32-9**	**6/ 28**	**0.011**	**2.1**	**0.287**	**None**	**Yes**	**Detected organic**
Acenaphthylene	**208-96-8**	**10/ 28**	**0.023**	**7.9**	**0.535**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**9/ 28**	**0.018**	**9.6**	**0.592**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**13/ 28**	**0.012**	**36**	**1.89**	None	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**17/ 28**	**0.0097**	**41**	**2.19**	None	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**15/ 28**	**0.02**	**54**	**2.86**	None	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**14/ 28**	**0.0096**	**24**	**1.38**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**13/ 28**	**0.034**	**19**	**1.07**	None	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**4/ 19**	**0.075**	**0.13**	**0.778**	**None**	**Yes**	**Detected organic**
Carbazole	**86-74-8**	**3/ 19**	**0.21**	**4.9**	**0.555**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**16/ 28**	**0.013**	**46**	**2.43**	None	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**8/ 28**	**0.042**	**5.7**	**0.396**	None	**Yes**	**Detected organic**
Dibenzofuran	**132-64-9**	**2/ 19**	**0.28**	**1.9**	**0.419**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**17/ 28**	**0.011**	**98**	**4.73**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**8/ 28**	**0.011**	**7.9**	**0.498**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**13/ 28**	**0.0087**	**24**	**1.35**	None	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**6/ 28**	**0.011**	**2.8**	**0.333**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**14/ 28**	**0.01**	**83**	**3.73**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**17/ 28**	**0.01**	**93**	**4.71**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**1/ 19**	**0.0018**	**0.0018**	**0.00596**	**None**	**Yes**	**Detected organic**
Acetone	**67-64-1**	**1/ 19**	**0.0078**	**0.0078**	**0.00662**	**None**	**Yes**	**Detected organic**

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

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.

VOC = Volatile organic compound.

SVOC = Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–24. SRC Screening Summary for Former Crash Area Subsurface Soil

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	12/ 12	5690	16200	9810	19500	No	Below background
Antimony	7440-36-0	8/ 10	0.079	0.099	0.132	0.96	No	Below background
Arsenic	**7440-38-2**	**12/ 12**	**6**	**24.7**	**10.7**	**19.8**	**Yes**	**Exceeds background**
Barium	**7440-39-3**	**12/ 12**	**16**	**137**	**55.6**	**124**	**Yes**	**Exceeds background**
Beryllium	**7440-41-7**	**12/ 12**	**0.3**	**1.1**	**0.561**	**0.88**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**11/ 12**	**0.033**	**0.14**	**0.0686**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	12/ 12	549	47800	12700	35500	No	Essential Nutrient
Chromium	7440-47-3	12/ 12	6.5	22.2	14.5	27.2	No	Below background
Cobalt	7440-48-4	12/ 12	5.1	12.1	9.09	23.2	No	Below background
Copper	7440-50-8	12/ 12	8.3	20.3	16.5	32.3	No	Below background
Iron	7439-89-6	12/ 12	13500	28200	22500	35200	No	Essential Nutrient
Lead	7439-92-1	12/ 12	6.9	15.3	11	19.1	No	Below background
Magnesium	7439-95-4	12/ 12	1220	8460	4770	8790	No	Essential Nutrient
Manganese	7439-96-5	12/ 12	169	530	325	3030	No	Below background
Mercury	7439-97-6	2/ 12	0.019	0.02	0.0553	0.044	No	Below background
Nickel	7440-02-0	12/ 12	10.2	29.1	21.8	60.7	No	Below background
Potassium	7440-09-7	12/ 12	458	2800	1490	3350	No	Essential Nutrient
Selenium	7782-49-2	12/ 12	0.47	1.4	0.783	1.5	No	Below background
Silver	**7440-22-4**	**3/ 12**	**0.037**	**0.057**	**0.0207**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	12/ 12	22.2	416	108	145	No	Essential Nutrient
Thallium	7440-28-0	12/ 12	0.078	0.2	0.146	0.91	No	Below background
Vanadium	7440-62-2	12/ 12	8.9	27.2	17.2	37.6	No	Below background
Zinc	7440-66-6	12/ 12	30.4	76.3	54.2	93.3	No	Below background

Table 4–24. SRC Screening Summary for Former Crash Area Subsurface Soil (continued)

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
				SVOCs				
Benz(a)anthracene	**56-55-3**	**1/ 12**	**0.013**	**0.013**	**0.00699**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 12**	**0.0081**	**0.0081**	**0.00885**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**3/ 12**	**0.0093**	**0.023**	**0.00901**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**3/ 12**	**0.011**	**0.031**	**0.0124**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**1/ 2**	**0.097**	**0.097**	**0.144**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**5/ 12**	**0.0094**	**0.023**	**0.0106**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**2/ 12**	**0.01**	**0.033**	**0.00917**	**None**	**Yes**	**Detected organic**
Naphthalene	**91-20-3**	**1/ 12**	**0.02**	**0.02**	**0.00984**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**4/ 12**	**0.011**	**0.028**	**0.0123**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**4/ 12**	**0.0086**	**0.034**	**0.0113**	**None**	**Yes**	**Detected organic**
				Pesticides/PCBs				
delta-BHC	**319-86-8**	**1/ 2**	**0.0044**	**0.0044**	**0.00335**	**None**	**Yes**	**Detected organic**

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

Table 4–25. SRC Screening Summary for Former Plane Burial Area Subsurface Soil

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	17/ 17	7200	18500	10700	19500	No	Below background
Arsenic	7440-38-2	17/ 17	5.2	18.3	11.6	19.8	No	Below background
Barium	**7440-39-3**	**17/ 17**	**32.5**	**196**	**62.9**	**124**	**Yes**	**Exceeds background**
Beryllium	7440-41-7	11/ 17	0.24	0.83	0.322	0.88	No	Below background
Cadmium	**7440-43-9**	**2/ 17**	**0.62**	**30**	**2.06**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	13/ 17	123	2370	648	35500	No	Essential Nutrient
Chromium	7440-47-3	17/ 17	9.7	24.3	13.7	27.2	No	Below background
Cobalt	7440-48-4	17/ 17	3.8	19.3	9.17	23.2	No	Below background
Copper	**7440-50-8**	**17/ 17**	**7.3**	**400**	**41.7**	**32.3**	**Yes**	**Exceeds background**
Iron	7439-89-6	17/ 17	15600	32600	22400	35200	No	Essential Nutrient
Lead	**7439-92-1**	**17/ 17**	**8.4**	**151**	**22**	**19.1**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	17/ 17	1340	4960	2170	8790	No	Essential Nutrient
Manganese	7439-96-5	17/ 17	90.9	1790	517	3030	No	Below background
Mercury	7439-97-6	17/ 17	0.018	0.042	0.03	0.044	No	Below background
Nickel	7440-02-0	17/ 17	9.9	35.1	16.3	60.7	No	Below background
Potassium	7440-09-7	17/ 17	398	2380	919	3350	No	Essential Nutrient
Selenium	7782-49-2	4/ 17	0.49	1.1	0.394	1.5	No	Below background
Thallium	7440-28-0	13/ 17	0.22	0.4	0.286	0.91	No	Below background
Vanadium	7440-62-2	17/ 17	13.2	27.7	19.5	37.6	No	Below background
Zinc	**7440-66-6**	**17/ 17**	**38.4**	**132**	**57.9**	**93.3**	**Yes**	**Exceeds background**
SVOCs								
Bis(2-ethylhexyl)phthalate	**117-81-7**	**5/ 17**	**0.051**	**0.43**	**0.188**	**None**	**Yes**	**Detected organic**
VOCs								
Dimethylbenzene	**1330-20-7**	**1/ 17**	**0.002**	**0.002**	**0.00284**	**None**	**Yes**	**Detected organic**
Methylene chloride	**75-09-2**	**2/ 17**	**0.0012**	**0.0016**	**0.00271**	**None**	**Yes**	**Detected organic**
Styrene	**100-42-5**	**6/ 17**	**0.00082**	**0.0027**	**0.00232**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**3/ 17**	**0.00063**	**0.0053**	**0.00278**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

VOC = Volatile organic compound.

SRC = Site-related contaminant.

SVOC = Semi-volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–26. SRC Screening Summary for Former Plane Refueling/Crash Strip Area Subsurface Soil

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	10/ 10	5340	13100	10200	19500	No	Below background
Antimony	7440-36-0	6/ 10	0.08	0.14	0.283	0.96	No	Below background
Arsenic	7440-38-2	10/ 10	3.8	16.2	12.6	19.8	No	Below background
Barium	7440-39-3	10/ 10	15.6	93.7	62.3	124	No	Below background
Beryllium	7440-41-7	6/ 10	0.5	0.67	0.441	0.88	No	Below background
Cadmium	**7440-43-9**	**7/ 10**	**0.056**	**0.44**	**0.172**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	9/ 10	720	18400	4150	35500	No	Essential Nutrient
Chromium	7440-47-3	10/ 10	6.7	19.1	14.9	27.2	No	Below background
Cobalt	7440-48-4	10/ 10	3.1	14	10.2	23.2	No	Below background
Copper	7440-50-8	10/ 10	6.9	22.4	17	32.3	No	Below background
Iron	7439-89-6	10/ 10	9550	31300	25200	35200	No	Essential Nutrient
Lead	7439-92-1	10/ 10	6.6	16.7	12.7	19.1	No	Below background
Magnesium	7439-95-4	10/ 10	1060	6030	3360	8790	No	Essential Nutrient
Manganese	7439-96-5	10/ 10	51.4	1310	470	3030	No	Below background
Mercury	**7439-97-6**	**4/ 10**	**0.02**	**0.05**	**0.0485**	**0.044**	**Yes**	**Exceeds background**
Nickel	7440-02-0	10/ 10	9	31.7	22.8	60.7	No	Below background
Potassium	7440-09-7	10/ 10	358	1790	1130	3350	No	Essential Nutrient
Selenium	7782-49-2	8/ 10	0.63	1	0.736	1.5	No	Below background
Silver	**7440-22-4**	**3/ 10**	**0.015**	**0.019**	**0.234**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	6/ 10	32.3	89.5	148	145	No	Essential Nutrient
Thallium	7440-28-0	10/ 10	0.13	0.31	0.208	0.91	No	Below background
Vanadium	7440-62-2	10/ 10	9.3	20.9	17.4	37.6	No	Below background
Zinc	7440-66-6	10/ 10	24.8	65.5	55.7	93.3	No	Below background

Table 4–26. SRC Screening for Former Plane Refueling/Crash Strip Area Subsurface Soil (continued)

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
SVOCs								
Acenaphthylene	**208-96-8**	**1/ 10**	**0.23**	**0.23**	**0.0805**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/ 10**	**0.09**	**0.09**	**0.0665**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**2/ 10**	**0.011**	**0.46**	**0.104**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**3/ 10**	**0.011**	**0.7**	**0.129**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**3/ 10**	**0.016**	**1**	**0.16**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**3/ 10**	**0.011**	**0.65**	**0.124**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**2/ 10**	**0.0089**	**0.23**	**0.0809**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**3/ 4**	**0.056**	**0.14**	**0.111**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**3/ 10**	**0.012**	**0.62**	**0.122**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 10**	**0.11**	**0.11**	**0.0685**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**3/ 10**	**0.022**	**1**	**0.161**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**3/ 10**	**0.0084**	**0.52**	**0.11**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**3/ 10**	**0.0095**	**0.33**	**0.0916**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**3/ 10**	**0.02**	**1**	**0.161**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SVOC = Semi-volatile organic compound.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–27. SRC Screening for Tributary to Hinkley Creek Discrete Sediment Samples

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	2/ 2	7580	13500	10500	13900	No	Below background
Arsenic	7440-38-2	2/ 2	4	10.6	7.3	19.5	No	Below background
Barium	7440-39-3	2/ 2	64.3	65.5	64.9	123	No	Below background
Beryllium	**7440-41-7**	**2/ 2**	**0.49**	**0.67**	**0.58**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 2**	**0.33**	**0.33**	**0.178**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	2/ 2	1120	4930	3030	5510	No	Essential Nutrient
Chromium	**7440-47-3**	**2/ 2**	**10.3**	**19.2**	**14.8**	**18.1**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**2/ 2**	**6.5**	**14.4**	**10.5**	**9.1**	**Yes**	**Exceeds background**
Copper	7440-50-8	2/ 2	10.3	19.1	14.7	27.6	No	Below background
Iron	7439-89-6	2/ 2	12800	32600	22700	28200	No	Essential Nutrient
Lead	7439-92-1	2/ 2	10.9	14.4	12.7	27.4	No	Below background
Magnesium	7439-95-4	2/ 2	1870	6480	4180	2760	No	Essential Nutrient
Manganese	7439-96-5	2/ 2	292	708	500	1950	No	Below background
Mercury	7439-97-6	1/ 2	0.032	0.032	0.0485	0.059	No	Below background
Nickel	**7440-02-0**	**2/ 2**	**13.3**	**33.6**	**23.5**	**17.7**	**Yes**	**Exceeds background**
Potassium	7440-09-7	2/ 2	580	1820	1200	1950	No	Essential Nutrient
Selenium	7782-49-2	2/ 2	0.68	1.2	0.94	1.7	No	Below background
Silver	**7440-22-4**	**1/ 2**	**0.031**	**0.031**	**0.0235**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	1/ 2	91.4	91.4	53.7	112	No	Essential Nutrient
Thallium	7440-28-0	2/ 2	0.1	0.18	0.14	0.89	No	Below background
Vanadium	7440-62-2	2/ 2	13.3	19.4	16.4	26.1	No	Below background
Zinc	7440-66-6	2/ 2	56	60.3	58.2	532	No	Below background
Explosives								
HMX	**2691-41-0**	**1/ 2**	**0.013**	**0.013**	**0.069**	**None**	**Yes**	**Detected organic**

Table 4–27. SRC Screening for Tributary to Hinkley Creek Discrete Sediment Samples (continued)

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
SVOCs								
Acenaphthene	**83-32-9**	**1/ 2**	**0.012**	**0.012**	**0.0223**	**None**	**Yes**	**Detected organic**
Anthracene	**120-12-7**	**1/ 2**	**0.026**	**0.026**	**0.0293**	**None**	**Yes**	**Detected organic**
Benz(a)anthracene	**56-55-3**	**2/ 2**	**0.01**	**0.059**	**0.0345**	**None**	**Yes**	**Detected organic**
Benzo(a)pyrene	**50-32-8**	**1/ 2**	**0.066**	**0.066**	**0.0493**	**None**	**Yes**	**Detected organic**
Benzo(b)fluoranthene	**205-99-2**	**2/ 2**	**0.012**	**0.083**	**0.0475**	**None**	**Yes**	**Detected organic**
Benzo(ghi)perylene	**191-24-2**	**2/ 2**	**0.012**	**0.041**	**0.0265**	**None**	**Yes**	**Detected organic**
Benzo(k)fluoranthene	**207-08-9**	**1/ 2**	**0.036**	**0.036**	**0.0343**	**None**	**Yes**	**Detected organic**
Bis(2-ethylhexyl)phthalate	**117-81-7**	**1/ 2**	**0.35**	**0.35**	**0.293**	**None**	**Yes**	**Detected organic**
Chrysene	**218-01-9**	**2/ 2**	**0.01**	**0.069**	**0.0395**	**None**	**Yes**	**Detected organic**
Dibenz(a,h)anthracene	**53-70-3**	**1/ 2**	**0.011**	**0.011**	**0.0218**	**None**	**Yes**	**Detected organic**
Fluoranthene	**206-44-0**	**1/ 2**	**0.1**	**0.1**	**0.0663**	**None**	**Yes**	**Detected organic**
Fluorene	**86-73-7**	**1/ 2**	**0.012**	**0.012**	**0.0223**	**None**	**Yes**	**Detected organic**
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1/ 2**	**0.037**	**0.037**	**0.0348**	**None**	**Yes**	**Detected organic**
Phenanthrene	**85-01-8**	**1/ 2**	**0.07**	**0.07**	**0.0513**	**None**	**Yes**	**Detected organic**
Pyrene	**129-00-0**	**2/ 2**	**0.015**	**0.082**	**0.0485**	**None**	**Yes**	**Detected organic**
VOCs								
2-Butanone	**78-93-3**	**1/ 2**	**0.0064**	**0.0064**	**0.0097**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

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

mg/kg = Milligrams per kilogram.

VOC = Volatile organic compound.

SVOC = Semi-volatile organic compound.

SRC = Site-related contaminant.

Bold indicates analyte identified as an SRC.

Table 4–28. SRC Screening for Wetlands/Pond North of Former Crash Area Discrete Sediment Samples

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	12000	12000	12000	13900	No	Below background
Arsenic	7440-38-2	1/ 1	4.3	4.3	4.3	19.5	No	Below background
Barium	7440-39-3	1/ 1	57.5	57.5	57.5	123	No	Below background
Beryllium	**7440-41-7**	**1/ 1**	**0.4**	**0.4**	**0.4**	**0.38**	**Yes**	**Exceeds background**
Cadmium	**7440-43-9**	**1/ 1**	**0.1**	**0.1**	**0.1**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	1/ 1	1520	1520	1520	5510	No	Essential Nutrient
Chromium	7440-47-3	1/ 1	14.6	14.6	14.6	18.1	No	Below background
Cobalt	7440-48-4	1/ 1	5.5	5.5	5.5	9.1	No	Below background
Copper	7440-50-8	1/ 1	9.6	9.6	9.6	27.6	No	Below background
Iron	7439-89-6	1/ 1	14800	14800	14800	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	12.3	12.3	12.3	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	2440	2440	2440	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	157	157	157	1950	No	Below background
Mercury	7439-97-6	1/ 1	0.023	0.023	0.023	0.059	No	Below background
Nickel	7440-02-0	1/ 1	12.7	12.7	12.7	17.7	No	Below background
Potassium	7440-09-7	1/ 1	758	758	758	1950	No	Essential Nutrient
Selenium	7782-49-2	1/ 1	0.52	0.52	0.52	1.7	No	Below background
Silver	**7440-22-4**	**1/ 1**	**0.031**	**0.031**	**0.031**	**0**	**Yes**	**Exceeds background**
Thallium	7440-28-0	1/ 1	0.14	0.14	0.14	0.89	No	Below background
Vanadium	7440-62-2	1/ 1	20.6	20.6	20.6	26.1	No	Below background
Zinc	7440-66-6	1/ 1	46.2	46.2	46.2	532	No	Below background
VOCs								
2-Butanone	**78-93-3**	**1/ 1**	**0.0044**	**0.0044**	**0.0044**	**None**	**Yes**	**Detected organic**
Ethylbenzene	**100-41-4**	**1/ 1**	**0.0015**	**0.0015**	**0.0015**	**None**	**Yes**	**Detected organic**
Toluene	**108-88-3**	**1/ 1**	**0.17**	**0.17**	**0.17**	**None**	**Yes**	**Detected organic**

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

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–29. SRC Screening for Former Crash Area Reservoir Off AOC Discrete Sediment Samples

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	8800	8800	8800	13900	No	Below background
Arsenic	7440-38-2	1/ 1	5.4	5.4	5.4	19.5	No	Below background
Barium	7440-39-3	1/ 1	48.3	48.3	48.3	123	No	Below background
Calcium	7440-70-2	1/ 1	2150	2150	2150	5510	No	Essential Nutrient
Chromium	7440-47-3	1/ 1	11.1	11.1	11.1	18.1	No	Below background
Cobalt	7440-48-4	1/ 1	7.5	7.5	7.5	9.1	No	Below background
Copper	7440-50-8	1/ 1	14.1	14.1	14.1	27.6	No	Below background
Iron	7439-89-6	1/ 1	15900	15900	15900	28200	No	Essential Nutrient
Lead	7439-92-1	1/ 1	16.7	16.7	16.7	27.4	No	Below background
Magnesium	7439-95-4	1/ 1	1730	1730	1730	2760	No	Essential Nutrient
Manganese	7439-96-5	1/ 1	164	164	164	1950	No	Below background
Nickel	7440-02-0	1/ 1	14.2	14.2	14.2	17.7	No	Below background
Potassium	7440-09-7	1/ 1	914	914	914	1950	No	Essential Nutrient
Thallium	7440-28-0	1/ 1	0.27	0.27	0.27	0.89	No	Below background
Vanadium	7440-62-2	1/ 1	15.4	15.4	15.4	26.1	No	Below background
Zinc	7440-66-6	1/ 1	52.4	52.4	52.4	532	No	Below background
				VOCs				
2-Butanone	**78-93-3**	**1/ 1**	**0.016**	**0.016**	**0.016**	**None**	**Yes**	**Detected organic**
Acetone	**67-64-1**	**1/ 1**	**0.061**	**0.061**	**0.061**	**None**	**Yes**	**Detected organic**

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

AOC = Area of concern.

CAS = Chemical Abstract Service.

mg/kg = Milligrams per kilogram.

SRC = Site-related contaminant.

VOC = Volatile organic compound.

Bold indicates analyte identified as an SRC.

Table 4–30. SRC Screening for Tributary to Hinkley Creek Surface Water Samples

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Average Result (mg/L)	Background Criteria[a] (mg/L)	SRC? (yes/no)	SRC Justification
Metals								
Aluminum	7429-90-5	2/ 2	0.241	0.441	0.341	3.37	No	Below background
Antimony	**7440-36-0**	**1/ 2**	**0.00026**	**0.00026**	**0.00138**	**0**	**Yes**	**Exceeds background**
Arsenic	7440-38-2	2/ 2	0.00065	0.00067	0.00066	0.0032	No	Below background
Barium	7440-39-3	2/ 2	0.0179	0.0244	0.0212	0.0475	No	Below background
Cadmium	**7440-43-9**	**1/ 2**	**0.000048**	**0.000048**	**0.000524**	**0**	**Yes**	**Exceeds background**
Calcium	7440-70-2	2/ 2	12.7	22.5	17.6	41.4	No	Essential Nutrient
Chromium	**7440-47-3**	**1/ 2**	**0.00061**	**0.00061**	**0.00156**	**0**	**Yes**	**Exceeds background**
Cobalt	**7440-48-4**	**2/ 2**	**0.00027**	**0.00046**	**0.000365**	**0**	**Yes**	**Exceeds background**
Copper	7440-50-8	1/ 2	0.0024	0.0024	0.00245	0.0079	No	Below background
Iron	7439-89-6	2/ 2	0.874	2.36	1.62	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**2/ 2**	**0.00023**	**0.00052**	**0.000375**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	2/ 2	3.82	5.54	4.68	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**2/ 2**	**0.13**	**0.509**	**0.32**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**2/ 2**	**0.00086**	**0.0013**	**0.00108**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	2/ 2	1.43	1.79	1.61	3.17	No	Essential Nutrient
Selenium	**7782-49-2**	**1/ 2**	**0.00037**	**0.00037**	**0.00144**	**0**	**Yes**	**Exceeds background**
Sodium	7440-23-5	2/ 2	1.84	21.8	11.8	21.3	No	Essential Nutrient
Vanadium	**7440-62-2**	**2/ 2**	**0.00052**	**0.00067**	**0.000595**	**0**	**Yes**	**Exceeds background**
SVOCs								
Bis(2-ethylhexyl)phthalate	**117-81-7**	**1/ 2**	**0.021**	**0.021**	**0.013**	**None**	**Yes**	**Detected organic**

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

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 4–31. SRC Screening for Wetland/Pond North of Former Crash Area Water Samples

Analyte	CAS Number	Freq of Detect	Minimum Detect (mg/L)	Maximum Detect (mg/L)	Average Result (mg/L)	Background Criteria[a] (mg/L)	SRC? (yes/no)	SRC Justification
Metals								
Aluminum	7429-90-5	1/ 1	0.225	0.225	0.225	3.37	No	Below background
Arsenic	7440-38-2	1/ 1	0.00072	0.00072	0.00072	0.0032	No	Below background
Barium	7440-39-3	1/ 1	0.0188	0.0188	0.0188	0.0475	No	Below background
Calcium	7440-70-2	1/ 1	14.3	14.3	14.3	41.4	No	Essential Nutrient
Cobalt	**7440-48-4**	**1/ 1**	**0.00063**	**0.00063**	**0.00063**	**0**	**Yes**	**Exceeds background**
Iron	7439-89-6	1/ 1	3.75	3.75	3.75	2.56	No	Essential Nutrient
Lead	**7439-92-1**	**1/ 1**	**0.0002**	**0.0002**	**0.0002**	**0**	**Yes**	**Exceeds background**
Magnesium	7439-95-4	1/ 1	4.67	4.67	4.67	10.8	No	Essential Nutrient
Manganese	**7439-96-5**	**1/ 1**	**0.737**	**0.737**	**0.737**	**0.391**	**Yes**	**Exceeds background**
Nickel	**7440-02-0**	**1/ 1**	**0.00098**	**0.00098**	**0.00098**	**0**	**Yes**	**Exceeds background**
Potassium	7440-09-7	1/ 1	1.57	1.57	1.57	3.17	No	Essential Nutrient
Sodium	7440-23-5	1/ 1	2.28	2.28	2.28	21.3	No	Essential Nutrient
Thallium	**7440-28-0**	**1/ 1**	**0.00037**	**0.00037**	**0.00037**	**0**	**Yes**	**Exceeds background**
VOCs								
Toluene	**108-88-3**	**1/ 1**	**0.00035**	**0.00035**	**0.00035**	**None**	**Yes**	**Detected organic**

[a] Background concentrations are published in the Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001d).
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 4–32. Data Summary and Designated Use for RI

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
Surface (0-1 ft) and Subsurface (>1 ft) Soil										
NTAsb-120-5293-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-120-5294-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-120-5295-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-121-5297-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-121-5298-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-121-5299-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-121-6133-FD	D	03/31/10	4–7	PBA08 RI	X	--	--	--	--	Field duplicate.
NTAsb-122-5301-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-122-5302-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-122-5303-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-123-5305-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-123-5306-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-123-5307-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-123-6132-FD	D	03/31/10	1–4	PBA08 RI	X	--	--	--	--	Field duplicate.
NTAsb-124-5309-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-124-5310-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-124-5311-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-124-5312-SO	D	03/31/10	7–13	PBA08 RI	--	X	X	X	--	
NTAsb-124-6134-FD	D	03/31/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
NTAsb-125-5313-SO	D	03/31/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-125-5314-SO	D	03/31/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-125-5315-SO	D	03/31/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-125-5316-SO	D	03/31/10	7–13	PBA08 RI	--	X	X	X	--	
NTAsb-126-5317-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-126-5318-SO	D	04/08/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-126-5319-SO	D	04/08/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsb-127-5321-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAsb-127-5322-SO	D	04/08/10	1–4	PBA08 RI	--	X	X	X	--	
NTAsb-127-5323-SO	D	04/08/10	4–7	PBA08 RI	--	X	X	X	--	
NTAsd-101-0124-SD	D	10/22/99	0–0.5	Phase I RI	--	X	X	X	X	
NTAso-065-0068-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-066-0070-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-067-0072-SO	D	11/03/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-068-0074-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-069-0076-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-070-0079-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
NTAso-071-0081-SO	D	10/27/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-072-0083-SO	D	10/27/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-073-0085-SO	D	11/02/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-073-0121-SO	D	11/02/99	3–5	Phase I RI	--	X	X	X	--	
NTAso-074-0087-SO	D	10/27/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-075-0089-SO	D	10/27/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-076-0091-SO	D	11/03/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-077-0093-SO	D	11/01/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-079-0096-SO	D	11/03/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-083-0101-SO	D	10/19/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-084-0103-SO	D	10/19/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-085-0105-SO	D	10/19/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-095-0116-SO	D	10/19/99	1–3	Phase I RI	--	X	X	X	--	
NTAso-100-0123-SO	D	11/04/99	1–3	Phase I RI	--	X	X	X	--	
NTAss-001-0001-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-002-0002-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-003-0003-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-004-0004-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-005-0005-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-006-0006-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-007-0007-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-008-0008-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-009-0009-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-010-0010-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-011-0011-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-012-0012-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-013-0013-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-014-0014-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-015-0015-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-016-0016-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-017-0017-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-018-0018-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-014-0014-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-019-0019-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-020-0020-SO	D	10/21/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-021-0021-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-022-0022-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-023-0023-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
NTAss-024-0024-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-025-0025-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-026-0026-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-027-0027-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-028-0028-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-029-0029-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-030-0030-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-031-0031-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-032-0032-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-032-0139-SO	D	10/24/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-033-0033-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-034-0034-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-035-0035-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-036-0036-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-037-0037-SO	D	10/22/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-038-0038-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-039-0040-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-040-0041-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-041-0042-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-042-0043-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-043-0044-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-043-0140-SO	D	10/25/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-044-0045-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-045-0046-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-046-0047-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-047-0048-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-048-0049-SO	D	10/24/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-049-0050-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-050-0051-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-051-0052-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-052-0053-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-053-0054-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-054-0055-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-055-0056-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-055-0141-SO	D	10/26/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-056-0057-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-057-0058-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-058-0060-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
NTAss-058-0137-SO	D	10/20/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-059-0061-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-060-0062-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-061-0063-SO	D	10/25/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-062-0064-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-063-0065-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-064-0066-SO	D	10/26/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-065-0067-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-066-0069-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-067-0071-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-068-0073-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-069-0075-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-069-0142-SO	D	11/02/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-069-0143-SO	D	11/02/99	1–3	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-070-0078-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-070-0120-SO	D	11/02/99	3–5	Phase I RI	--	X	X	X	--	
NTAss-070-0147-SO	D	11/02/99	3–5	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-071-0080-SO	D	10/27/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-072-0082-SO	D	10/27/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-073-0084-SO	D	11/02/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-073-0138-SO	D	11/02/99	1–3	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-073-0146-SO	D	11/02/99	3–5	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-074-0086-SO	D	10/27/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-075-0088-SO	D	10/27/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-076-0090-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-077-0092-SO	D	11/01/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-078-0094-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-079-0095-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-080-0097-SO	D	11/01/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-081-0098-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-082-0099-SO	D	11/03/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-083-0100-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-084-0102-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-085-0104-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-086-0106-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-087-0107-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-088-0108-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-089-0109-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
NTAss-090-0110-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-091-0111-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-091-0144-SO	D	10/19/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-092-0112-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-093-0113-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-094-0114-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-095-0115-SO	D	10/19/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-096-0117-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-097-0118-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-098-0119-SO	D	10/20/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-098-0145-SO	D	10/20/99	0–1	Phase I RI	X	--	--	--	--	Field duplicate.
NTAss-100-0122-SO	D	11/04/99	0–1	Phase I RI	--	X	X	X	X	
NTAss-128-5325-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-129-5326-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-130-5327-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-130-6105-FD	D	04/08/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
NTAss-131-5328-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-132-5329-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-133-5330-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-134-5331-SO	D	04/08/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
NTAss-135-5332-SO	D	04/08/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
NTAss-136-5333-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-137-5334-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-137-6107-FD	D	04/08/10	0–1	PBA08 RI	X	--	--	--	--	Field duplicate.
NTAss-138-5335-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-139-5336-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-140-5337-SO	D	04/08/10	0–1	PBA08 RI	--	X	--	X	--	Sample collected for chromium speciation analysis only.
NTAss-141-5338-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
NTAss-142-5339-SO	D	04/08/10	0–1	PBA08 RI	--	X	X	X	X	
RVAP-381	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RVAP-382	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
RVAP-383	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RVAP-384	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RVAP-385	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
RVAP-386	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Field duplicate. Used for initial evaluation of site.
Sediment										
NTAsd-102-0125-SD	D	10/22/99	0–0.5	Phase I RI	--	X	X	X	X	
NTAsd-103-0126-SD	D	10/24/99	0–0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsd-104-0127-SD	D	10/24/99	0–0.5	Phase I RI	--	X	--	--	--	Sample represents drainage upstream of AOC.
NTAsd-104-0148-SD	D	10/24/99	0–0.5	Phase I RI	X	--	--	--	--	Field duplicate.
NTAsd-105-0128-SD	D	10/22/99	0–0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsd-106-0129-SD	D	10/24/99	0–0.5	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsd-143-5343-SD	D	03/09/10	0–0.5	PBA08 RI	--	X	X	X	X	
NTAsd-144-5344-SD	D	03/09/10	0–0.5	PBA08 RI	--	X	X	X	X	
NTAsd-145-5345-SD	D	02/25/10	0–0.5	PBA08 RI	--	X	X	X	X	
RVAP-38B	D	10/28/96	0–0.5	1996 RRSE	--	--	--	--	--	Used for initial evaluation of site.
Surface Water										
NTAsw-102-0131-SW	D	10/22/99	0–0.1	Phase I RI	--	X	--	--	--	
NTAsw-103-0132-SW	D	10/24/99	0–0.1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsw-104-0133-SW	D	10/24/99	0–0.1	Phase I RI	--	X	--	--	--	Sample represents drainage upstream of AOC.
NTAsw-104-0149-SW	D	10/24/99	0–0.1	Phase I RI	X	--	--	--	--	Field duplicate.

Table 4–32. Data Summary and Designated Use for RI (continued)

Sample ID	Type	Date	Depth (ft)	Sampling Event	QC	N&E	F&T	HHRA	ERA	Comments
NTAsw-105-0134-SW	D	10/22/99	0–0.1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsw-106-0135-SW	D	10/24/99	0–0.1	Phase I RI	--	X	--	--	--	Sample not used for HHRA and ERA because more recent sample was taken at the same location.
NTAsw-143-5340-SW	D	03/09/10	-	PBA08 RI	--	X	X	X	X	
NTAsw-144-5341-SW	D	03/09/10	-	PBA08 RI	--	X	X	X	X	
NTAsw-145-5342-SW	D	02/25/10	-	PBA08 RI	--	X	X	X	X	

AOC = Area of concern.
D = Discrete.
ERA = Ecological risk assessment.
ft = Feet.
F&T = Fate and transport.
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.
RRSE = Relative risk site evaluation.

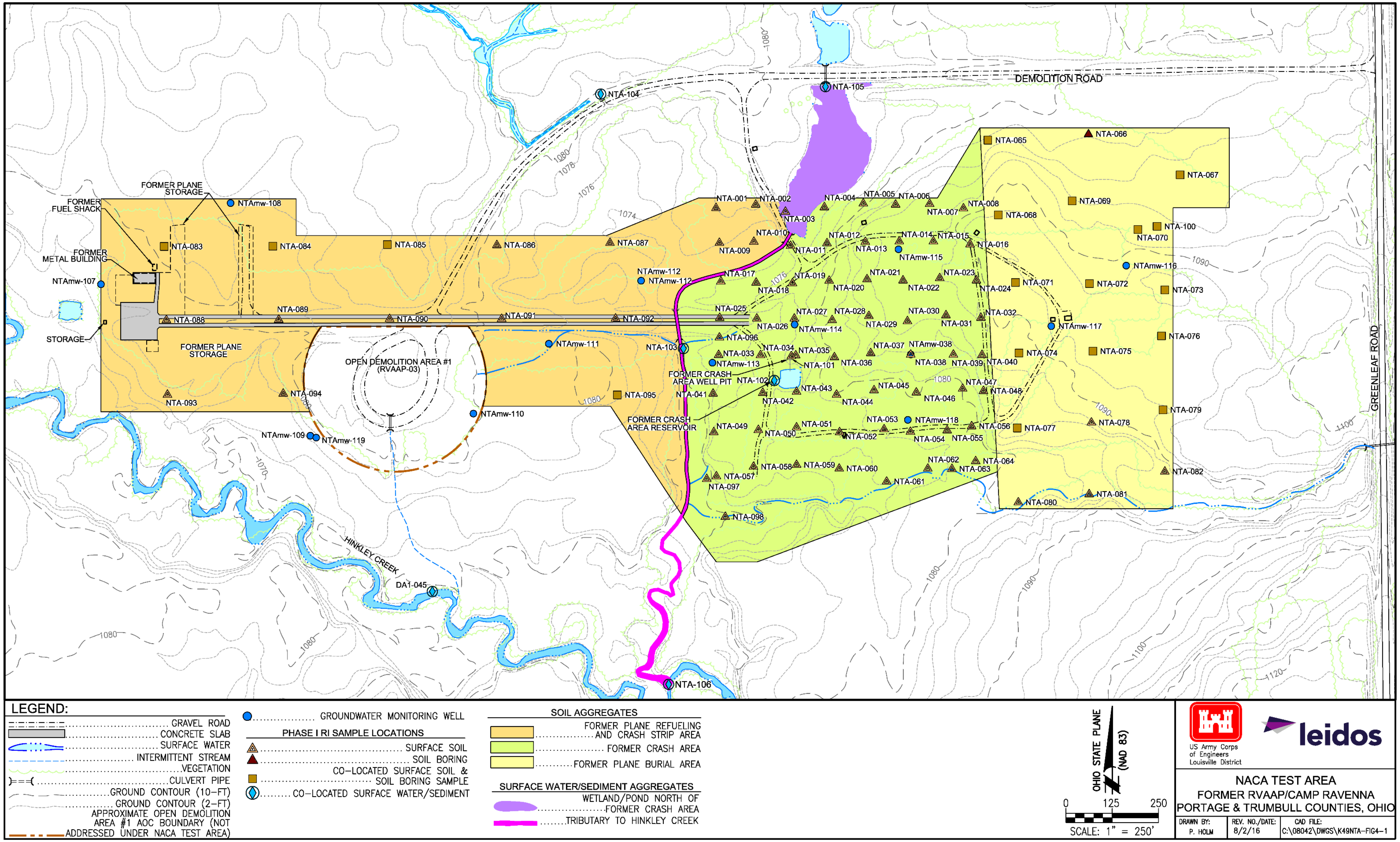

Figure 4–1. Phase I RI Sample Locations at NACA Test Area

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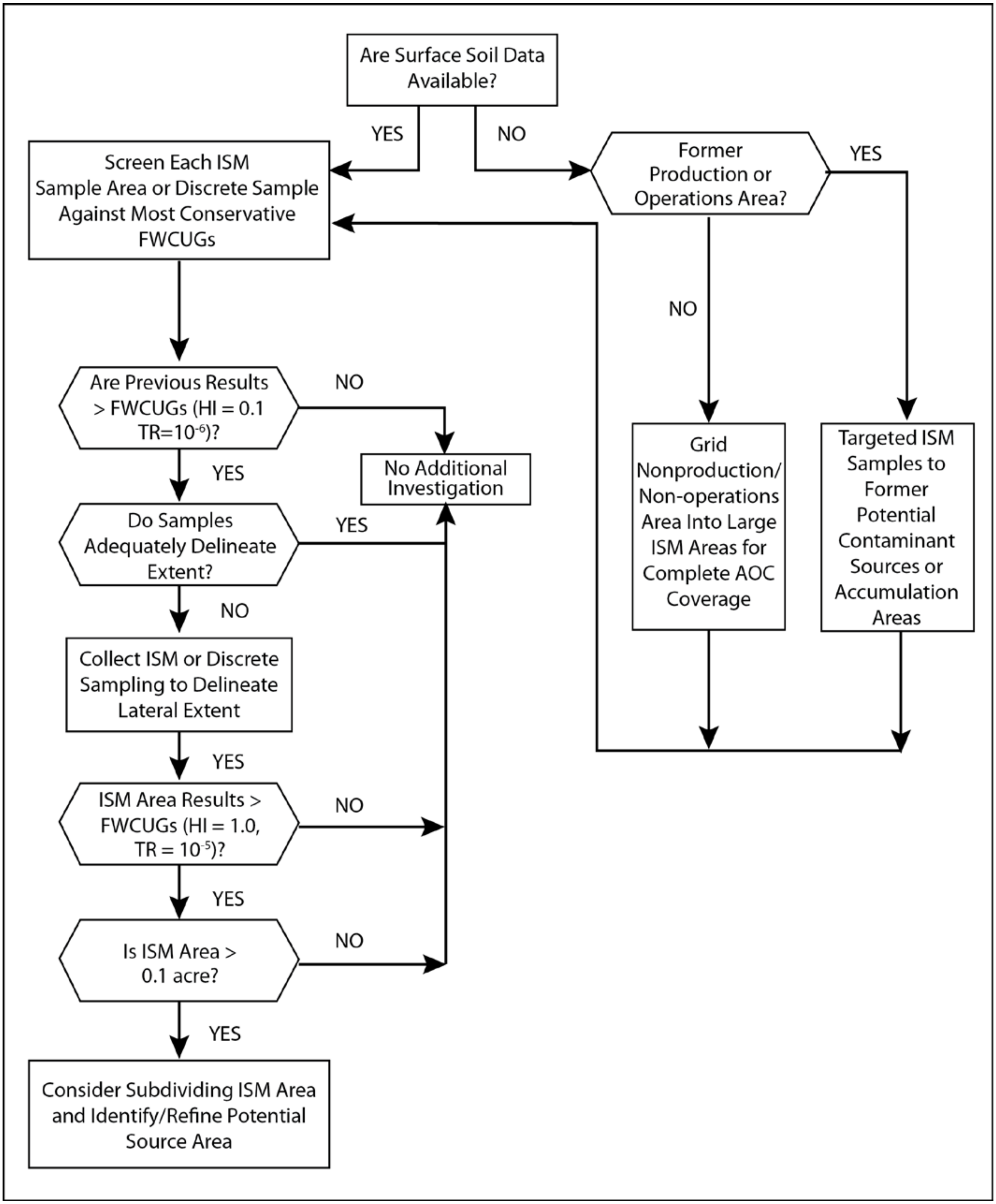

Figure 4–2. PBA08 RI Surface Soil Sampling

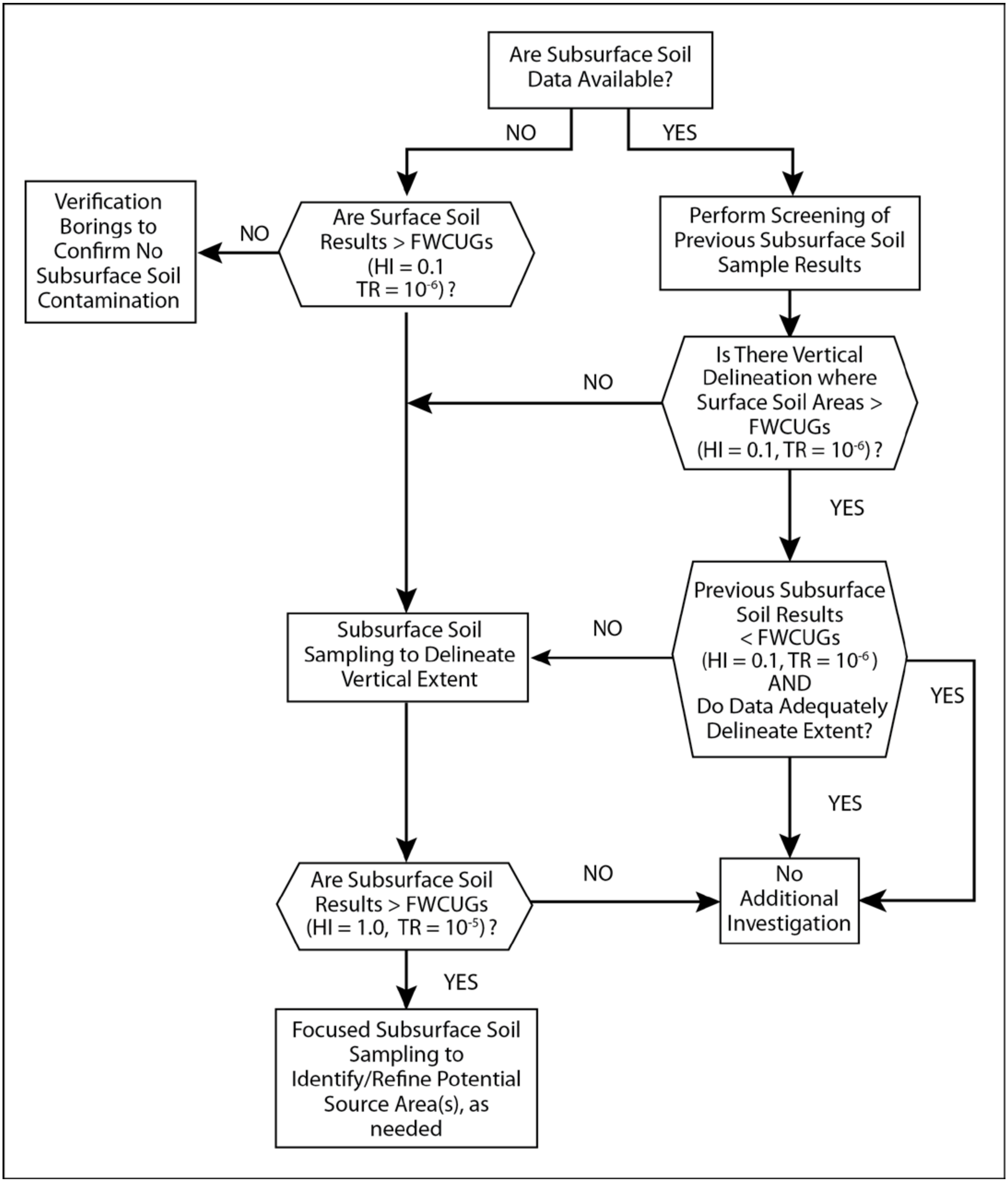

Figure 4–3. PBA08 RI Subsurface Soil Sampling

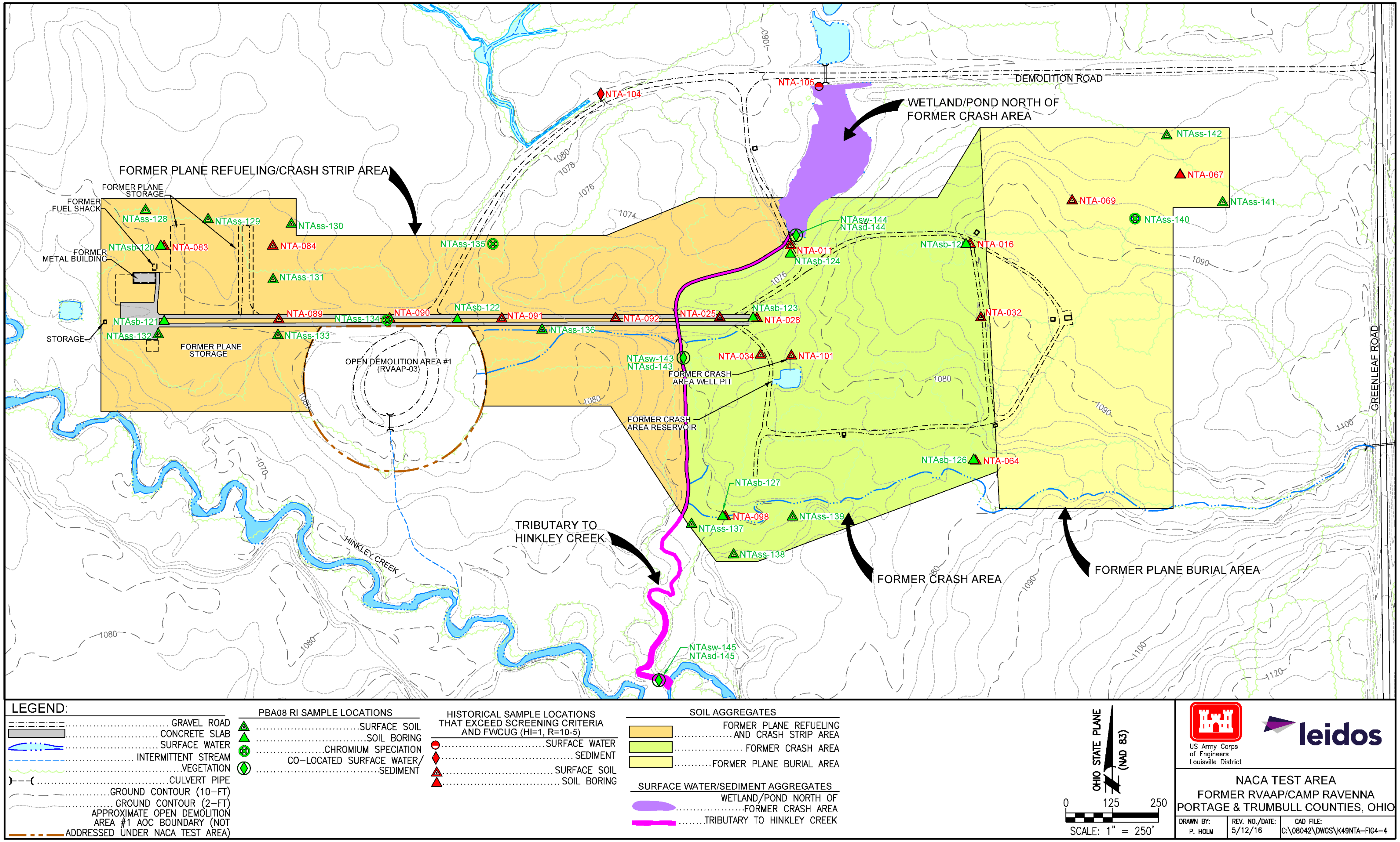

Figure 4–4. PBA08 RI Sample Locations at NACA Test Area

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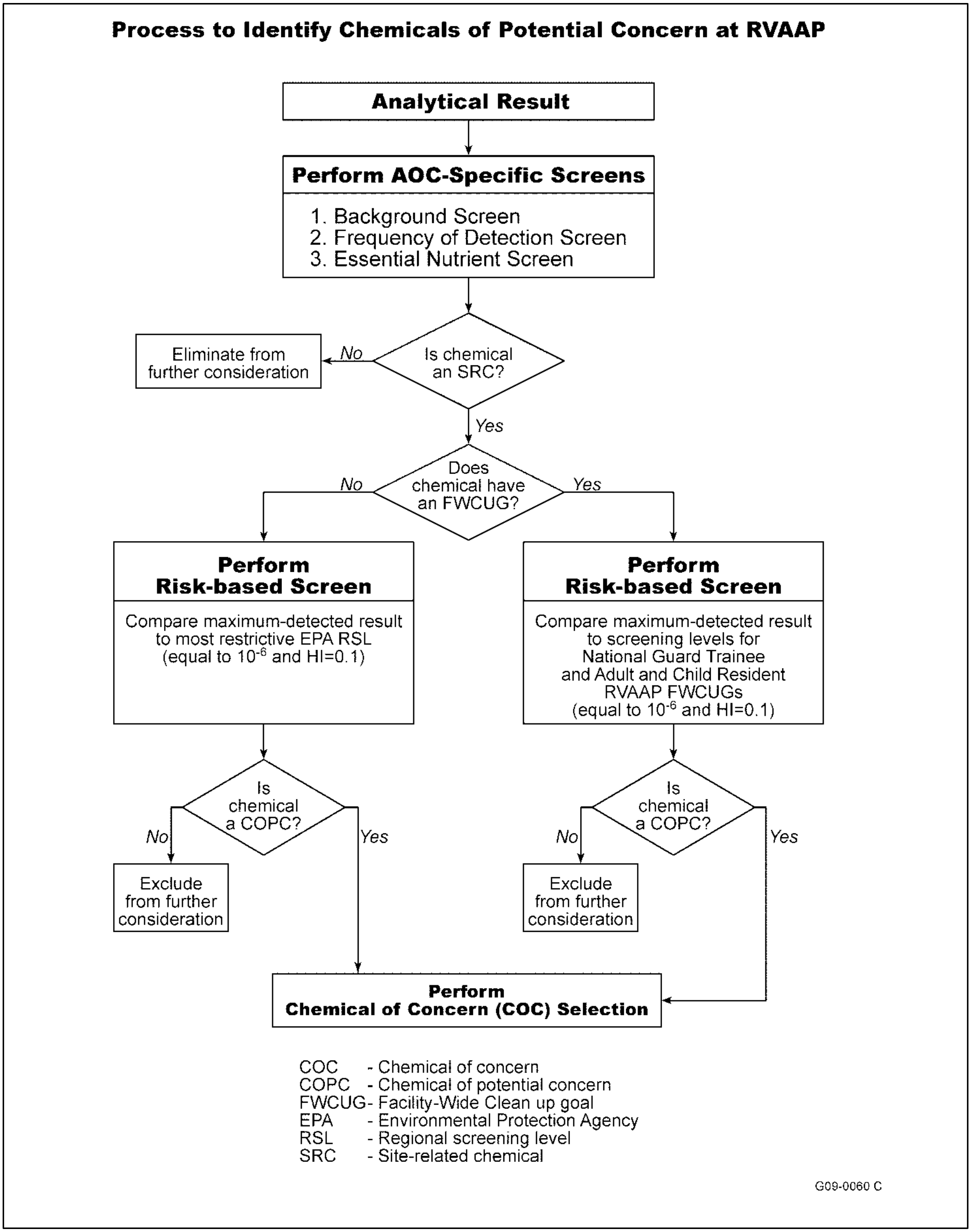

Figure 4–5. Process to Identify RVAAP COPCs in the HHRA (USACE 2010a)

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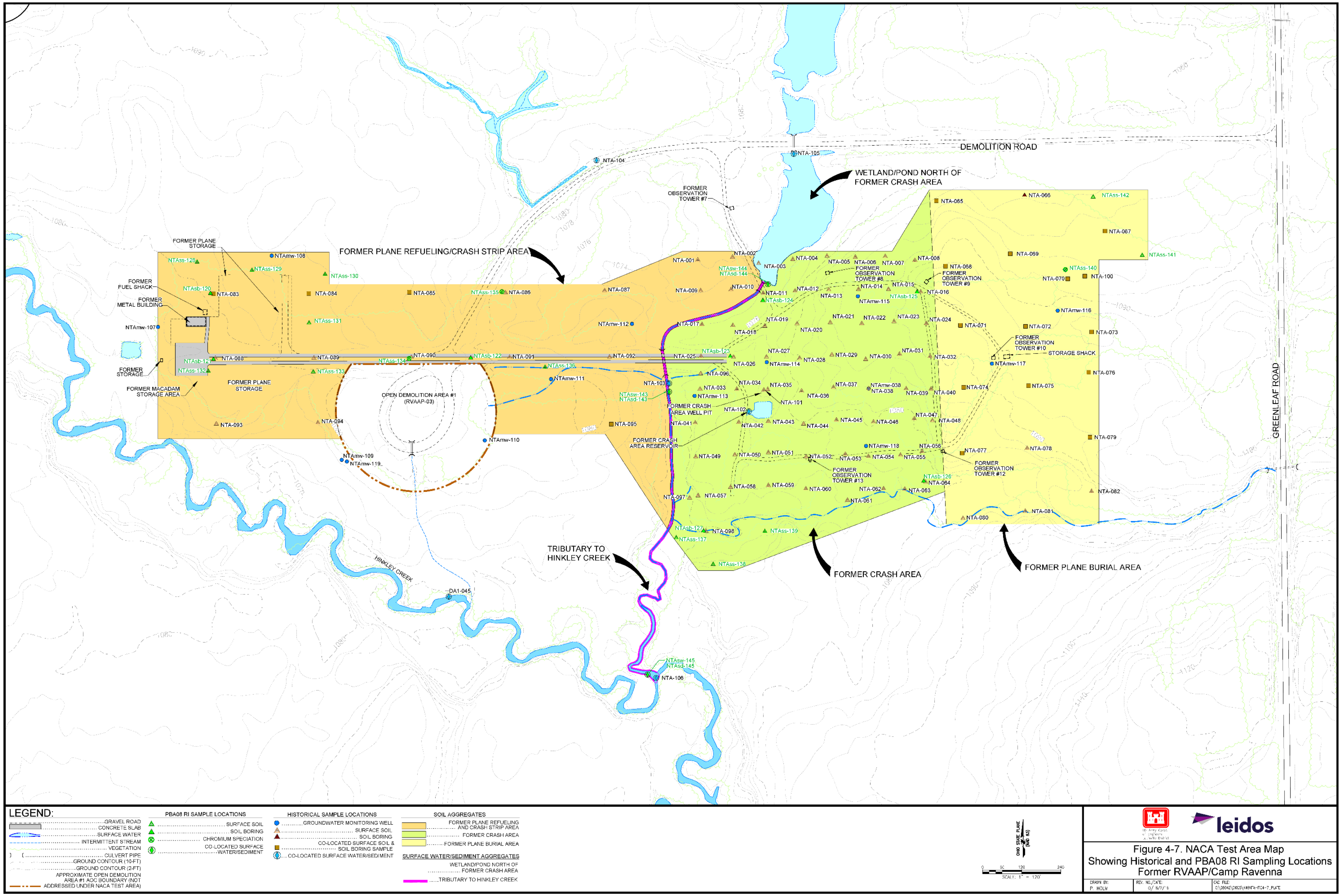

Figure 4–6. All NACA Test Area RI Sample Locations

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section evaluates the nature and extent of contamination and discusses the nature and extent of SRCs in environmental media at NACA Test Area.

As discussed in Section 2.2.2, anticipated primary COPCs were identified in Table 1-2 of the Phase I RI Report; these COPCs are also presented in Table 2-2 of this Phase II RI Report. As discussed in Section 4.0, data from all eligible 1999 Phase I RI or 2010 PBA08 RI samples were combined and screened to identify SRCs representing current conditions at NACA Test Area. This screening is considered an update to the screening and evaluation performed during the Phase I RI.

Given the entirety of chemical data collected during the RIs, this evaluation discusses the SRCs identified in Section 4.0 that are or are not considered anticipated primary COPCs. 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 an 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 - Detected Concentrations of Explosives and Propellants in Soil - All Soil Exposure Units.
- Figure 5-2 - Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Crash Area.
- Figure 5-3 - Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Plane Burial Area.
- Figure 5-4 - Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Plane Refueling/Crash Strip Area.
- Figure 5-5 - PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Soil - All Soil Exposure Units.
- Figure 5-6 - Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Crash Area.
- Figure 5-7 - Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Plane Burial Area.
- Figure 5-8 - Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Plane Refueling/Crash Strip Area.
- Figure 5-9 - Detected Concentrations of Explosives and Propellants in Surface Water and Sediment.
- Figure 5-10 - Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic Chemicals in Surface Water and Sediment.

- Figure 5-11 - SVOC Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Surface Water and Sediment.
- Figure 5-12 - Detected Concentrations of VOCs, Pesticides, and PCBs in in Surface Water and Sediment.

All validated NACA Test Area data from the 1999 Phase I RI and 2010 PBA08 RI are included in Appendix D. Complete analytical data packages from the PBA08 RI are also included in Appendix D.

Contaminant nature and extent is presented below for each medium and class of analyte.

5.1 SOIL EXPOSURE UNITS

As discussed in Section 2.2.4, spatial aggregates were established at NACA Test Area as part of the data aggregation for the evaluation of nature and extent and prior to the risk assessment evaluations. The EUs take into account how the areas were previously used and the extensiveness of potential contamination within a given area. EUs for evaluating the nature and extent of soil at NACA Test Area were aggregated into the following EUs and are shown on Figure 2-3:

- Former Crash Area,
- Former Crash Area Well Pit,
- Former Plane Burial Area, and
- Former Plane Refueling/Crash Strip Area.

5.1.1 Contaminant Nature and Extent in the Former Crash Area

Tables 4-20 and 4-24 present the results of the SRC screening for surface and subsurface soil at the Former Crash Area at NACA Test Area. The following subsections discuss the concentrations and distribution of surface and subsurface soil results for the Former Crash Area.

5.1.1.1 Explosives and Propellants

Surface and Subsurface Soil

One explosive (TNT) and one propellant (nitrocellulose) were identified as SRCs in surface soil at the Former Crash Area. The explosive TNT was detected in 1 of 16 samples at a concentration of 0.15J mg/kg at Phase I RI sample location NTA-037. Explosives were not detected in any PBA08 RI samples. Nitrocellulose was detected in 4 of 10 samples with concentrations ranging from 1.4J mg/kg (PBA08 RI location NTAss-139) to 52.2 mg/kg (PBA08 RI location NTAsb-123).

As shown in Figure 5-1, the explosives and propellant detections were spread from north to south, but from east to west were predominantly observed in the central portion of the Former Crash Area. The concentrations of TNT and nitrocellulose were below their respective SLs (3.65 and 19,000,000 mg/kg) and are not considered Phase II RI COPCs. No explosives or propellants were detected in the subsurface soil at the Former Crash Area.

5.1.1.2 Inorganic Chemicals

Surface Soil

Aluminum, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, and zinc were anticipated primary COPCs also identified as SRCs in surface soil at the Former Crash Area. These inorganic chemicals either were detected above their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Aluminum was detected above the background concentration of 17,700 mg/kg in four samples, with a maximum concentration of 25,400 mg/kg observed at Phase I RI sample location NTA-025.
- Arsenic was detected above the background concentration of 15.4 mg/kg in three samples, with a maximum concentration of 19 mg/kg observed at Phase I RI sample location NTA-064.
- Barium was detected above the background concentration of 88.4 mg/kg in 16 samples, with a maximum concentration of 254 mg/kg observed at Phase I RI sample location NTA-025.
- Cadmium does not have a background concentration. The inorganic chemical was detected in 13 samples, with a maximum concentration of 1.3 mg/kg observed at Phase I RI sample location NTA-030.
- Chromium was detected above the background concentration of 17.4 mg/kg in eight samples, with a maximum concentration of 25.2 mg/kg observed at Phase I RI sample location NTA-096.
- Copper was detected above the background concentration of 17.7 mg/kg in 11 samples, with a maximum concentration of 55.6 mg/kg observed at Phase I RI sample location NTA-030.
- Lead was detected above the background concentration of 26.1 mg/kg in eight samples, with a maximum concentration of 50.9 mg/kg observed at PBA08 RI sample location NTAsb-127.
- Manganese was detected above the background concentration of 1,450 mg/kg in four samples, with a maximum concentration of 4,500 mg/kg observed at Phase I RI sample location NTAss-034.
- Mercury was detected above the background concentration of 0.036 mg/kg in 22 samples, with a maximum concentration of 0.1 mg/kg observed at Phase I RI sample location NTAss-062.
- Selenium was detected above the background concentration of 1.4 mg/kg in five samples, with a maximum concentration of 2.6 mg/kg observed at Phase I RI sample location NTA-034.
- Zinc was detected above the background concentration of 61.8 mg/kg in 16 samples, with a maximum concentration of 231 mg/kg observed at Phase I RI sample location NTA-062.

Figure 5-2 presents the locations with concentrations that exceeded SLs and background for these chemicals. Of the 11 chemicals, 3 (aluminum, arsenic, and manganese) were detected at concentrations above the SL and are considered Phase II RI COPCs. Chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg). The SL exceedances do not appear to be concentrated in any particular area of the EU.

Although not identified as anticipated primary COPCs, antimony, cobalt, nickel, and thallium were identified as SRCs from the RVAAP screening process, as presented in Table 4-20 and summarized below:

- Antimony was detected above the background concentration of 0.96 mg/kg in one sample, with a maximum concentration of 1.1J mg/kg observed at Phase I RI sample location NTAss-018.
- Cobalt was detected above the background concentration of 10.4 mg/kg in seven samples, with a maximum concentration of 38.2 mg/kg observed at Phase I RI sample location NTAss-034. Cobalt also exceeded its respective SL (7.03 mg/kg) and is considered a Phase II RI COPC.
- Nickel was detected above the background concentration of 21.1 mg/kg in 10 samples, with a maximum concentration of 29.2 mg/kg observed at Phase I RI sample location NTAss-097.
- Thallium does not have a background concentration. It was detected in 59 samples with a maximum concentration of 0.57J mg/kg observed at Phase I RI sample location NTAss-096.

Subsurface Soil

Arsenic, barium, cadmium, and silver were anticipated primary COPCs also identified as SRCs in subsurface soil at the Former Crash Area. These inorganic chemicals either exceeded their respective background concentrations or do not have a background concentration for comparison purposes, as summarized below:

- Arsenic was detected above the background concentration of 19.8 mg/kg in one sample, with a maximum concentration of 24.7J mg/kg observed at PBA08 RI sample location NTAsb-124 from the 4–7 ft bgs interval.
- Barium was detected above the background concentration of 124 mg/kg in one sample, with a maximum concentration of 137J mg/kg observed at PBA08 RI sample location NTAsb-124 from the 1–4 ft bgs interval.
- Cadmium does not have a background concentration. It was detected in 11 samples with a maximum concentration of 0.14J mg/kg observed at PBA08 RI sample location NTAsb-126 from the 4–7 ft bgs interval.
- Silver does not have a background concentration. It was detected in 11 samples with a maximum concentration of 0.057J mg/kg observed at PBA08 RI sample location NTAsb-124 from the 1–4 ft bgs interval.

Figure 5-2 presents the locations with concentrations that exceeded SLs and background for these chemicals. Of these four chemicals, only arsenic exceeded its respective SL of 0.425 mg/kg and was considered a Phase II RI COPC.

Although not identified as an anticipated primary COPC, beryllium was identified as an SRC from the RVAAP screening process, as presented in Table 4-24. The maximum concentration of 1.1 mg/kg was detected at PBA08 RI sample location NTAsb-124 from the 1–4 ft bgs interval. This concentration was the only detection above the background concentration of 0.88 mg/kg but was below its respective SL of 16 mg/kg.

5.1.1.3 Semi-volatile Organic Compounds

Surface Soil

SVOCs were identified as anticipated primary COPCs at NACA Test Area based on previous aircraft releases. SVOCs do not have background concentrations for comparison to chemical results; consequently, a large number of SVOCs were identified as SRCs in surface soil. A total of 12 were identified as a result of the data screening. Of the 12 SVOC SRCs, 5 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno (1,2,3-cd)pyrene] that exceeded the SLs and were identified as Phase II RI COPCs. Figure 5-5 presents the PAH exceedances of the SLs in the Former Crash Area surface soil samples.

PAH detections were typically consolidated into the portion of the EU where the crash strip terminated at the crash barrier concrete structure. The majority of SRC detections and highest concentrations of PAH COPCs were observed at Phase I RI sample locations NTA-026. Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene detected at Phase I RI sample location NTA-026 exceeded the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1. The detected concentration of benzo(a)pyrene at Phase I RI sample location NTA-032 exceeded the Resident Receptor (Adult and Child) FWCUG at TR of 1E-05, HQ of 1. All other PAH concentrations were detected at concentrations less than the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1.

Subsurface Soil

Ten SVOCs, nine of which were PAHs, were identified as SRCs in subsurface soil at the Former Crash Area. All of the detected SVOC concentrations were below their respective SLs. The maximum concentrations of 6 [benz(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, and pyrene] of the 10 SVOC SRCs were observed at PBA08 RI sample location NTAsb-123 from the 1–4 ft bgs interval. The maximum concentrations of the remaining four SVOC SRCs [benzo(a)pyrene, benzo(ghi)perylene, naphthalene, and phenanthrene] were observed at PBA08 RI sample location NTAsb-124 from the 7–13 ft bgs interval.

5.1.1.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Surface Soil

Two VOCs (dimethylbenzene and methylene chloride) were identified as SRCs in surface soil at the Former Crash Area. VOCs were detected in 18 surface soil samples collected during the Phase I RI, as shown in Figure 5-6. Dimethylbenzene was detected in 9 of 64 samples comprising the data set, with concentrations ranging from 0.0012J mg/kg (NTA-048) to 0.0023J mg/kg (NTA-024). Methylene chloride was detected in 6 of 64 samples, with concentrations ranging from 0.0028J mg/kg (NTA-014, NTA-021 and NTA-022) to 0.0046J mg/kg (NTA-028). All of the VOC concentrations detected in surface soil were below their respective SLs, and the VOC SRCs were not considered COPCs.

No pesticides or PCBs were detected in the surface soil at the Former Crash Area.

Subsurface Soil

The pesticide delta-hexachlorocyclohexane (BHC) was identified as an SRC in subsurface soil at the Former Crash Area. Delta-BHC was detected at a concentration of 0.0044J mg/kg in the 1–4 ft bgs interval at PBA08 RI sample location NTAsb-123, located in the western portion of the EU at the end of the crash strip (Figure 5-6).

No VOCs or PCBs were detected in subsurface soil at the Former Crash Area.

5.1.2 Contaminant Nature and Extent in the Former Crash Area Well Pit

Table 4-21 presents the results of the SRC screening for surface soil at the Former Crash Area Well Pit at NACA Test Area. The following subsections discuss the concentrations and distribution of surface soil results for the Former Crash Area Well Pit.

5.1.2.1 Explosives and Propellants

The propellant nitrocellulose was an anticipated primary COPC also identified as an SRC in the one surface soil sample collected at the Former Crash Area Well Pit. Nitrocellulose was detected at a concentration of 11 mg/kg at location NTA-101. The detected concentration of nitrocellulose was below its respective SL of 19,000,000 mg/kg and was not considered a Phase II RI COPC. No explosives were detected as SRCs in surface soil at the Former Crash Area Well Pit.

5.1.2.2 Inorganic Chemicals

Barium, cadmium, chromium, copper, lead, silver, and zinc were anticipated primary COPCs also identified as SRCs in the one surface soil sample collected at the Former Crash Area Well Pit. These inorganic chemicals either exceeded their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Barium was detected above the background concentration of 88.4 mg/kg at a concentration of 436 mg/kg.
- Cadmium does not have a background concentration. The inorganic chemical was detected at a concentration of 5 mg/kg.
- Chromium was detected above the background concentration of 17.4 mg/kg at a concentration of 24.6 mg/kg.
- Copper was detected above the background concentration of 17.7 mg/kg at a concentration of 155J mg/kg.
- Lead was detected above the background concentration of 26.1 mg/kg at a concentration of 13,200 mg/kg.

- Silver does not have a background concentration. The inorganic chemical was detected at a concentration of 0.5J mg/kg.
- Zinc was detected above the background concentration of 61.8 mg/kg at a concentration of 631 mg/kg.

Figure 5-2 presents the location of the one surface soil sample collected in the Former Crash Area Well Pit EU (NTA-101) with concentrations that exceeded SLs and background for these chemicals. Of the seven chemicals, two (barium and lead) were detected at concentrations above the SL and were considered Phase II RI COPCs. Chromium exceeded the SL for hexavalent chromium (1.64 mg/kg), but did not exceed the SL for trivalent chromium (8,147 mg/kg).

Although not identified as anticipated primary COPCs, nickel and thallium were identified as SRCs from the RVAAP screening process, as presented in Table 4-21. Nickel or thallium did not exceed their respective SLs and were not considered Phase II RI COPCs.

5.1.2.3 Semi-volatile Organic Compounds

SVOCs were not detected in the surface soil sample collected at the Former Crash Area Well Pit.

5.1.2.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

One VOC (dimethylbenzene) was identified as an SRC for the Former Crash Area Well Pit surface soil. Dimethylbenzene was detected at a concentration of 0.03J mg/kg at location NTA-101, which is below the SL of 65 mg/kg. Pesticides and PCBs were not detected in the surface soil sample collected at the Former Crash Area Well Pit.

5.1.3 Contaminant Nature and Extent in the Former Plane Burial Area

Tables 4-22 and 4-25 present the results of the SRC screening for surface and subsurface soil at the Former Plane Burial Area at NACA Test Area. The following subsections discuss the concentrations and distribution of surface and subsurface soil results for the Former Plane Burial Area.

5.1.3.1 Explosives and Propellants

Surface and Subsurface Soil

One explosive (TNT) was an anticipated primary COPC also identified as an SRC in surface soil at the Former Plane Burial Area. TNT was detected in one of four samples at a concentration of 0.11J mg/kg (Phase I RI sample location NTA-067). The detected concentration was below its SL of 3.65 mg/kg and was not considered a Phase II RI COPC. No explosives were detected in subsurface soil at the Former Plane Burial Area, and no propellants were detected in either surface or subsurface soil.

5.1.3.2 Inorganic Chemicals

Surface Soil

Aluminum, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc were anticipated primary COPCs also identified as SRCs in surface soil at the Former Plane Burial Area. These inorganic chemicals either exceeded their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Aluminum was detected above the background concentration of 17,700 mg/kg in two samples, with a maximum concentration of 31,200 mg/kg observed at Phase I RI sample location NTA-070.
- Arsenic was detected above the background concentration of 15.4 mg/kg in one sample, with a maximum concentration of 23 mg/kg observed at Phase I RI sample location NTA-067.
- Barium was detected above the background concentration of 88.4 mg/kg in four samples, with a maximum concentration of 253 mg/kg observed at Phase I RI sample location NTA-067.
- Cadmium does not have a background concentration. The inorganic chemical was detected in six samples, with a maximum concentration of 14.5 mg/kg observed at Phase I RI sample location NTA-070.
- Chromium was detected above the background concentration of 17.4 mg/kg in four samples, with a maximum concentration of 54.2 mg/kg observed at Phase I RI sample location NTA-070.
- Copper was detected above the background concentration of 17.7 mg/kg in five samples, with a maximum concentration of 1,760 mg/kg observed at Phase I RI sample location NTA-070.
- Lead was detected above the background concentration of 26.1 mg/kg in two samples, with a maximum concentration of 149 mg/kg observed at Phase I RI sample location NTA-070.
- Manganese was detected above the background concentration of 1,450 mg/kg in two samples, with a maximum concentration of 2,190 mg/kg observed at Phase I RI sample location NTA-067.
- Mercury was detected above the background concentration of 0.036 mg/kg in 14 samples, with a maximum concentration of 0.073 mg/kg observed at Phase I RI sample locations NTA-082 and NTA-100.
- Selenium was detected above the background concentration of 1.4 mg/kg in one sample, with a maximum concentration of 1.4 mg/kg observed at Phase I RI sample location NTA-141.
- Silver does not have a background concentration. The inorganic chemical was detected in three samples, with a maximum concentration of 1.5 mg/kg observed at Phase I RI sample location NTA-070.
- Zinc was detected above the background concentration of 61.8 mg/kg in nine samples, with a maximum concentration of 603 mg/kg observed at Phase I RI sample location NTA-070.

Figure 5-3 presents the locations with concentrations that exceeded SLs and background for these chemicals. Of the 12 chemicals, 5 (aluminum, arsenic, cadmium, copper, and manganese) were detected at concentrations above the SL and were considered Phase II RI COPCs. Chromium exceeded the SL for hexavalent chromium (1.64 mg/kg) but did not exceed the SL for trivalent chromium (8,147 mg/kg).

The maximum concentrations of three of the five chemicals (aluminum, cadmium, and copper) were observed at Phase I RI sample location NTA-070. The maximum concentrations of the remaining chemicals (arsenic and manganese) were detected at Phase I RI sample location NTA-067.

Although not identified as anticipated primary COPCs, antimony, beryllium, cobalt, nickel, thallium, and vanadium were identified as SRCs from the RVAAP screening process, as presented in Table 4-22. Of these constituents, two (antimony and cobalt) were above the background concentrations and exceeded their respective SLs. Figure 5-3 also presents exceedances of the SL and background for these two chemicals in surface soil. Observations regarding other individual inorganic SRCs that exceeded their respective SLs in surface soil at the Former Plane Burial Area are presented below:

- Antimony was detected above the background concentration of 0.96 mg/kg and the SL of 2.82 mg/kg in one sample, with a maximum concentration of 2.9 mg/kg observed at Phase I RI sample location NTA-070.
- Cobalt was detected above the background concentration of 10.4 mg/kg and the SL of 7.03 mg/kg in three samples, with a maximum concentration of 12 mg/kg observed at Phase I RI sample location NTA-078.

Subsurface Soil

Barium, cadmium, copper, lead, and zinc were anticipated primary COPCs identified as SRCs in subsurface soil at the Former Plane Burial Area. These inorganic chemicals either exceeded their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Barium was detected above the background concentration of 124 mg/kg in one sample, with a concentration of 196J mg/kg observed at Phase I RI sample location NTA-067 from the 1–3 ft bgs interval.
- Cadmium does not have a background concentration. The maximum concentration of 30 mg/kg was observed at Phase I RI sample location NTA-073 from the 1–3 ft-bgs interval.
- Copper was detected above the background concentration of 32.3 in three samples, with a maximum concentration of 400J mg/kg observed at Phase I RI sample location NTA-073 from the 1–3 ft bgs interval.
- Lead was detected above the background concentration of 19.1 mg/kg in two samples, with a maximum concentration of 151 mg/kg observed at Phase I RI sample location NTA-073 from the 1–3 ft bgs interval.
- Zinc was detected above the background concentration of 93.3 mg/kg in one sample, with a concentration of 132 mg/kg observed at Phase I RI sample location NTA-073 from the 1–3 ft bgs interval.

As summarized above, the maximum concentrations for four of the five SRCs were observed in the 1–3 ft bgs interval at Phase I RI sample location NTA-073. The locations of the detections are presented in Figure 5-3. Of these five chemicals, cadmium and copper exceeded their respective SLs of 6.41 and 311 mg/kg, respectively, and were considered Phase II RI COPCs.

5.1.3.3 Semi-volatile Organic Compounds

Surface and Subsurface Soil

Six SVOCs, four of which were PAHs, were identified as SRCs in surface soil at the Former Plane Burial Area. One SVOC was identified as an SRC in subsurface soil. None of the SVOC SRCs exceeded their respective SLs in surface and subsurface soil and were not considered Phase II RI COPCs.

5.1.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Surface Soil

Four VOCs (acetone, methylene chloride, styrene, and toluene) were identified as SRCs in surface soil at the Former Plane Burial Area. VOCs were detected in eight surface soil samples collected during the Phase I RI, as shown in Figure 5-7. Three of the four VOCs were detected at NTA-081, where acetone (0.0079J mg/kg) and methylene chloride (0.0015J mg/kg) were detected at their maximum concentrations. The maximum concentrations for styrene (0.0015J mg/kg) and toluene (0.0042J mg/kg) were detected at NTA-073 and NTA-076, respectively. All of the VOC concentrations detected in surface soil were below their respective SLs, and the VOC SRCs were not considered Phase II RI COPCs.

No pesticides or PCBs were detected in surface soil at the Former Plane Burial Area.

Subsurface Soil

Four VOCs (dimethylbenzene, methylene chloride, styrene, and toluene) were identified as SRCs for subsurface soil at the Former Plane Burial Area. At least 1 VOC was detected in 8 of 17 samples collected. The highest frequency of detection within an individual sample was the detection of three VOC SRCs (methylene chloride, toluene, and styrene) from the 1–3 ft bgs interval at Phase I RI sample location NTA-067. All of the detected concentrations were below their respective SLs, and the VOC SRCs were not considered to be Phase II RI COPCs. No pesticides or PCBs were detected in subsurface soil at the Former Plane Burial Area.

5.1.4 Contaminant Nature and Extent in the Former Plane Refueling/Crash Strip Area

Tables 4-23 and 4-26 present the results of the SRC screening for surface and subsurface soil at the Former Plane Refueling/Crash Strip Area at NACA Test Area. The following subsections discuss the concentrations and distribution of surface and subsurface soil results for the Former Plane Refueling/Crash Strip Area.

5.1.4.1 <u>Explosives and Propellants</u>

Surface and Subsurface Soil

Four explosives [1,3,5-trinitrobenzene (TNB)]; TNT; 2,4- DNT; and HMX] and one propellant (nitrocellulose) were anticipated primary COPCs also identified as SRCs in surface soil at the Former Plane Refueling/Crash Strip Area. The explosives TNB and TNT were detected in 1 of 11 samples (PBA08 RI sample location NTAss-136) at concentrations of 0.02J and 5.5 mg/kg, respectively. The explosive DNT was detected in 3 of 11 samples ranging from 0.014J mg/kg (PBA08 RI location NTAss-136) to 0.22J mg/kg (PBA08 RI location NTAss-133). The explosive HMX also was detected in 3 of 11 samples ranging in concentration from 0.012J mg/kg (PBA08 RI location NTAss-131) to 0.017J mg/kg (PBA08 RI location NTAsb-120). The propellant nitrocellulose was detected in one of two samples (Phase I RI sample NTA-090) at a concentration of 3.5 mg/kg. As shown in Figure 5-1, the majority of explosives and propellant detections at the Former Plane Refueling/Crash Strip Area occurred at sample locations in the northwest portion of the EU and northwest of RVAAP-03 ODA1.

All detected concentrations of explosives and the propellant at the Former Plane Refueling/Crash Strip Area were below their respective SLs, except TNT. The detected concentration of TNT at PBA08 sample location NTAss-136 was above its respective SL of 3.65 mg/kg and is considered a Phase II RI COPC.

No explosives or propellants were detected in subsurface soil at the Former Plane Refueling/Crash Strip Area.

5.1.4.2 <u>Inorganic Chemicals</u>

Surface Soil

Aluminum, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc were anticipated primary COPCs also identified as SRCs in surface soil at the Former Plane Refueling/Crash Strip Area.

These inorganic chemicals either exceeded their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Aluminum was detected above the background concentration of 17,700 mg/kg in four samples, with a maximum concentration of 33,900 mg/kg observed at Phase I RI sample location NTA-092.
- Arsenic was detected above the background concentration of 15.4 mg/kg in two samples, with a maximum concentration of 22.1 mg/kg observed at Phase I RI sample location NTAss-128.
- Barium was detected above the background concentration of 88.4 mg/kg in 10 samples, with a maximum concentration of 359 mg/kg observed at Phase I RI sample location NTA-092.

- Cadmium does not have a background concentration. The inorganic chemical was detected in 12 samples, with a maximum concentration of 5.2 mg/kg observed at Phase I RI sample location NTA-083.
- Chromium was detected above the background concentration of 17.4 mg/kg in seven samples, with a maximum concentration of 149 mg/kg observed at PBA08 RI sample location NTAsb-121.
- Copper was detected above the background concentration of 17.7 mg/kg in two samples, with a maximum concentration of 30.3 mg/kg observed at Phase I RI sample location NTA-094.
- Lead was detected above the background concentration of 26.1 mg/kg in one sample, with a maximum concentration of 56.6 mg/kg observed at Phase I RI sample location NTA-083.
- Manganese was detected above the background concentration of 1,450 mg/kg in seven samples, with a maximum concentration of 6,240 mg/kg observed at Phase I RI sample location NTA-084.
- Mercury was detected above the background concentration of 0.036 mg/kg in 13 samples, with a maximum concentration of 0.073J mg/kg observed at Phase I RI sample location NTA-084.
- Selenium was detected above the background concentration of 1.4 mg/kg in four samples, with a maximum concentration of 2.8 mg/kg observed at Phase I RI sample location NTA-092.
- Silver does not have a background concentration. The inorganic chemical was detected in seven samples, with a maximum concentration of 1.3 mg/kg observed at Phase I RI sample location NTA-085.
- Zinc was detected above the background concentration of 61.8 mg/kg in nine samples, with a maximum concentration of 158 mg/kg observed at Phase I RI sample location NTA-084.

Figure 5-4 presents the locations with concentrations that exceeded SLs and background for these chemicals. Of the 12 chemicals, 4 (aluminum, arsenic, barium, and manganese) were detected at concentrations above their respective SLs and were considered Phase II RI COPCs. Chromium exceeded the SL for hexavalent chromium (1.64 mg/kg), but did not exceed the SL for trivalent chromium (8,147 mg/kg).

Although not identified as previously used during historical operations, beryllium, cobalt, cyanide, nickel, thallium, and vanadium were identified as SRCs from the RVAAP screening process, as presented in Table 4-22. Of these constituents, two (cobalt and cyanide) exceeded their respective SLs and background concentrations. Figure 5-4 also presents exceedances of the SL and background for these two chemicals in surface soil. Observations regarding other individual inorganic SRCs that exceeded their respective SLs in the Former Plane Refueling/Crash Test Strip Area are presented below:

- Cobalt was detected above the background concentration of 10.4 mg/kg and the SL of 7.03 mg/kg in seven samples, with a maximum concentration of 27.5 mg/kg observed at Phase I RI sample location NTA-084.
- Cyanide does not have a background concentration. The maximum concentration observed at Phase I RI sample location NTA-092 of 1.6 mg/kg exceeded the SL of 0.27 mg/kg.

Subsurface Soil

Cadmium, mercury, and silver were anticipated primary COPCs also identified as SRCs. These inorganic chemicals either exceeded their respective background concentrations or do not have background concentrations for comparison purposes, as summarized below:

- Cadmium does not have a background concentration. The maximum concentration of 0.44J mg/kg was observed at Phase I RI sample location NTA-083 from the 1–3 ft bgs interval.
- Mercury was detected above the background concentration of 0.044 mg/kg in one sample, with a concentration of 0.05J mg/kg observed at Phase I RI sample location NTA-084 from the 1–3 ft bgs interval.
- Silver does not have a background concentration. The maximum concentration of 0.019J mg/kg was observed at PBA08 RI sample location NTAsb-121 from the 1–4 ft bgs interval.

The locations of the detections are presented in Figure 5-2. All of the detected concentrations of these three chemicals were below their respective SLs and were not considered Phase II RI COPCs.

5.1.4.3 Semi-volatile Organic Compounds

Surface Soil

Nineteen SVOCs were identified as SRCs in surface soil at the Former Plane Refueling/Crash Strip Area; 16 of the SRCs were PAHs. Of the 19 SVOC SRCs, 7 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno (1,2,3-cd)pyrene] that exceeded the SLs and were identified as COPCs. Figure 5-5 presents the PAH exceedances of the SLs in the Former Plane Refueling/Crash Strip Area surface soil samples.

PAH detections were generally concentrated along the grass median of the crash strip structure, with available surface soil data effectively bounding the distribution of these SRCs at the northern and southern extent of the EU. The majority of the highest concentrations of PAH COPCs were observed at Phase I RI sample location NTAss-088, located at the western end of the EU and at the starting point of the crash strip. A PBA08 RI surface soil sample (NTAss-132) collected adjacent to NTA-088 exhibited a high frequency of PAH detections; however, the concentrations were detected at one to two orders of magnitude lower, on average, than those observed historically. The decline in PAH concentrations over the 10-year period between the Phase I RI and PBA08 RI sampling is likely attributable to natural degradation processes. Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1 at multiple sample locations, as shown on Figure 5-5.

Subsurface Soil

Fourteen SVOCs were identified as SRCs in subsurface soil at the Former Plane Refueling/Crash Strip Area. Of the 14 SVOC SRCs, 5 were PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] that exceeded the SLs and were identified as COPCs. Figure 5-5 presents the PAH exceedances of the SL in the Former Plane Refueling/Crash Strip Area subsurface soil samples.

The maximum concentrations of the five PAH COPCs were observed at Phase I RI sample location NTA-083 from the 1–3 ft bgs interval. A PBA08 RI subsurface sample was collected adjacent to NTA-083, and the PAH concentrations in the 1–4 ft bgs interval for these five PAHs were non-detectable. Concentrations of benzo(a)pyrene exceeded the Resident Receptor (Adult and Child) FWCUG at TR of 1E-05, HQ of 1 at NTA-083, as shown on Figure 5-5.

5.1.4.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Surface and Subsurface Soil

Two VOCs (2-butanone and acetone) were identified as SRCs in surface soil at the Former Plane Refueling/Crash Strip Area. 2-Butanone was detected in one sample location, PBA08 RI location NTAss-129, at a concentration of 0.0018J mg/kg. Acetone was detected in one sample location, Phase I RI sample location NTA-086, at a concentration of 0.0078J mg/kg. The location of each VOC detection is presented on Figure 5-8. Both concentrations were below their respective SLs, and the VOC SRCs were not considered COPCs.

No pesticides or PCBs were detected in Former Plane Refueling/Crash Strip Area surface soil. VOCs, PCBs, or pesticides were not detected in subsurface soil at the Former Plane Refueling/Crash Strip Area.

5.1.5 Surface Soil Discrete Sample Results for Chromium Speciation

During the PBA08 RI, surface soil samples were collected from three discrete sample locations and analyzed for hexavalent chromium and total chromium. Samples were collected from the three sampling areas having the highest (NTAss-134), mid-point (NTAss-135), and lowest (NTAss-140) total historical chromium results. This sampling attempted to determine the contribution of hexavalent chromium to total chromium over a range of concentrations in soil at NACA Test Area for use in the HHRA (Section 7.2).

Chromium speciation results are shown in Table 5-1. Two of the three samples (NTAss-134 and NTAss-135) were above the facility-wide background concentration of 17.4 mg/kg for total chromium. Hexavalent chromium was not detected in any of the three samples and did not appear to be correlated to total chromium values. A detailed assessment of the speciation results respective to the HHRA is presented in Section 7.2.4.1.

5.2 SEDIMENT AND SURFACE WATER EXPOSURE UNITS

As discussed in Section 2.2.4, spatial aggregates were established at NACA Test Area as part of the data aggregation for evaluating nature and extent and prior to the risk assessment evaluations. The EUs take into account how the areas were previously used and the extent potential contamination within a given area. Four sediment and surface water EUs were established for NACA Test Area:

- Tributary to Hinkley Creek,
- Wetland/Pond North of the Former Crash Area,
- Former Crash Area Reservoir, and
- Off-AOC.

5.2.1 Contaminant Nature and Extent at the Tributary to Hinkley Creek

Two sediment and two surface water samples were collected during the PBA08 RI from the Tributary to Hinkley Creek and were analyzed for the RVAAP full analytical suite. Tables 4-27 and 4-30 present the results of the SRC screening for sediment at NACA Test Area for the Tributary to Hinkley Creek. The results of the detected analytes for the PBA08 RI sediment and surface water samples collected from the Tributary to Hinkley Creek are summarized in Tables 4-15 and 4-16. Complete copies of the laboratory analytical packages are presented in Appendix D. Figures 5-9 through 5-12 present the locations and concentrations of SL exceedances identified in sediment and surface water at the NACA Test Area as a whole.

5.2.1.1 Explosives and Propellants

One explosive (HMX) was identified as an SRC in sediment at the Tributary to Hinkley Creek. HMX was detected in PBA08 RI sample NTAsd-143 at a concentration of 0.013J mg/kg, but was not detected at downstream PBA08 RI sample NTAsd-145. Explosives were not detected in the other sediment sample collected in this EU. Propellants were not detected in either of the samples collected in this EU. In addition, no propellants or explosives were detected in surface water at the Tributary to Hinkley Creek.

5.2.1.2 Inorganic Chemicals

Cadmium, chromium, and silver were anticipated primary COPCs also identified as SRCs in sediment, and cadmium, chromium, lead, manganese, and selenium were identified as SRCs in surface water in the Tributary to Hinkley Creek. They either exceeded their respective background concentrations or do not have a representative background concentration for comparison purposes. All the detected concentrations were below their respective SLs and were not considered Phase II RI COPCs.

Although not anticipated primary COPCs, beryllium, cobalt, and nickel were identified as SRCs in sediment from the RVAAP screening process, as presented in Table 4-27. Of these three inorganic chemicals, only cobalt was above the background concentration of 9.1 mg/kg and exceeded its respective SL of 2.3 mg/kg, with a concentration of 14.4 mg/kg at PBA08 RI sample location NTAsd-145. Cobalt was considered a Phase II RI COPC in sediment in the Tributary to Hinkley Creek.

Antimony, cobalt, nickel, and vanadium were four additional inorganic chemicals that were identified as SRCs in surface water. These inorganic chemicals do not have representative background concentrations. All the detected concentrations were below their respective SLs and were not considered Phase II RI COPCs.

5.2.1.3 Semi-volatile Organic Compounds

Fifteen SVOCs were identified as SRCs in sediment at the Tributary to Hinkley Creek. With the exception of bis(2-ethylhexyl)phthalate, all SVOCs were PAHs. The 14 PAH SVOC SRCs in sediment were detected at their maximum concentrations at PBA08 RI sample location NTAsd-143. Six SVOC SRCs were detected at downstream PBA08 RI location NTAsd-145. Only one PAH, benzo(a)pyrene, exceeded its respective SL of 0.022 mg/kg, with a concentration of 0.066J mg/kg observed at PBA08 RI sample location NTAsd-143. The benzo(a)pyrene concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1.

One SVOC was identified as an SRC for surface water at the Tributary to Hinkley Creek. Bis(2-ethylhexyl)phthalate was detected at PBA08 RI location NTAsw-145 at a concentration of 0.021 mg/L but was not detected at upstream location NTAsw-143. The bis(2-ethylhexyl)phthalate concentration was detected above its respective SL of 0.00349 mg/L.

5.2.1.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

One VOC (2-butanone) was identified as an SRC in sediment at the Tributary to Hinkley Creek. The VOC 2-butanone was detected at a concentration of 0.0064J mg/kg at PBA08 RI location NTAsd-143 and was detected at a concentration below the SL of 2,700 mg/kg.

No pesticides or PCBs were detected in sediment, and VOCs, pesticides, or PCBs were not detected in surface water at the Tributary to Hinkley Creek.

5.2.2 Contaminant Nature and Extent for the Wetland/Pond North of the Former Crash Area

One sediment and one surface water sample were collected during the PBA08 RI from the Wetland/Pond North of the Former Crash Area and were analyzed for the RVAAP full analytical suite. Tables 4-28 and 4-31 present the results of the SRC screening for sediment at NACA Test Area for the Wetland/Pond North of the Former Crash Area. The results of the detected analytes for the PBA08 RI sediment and surface water samples collected from the Wetland/Pond North of the Former Crash Area are summarized in Tables 4-15 and 4-16. Complete copies of the laboratory analytical packages are presented in Appendix D. Figures 5-9 through 5-12 present the locations and concentrations of SL exceedances identified in sediment and surface water at the NACA Test Area as a whole.

5.2.2.1 Explosives and Propellants

No explosives or propellants were detected in sediment or surface water at the Wetland/Pond North of the Former Crash Area.

5.2.2.2 Inorganic Chemicals

Sediment

Cadmium and silver were anticipated primary COPCs also identified as SRCs in sediment in the Wetland/Pond North of the Former Crash Area. These inorganic chemicals do not have a representative background concentration for comparison purposes, as summarized below:

- Cadmium does not have a background concentration. Cadmium was detected in the one sediment location, NTAsd-144, at a low, estimated concentration of 0.1J mg/kg.
- Silver does not have a background concentration. Silver was detected in the one sediment sample location, NTAsd-144, at a low, estimated concentration of 0.031J mg/kg.

The detected concentrations of cadmium and silver did not exceed their respective SLs and were not considered to be Phase II RI COPCs.

Although not identified as an anticipated primary COPC, beryllium was identified as an SRC from the RVAAP screening process, as presented in Table 4-28. Beryllium was detected above the background concentration in the one sediment sample location, NTAsd-144, at a concentration of 0.4 mg/kg. The concentration was below its respective SL and was not considered to be a Phase II RI COPC.

Surface Water

Five inorganic chemicals were identified as SRCs in surface water at the Wetland/Pond North of the Former Crash Area. Two of the five inorganic chemicals (lead and manganese) were anticipated primary COPCs. Lead was detected at a concentration of 0.0002J mg/L, which is below its respective SL of 0.015 mg/L. The detected manganese concentration of 0.737 mg/L exceeded its respective SL of 0.633 mg/L, and manganese was considered a Phase II RI COPC.

Three of the five inorganic chemicals identified as SRCs in surface water at the Wetland/Pond North of the Former Crash Area were anticipated primary COPCs. The detected concentrations of nickel and thallium did not exceed their respective SLs; however, the detected cobalt concentration of 0.00063J mg/L exceeded its respective SL of 0.0006 mg/L. Cobalt was considered a Phase II RI COPC.

5.2.2.3 Semi-volatile Organic Compounds

SVOCs were not detected in sediment or surface water at the Wetland/Pond North of the Former Crash Area.

5.2.2.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Three VOCs were identified as SRCs in sediment at the Wetland/Pond North of the Former Crash Area (Table 4-28). The VOCs 2-butanone, ethylbenzene, and toluene were detected in PBA08 RI location NTAsd-144 but were not detected in the Phase I RI sample for this EU. All VOC detections in sediment were below their respective SLs. Only 2-butanone was detected in sediment downstream at the Tributary to Hinkley Creek.

One VOC (toluene) was identified as an SRC in surface water at the Wetland/Pond North of the Former Crash Area. Toluene was detected in PBA08 RI sample NTAsw-144 at a concentration of 0.00035J mg/L, which is below its respective SL of 0.11 mg/L.

No pesticides or PCBs were detected in sediment or surface water at the Wetland/Pond North of the Former Crash Area.

5.2.3 Contaminant Nature and Extent for the Former Crash Area Reservoir

Surface water data collected during the Phase I RI was used only for evaluating the nature and extent of contamination at the Former Crash Area Reservoir. The Phase I RI sediment sample was included in the SRC screening (Table 4-29). The results of the detected analytes for the Phase I RI sediment and surface water samples collected from the Former Crash Area Reservoir are summarized in Tables 4-4 and 4-5. Complete copies of the laboratory analytical packages are presented in Appendix D.

5.2.3.1 Explosives and Propellants

No explosives or propellants were detected in sediment or surface water at the Former Crash Area Reservoir.

5.2.3.2 Inorganic Chemicals

No inorganic chemicals were identified as SRCs in sediment or surface water at the Former Crash Area Reservoir.

5.2.3.3 Semi-volatile Organic Compounds

SVOCs were not detected in sediment or surface water at the Former Crash Area Reservoir.

5.2.3.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

Two VOCs (2-butanone and acetone) were identified as SRCs for Former Crash Area Reservoir sediment. The VOCs 2-butanone and acetone were detected at Phase I RI location NTA-102 at concentrations of 0.016J and 0.061J mg/kg, respectively. The detected concentrations were below their respective SLs of 2,700 and 6,100 mg/kg.

No pesticides or PCBs were detected in sediment, and VOCs, pesticides, and PCBs were not detected in surface water for the Former Crash Area Reservoir.

5.2.4 Contaminant Nature and Extent for the Off-AOC EU

One sediment and one surface water sample (NTAsd/sw-104) were collected during the Phase I RI at a drainage conveyance upstream of NACA Test Area. These samples were included in the nature and extent evaluation to provide data on off-AOC conditions for comparison purposes. The results of the detected analytes for the Phase I RI sediment and surface water samples collected from the off-AOC sample location are summarized in Tables 4-4 and 4-5. Complete copies of the laboratory analytical packages are presented in Appendix D.

5.2.4.1 Explosives and Propellants

No explosives were detected in sediment at the off-AOC Phase I RI sample location; however, the propellant nitrocellulose was detected at a concentration of 4.8 mg/kg. The explosive 2,4-DNT was detected at Phase I RI off-AOC surface water station NTA-104 at a concentration of 0.000051J mg/L. This explosive was not detected in any of the other surface water samples collected at NACA Test Area.

5.2.4.2 Inorganic Chemicals

Eight inorganic chemicals were detected above background concentrations at off-AOC location NTA-104. Barium was detected at a concentration of 398 mg/kg, which is above the background concentration of 123 mg/kg and the SL of 351 mg/kg. Beryllium was detected at a concentration of 0.9J mg/kg, which is slightly above the background concentration of 0.38 mg/kg. Cadmium was detected at a concentration of 1.1J mg/kg. Cobalt was detected at a concentration of 29.9J mg/kg, which is above the background concentration of 9.1 mg/kg and the SL of 2.3 mg/kg. Cyanide was detected at a concentration of 0.74 mg/kg, which is above the SL of 0.27 mg/kg. Manganese was detected at a concentration of 9,440 mg/kg, which is above the background concentration of 1,950 mg/kg and the SL of 35.1 mg/kg. Nickel was detected at a concentration of 34.9 mg/kg, which is above the background concentration of 17.7 mg/kg. Selenium was detected at a concentration of 2.9J mg/kg, which is above the background concentration of 1.7 mg/kg. The concentrations detected at the upstream, off-AOC location were higher than those observed at either of the NACA Test Area sediment data EUs.

Lead, manganese, and zinc were detected above background concentrations at the Phase I RI off-AOC surface water sample location. The concentrations of lead (0.0027J mg/L) and zinc (0.06 mg/L) were below their respective SLs of 0.015 and 0 mg/L, respectively.

5.2.4.3 Semi-volatile Organic Compounds

SVOCs were not detected in sediment or surface water at off-AOC sample location NTA-104.

5.2.4.4 Volatile Organic Compounds, Pesticides, and Polychlorinated Biphenyls

VOCs, pesticides, and PCBs were not detected in sediment at off-AOC sample location NTA-104. The VOC acetone was detected at off-AOC surface water sample location NTA-104 with a concentration of 0.0042J mg/kg. Pesticides and PCBs were not detected in surface water at the off-AOC sample.

5.3 SUMMARY OF CONTAMINANT NATURE AND EXTENT

5.3.1 Soil

Data from the 1999 Phase I RI and the 2010 PBA08 RI were used to identify SRCs at NACA Test Area. This data set effectively characterizes the nature and extent of 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. 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 NACA Test Area.

The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered Phase II RI COPCs, except one surface sample location at the Former Plane Refueling/Crash Strip Area. A concentration of 5.5 mg/kg of TNT exceeded the SL of 3.65 mg/kg and was considered a Phase II RI COPC for the EU. TNT was not detected in the subsurface samples collected at the Former Plane Refueling/Crash Strip.

Twelve inorganic chemicals (arsenic, aluminum, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc) were identified as anticipated primary COPCs and as inorganic SRCs. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), chromium, mercury, selenium, silver, and zinc concentrations were below their respective SLs; therefore, these chemicals were not considered Phase II RI COPCs at any of the EUs comprising NACA Test Area.

Aluminum, arsenic, and manganese were considered Phase II RI COPCs in surface soil at the Former Crash Area. Of these three inorganic chemicals, arsenic was the only Phase II RI COPC in subsurface soil in one PBA08 RI sample location (NTAsb-124, 4–7 ft bgs interval). Arsenic exceeded the Resident Receptor (Adult and Child) FWCUG at TR of 1E-05, HQ of 1 in surface and subsurface soil with a MDC of 24.7J mg/kg at NTAsb-124 (in the 4–7 ft bgs interval). Arsenic was detected below the background concentration (13.9J mg/kg) in the next sample interval (from 7–13 ft bgs). Manganese exceeded the National Guard Trainee FWCUG at TR of 1E-05, HQ of 1 in surface soil with an MDC of 4,500 mg/kg at NTA-034.

Barium and lead concentrations of 436 and 13,200 mg/kg, respectively, exceeded their respective SLs of 351 and 400 mg/kg in the one surface soil sample collected at the Former Crash Area Well Pit. Both inorganic chemicals were considered Phase II RI COPCs. Only lead exceeded the RSL, but barium was below the National Guard Trainee FWCUG at TR of 1E-05, HQ of 1.

Five chemicals (aluminum, arsenic, cadmium, copper, and manganese) were considered Phase II RI COPCs in surface soil at the Former Plane Burial Area. In subsurface soil, cadmium and copper were considered Phase II RI COPCs. Although not identified as anticipated primary COPCs, antimony and cobalt also were considered Phase II RI COPCs in surface soil at the Former Plane Burial Area. Of the Phase II RI COPCs identified in surface and subsurface soil at the Former Plane Burial Area, only concentrations of arsenic and manganese in surface soil exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1. The MDC of arsenic and manganese was 23 mg/kg and 2,190 mg/kg, respectively, at Phase I RI sample location NTA-067.

Aluminum, arsenic, barium, and manganese were considered Phase II RI COPCs in surface soil at the Former Plane Refueling/Crash Strip Area. Although not identified as anticipated primary COPCs, cobalt and cyanide also were considered Phase II RI COPCs in the surface soil. Arsenic and manganese exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1. The MDC of arsenic was 22.1 mg/kg at PBA08 sample location NTAss-128. Manganese was detected at a maximum concentration of 6,240J mg/kg at Phase I RI sample location NTA-084. No inorganic chemical Phase II RI COPCs were identified in subsurface soil.

SVOCs were not detected in surface soil at the Former Crash Area Well Pit. SVOCs were Phase II RI COPCs in surface and subsurface soil at the Former Plane Burial Area. Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected in Former Crash Area surface soil at Phase I RI sample location NTA-026, which exceeded the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1. The detected concentration of benzo(a)pyrene in the surface sample at Phase I RI sample location NTA-032 also exceeded the Resident Receptor (Adult and Child) FWCUG at TR of 1E-05, HQ of 1. Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1 at multiple surface soil sample locations at the Former Plane Refueling/Crash Strip Area. In subsurface soil, only benzo(a)pyrene exceeded the Resident Receptor (Adult and Child) FWCUG at TR of 1E-05, HQ of 1 at one subsurface sample location. All other PAH concentrations detected in surface and subsurface soil at the Former Crash Area and Former Plane Refueling/Crash Strip Area were below the Resident Receptor (Adult and Child) FWCUGs at TR of 1E-05, HQ of 1.

None of the detected concentrations of VOCs at NACA Test Area in surface or subsurface soil exceeded their respective SLs. Pesticides and PCBs were not detected in any of the surface or subsurface samples collected for the four EUs comprising NACA Test Area except for the pesticide delta-hexachlorobenzene which was identified as an SRC in the subsurface soil at the Former Crash Area.

5.3.2 Sediment and Surface Water

The Tributary to Hinkley Creek was evaluated using two sediment and two surface water samples. No explosives or propellants were detected in the surface water samples and no propellants were detected in the sediment samples. One explosive (HMX) was detected at a low, estimated concentration in one sediment sample, but was not detected at the downstream sample. The concentration was below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for inorganic chemicals in the Tributary to Hinkley Creek exceeded the RSL at a TR of 1E-06, HQ of 0.1, except a sediment concentration of cobalt at NTAsd-145. One PAH, benzo(a)pyrene, exceeded its respective SL in sediment; however, the concentration was below the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Bis(2-ethylhexyl)phthalate was detected above its respective SL in a surface water sample. No pesticides or PCBs were detected in sediment and VOCs, pesticides, or PCBs were not detected in surface water at the Tributary to Hinkley Creek. One VOC (2-butanone) was detected at NTAsd-143 below the SL.

One sediment and one surface water sample were used to evaluate the Wetland/Pond North of the Former Crash Area. No explosives or propellants were detected in sediment or surface water. All of the detected concentrations of inorganic chemicals in sediment and surface water were below the RSL at a TR of 1E-06, HQ of 0.1. In surface water, cobalt and manganese exceeded the SL at a TR of 1E-06, HQ of 0.1 but not at a TR of 1E-05, HQ of 1. SVOCs, pesticides, and PCBs were not detected in sediment or surface water samples at the Wetland/Pond North of the Former Crash Area. Three VOCs (2-butanone, ethylbenzene, and toluene) were detected in sediment and one VOC (toluene) was detected in surface water. The detected concentrations were below the SL at a TR of 1E-06, HQ of 0.1.

Sediment and surface water samples collected during the Phase I RI at the Former Crash Reservoir were used to evaluate the nature and extent for comparison purposes only. No explosives, propellants, SVOCs, pesticides, or PCBs were detected in sediment or surface water. In addition, no inorganic chemicals were identified as SRCs in sediment or surface water. Two VOCs (2-butanone and acetone) were detected in sediment at concentrations below the RSL at a TR of 1E-06, HQ of 0.1. VOCs were not detected in surface water for the Former Crash Area Reservoir.

One sediment and one surface water sample were collected during the Phase I RI at a drainage conveyance upstream of NACA Test Area. These samples were included in the nature and extent evaluation to provide data on off-AOC conditions for comparison purposes. No explosives were detected in sediment at the off-AOC Phase I RI sample location; however, the propellant nitrocellulose was detected at a concentration of 4.8 mg/kg. The explosive 2,4-DNT was detected at Phase I RI off-AOC surface water station NTA-104 at a concentration of 0.000051J mg/L. This explosive was not detected in any of the other surface water samples collected at NACA Test Area. Eight inorganic chemicals (barium, beryllium, cadmium, cobalt, cyanide, manganese, nickel, and selenium) were detected above background concentrations in sediment. Barium, cobalt, cyanide, and manganese were detected at concentrations above their respective SLs in sediment. The concentrations detected at the upstream, off-AOC location were higher than those observed at either of the NACA Test Area sediment data EUs. VOCs were not detected in sediment, but acetone was detected in surface water below the RSL. SVOCs, pesticides, and PCBs were not detected in sediment and surface water at the off-AOC sample locations.

Table 5–1. Chromium Speciation Results

Sample Location	Hexavalent Chromium Concentration (mg/kg)	Total Chromium Concentration[a] (mg/kg)	Percent Hexavalent Chromium (%)
NTAss-134	<0.95U	47.2	NA
NTAss-135	<1.1U	17.9	NA
NTAss-140	<1.3U	12.2	NA

[a] Background screening value for total chromium = 17.4 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 = Non-detectable concentration.

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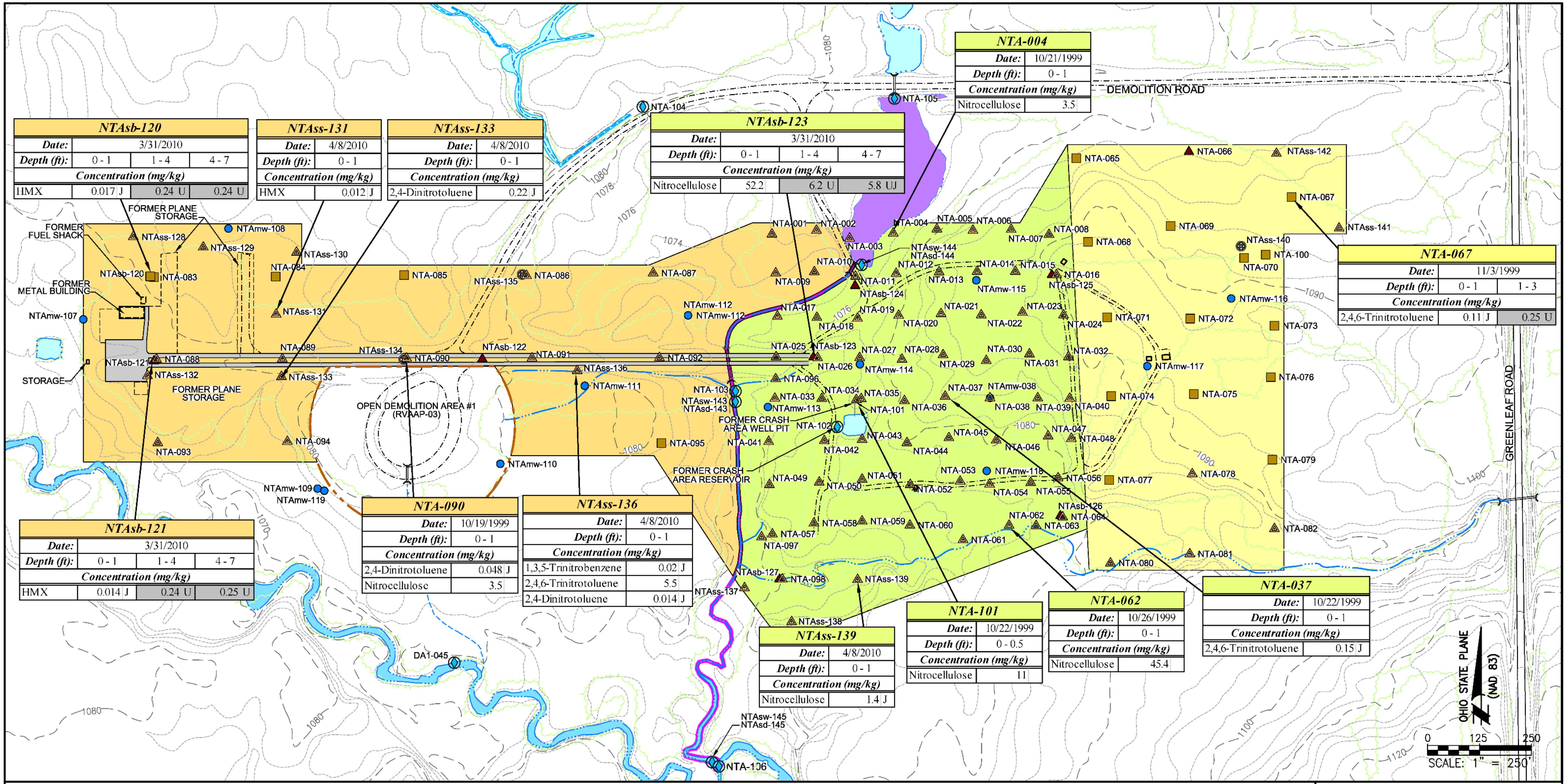

NTAsb-120

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
HMX	0.017 J	0.24 U	0.24 U

NTAss-131

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
HMX	0.012 J

NTAss-133

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4-Dinitrotoluene	0.22 J

NTAsb-123

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Nitrocellulose	52.2	6.2 U	5.8 UJ

NTA-004

Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	3.5

NTA-067

Date:	11/3/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
2,4,6-Trinitrotoluene	0.11 J	0.25 U

NTAsb-121

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
HMX	0.014 J	0.24 U	0.25 U

NTA-090

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4-Dinitrotoluene	0.048 J
Nitrocellulose	3.5

NTAss-136

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
1,3,5-Trinitrobenzene	0.02 J
2,4,6-Trinitrotoluene	5.5
2,4-Dinitrotoluene	0.014 J

NTAss-139

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	1.4 J

NTA-101

Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Nitrocellulose	11

NTA-062

Date:	10/26/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Nitrocellulose	45.4

NTA-037

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
2,4,6-Trinitrotoluene	0.15 J

LEGEND:

═══	GRAVEL ROAD
▭	CONCRETE SLAB
≈	SURFACE WATER
- - -	INTERMITTENT STREAM
∿	VEGETATION
)==(	CULVERT PIPE
— —	GROUND CONTOUR (10–FT)
— —	GROUND CONTOUR (2–FT)
— · —	APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
△	SURFACE SOIL
▲	SOIL BORING
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
●	GROUNDWATER MONITORING WELL

SOIL AGGREGATES

🟧	FORMER PLANE REFUELING/CRASH STRIP AREA
🟩	FORMER CRASH AREA
🟨	FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

🟪	WETLAND/POND NORTH OF FORMER CRASH AREA
▬	TRIBUTARY TO HINKLEY CREEK

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).

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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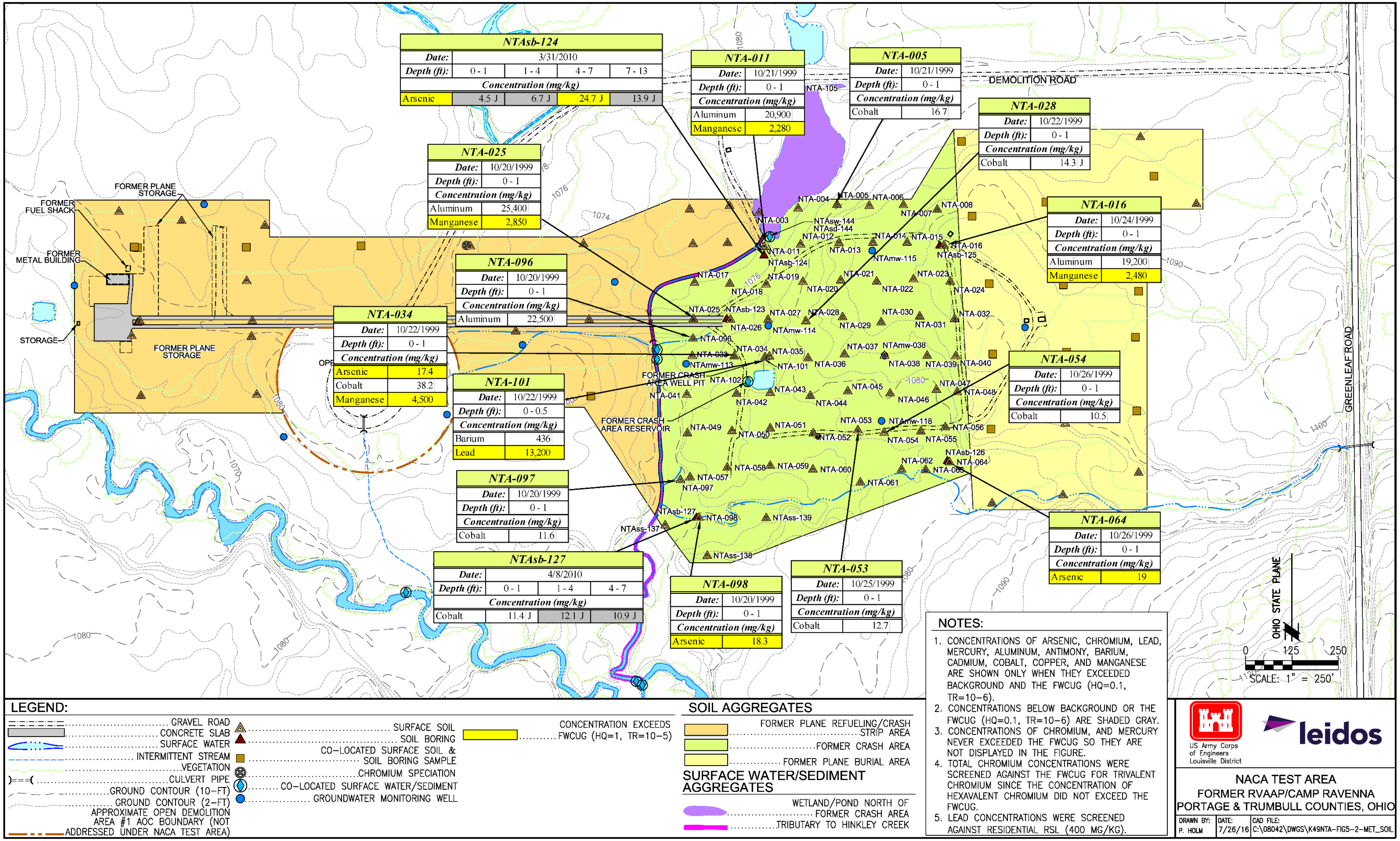
Figure 5–1. Detected Concentrations of Explosives and Propellants in Soil - All Soil Exposure Units



NTAsb-124				
Date:	3/31/2010			
Depth (ft):	0 - 1	1 - 4	4 - 7	7 - 13
Concentration (mg/kg)				
Arsenic	4.5 J	6.7 J	24.7 J	13.9 J

NTA-011	
Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	20,900
Manganese	2,280

NTA-005	
Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	16.7

NTA-028	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	14.3 J

NTA-025	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	25,400
Manganese	2,850

NTA-016	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	19,200
Manganese	2,480

NTA-096	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	22,500

NTA-034	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	17.4
Cobalt	38.2
Manganese	4,500

NTA-054	
Date:	10/26/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.5

NTA-101	
Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Barium	436
Lead	13,200

NTA-097	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	11.6

NTA-064	
Date:	10/26/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	19

NTAsb-127			
Date:	4/8/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Cobalt	11.4 J	12.1 J	10.9 J

NTA-098	
Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	18.3

NTA-053	
Date:	10/25/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	12.7

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, ANTIMONY, BARIUM, CADMIUM, COBALT, COPPER, AND MANGANESE 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. CONCENTRATIONS OF CHROMIUM, AND MERCURY NEVER EXCEEDED THE FWCUG SO THEY ARE NOT DISPLAYED IN THE FIGURE.
4. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM SINCE THE CONCENTRATION OF HEXAVALENT CHROMIUM DID NOT EXCEED THE FWCUG.
5. LEAD CONCENTRATIONS WERE SCREENED AGAINST RESIDENTIAL RSL (400 MG/KG).

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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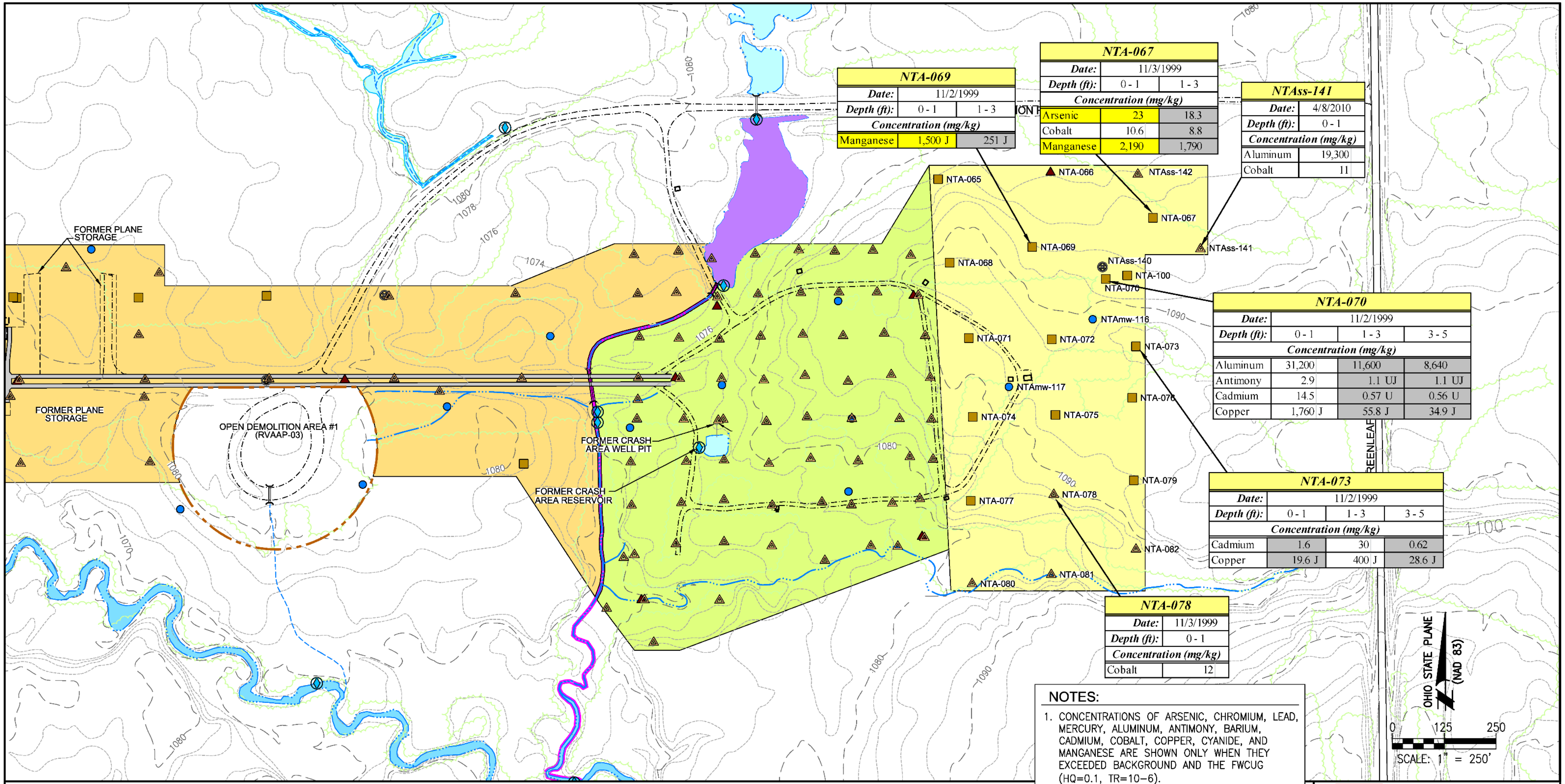
Figure 5–2. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Crash Area



NTA-069

Date:	11/2/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Manganese	1,500 J	251 J

NTA-067

Date:	11/3/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Arsenic	23	18.3
Cobalt	10.6	8.8
Manganese	2,190	1,790

NTAss-141

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	19,300
Cobalt	11

NTA-070

Date:	11/2/1999		
Depth (ft):	0 - 1	1 - 3	3 - 5
Concentration (mg/kg)			
Aluminum	31,200	11,600	8,640
Antimony	2.9	1.1 UJ	1.1 UJ
Cadmium	14.5	0.57 U	0.56 U
Copper	1,760 J	55.8 J	34.9 J

NTA-073

Date:	11/2/1999		
Depth (ft):	0 - 1	1 - 3	3 - 5
Concentration (mg/kg)			
Cadmium	1.6	30	0.62
Copper	19.6 J	400 J	28.6 J

NTA-078

Date:	11/3/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	12

LEGEND:

═ ═ ═	GRAVEL ROAD
▭	CONCRETE SLAB
	SURFACE WATER
- - -	INTERMITTENT STREAM
	VEGETATION
)==(	CULVERT PIPE
	GROUND CONTOUR (10-FT)
	GROUND CONTOUR (2-FT)
	APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
△	SURFACE SOIL
▲	SOIL BORING
■	CO-LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO-LOCATED SURFACE WATER/SEDIMENT
●	GROUNDWATER MONITORING WELL
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10-5)

SOIL AGGREGATES

🟧	FORMER PLANE REFUELING/CRASH STRIP AREA
🟩	FORMER CRASH AREA
🟨	FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

🟪	WETLAND/POND NORTH OF FORMER CRASH AREA
	TRIBUTARY TO HINKLEY CREEK

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, ANTIMONY, BARIUM, CADMIUM, COBALT, COPPER, CYANIDE, AND MANGANESE 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. CONCENTRATIONS OF CHROMIUM, AND MERCURY NEVER EXCEEDED THE FWCUG SO THEY ARE NOT DISPLAYED IN THE FIGURE.
4. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM SINCE THE CONCENTRATION OF HEXAVALENT CHROMIUM DID NOT EXCEED THE FWCUG.
5. LEAD CONCENTRATIONS WERE SCREENED AGAINST RESIDENTIAL RSL (400 MG/KG).

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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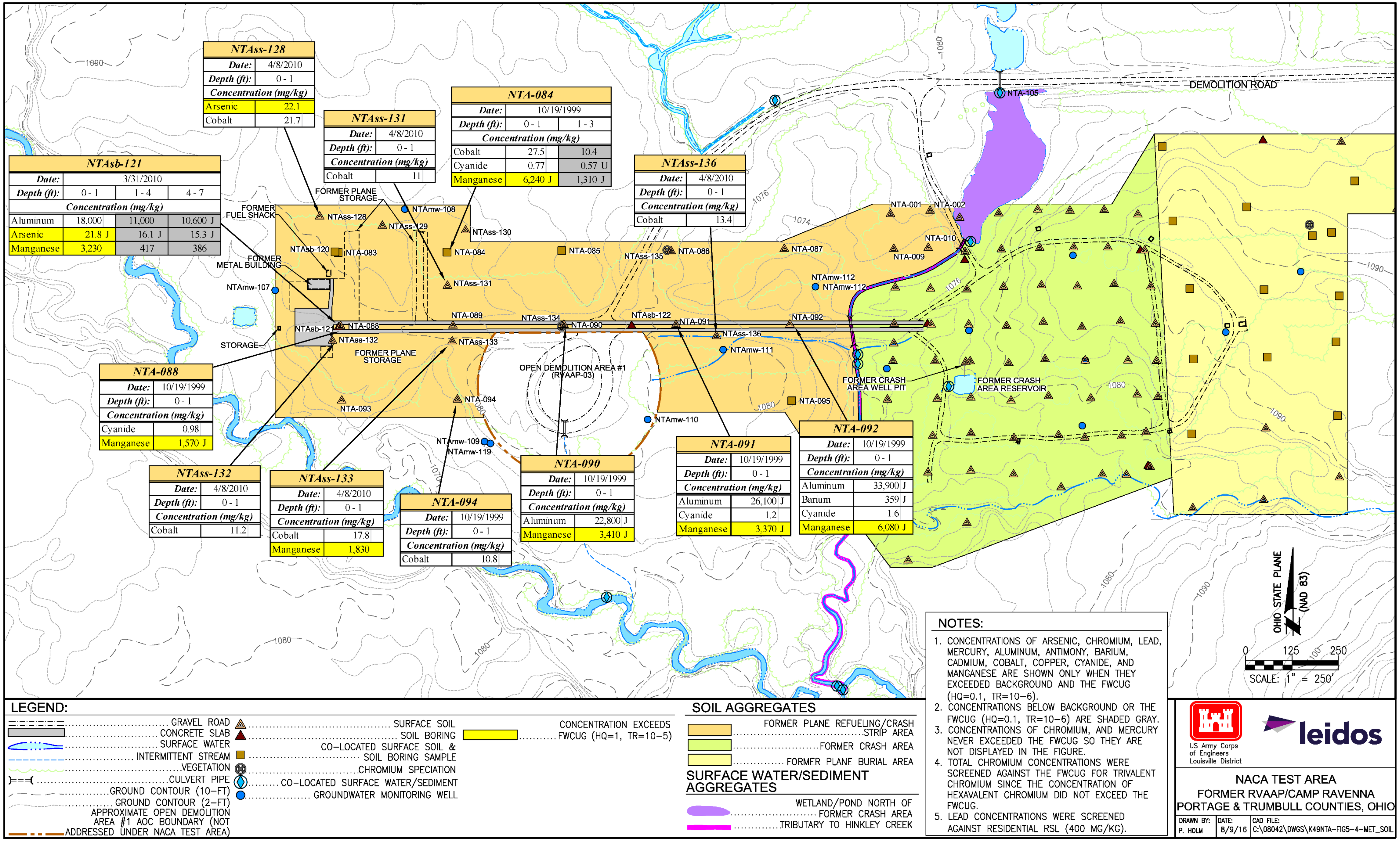
Figure 5–3. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Plane Burial Area



NTAss-128	
Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Arsenic	22.1
Cobalt	21.7

NTAsb-121			
Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Aluminum	18,000	11,000	10,600 J
Arsenic	21.8 J	16.1 J	15.3 J
Manganese	3,230	417	386

NTAss-131	
Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	11

NTA-084		
Date:	10/19/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Cobalt	27.5	10.4
Cyanide	0.77	0.57 U
Manganese	6,240 J	1,310 J

NTAss-136	
Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	13.4

NTA-088	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cyanide	0.98
Manganese	1,570 J

NTAss-132	
Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	11.2

NTAss-133	
Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	17.8
Manganese	1,830

NTA-094	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Cobalt	10.8

NTA-090	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	22,800 J
Manganese	3,410 J

NTA-091	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	26,100 J
Cyanide	1.2
Manganese	3,370 J

NTA-092	
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Aluminum	33,900 J
Barium	359 J
Cyanide	1.6
Manganese	6,080 J

LEGEND:

=:=:=:=	GRAVEL ROAD
▭	CONCRETE SLAB
⬭	SURFACE WATER
- - - -	INTERMITTENT STREAM
~~	VEGETATION
)==(	CULVERT PIPE
— - —	GROUND CONTOUR (10–FT)
- - -	GROUND CONTOUR (2–FT)
— · —	APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
△	SURFACE SOIL
▲	SOIL BORING
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
●	GROUNDWATER MONITORING WELL
🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

SOIL AGGREGATES

🟧	FORMER PLANE REFUELING/CRASH STRIP AREA
🟩	FORMER CRASH AREA
🟨	FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

⬬	WETLAND/POND NORTH OF FORMER CRASH AREA
▬	TRIBUTARY TO HINKLEY CREEK

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, ALUMINUM, ANTIMONY, BARIUM, CADMIUM, COBALT, COPPER, CYANIDE, AND MANGANESE 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. CONCENTRATIONS OF CHROMIUM, AND MERCURY NEVER EXCEEDED THE FWCUG SO THEY ARE NOT DISPLAYED IN THE FIGURE.
4. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM SINCE THE CONCENTRATION OF HEXAVALENT CHROMIUM DID NOT EXCEED THE FWCUG.
5. LEAD CONCENTRATIONS WERE SCREENED AGAINST RESIDENTIAL RSL (400 MG/KG).

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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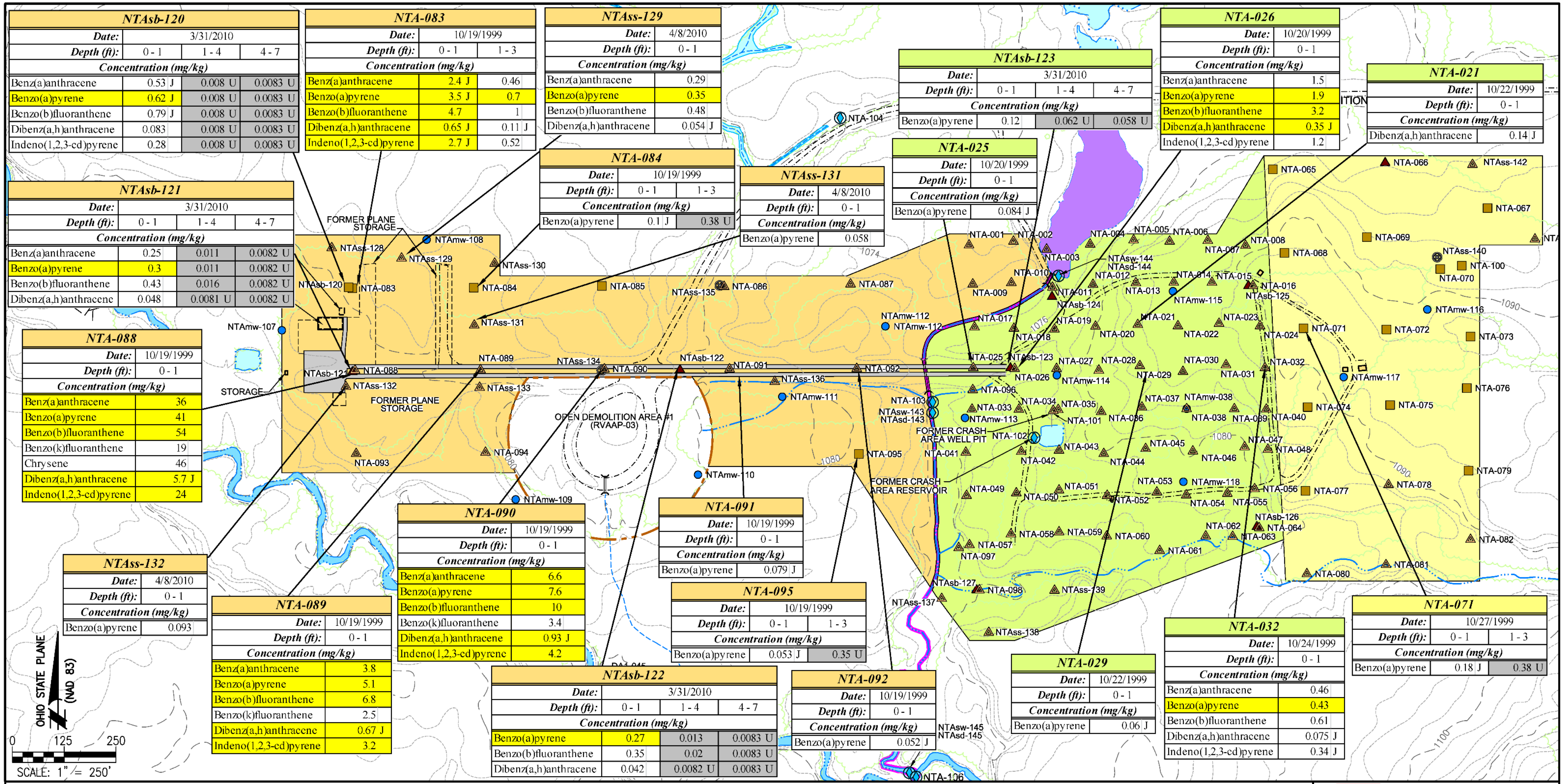
Figure 5–4. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Soil - Former Plane Refueling/Crash Strip Area



NTAsb-120

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.53 J	0.008 U	0.0083 U
Benzo(a)pyrene	0.62 J	0.008 U	0.0083 U
Benzo(b)fluoranthene	0.79 J	0.008 U	0.0083 U
Dibenz(a,h)anthracene	0.083	0.008 U	0.0083 U
Indeno(1,2,3-cd)pyrene	0.28	0.008 U	0.0083 U

NTA-083

Date:	10/19/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Benz(a)anthracene	2.4 J	0.46
Benzo(a)pyrene	3.5 J	0.7
Benzo(b)fluoranthene	4.7	1
Dibenz(a,h)anthracene	0.65 J	0.11 J
Indeno(1,2,3-cd)pyrene	2.7 J	0.52

NTAss-129

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.29
Benzo(a)pyrene	0.35
Benzo(b)fluoranthene	0.48
Dibenz(a,h)anthracene	0.054 J

NTAsb-123

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.12	0.062 U	0.058 U

NTA-026

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	1.5
Benzo(a)pyrene	1.9
Benzo(b)fluoranthene	3.2
Dibenz(a,h)anthracene	0.35 J
Indeno(1,2,3-cd)pyrene	1.2

NTA-021

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dibenz(a,h)anthracene	0.14 J

NTAsb-121

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.25	0.011	0.0082 U
Benzo(a)pyrene	0.3	0.011	0.0082 U
Benzo(b)fluoranthene	0.43	0.016	0.0082 U
Dibenz(a,h)anthracene	0.048	0.0081 U	0.0082 U

NTA-084

Date:	10/19/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Benzo(a)pyrene	0.1 J	0.38 U

NTAss-131

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.058

NTA-025

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.084 J

NTA-088

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	36
Benzo(a)pyrene	41
Benzo(b)fluoranthene	54
Benzo(k)fluoranthene	19
Chrysene	46
Dibenz(a,h)anthracene	5.7 J
Indeno(1,2,3-cd)pyrene	24

NTA-090

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	6.6
Benzo(a)pyrene	7.6
Benzo(b)fluoranthene	10
Benzo(k)fluoranthene	3.4
Dibenz(a,h)anthracene	0.93 J
Indeno(1,2,3-cd)pyrene	4.2

NTA-091

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.079 J

NTAss-132

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.093

NTA-095

Date:	10/19/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Benzo(a)pyrene	0.053 J	0.35 U

NTA-089

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	3.8
Benzo(a)pyrene	5.1
Benzo(b)fluoranthene	6.8
Benzo(k)fluoranthene	2.5
Dibenz(a,h)anthracene	0.67 J
Indeno(1,2,3-cd)pyrene	3.2

NTA-032

Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.46
Benzo(a)pyrene	0.43
Benzo(b)fluoranthene	0.61
Dibenz(a,h)anthracene	0.075 J
Indeno(1,2,3-cd)pyrene	0.34 J

NTA-071

Date:	10/27/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Benzo(a)pyrene	0.18 J	0.38 U

NTA-029

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.06 J

NTAsb-122

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benzo(a)pyrene	0.27	0.013	0.0083 U
Benzo(b)fluoranthene	0.35	0.02	0.0083 U
Dibenz(a,h)anthracene	0.042	0.0082 U	0.0083 U

NTA-092

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.052 J

LEGEND:

═══	GRAVEL ROAD
▭	CONCRETE SLAB
≈	SURFACE WATER
- - -	INTERMITTENT STREAM
~~	VEGETATION
)==(	CULVERT PIPE
— —	GROUND CONTOUR (10–FT)
- -	GROUND CONTOUR (2–FT)
— · —	APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
▲	SURFACE SOIL
▲	SOIL BORING
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
●	GROUNDWATER MONITORING WELL

SOIL AGGREGATES

🟧	FORMER PLANE REFUELING/CRASH STRIP AREA
🟩	FORMER CRASH AREA
🟨	FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

🟪	WETLAND/POND NORTH OF FORMER CRASH AREA
▬	TRIBUTARY TO HINKLEY CREEK

🟨	CONCENTRATION EXCEEDS FWCUG (HQ=1, TR=10–5)

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

US Army Corps of Engineers Louisville District

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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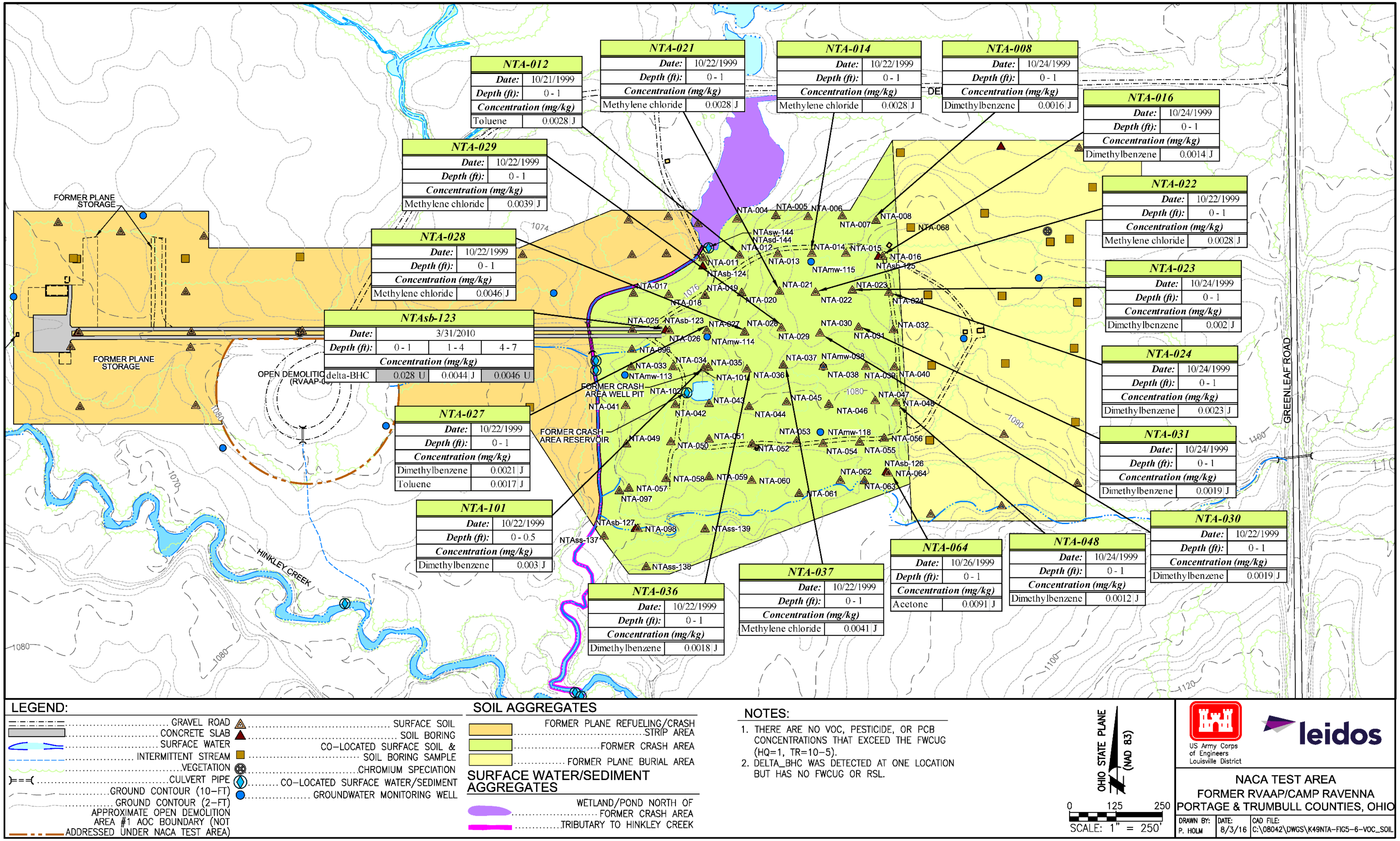
Figure 5–5. PAH Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Soil - All Soil Exposure Units



NTA-012	
Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Toluene	0.0028 J

NTA-021	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0028 J

NTA-014	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0028 J

NTA-008	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0016 J

NTA-016	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0014 J

NTA-029	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0039 J

NTA-022	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0028 J

NTA-028	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0046 J

NTA-023	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.002 J

NTAsb-123			
Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
delta-BHC	0.028 U	0.0044 J	0.0046 U

NTA-024	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0023 J

NTA-027	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0021 J
Toluene	0.0017 J

NTA-031	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0019 J

NTA-101	
Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Dimethylbenzene	0.003 J

NTA-030	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0019 J

NTA-064	
Date:	10/26/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Acetone	0.0091 J

NTA-048	
Date:	10/24/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0012 J

NTA-037	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0041 J

NTA-036	
Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Dimethylbenzene	0.0018 J

NOTES:

1. 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.

NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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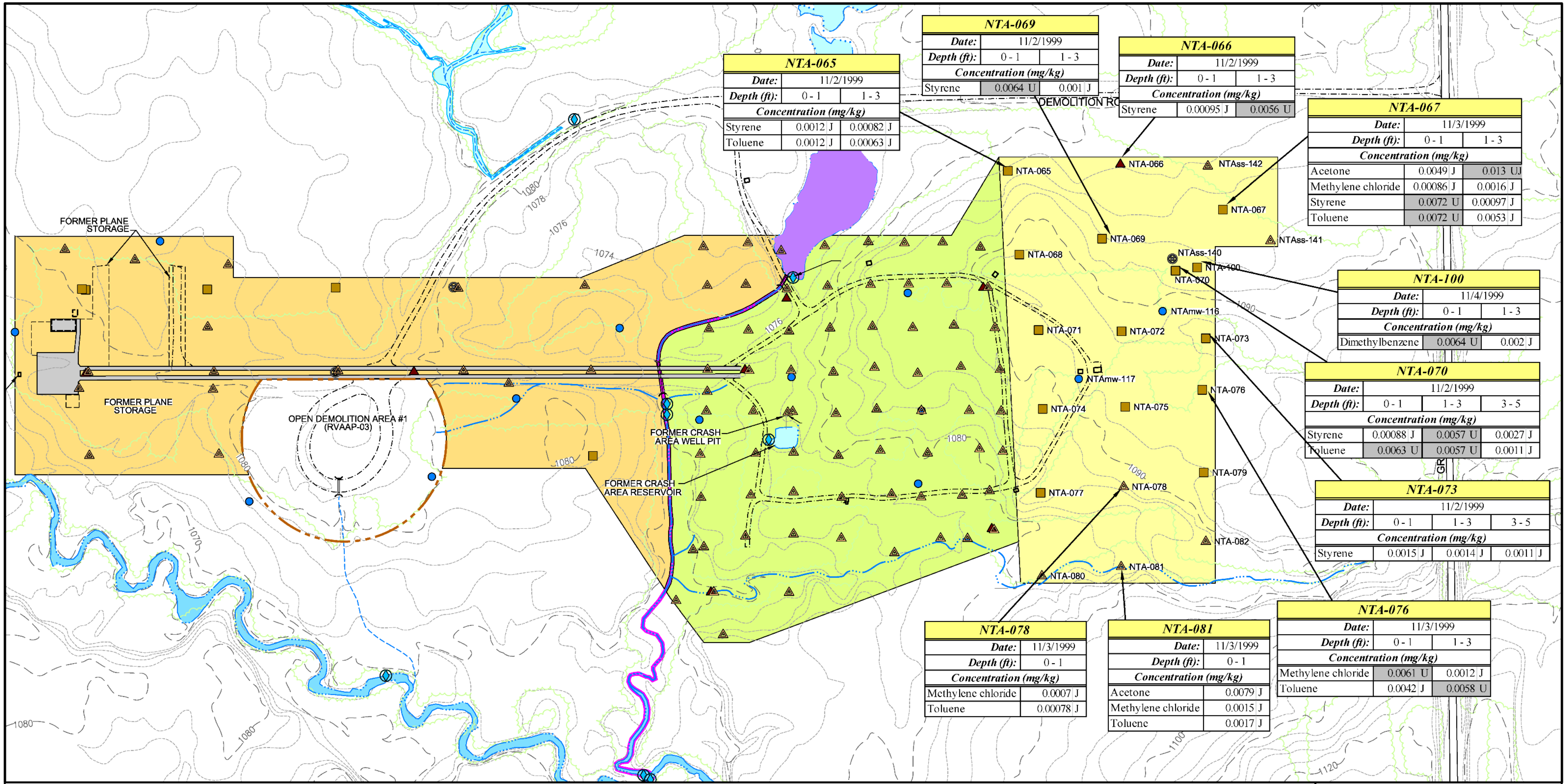
Figure 5–6. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Crash Area



NTA-065

Date:	11/2/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Styrene	0.0012 J	0.00082 J
Toluene	0.0012 J	0.00063 J

NTA-069

Date:	11/2/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Styrene	0.0064 U	0.001 J

NTA-066

Date:	11/2/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Styrene	0.00095 J	0.0056 U

NTA-067

Date:	11/3/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Acetone	0.0049 J	0.013 UJ
Methylene chloride	0.00086 J	0.0016 J
Styrene	0.0072 U	0.00097 J
Toluene	0.0072 U	0.0053 J

NTA-100

Date:	11/4/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Dimethylbenzene	0.0064 U	0.002 J

NTA-070

Date:	11/2/1999		
Depth (ft):	0 - 1	1 - 3	3 - 5
Concentration (mg/kg)			
Styrene	0.00088 J	0.0057 U	0.0027 J
Toluene	0.0063 U	0.0057 U	0.0011 J

NTA-073

Date:	11/2/1999		
Depth (ft):	0 - 1	1 - 3	3 - 5
Concentration (mg/kg)			
Styrene	0.0015 J	0.0014 J	0.0011 J

NTA-078

Date:	11/3/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Methylene chloride	0.0007 J
Toluene	0.00078 J

NTA-081

Date:	11/3/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Acetone	0.0079 J
Methylene chloride	0.0015 J
Toluene	0.0017 J

NTA-076

Date:	11/3/1999	
Depth (ft):	0 - 1	1 - 3
Concentration (mg/kg)		
Methylene chloride	0.0061 U	0.0012 J
Toluene	0.0042 J	0.0058 U

LEGEND:

GRAVEL ROAD
CONCRETE SLAB
SURFACE WATER
INTERMITTENT STREAM
VEGETATION
CULVERT PIPE
GROUND CONTOUR (10-FT)
GROUND CONTOUR (2-FT)
APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
△ SURFACE SOIL
▲ SOIL BORING
■ CO-LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗ CHROMIUM SPECIATION
◈ CO-LOCATED SURFACE WATER/SEDIMENT
● GROUNDWATER MONITORING WELL

SOIL AGGREGATES

🟧 FORMER PLANE REFUELING/CRASH STRIP AREA
🟩 FORMER CRASH AREA
🟨 FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

🟪 WETLAND/POND NORTH OF FORMER CRASH AREA
▬ TRIBUTARY TO HINKLEY CREEK

NOTES:

1. 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.

OHIO STATE PLANE (NAD 83)

0 125 250
SCALE: 1" = 250'

US Army Corps of Engineers
Louisville District

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NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

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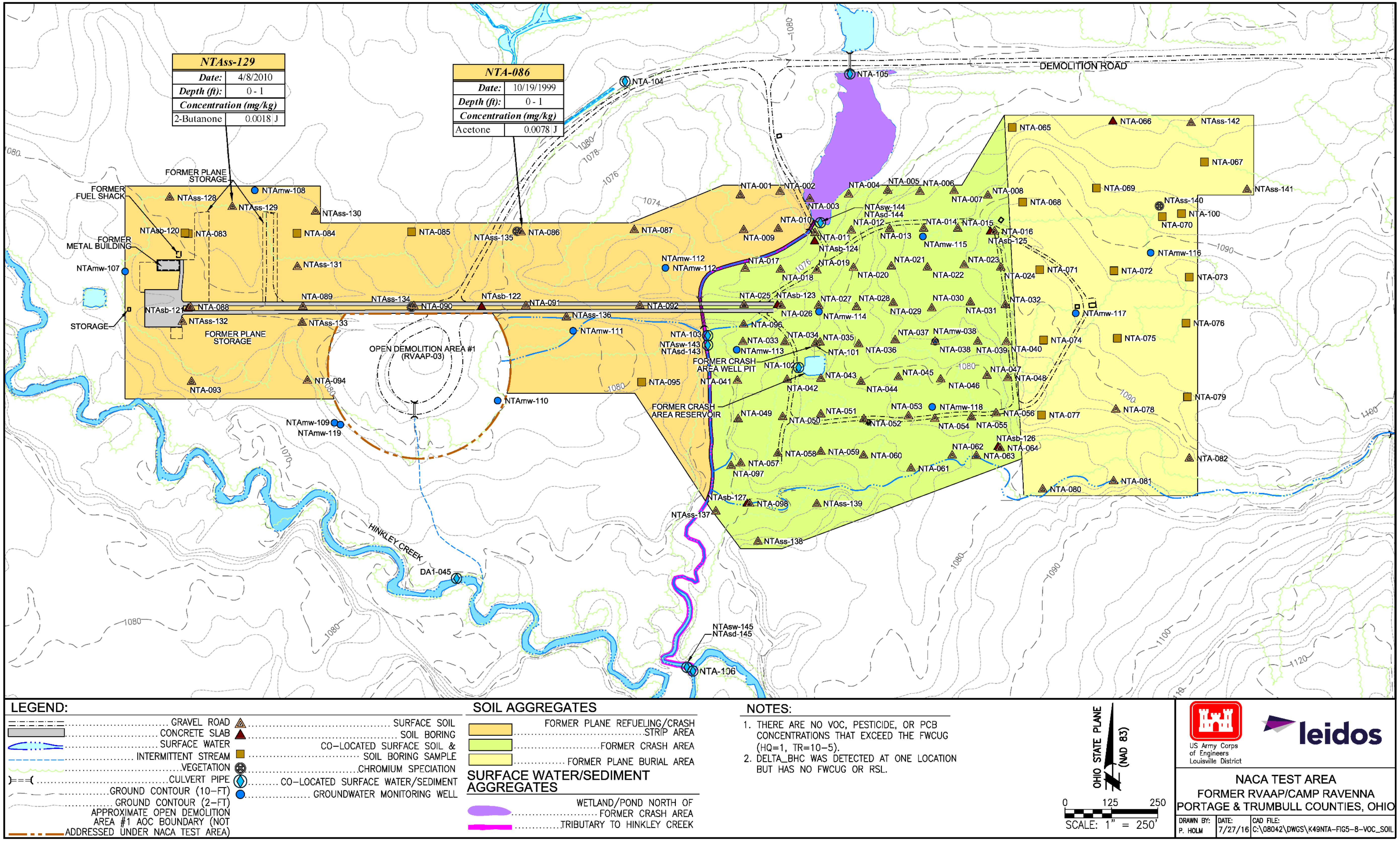
DATE: 8/3/16
CAD FILE: C:\08042\DWGS\K49NTA-FIG5-7-VOC_SOIL

Figure 5–7. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Plane Burial Area



NTAss-129

Date:	4/8/2010
Depth (ft):	0 - 1
Concentration (mg/kg)	
2-Butanone	0.0018 J

NTA-086

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Acetone	0.0078 J

LEGEND:

═══	GRAVEL ROAD
▭	CONCRETE SLAB
⊂⊃	SURFACE WATER
- - -	INTERMITTENT STREAM
·····	VEGETATION
)==(	CULVERT PIPE
— —	GROUND CONTOUR (10–FT)
– –	GROUND CONTOUR (2–FT)
– · –	APPROXIMATE OPEN DEMOLITION AREA #1 AOC BOUNDARY (NOT ADDRESSED UNDER NACA TEST AREA)
△	SURFACE SOIL
▲	SOIL BORING
■	CO–LOCATED SURFACE SOIL & SOIL BORING SAMPLE
⊗	CHROMIUM SPECIATION
◈	CO–LOCATED SURFACE WATER/SEDIMENT
●	GROUNDWATER MONITORING WELL

SOIL AGGREGATES

🟧	FORMER PLANE REFUELING/CRASH STRIP AREA
🟩	FORMER CRASH AREA
🟨	FORMER PLANE BURIAL AREA

SURFACE WATER/SEDIMENT AGGREGATES

🟪	WETLAND/POND NORTH OF FORMER CRASH AREA
▬	TRIBUTARY TO HINKLEY CREEK

NOTES:

1. 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.

NACA TEST AREA
FORMER RVAAP/CAMP RAVENNA
PORTAGE & TRUMBULL COUNTIES, OHIO

DRAWN BY:	DATE:	CAD FILE:
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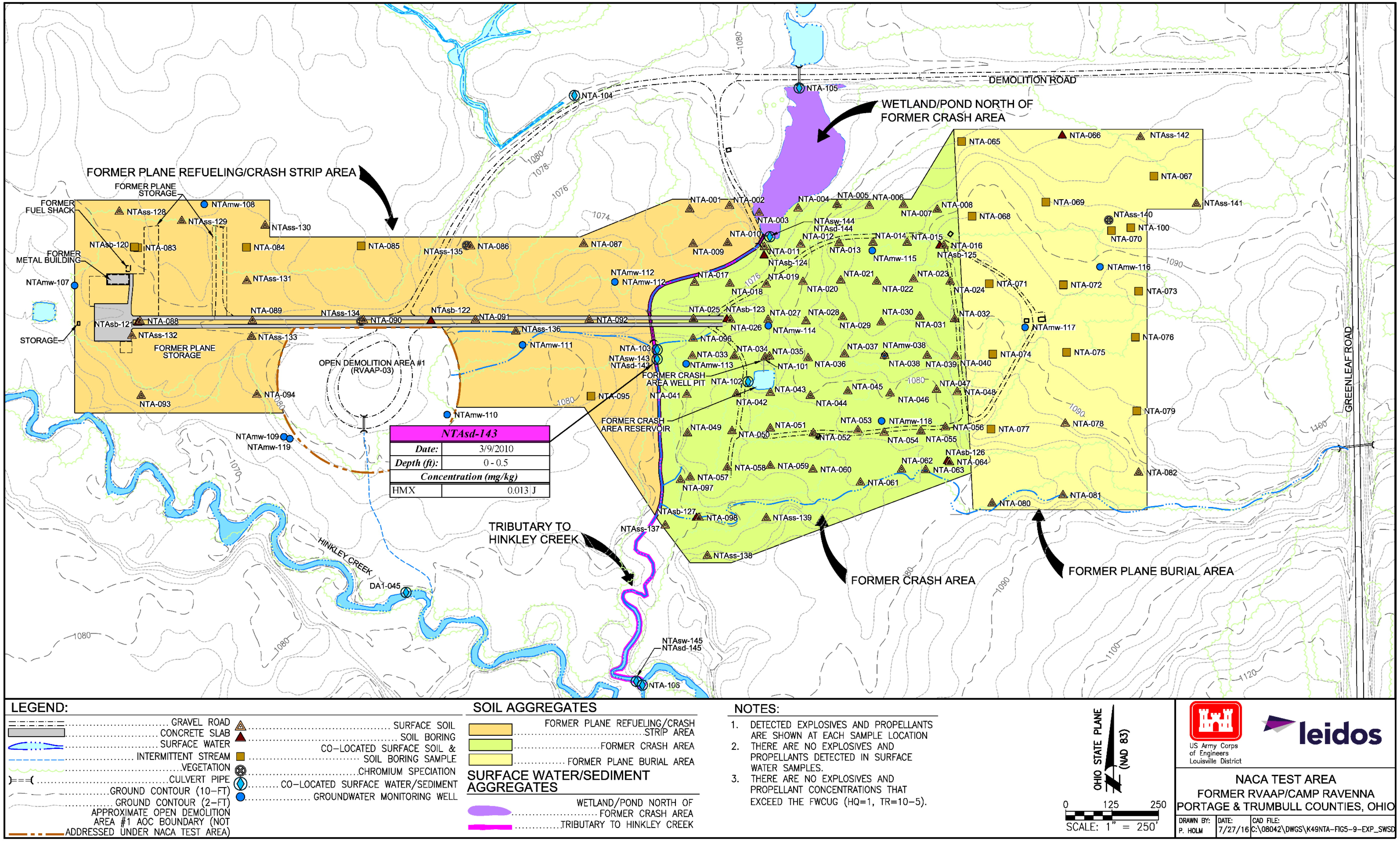
Figure 5–8. Detected Concentrations of VOCs, Pesticides, and PCBs in Soil - Former Plane Refueling/Crash Strip Area



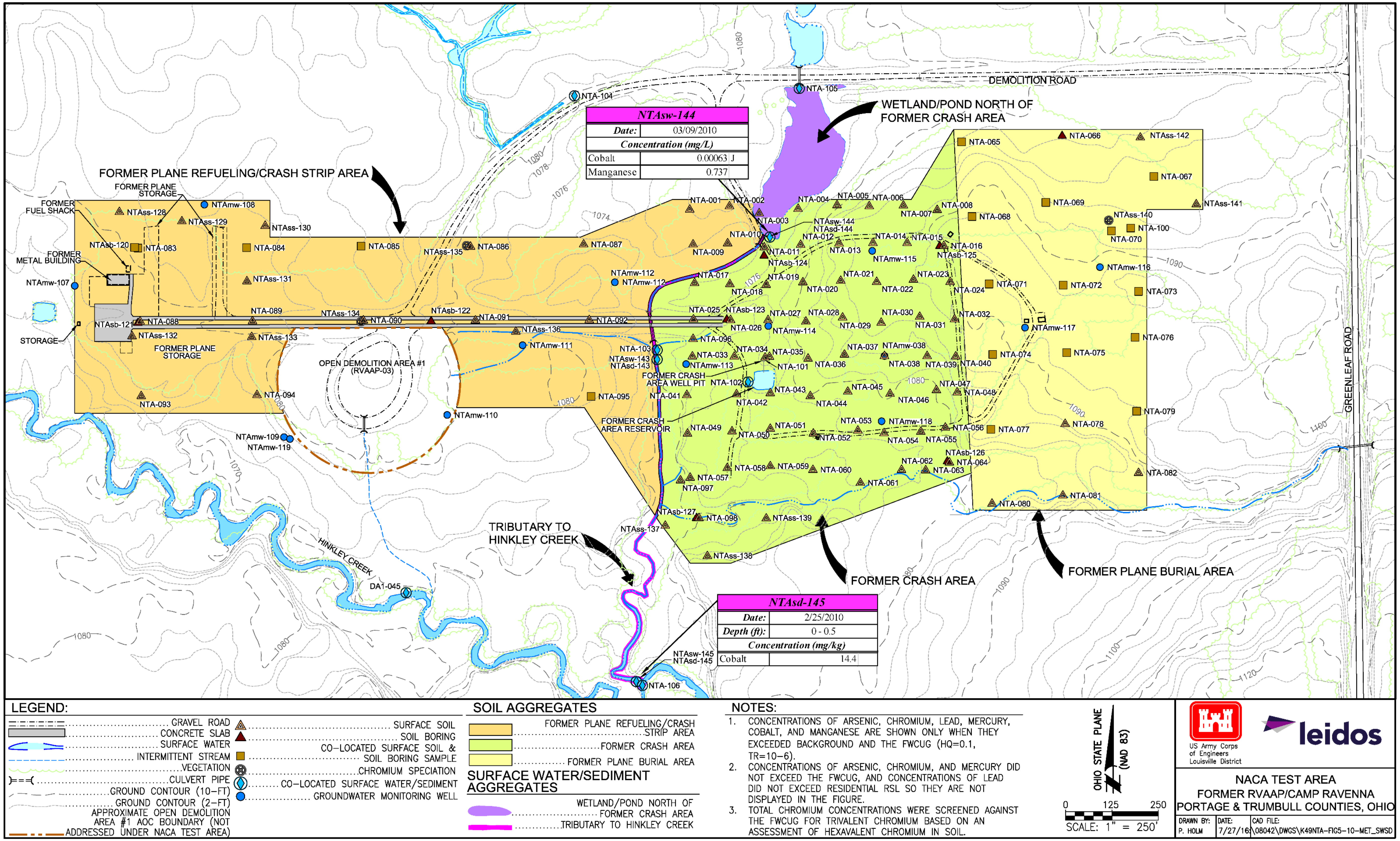
NTAsd-143

Date:	3/9/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
HMX	0.013 J

NOTES:

1. DETECTED EXPLOSIVES AND PROPELLANTS ARE SHOWN AT EACH SAMPLE LOCATION
2. THERE ARE NO EXPLOSIVES AND PROPELLANTS DETECTED IN SURFACE WATER SAMPLES.
3. THERE ARE NO EXPLOSIVES AND PROPELLANT CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).

Figure 5–9. Detected Concentrations of Explosives and Propellants in Surface Water and Sediment



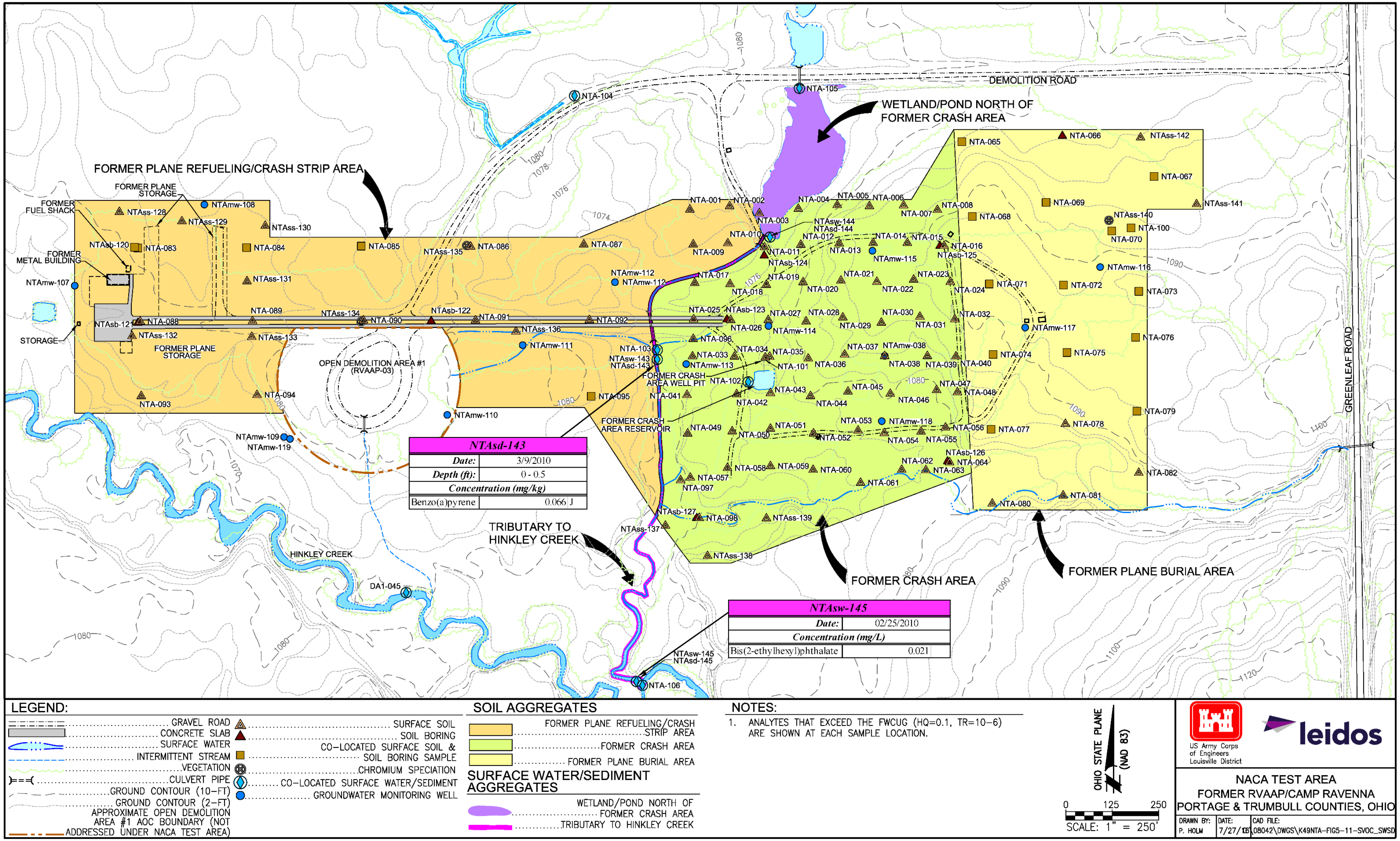
NTAsw-144	
Date:	03/09/2010
Concentration (mg/L)	
Cobalt	0.00063 J
Manganese	0.737

NTAsd-145	
Date:	2/25/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Cobalt	14.4

NOTES:

1. CONCENTRATIONS OF ARSENIC, CHROMIUM, LEAD, MERCURY, COBALT, AND MANGANESE ARE SHOWN ONLY WHEN THEY EXCEEDED BACKGROUND AND THE FWCUG (HQ=0.1, TR=10-6).
2. CONCENTRATIONS OF ARSENIC, CHROMIUM, AND MERCURY DID NOT EXCEED THE FWCUG, AND CONCENTRATIONS OF LEAD DID NOT EXCEED RESIDENTIAL RSL SO THEY ARE NOT DISPLAYED IN THE FIGURE.
3. TOTAL CHROMIUM CONCENTRATIONS WERE SCREENED AGAINST THE FWCUG FOR TRIVALENT CHROMIUM BASED ON AN ASSESSMENT OF HEXAVALENT CHROMIUM IN SOIL.

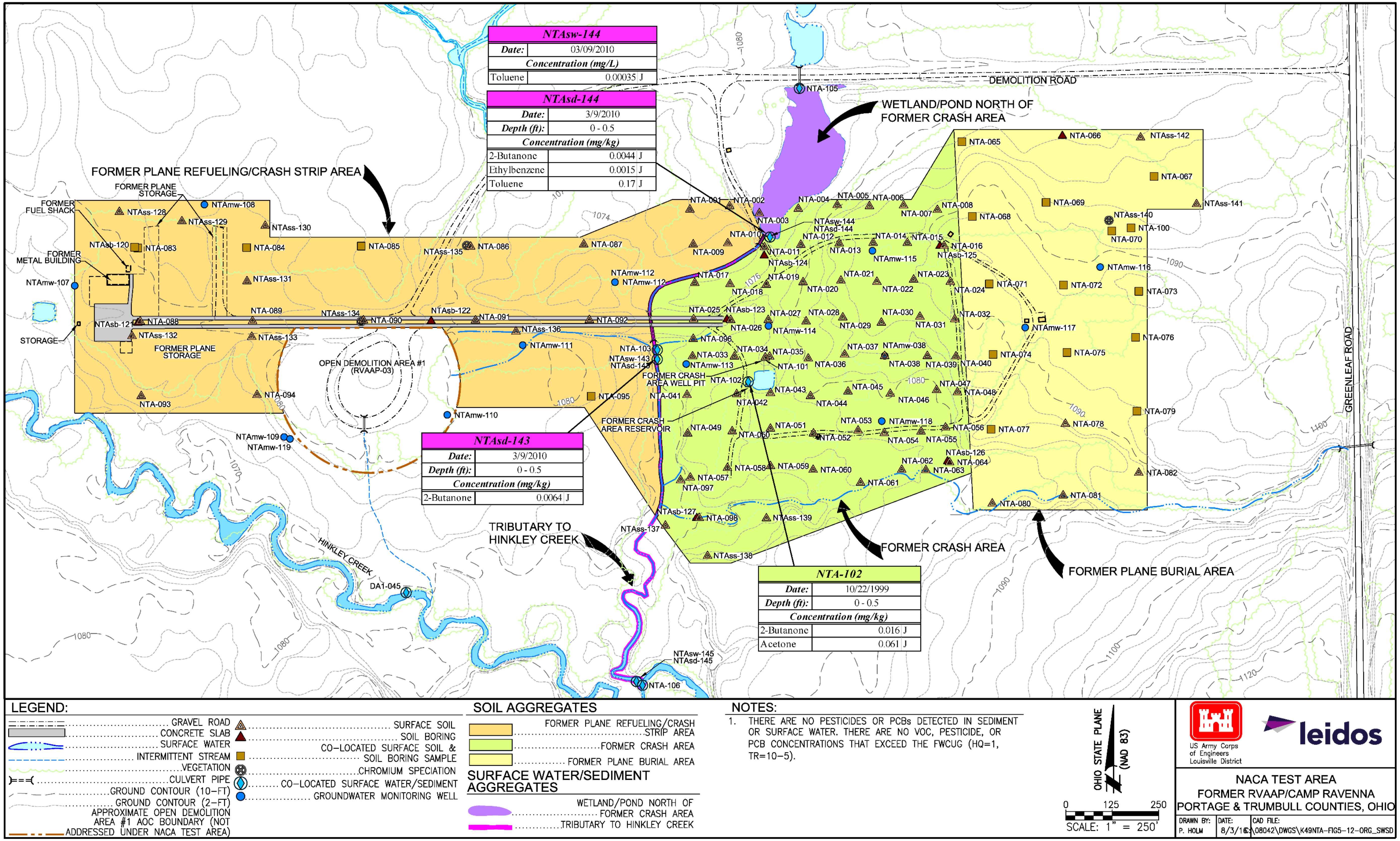
Figure 5–10. Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) for Inorganic SRCs in Surface Water and Sediment



NTAsd-143	
Date:	3/9/2010
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Benzo(a)pyrene	0.066 J

NTAsw-145	
Date:	02/25/2010
Concentration (mg/L)	
Bis(2-ethylhexyl)phthalate	0.021

Figure 5–11. SVOC Exceedances of FWCUG (HQ of 0.1, TR of 1E-06) in Surface Water and Sediment



NTAsw-144		
Date:	03/09/2010	
Concentration (mg/L)		
Toluene	0.00035	J

NTAsd-144		
Date:	3/9/2010	
Depth (ft):	0 - 0.5	
Concentration (mg/kg)		
2-Butanone	0.0044	J
Ethylbenzene	0.0015	J
Toluene	0.17	J

NTAsd-143		
Date:	3/9/2010	
Depth (ft):	0 - 0.5	
Concentration (mg/kg)		
2-Butanone	0.0064	J

NTA-102		
Date:	10/22/1999	
Depth (ft):	0 - 0.5	
Concentration (mg/kg)		
2-Butanone	0.016	J
Acetone	0.061	J

NOTES:

1. THERE ARE NO PESTICIDES OR PCBs DETECTED IN SEDIMENT OR SURFACE WATER. THERE ARE NO VOC, PESTICIDE, OR PCB CONCENTRATIONS THAT EXCEED THE FWCUG (HQ=1, TR=10–5).

Figure 5–12. Detected Concentrations of VOCs, Pesticides, and PCBs in Surface Water and Sediment

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 NACA Test Area 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 the SRCs with the potential to migrate from soil and sediment to groundwater as initial CMCOPCs. Section 6.5 describes fate and transport modeling of final CMCOPCs and presents CMCOCs. Section 6.6 provides an evaluation of the identified CMCOPCs to identify the final CMCOCs. Section 6.7 presents the summary and conclusions of this fate and transport analysis.

6.1 PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CONTAMINANTS

Using available process knowledge and previous investigation results, the Phase I RI Report established anticipated primary COPCs that include inorganic chemicals (metals), SVOCs, and VOCs, as shown in Table 2-2 of this Phase II RI Report. These chemical groups are associated with burned or partly combusted fuels, deicing compounds, lubricants, hydraulic fluids, as well as fire extinguishing agents (specifically bromochloromethane) (AGOH 1997, NACA 1953). Explosives, such as TNT and its associated degradation products and propellants are not directly related to past operations. However, because of the proximity of ODA1, explosives and propellants are also considered to be potential contaminants, especially in the southern portion of the crash strip area.

The evaluation of contaminant fate and transport not only includes anticipated primary COPCs identified in the Phase I RI Report but also includes chemicals that were identified as SRCs in this Phase II RI. The comprehensive list of surface and subsurface soil SRCs (including 17 inorganic chemicals and 18 organic chemicals in the Former Crash Area, 18 inorganic chemicals and 12 organic chemicals in the Former Plane Burial Area, and 18 inorganic chemicals and 26 organic chemicals in the Former Plane Refueling/Crash Strip Area) and sediment SRCs (including 6 inorganic chemicals and 17 organic chemicals in the Tributary to Hinkley Creek EU, 3 inorganic chemicals and 3 organic chemicals in the Wetland/Pond North of Former Crash Area EU, and 2 organic chemicals in the Former Crash Area Reservoir EU) was detailed in Section 4.0 and is summarized below:

- Inorganic SRCs in surface and subsurface soil: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

- Inorganic SRCs in sediment: beryllium, cadmium, chromium, cobalt, nickel, and silver.
- Organic SRCs in surface and subsurface soil: 1,3,5-TNB; TNT; 2,4-DNT; 2-butanone; acenaphthene; acenaphthylene; acetone; anthracene; benz(*a*)anthracene; benzo(*a*)pyrene; benzo(*b*)fluoranthene; benzo(*ghi*)perylene; benzo(*k*)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; delta-BHC; dibenz(a,h)anthracene; dibenzofuran; dimethylbenzene; di-n-butyl phthalate; fluoranthene; fluorene; HMX; indeno(1,2,3-*cd*)pyrene; methylene chloride; naphthalene; nitrocellulose; phenanthrene; pyrene; styrene; and toluene.
- Organic SRCs in sediment: 2-butanone; acenaphthene; acetone; anthracene; benz(*a*)anthracene; benzo(*a*)pyrene; benzo(*b*)fluoranthene; benzo(*ghi*)perylene; benzo(*k*)fluoranthene; bis(2-ethylhexyl)phthalate; chrysene; dibenz(*a,h*)anthracene; ethylbenzene; fluoranthene; fluorene; HMX; indeno(1,2,3-*cd*)pyrene; phenanthrene; pyrene; and toluene.

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. The 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 an 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 (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

Several explosive chemicals, including 2,4-DNT; HMX; nitrocellulose; 1,3,5-TNB; and 2,4,6-TNT, were detected in soil and sediment at NACA Test Area. 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 biotransformation of 2,4-DNT has been systematically studied in laboratory cell cultures. The biotransformation pathway is shown in Appendix E, Figure E-2 (McCormick et al. 1978). 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 chemicals TNB and 1,3-dinitrobenzene is reduction of nitro groups to form amino groups. TNB is a photolytic product of TNT but will not undergo further photolysis. TNB will also resist hydrolysis. The breakdown of TNB is primarily through microbial degradation (USACHPPM 2001).

Limited information exists regarding biotransformation or biodegradation of HMX and nitrocellulose. Biotransformation of HMX, primarily by anaerobic degradation (ERDC 2007), occurs at a slow rate in the environment (USACHPPM 2001). HMX is primarily broken down by photolysis and has a photolytic rate constant of 0.15 days (USEPA 1988). Breakdown products of HMX include nitrate, nitrite, and formaldehyde (USACHPPM 2001). Appendix E, Figure E-3 shows the biotransformation pathway for HMX (ATSDR 1997). Nitrocellulose is an aliphatic nitrate ester that will gelatinize when mixed with nitroglycerin. 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).

6.2 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

The conceptual site model (CSM), which defines the framework for fate and transport modeling, describes conditions at NACA Test Area, 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 and the greater the accuracy of the assumptions, 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 follows.

6.2.1 Contaminant Sources

No primary contaminant sources are located on the AOC. Secondary sources (contaminated soil) identified in previous investigations are further evaluated in this report. Another potential secondary source of contamination at the AOC is contaminated sediment, which if deposited adjacent to a stream/ditch during a storm event, has potential to leach contaminants to groundwater.

6.2.2 Hydrogeology

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

- The topography at NACA Test Area ranges from approximately 1,070 ft amsl near the center of the AOC along a tributary to Hinkley Creek to approximately 1,094 ft amsl in the eastern portion of the AOC within the Former Plane Burial Area. Surface water drainage associated with heavy rainfall events follows the topography. Most of the surface runoff flows overland to the center of the AOC into the tributary to Hinkley Creek. Surface runoff in the western portion of the Former Plane Refueling/Crash Strip Area flows southwest and drains into Hinkley Creek (Figure 3-1).
- Soil beneath the AOC consists of silt loam that exhibits seasonal wetness, rapid runoff, and low permeability (USDA 2010). Bedrock was not encountered, even at a depth of 130 ft bgs, during monitoring well installation (wells NTAmw-107 through NTAmw-119 under the Phase I RI (MKM 2007).

- Twelve groundwater monitoring wells were installed at the AOC in 2004 during the Characterization of 14 AOCs to an average depth of 23.2 ft bgs. All groundwater monitoring wells monitor the unconsolidated zone.
- Water level elevations at the AOC range from 1,067.38–1,090.10 ft amsl (0.33–15.66 ft bgs), with the highest elevation at NTAmw-116 (Figure 3-1). Potentiometric data indicate the groundwater table occurs within the unconsolidated zone throughout the AOC. The flow direction is southwest toward Hinkley Creek, with a hydraulic gradient ranging from 0.00278 ft/ft in the western portion of the AOC (Former Plane Refueling/Crash Strip Area) to 0.0297 ft/ft in the eastern portion of the AOC (Former Plane Burial Area) (Figure 3-1).

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 soil to the water table (vertical migration) and lateral transport to a downgradient receptor (i.e., Hinkley Creek south of NACA Test Area);
- Contaminated sediment transported to potential downstream receptors;
- Contaminated surface water migrating to potential downstream receptors;
- Contaminated sediment within wet ditches deposited on ditch banks as a secondary source of leaching to the water table (vertical migration) and lateral transport to potential 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 at the downgradient receptors. 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 2003a).

Additional factors that affect the leaching rate include a chemical's solubility, sorption capacity (expressed by the 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 NACA Test Area. 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 leaching of soil contaminants 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 1994). 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 the 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 CMCOPCs. The five steps for the soil leachability analysis are illustrated in Figure 6-2.

6.3.1 Soil Screening Analysis

Four different aggregates exist for the AOC for the soil screening analysis: Former Crash Area, Former Crash Area Well Pit, Former Plane Burial Area, and Former Plane Refueling/Crash Strip Area. The Former Crash Area Well Pit was not considered in the soil screening because the sample was taken inside a well vault and was not representative of the soil exposed at the AOC. Each aggregate was screened separately to identify potential CMCOPCs. 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 is 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, eliminates 6 inorganic chemicals and 7 organic chemicals from the Former Crash Area, 4 inorganic chemicals and 9 organic chemicals from the Former Plane Burial Area, and 6 inorganic chemicals and 10 organic chemicals from the Former Plane Refueling/Crash Strip Area from further consideration. A total of 11 inorganic and 11 organic SRCs from the Former Crash Area, 14 inorganic and 3 organic SRCs from the Former Plane Burial Area, and 12 inorganic and 16 organic SRCs from the Former Plane Refueling/Crash Strip Area 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 aggregate-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 NACA Test Area aggregate from an aggregate-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 estimation of 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)

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

Where:

d_a = aquifer thickness (m)

$d \leq d_a$

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. 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.

Based on this screening and an AOC-specific DAF of 1.46, 2.17, and 1.09 for the Former Crash Area, Former Plane Burial Area, and Former Plane Refueling/Crash Strip Area, respectively, copper and nickel at the Former Crash Area and aluminum, nickel, silver, zinc, and methylene chloride at the Former Plane Burial Area were eliminated from further consideration. All the remaining SRCs exceeded their published or calculated GSSL multiplied by the respective DAF and were identified as initial CMCOPCs, based on leaching to groundwater. The SRCs identified as initial CMCOPCs are presented in Appendix E, Table E-6.

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 2003a). 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 a CMCOPC to migrate vertically from the base of the soil interval detected above the background concentration to the water table. This distance is 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 the 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) were 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 the CMCOPCs based on contaminant migration from sediment to groundwater. Any identified CMCOPCs are modeled with the Analytical Transient 1-, 2-, 3-Dimensional (AT123D) model to a downgradient receptor if present. The four steps for the sediment screening analysis are illustrated in Figure 6-3.

Four different aggregates exist for the AOC for the sediment screening analysis: Tributary to Hinkley Creek, Wetland/Pond North of Former Crash Area, Former Crash Area Reservoir, and Former Crash Area Well Pit. The Former Crash Area Well Pit was not considered in the sediment screening because the sample was taken inside a well vault and was not representative of the sediment exposed at the AOC. 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 each aggregate was used for sediment SRCs that did not have a sample-specific DAF. The DAFs calculated for each chemical are shown in Table 6-2 and also in Appendix E, Table E-8 for the three aggregates (Tributary to Hinkley Creek, Wetland/Pond North of Former Crash Area, and Former Crash Area Reservoir).

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 (see Table 6-2), there were no initial CMCOPCs in the sediment samples from NACA Test Area aggregates.

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), the CMCOPC was further evaluated using the 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 groundwater. The predicted concentrations of CMCOPCs in groundwater beneath the source were compared to available groundwater monitoring results for the AOC to validate modeling results and provide WOE for identifying or eliminating CMCOCs.

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, eight discrete sampling locations for the Former Crash Area, four discrete sampling locations for the Former Plane Burial Area, and three discrete sampling locations for the Former Plane Refueling/Crash Strip Area 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 RVAAP FWCUGs for the Resident Receptor Adult, 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 CMCOPC was further evaluated using the AT123D model 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 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 RVAAP FWCUGs for the Resident Receptor Adult, MCL, and RSL. If the predicted maximum concentration of a 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. If the predicted maximum concentration of a CMCOPC in groundwater directly below the source areas and at the downgradient receptor location was lower than the screening criteria, the chemical would not be considered a CMCOC.

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-9. 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 model (Youngstown station) and HELP model (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-10. 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 subsurface soil and is presented in Table 6-3. 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 Phase I 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 6-3. 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 CMCOPC, listed in Table 6-1, were used as source term concentrations for SESOIL.

6.5.2.6 Application Data

Six different layering schemes were developed for sample locations within the Former Crash Area, three different layering schemes were developed for sample locations within the Former Plane Burial Area, and three different layering schemes were developed for sample locations within the Former Plane Refueling/Crash Strip Area due to varying thicknesses of the loading and leaching zones that are based on varying soil sample and groundwater depths throughout the AOC. Details of the model layers utilized in this modeling are presented in Appendix E, Table E-11.

Each model was arranged in four layers of varying thicknesses. Dependent on the chemical being modeled, the top three layers varied between contaminant loading layers and leaching layers, with two sublayers in Layers 1 and 3 and four sublayers in Layer 2. The fourth layer (Layer 4) did not contain sublayers. Layer 4 was included just above the water table to read output results at the water table/vadose zone interface (i.e., leachate concentration entering groundwater).

6.5.3 SESOIL Modeling Results

SESOIL modeling was performed for initial CMCOPCs [i.e., antimony, arsenic, barium, cobalt, lead, selenium, thallium, benz(*a*)anthracene, naphthalene, and methylene chloride in the Former Crash Area; antimony, arsenic, barium, cadmium, copper, lead, manganese, selenium, and thallium in the Former Plane Burial Area; and selenium, silver, and 2,4-DNT in the Former Plane Refueling/Crash Strip Area] that have the potential to reach the water table within 1,000 years based on the soil screening analysis results (Table 6-1). Table 6-4 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 CMCOPCs, if available, are also shown in this table for comparison purposes. Benz(*a*)anthracene and methylene chloride in the Former Crash Area, lead in the Former Plane Burial Area, and silver in the Former Plane Refueling/Crash Strip Area were eliminated based on the SESOIL modeling results; the remaining initial CMCOPCs were selected as the final CMCOPCs for evaluation using the AT123D model. Appendix E, Figures E-4 through E-25 show the leachate mass flux versus time plots generated by SESOIL to be used as input to AT123D modeling.

Antimony, arsenic, barium, cobalt, lead, selenium, thallium, and naphthalene in the Former Crash Area; antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium in the Former Plane Burial Area; and selenium and 2,4-DNT in the Former Plane Refueling/Crash Strip Area 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 is not reflective of 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 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 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 6-3. 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-12. A discussion of model assumptions and limitations is presented in Section 6.5.6.

Appendix E, Figures E-26 through E-43 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 (as there are no sediment CMCOPCs) are shown in Table 6-5. The results show predicted groundwater concentrations for CMCOPCs beneath the source area and at the selected downgradient receptor location (i.e., Hinkley Creek southwest of NACA Test Area). Observed groundwater concentrations from AOC monitoring wells are included in Table 6-5; 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 Hinkley Creek.

The maximum predicted concentrations of all of the final soil CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area and were, therefore, modeled to the downgradient receptor (i.e., Hinkley Creek southwest of NACA Test Area). There were no identified sediment CMCOPCs requiring lateral transport modeling using the AT123D model.

Lateral transport modeling showed the maximum predicted concentrations of final soil CMCOPCs did not exceed the screening criteria at their downgradient receptor location (Hinkley Creek southwest of NACA Test Area). Lead in the Former Crash Area did not exceed the screening criteria in groundwater beneath the source area and was eliminated as a CMCOC. However, antimony, arsenic, barium, cobalt, selenium, thallium, and naphthalene in the Former Crash Area; antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium in the Former Plane Burial Area; and selenium and 2,4-DNT in the Former Plane Refueling/Crash Strip Area exceeded screening criteria in groundwater beneath their respective source areas and were retained for further evaluation. Figure 6-5 presents CMCOCs identified 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 anticipated primary COPCs in the Phase I RI Report but also chemicals identified during the RVAAP SRC screening process in this Phase II RI.
- 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.
- As 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 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 are 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 concentration for SESOIL model layers; this is a highly conservative assumption that is expected to produce higher leachate concentrations for the 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.

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 model input parameters that have the most influence on the model predictions. These parameters are: (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. These DAFs were used in the sediment screening analysis to identify CMCOPCs for predictive modeling and 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 final CMCOCs and a qualitative assessment of the results and considerations of the limitations and assumptions.

6.6.1 Evaluation of Remaining Soil CMCOPCs

6.6.1.1 Former Crash Area

Antimony. Of the 82 surface and subsurface soil samples collected in the Former Crash Area, only 1 sample (NTAss-018-0018-SO) exceeded the surface and subsurface soil background concentration of 0.96 mg/kg at a concentration of 1.1 mg/kg. Antimony was not considered a Phase II RI COPC in the Former Crash Area. Although antimony has been detected in the AOC groundwater samples collected from 2009–2015, the MDC is below its MCL (Table 6-5). Using the maximum soil concentration, antimony modeling results indicate it would take more than 300 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.006 mg/L), and antimony is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

Arsenic. Of the 82 surface and subsurface soil samples collected in the Former Crash Area, only 1 sample (NTAsb-124-5311-SO) exceeded the subsurface soil background concentration of 19.8 mg/kg at a concentration of 24.7 mg/kg. Arsenic was not considered a COC in the HHRA in the Former Crash Area. Using the maximum soil concentration, arsenic modeling results indicate it would take more than 50 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.01 mg/L), and arsenic is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Although arsenic has been detected in the AOC groundwater samples collected from 2009–2015 at concentrations above its MCL (Table 6-5), concentrations have decreased below the MCL in recent years. It should be noted here 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.

Barium. Of the 82 surface and subsurface soil samples collected in the Former Crash Area, only 5 samples exceeded the subsurface soil background concentration of 124 mg/kg. The maximum soil concentration for barium at the Former Crash Area (i.e., 254 mg/kg at NTAss-025-0025-SO) was well below the soil residential RSL (1,500 mg/kg) and the Resident Receptor Adult FWCUG at an HQ of 0.1 (8,966 mg/kg), and it was not considered a COC in the HHRA in the Former Crash Area. Although barium has been detected in the AOC groundwater samples collected from 2009–2015, the MDC is below its MCL (Table 6-5). Using the maximum soil concentration, barium modeling results indicate it would take nearly 450 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (2 mg/L), and barium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

Cobalt. Of the 82 surface and subsurface soil samples collected in the Former Crash Area, only 1 sample (NTAss-034-0034-SO) exceeded the subsurface soil background concentration of 23.2 mg/kg at a concentration of 38.2 mg/kg. Cobalt was not considered a COC in the HHRA in the Former Crash Area. Although cobalt has been detected in the AOC groundwater samples collected from 2009–2015 above its RSL (Table 6-5), this was a single detection in 2009, and cobalt has not been detected in AOC groundwater since then. Using the maximum soil concentration, cobalt modeling results indicate it would take nearly 400 years for a breakthrough in groundwater beneath the source at a concentration above the RSL (0.006 mg/L), and cobalt is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

Selenium. Of the 82 surface and subsurface soil samples collected in the Former Crash Area, only 3 samples exceeded the subsurface soil background concentration of 1.5 mg/kg. The maximum soil concentration for selenium (i.e., 2.6 mg/kg at NTAss-034-0034-SO) was below the soil residential RSL (39 mg/kg), and selenium was not considered a Phase II RI COPC in the Former Crash Area. Selenium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, selenium modeling results indicate it would take about 50 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (see Table 6-5).

Thallium. None of the 82 surface and subsurface soil samples collected for thallium in the Former Crash Area exceeded the subsurface soil background concentration of 0.91 mg/kg. Thallium was not considered a Phase II RI COPC in the Former Crash Area. Thallium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, thallium modeling results indicate it would take about 500 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 detectable concentrations within 1,000 years (Table 6-5).

Naphthalene. The only detected soil concentration for naphthalene in the Former Crash Area was 0.02 mg/kg at NTAsb-124-5312-SO, which was below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (368 mg/kg), and RSL of 122 mg/kg, and was not considered a Phase II RI COPC in the Former Crash Area. Naphthalene has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). The naphthalene modeling results using the maximum concentration indicate it would take nearly 450 years for a breakthrough in groundwater beneath the source at a concentration above its RSL (0.00017 mg/L). Also, naphthalene is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Therefore, this evaluation concludes that the model-predicted concentrations are conservative, and naphthalene would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

6.6.1.2 Former Plane Burial Area

Antimony. Of the 38 surface and subsurface soil samples collected in the Former Plane Burial Area, only 1 sample (NTAss-070-0078-SO) exceeded the surface and subsurface soil background concentration of 0.96 mg/kg at a concentration of 2.9 mg/kg. Antimony was not considered a COC in the HHRA in the Former Plane Burial Area. Although antimony has been detected in the AOC groundwater samples collected from 2009–2015, the MDC is below its MCL (Table 6-5). Using the maximum soil concentration, antimony modeling results indicate it would take approximately 40 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.006 mg/L) with peak concentrations occurring at approximately 200 years, and antimony is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Based on the AOC period of operations, this indicates that the model-predicted concentrations are conservative.

Arsenic. Of the 38 surface and subsurface soil samples collected in the Former Plane Burial Area, only 1 sample (NTAss-067-0071-SO) exceeded the subsurface soil background concentration of 19.8 mg/kg at a concentration of 23 mg/kg. Arsenic was not considered a COC in the HHRA in the Former Plane Burial Area. Using the maximum soil concentration, arsenic modeling results indicate it would take approximately 35 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.01 mg/L), and arsenic is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Although arsenic has been detected in the AOC groundwater samples collected from 2009–2015 at concentrations above its MCL (Table 6-5), concentrations have decreased below the MCL in recent years. It should be noted here 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.

Barium. Of the 38 surface and subsurface soil samples collected in the Former Plane Burial Area, only 3 samples exceeded the subsurface soil background concentration of 124 mg/kg. The maximum soil concentration for barium at the Former Plane Burial Area (i.e., 253 mg/kg at NTAss-067-0071-SO) was well below the soil residential RSL (1,500 mg/kg) and the Resident Receptor Adult FWCUG at an HQ of 0.1 (8,966 mg/kg), and it was not considered a Phase II RI COPC in the Former Plane Burial Area. Although barium has been detected in the AOC groundwater samples collected from 2009–2015, the MDC is below its MCL (Table 6-5). Using the maximum soil concentration, arsenic modeling results indicate it would take nearly 100 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (2 mg/L), and barium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

Cadmium. The maximum soil concentration for cadmium at the Former Plane Burial Area (i.e., 30 mg/kg at NTAso-073-0085-SO) was below the soil industrial RSL (98 mg/kg) and slightly higher than the Resident Receptor Adult FWCUG at an HQ of 0.1 (22.3 mg/kg), and it was not considered a COC in the HHRA at the Former Plane Burial Area. Also, cadmium was not identified as a potential contaminant from historical usage at NACA Test Area and did not have widespread contamination. Cadmium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, cadmium modeling results indicate it would take nearly 200 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (0.005 mg/L), and cadmium is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5).

Copper. The maximum soil concentration for copper at the Former Plane Burial Area (i.e., 1,760 mg/kg at NTAss-070-0078-SO) was below the soil industrial RSL (4,700 mg/kg) and the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (2,714 mg/kg), and it was not considered a COC in the HHRA at the Former Plane Burial Area. Although copper has been detected in the AOC groundwater samples collected from 2009–2015, the MDC is below its MCL (Table 6-5) and it has been detected in sampling events after 2009. Using the maximum soil concentration, copper modeling results indicate it would take less than 24 years for a breakthrough in groundwater beneath the source at a concentration above the MCL (1.3 mg/L) with peak concentrations occurring at approximately 150 years, and copper is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Based on the AOC period of operations, this indicates that the model-predicted concentrations are conservative.

Manganese. None of the 38 surface and subsurface soil samples collected at the Former Plane Burial Area exceeded the subsurface soil background concentration of 3,030 mg/kg. The maximum soil concentration for manganese at the Former Plane Burial Area (i.e., 2,190 mg/kg at NTAss-067-0071-SO) was below the soil industrial RSL (2,600 mg/kg), and it was not considered a COC in the HHRA at the Former Plane Burial Area. Using the maximum soil concentration, manganese modeling results indicate it would take nearly 100 years for a breakthrough in groundwater beneath the source at a concentration above the RSL (0.43 mg/L), and manganese is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Manganese has been detected in the AOC groundwater samples collected from 2009–2015 at concentrations above its MCL (Table 6-5); however, concentrations have decreased below the MCL in recent years (2012–2015). It should be noted here that the background concentration of manganese in unconsolidated groundwater also exceeds the MCL. Therefore, if manganese is detected in groundwater above its MCL, it should be considered background related and not due to contamination from the site.

Selenium. Of the 38 surface and subsurface soil samples collected in the Former Plane Burial Area, the MDC (1.4 mg/kg) is equal to the surface soil background concentration, and no samples exceeded the subsurface soil background concentration of 1.5 mg/kg. The maximum soil concentration for selenium (i.e., 1.4 mg/kg at NTAss-141-5338-SO) was below the soil residential RSL (39 mg/kg), and selenium was not considered a Phase II RI COPC in the Former Plane Burial Area. Selenium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, selenium modeling results indicate it would take about 7 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (Table 6-5). Therefore, if selenium is detected in groundwater above its MCL, it should be considered background related and not due to contamination from the site.

Thallium. None of the 38 surface and subsurface soil samples collected for thallium in the Former Plane Burial Area exceeded the subsurface soil background concentration of 0.91 mg/kg; although, the maximum exceeded the surface soil background concentration. Thallium was not considered a Phase II RI COPC in the Former Plane Burial Area. Thallium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, thallium modeling results indicate it would take about 200 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 detectable concentrations within 1,000 years (Table 6-5).

6.6.1.3 Former Plane Refueling/Crash Strip Area

Selenium. Of the 38 surface and subsurface soil samples collected in the Former Plane Refueling/Crash Strip Area, only 4 samples exceeded the subsurface soil background concentration of 1.5 mg/kg. The maximum soil concentration for selenium (i.e., 2.8 mg/kg at NTAss-092-0112-SO) was below the soil residential RSL (39 mg/kg), and selenium was not considered a Phase II RI COPC in the Former Plane Refueling/Crash Strip Area. Selenium has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Using the maximum soil concentration, selenium modeling results indicate it would take about 150 years for a breakthrough in groundwater beneath the source at a concentration above its MCL (0.050 mg/L), and selenium is not predicted to migrate to the downgradient receptor location at concentrations exceeding its MCL within 1,000 years (Table 6-5).

2,4-DNT. The maximum soil concentration for 2,4-DNT in the Former Plane Refueling/Crash Strip Area was 0.22 mg/kg at NTAss-133-5330-SO, which is below the Resident Receptor Adult FWCUG at a TR of 1E-06, HQ of 0.1 (0.753 mg/kg), and the soil industrial RSL of 0.74 mg/kg, and was not considered a Phase II RI COPC in the Former Plane Refueling/Crash Strip Area. The 2,4-DNT modeling results using this maximum concentration indicate it would take nearly 700 years for a breakthrough in groundwater beneath the source at a concentration above its RSL (0.00024 mg/L). 2,4-DNT has not been detected in the AOC groundwater samples collected from 2009–2015 (Table 6-5). Also, 2,4-DNT is not predicted to migrate to the downgradient receptor location at detectable concentrations within 1,000 years (Table 6-5). Therefore, this evaluation concludes that the model-predicted concentrations are conservative and 2,4-DNT would be expected to be below its RSL based on its estimated site-specific biodegradation rate.

This qualitative assessment concludes that the soil contaminants identified as CMCOCs for evaluation, due to predicted groundwater concentrations beneath a source only (none of the CMCOCs migrate to the downgradient receptor location at concentrations exceeding their respective MCLs/RSLs), 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 NACA Test Area, 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 NACA Test Area. 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 surface soil, subsurface soil, and sediment at NACA Test Area were evaluated through the stepwise fate and transport evaluation. Evaluation of modeling results with respect to current AOC groundwater data and model limitations identified the following CMCOPCs for soil (as there were not any sediment CMCOPCs):

- Antimony, arsenic, barium, cobalt, selenium, thallium, and naphthalene in the Former Crash Area;
- Antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium in the Former Plane Burial Area; and
- Selenium and 2,4-DNT in the Former Plane Refueling/Crash Strip Area.

These CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed the screening criteria in groundwater at the downgradient receptor location.

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 NACA Test Area that may potentially impact groundwater at NACA Test Area beneath the source or at the downgradient receptor location. This qualitative assessment concluded there were no CMCOCs present in soil and sediment that may impact 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? (Yes/No)
Former Crash Area				
Inorganic Chemicals				
Antimony	1.10E+00	NTAss-018-0018-SO	0 - 1	Yes
Arsenic	2.47E+01	NTAsb-124-5311-SO	4 - 7	Yes
Barium	2.54E+02	NTAss-025-0025-SO	0 - 1	Yes
Cobalt	3.82E+01	NTAss-034-0034-SO	0 - 1	Yes
Lead	5.09E+01	NTAsb-127-5321-SO	0 - 1	Yes
Selenium	2.60E+00	NTAss-034-0034-SO	0 - 1	Yes
Thallium	5.70E-01	NTAss-096-0117-SO	0 - 1	Yes
Semi-volatile Organic Compounds				
Benz(a)anthracene	1.50E+00	NTAss-026-0026-SO	0 - 1	Yes
Naphthalene	2.00E-02	NTAsb-124-5312-SO	7 - 13	Yes
Volatile Organic Compounds				
Methylene chloride	4.60E-03	NTAss-028-0028-SO	0 - 1	Yes
Former Plane Burial Area				
Inorganic Chemicals				
Antimony	2.90E+00	NTAss-070-0078-SO	0 - 1	Yes
Arsenic	2.30E+01	NTAss-067-0071-SO	0 - 1	Yes
Barium	2.53E+02	NTAss-067-0071-SO	0 - 1	Yes
Cadmium	3.00E+01	NTAso-073-0085-SO	1 - 3	Yes
Copper	1.76E+03	NTAss-070-0078-SO	0 - 1	Yes
Lead	1.51E+02	NTAso-073-0085-SO	1 - 3	Yes
Manganese	2.19E+03	NTAss-067-0071-SO	0 - 1	Yes
Selenium	1.40E+00	NTAss-141-5338-SO	0 - 1	Yes
Thallium	5.20E-01	NTAss-067-0071-SO	0 - 1	Yes
Former Plane Refueling/Crash Strip Area				
Inorganic Chemicals				
Selenium	2.80E+00	NTAss-092-0112-SO	0 - 1	Yes
Silver	1.30E+00	NTAss-085-0104-SO	0 - 1	Yes
Explosives				
2,4-Dinitrotoluene	2.20E-01	NTAss-133-5330-SO	0 - 1	Yes

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

Table 6–2. Sediment Screening Results for NACA Test Area

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 Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC (Yes/No)
Tributary to Hinkley Creek Aggregate														
Inorganic Chemicals														
Beryllium	7440-41-7	3.80E-01	6.70E-01	NTAsd-145-5345-SD	NA	-	7.90E+02	e	8.48E-04	1	8.48E-04	4.00E-03	MCL	No
Cadmium	7440-43-9	0.00E+00	3.30E-01	NTAsd-143-5343-SD	NA	-	7.50E+01	e	4.40E-03	1	4.40E-03	5.00E-03	MCL	No
Chromium	7440-47-3	1.81E+01	1.92E+01	NTAsd-145-5345-SD	NA	-	1.90E+01	e	1.01E+00	1657	6.10E-04	1.00E-01	MCL	No
Cobalt	7440-48-4	9.10E+00	1.44E+01	NTAsd-145-5345-SD	NA	-	4.50E+01	e	3.20E-01	314	1.02E-03	6.00E-03	RSL	No
Nickel	7440-02-0	1.77E+01	3.36E+01	NTAsd-145-5345-SD	NA	-	6.50E+01	e	5.17E-01	238	2.17E-03	3.90E-01	RSL	No
Silver	7440-22-4	0.00E+00	3.10E-02	NTAsd-143-5343-SD	NA	-	8.30E+00	e	3.73E-03	1	3.73E-03	9.40E-02	RSL	No
Explosives														
HMX	2691-41-0	None	1.30E-02	NTAsd-143-5343-SD	5.32E+02	e	1.94E+01	f	6.70E-04	1	6.70E-04	1.00E+00	RSL	No
Semi-volatile Organic Compounds														
Acenaphthene	83-32-9	None	1.20E-02	NTAsd-143-5343-SD	5.03E+03	e	1.83E+02	f	6.56E-05	1	6.56E-05	2.20E+00	RSL	No
Anthracene	120-12-7	None	2.60E-02	NTAsd-143-5343-SD	1.64E+04	e	5.96E+02	f	4.36E-05	1	4.36E-05	1.10E+01	RSL	No
Benz(*a*)anthracene	56-55-3	None	5.90E-02	NTAsd-143-5343-SD	1.77E+05	e	6.44E+03	f	9.16E-06	1	9.16E-06	1.20E-05	RSL	No
Benzo(*a*)pyrene	50-32-8	None	6.60E-02	NTAsd-143-5343-SD	5.87E+05	e	2.14E+04	f	3.08E-06	1	3.08E-06	2.00E-04	MCL	No
Benzo(*b*)fluoranthene	205-99-2	None	8.30E-02	NTAsd-143-5343-SD	5.99E+05	**e**	2.18E+04	**f**	3.81E-06	1	3.81E-06	3.40E-05	RSL	No
Benzo(*ghi*)perylene[d]	191-24-2	None	4.10E-02	NTAsd-143-5343-SD	1.07E+07	g	3.89E+05	f	1.05E-07	1	1.05E-07	1.20E-01	RSL	No
Benzo(*k*)fluoranthene	207-08-9	None	3.60E-02	NTAsd-143-5343-SD	5.87E+05	e	2.14E+04	f	1.68E-06	1	1.68E-06	3.40E-04	RSL	No
Bis(2-ethylhexyl)phthalate	117-81-7	None	3.50E-01	NTAsd-145-5345-SD	1.20E+05	e	4.35E+03	f	8.05E-05	1	8.05E-05	6.00E-03	MCL	No
Chrysene	218-01-9	None	6.90E-02	NTAsd-143-5343-SD	1.81E+05	e	6.57E+03	f	1.05E-05	1	1.05E-05	3.40E-03	RSL	No
Dibenz(*ah*)anthracene	53-70-3	None	1.10E-02	NTAsd-143-5343-SD	1.91E+06	e	6.96E+04	f	1.58E-07	1	1.58E-07	3.40E-06	RSL	No
Fluoranthene	206-44-0	None	1.00E-01	NTAsd-143-5343-SD	5.55E+04	e	2.02E+03	f	4.95E-05	1	4.95E-05	8.00E-01	RSL	No
Fluorene	86-73-7	None	1.20E-02	NTAsd-143-5343-SD	9.16E+03	e	3.33E+02	f	3.60E-05	1	3.60E-05	2.90E-01	RSL	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	None	3.70E-02	NTAsd-143-5343-SD	1.95E+06	e	7.10E+04	f	5.21E-07	1	5.21E-07	3.40E-05	RSL	No
Phenanthrene[d]	85-01-8	None	7.00E-02	NTAsd-143-5343-SD	1.82E+04	g	6.62E+02	f	1.06E-04	1	1.06E-04	1.20E-01	RSL	No
Pyrene	129-00-0	None	8.20E-02	NTAsd-143-5343-SD	5.43E+04	e	1.98E+03	f	4.14E-05	1	4.14E-05	1.20E-01	RSL	No
Volatile Organic Compounds														
2-Butanone	78-93-3	None	6.40E-03	NTAsd-143-5343-SD	4.51E+00	e	1.64E-01	f	3.90E-02	1	3.90E-02	5.60E+00	RSL	No
Wetland/Pond North of Former Crash Area Aggregate														
Inorganic Chemicals														
Beryllium	7440-41-7	3.80E-01	4.00E-01	NTAsd-144-5344-SD	NA	-	7.90E+02	e	5.06E-04	3	1.69E-04	4.00E-03	MCL	No
Cadmium	7440-43-9	0.00E+00	1.00E-01	NTAsd-144-5344-SD	NA	-	7.50E+01	e	1.33E-03	3	4.44E-04	5.00E-03	MCL	No
Silver	7440-22-4	0.00E+00	3.10E-02	NTAsd-144-5344-SD	NA	-	8.30E+00	e	3.73E-03	3	1.24E-03	9.40E-02	RSL	No
Volatile Organic Compounds														
2-Butanone	78-93-3	None	4.40E-03	NTAsd-144-5344-SD	4.51E+00	e	1.64E-01	f	2.68E-02	3	8.94E-03	5.60E+00	RSL	No
Ethylbenzene	100-41-4	None	1.50E-03	NTAsd-144-5344-SD	4.46E+02	e	1.62E+01	f	9.26E-05	3	3.09E-05	7.00E-01	MCL	No
Toluene	108-88-3	None	1.70E-01	NTAsd-144-5344-SD	2.34E+02	e	8.52E+00	f	2.00E-02	57	3.50E-04	1.00E+00	MCL	No
Former Crash Area Reservoir Aggregate														
Volatile Organic Compounds														
2-Butanone	78-93-3	None	1.60E-02	NTAsd-102-0125-SD	4.51E+00	e	1.64E-01	f	9.76E-02	3	3.25E-02	5.60E+00	RSL	No

Table 6–2. Sediment Screening Results for NACA Test Area (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 Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC (Yes/No)
Former Crash Area Reservoir Aggregate														
Volatile Organic Compounds														
2-Butanone	78-93-3	None	1.60E-02	NTAsd-102-0125-SD	4.51E+00	e	1.64E-01	f	9.76E-02	3	3.25E-02	5.60E+00	RSL	No
Acetone	67-64-1	None	6.10E-02	NTAsd-102-0125-SD	2.36E+00	e	8.60E-02	f	7.09E-01	3	2.36E-01	1.40E+01	RSL	No

Sediment samples were taken from 0– 0.5 ft below ground surface at discrete sample locations in each of the three sediment aggregates.

[a] Background criteria for sediment are 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 2001d).

[b] Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.

[c] An aggregate-specific DAF was calculated based on the sediment and co-located surface water concentrations and the lowest calculated DAF for each aggregate [i.e., 1 for bis(2-ethylhexyl)phthalate at Tributary to Hinkley Creek, 3 for manganese at Wetland/Pond North of Former Crash Area, and 3 for calcium at Former Crash Area Reservoir was used for analytes that did not have an exposure unit-specific DAF].

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

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

[f] K_d value for organic chemicals calculated by multiplying the K_{oc} by the fraction organic carbon of 0.0364 (USACE 2001a. *Phase I Remedial Investigation Report for the NACA Test Area at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. December 2001.)

[g] USEPA 1994. *Risk Reduction Engineering Laboratory Treatability Database*, Ver. 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.

Table 6–3. Unit-Specific Parameters Used in SESOIL and AT123D Modeling

Parameter	Symbol	Unit	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	4.97E+08	Average area for AOC soil aggregates estimated from Figure 2-3
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	3.64E-02	Average geotechnical data from USACE 2001a
Bulk density	ρ_b	kg/L	1.81	
Moisture content	w	wt %	17.3	
Water-filled soil porosity	Tw	unitless	0.312	
Air-filled soil porosity	Ta	unitless	0.008	
Porosity – total	n_T	unitless	0.320	
Vadose zone thickness	Vz	m	0.30 to 5.5	Based on ground surface elevations and depth to water table from Figure 3-1
Leaching zone thickness	Th	m	0.076 to 5.2	Based on vadose zone thicknesses and results for CMCOPCs in soil
AT123D				
Aquifer thickness	h	m	6	Conservative assumption for shallow bedrock aquifer. Facility-wide assumption for the unconsolidated aquifer presented in the Load Line 1 investigation was 6 m (USACE 2003a)
Hydraulic conductivity in saturated zone	K_S	cm/s	4.12E-04	Average of slug test results (MKM 2007)
Hydraulic gradient	i	unitless	0.00278 to 0.0297	Average gradients determined from Figure 3-1

Table 6–3. Unit-Specific Parameters Used in SESOIL and AT123D Modeling (continued)

Parameter	Symbol	Unit	Value	Source for Value
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 Appendix E, Table E-7

MKM 2007. Characterization of 14 AOCs at Ravenna Army Ammunition Plant. March 2007.

USACE 2001a. Phase I Remedial Investigation Report for the NACA Test Area at the Ravenna Army Ammunition Plant, Ravenna, Ohio. December 2001.

USACE 2003a. Phase II Remedial Investigation Report for the Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. June 2003.

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

AOC = Area of concern.
AT123D = Analytical Transient 1-, 2-,3-Dimensional model.
cm^2 = Square centimeters.
CMCOPC = Contaminant migration chemical of potential concern.
cm/s = Centimeters per second.
kg/L = Kilograms per liter.
m = Meter.
m/yr = Meters per year.
SESOIL = Seasonal Soil Compartment model.
wt % = Weight by percent.

Table 6–4. 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 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)
Former Crash Area										
Inorganic Chemicals										
Antimony	**1.10E+00**	**NTAss-018-0018-SO**	**1**	**3**	**2.74E-02**	**359**	**6.00E-03**	**1.30E-03**	**0.00E+00**	**Yes**
Arsenic	**2.47E+01**	**NTAsb-124-5311-SO**	**7**	**7**	**1.22E+00**	**130**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Barium	**2.54E+02**	**NTAss-025-0025-SO**	**1**	**4**	**5.09E+00**	**445**	**2.00E+00**	**7.06E-01**	**8.21E-02**	**Yes**
Cobalt	**3.82E+01**	**NTAss-034-0034-SO**	**1**	**4**	**6.94E-01**	**488**	**6.00E-03**	**7.29E-02**	**0.00E+00**	**Yes**
Lead	**5.09E+01**	**NTAsb-127-5321-SO**	**1**	**1**	**5.00E-02**	**1,000**	**1.50E-02**	**None**	**0.00E+00**	**Yes**
Selenium	**2.60E+00**	**NTAss-034-0034-SO**	**1**	**4**	**4.26E-01**	**57**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Thallium	**5.70E-01**	**NTAss-096-0117-SO**	**1**	**3**	**9.04E-03**	**565**	**2.00E-03**	**2.91E-04**	**0.00E+00**	**Yes**
Semi-volatile Organic Compounds										
Benz(a)anthracene	1.50E+00	NTAss-026-0026-SO	1	3	0.00E+00	Did not reach water table	1.20E-05	4.00E-06	None	No
Naphthalene	**2.00E-02**	**NTAsb-124-5312-SO**	**13**	**13**	**4.79E-04**	**400**	**1.70E-04**	**None**	**None**	**Yes**
Volatile Organic Compounds										
Methylene chloride	4.60E-03	NTAss-028-0028-SO	1	7	1.31E-04	19	5.00E-03	5.34E-03	None	No
Former Plane Burial Area										
Inorganic Chemicals										
Antimony	**2.90E+00**	**NTAss-070-0078-SO**	**1**	**1**	**1.99E-01**	**137**	**6.00E-03**	**1.30E-03**	**0.00E+00**	**Yes**
Arsenic	**2.30E+01**	**NTAss-067-0071-SO**	**1**	**3**	**1.25E+00**	**176**	**1.00E-02**	**5.60E-05**	**1.17E-02**	**Yes**
Barium	**2.53E+02**	**NTAss-067-0071-SO**	**3**	**3**	**9.63E+00**	**254**	**2.00E+00**	**7.06E-01**	**8.21E-02**	**Yes**
Cadmium	**3.00E+01**	**NTAso-073-0085-SO**	**5**	**5**	**3.11E-01**	**756**	**5.00E-03**	**1.47E-03**	**0.00E+00**	**Yes**
Copper	**1.76E+03**	**NTAss-070-0078-SO**	**1**	**1**	**1.55E+02**	**107**	**1.30E+00**	**None**	**0.00E+00**	**Yes**
Lead	1.51E+02	NTAso-073-0085-SO	5	5	0.00E+00	Did not reach water table	1.50E-02	None	0.00E+00	No
Manganese	**2.19E+03**	**NTAss-067-0071-SO**	**1**	**3**	**5.40E+01**	**390**	**4.30E-01**	**1.58E-01**	**1.02E+00**	**Yes**
Selenium	**1.40E+00**	**NTAss-141-5338-SO**	**1**	**1**	**8.37E-01**	**16**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Thallium	**5.20E-01**	**NTAss-067-0071-SO**	**1**	**3**	**1.01E-02**	**449**	**2.00E-03**	**2.91E-04**	**0.00E+00**	**Yes**
Former Plane Refueling/Crash Strip Area										
Inorganic Chemicals										
Selenium	**2.80E+00**	**NTAss-092-0112-SO**	**1**	**8**	**2.06E-01**	**120**	**5.00E-02**	**None**	**0.00E+00**	**Yes**
Silver	1.30E+00	NTAss-085-0104-SO	1	18	2.22E-02	459	9.40E-02	None	0.00E+00	No
Explosives										
2,4-Dinitrotoluene	**2.20E-01**	**NTAss-133-5330-SO**	**1**	**12**	**2.09E-03**	**755**	**2.40E-04**	**1.20E-04**	**None**	**Yes**

[a] The FWCUG is based on a target risk of 1E-06, hazard quotient of 0.1.

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

bgs = Below ground surface.
C_L = Leachate concentration.
CMCOPC = Contaminant migration chemical of potential concern.
ft = Feet.
FWCUG=Facility-wide cleanup goal.
MCL=Maximum contaminant level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
RSL=Regional screening level.
SESOIL = Seasonal Soil Compartment model.
Bold = CMCOPCs exceeding MCL/RSL, FWCUG, and facility-wide background concentrations.

Table 6–5. Summary of AT123D Modeling Results

Final CMCOPC	Maximum Leachate Concentration, $C_{L,\ max}$[a] (mg/L)	Predicted Maximum Groundwater Concentration[b] ($C_{GW,\ max}$) Beneath Source (mg/L)	Predicted Maximum Groundwater Concentration[b] ($C_{R,\ max}$) Downgradient Receptor (mg/L)	Distance to Downgradient Receptor (ft)	Observed Maximum Groundwater Concentrations[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)
Former Crash Area									
Inorganic Chemicals									
Antimony	2.74E-02	1.40E-02	0.00E+00	1,385	4.40E-04	6.00E-03	1.30E-03	0.00E+00	Yes
Arsenic	1.22E+00	7.21E-01	0.00E+00	1,460	4.12E-02	1.00E-02	5.60E-05	1.17E-02	Yes
Barium	5.09E+00	2.74E+00	0.00E+00	1,160	1.24E-01	2.00E+00	7.06E-01	8.21E-02	Yes
Cobalt	6.94E-01	3.75E-01	0.00E+00	1,200	1.46E-02	6.00E-03	7.29E-02	0.00E+00	Yes
Lead	5.00E-021	1.10E-02	0.00E+00	650	2.55E-02	1.50E-02	None	0.00E+00	No
Selenium	4.26E-01	1.41E-01	1.37E-05	1,200	ND	5.00E-02	None	0.00E+00	Yes
Thallium	9.04E-03	4.69E-03	0.00E+00	1,120	ND	2.00E-03	2.91E-04	0.00E+00	Yes
Semi-volatile Organic Compounds									
Naphthalene	4.79E-04	2.66E-04	0.00E+00	1,460	ND	1.70E-04	None	None	Yes
Former Plane Burial Area									
Inorganic Chemicals									
Antimony	1.99E-01	9.28E-02	0.00E+00	2,020	4.40E-04	6.00E-03	1.30E-03	0.00E+00	Yes
Arsenic	1.25E+00	7.88E-01	0.00E+00	2,250	4.12E-02	1.00E-02	5.60E-05	1.17E-02	Yes
Barium	9.63E+00	6.16E+00	0.00E+00	2,250	1.24E-01	2.00E+00	7.06E-01	8.21E-02	Yes
Cadmium	3.11E-01	2.12E-01	0.00E+00	1,960	1.40E-04	5.00E-03	1.47E-03	0.00E+00	Yes
Copper	1.55E+02	7.19E+01	0.00E+00	2,020	5.58E-02	1.30E+00	None	0.00E+00	Yes
Manganese	5.40E+01	3.48E+01	0.00E+00	2,250	9.27E-01	4.30E-01	1.58E-01	1.02E+00	Yes
Selenium	8.37E-01	3.46E-01	0.00E+00	2,230	ND	5.00E-02	None	0.00E+00	Yes
Thallium	1.01E-02	6.63E-03	0.00E+00	2,250	ND	2.00E-03	2.91E-04	0.00E+00	Yes
Former Plane Refueling/Crash Strip Area									
Semi-volatile Organic Compounds									
Selenium	2.06E-01	1.17E-01	7.57E-05	970	ND	5.00E-02	None	0.00E+00	Yes
Explosives									
2,4-Dinitrotoluene	2.09E-03	1.27E-03	0.00E+00	550	ND	2.40E-04	1.20E-04	None	Yes

[a] Represents Seasonal Soil Compartment model (SESOIL)-predicted maximum leachate concentration just above the water table.
[b] The predicted concentration was estimated using the results from the SESOIL model and applying the AT123D model.
[c] Observed groundwater concentrations were obtained from the *RVAAP Facility-wide Groundwater Monitoring Program 2009 Annual Report* (EQM 2010) and the groundwater sampling results through 2015.
[d] The Resident Receptor Adult FWCUG is based on a target risk of 10^{-6} and a hazard quotient of 0.1.
[e] The CMCOC was identified by comparing the predicted concentration in groundwater beneath the source to the MCL/RSL, Resident Receptor Adult FWCUG, and facility-wide background concentrations. 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.
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 cleanup goal.
MCL = Maximum contaminant level.
mg/L = Milligrams per liter.
ND = Not detected.
RSL = Regional screening level.
WOE = Weight of evidence.

Not to scale

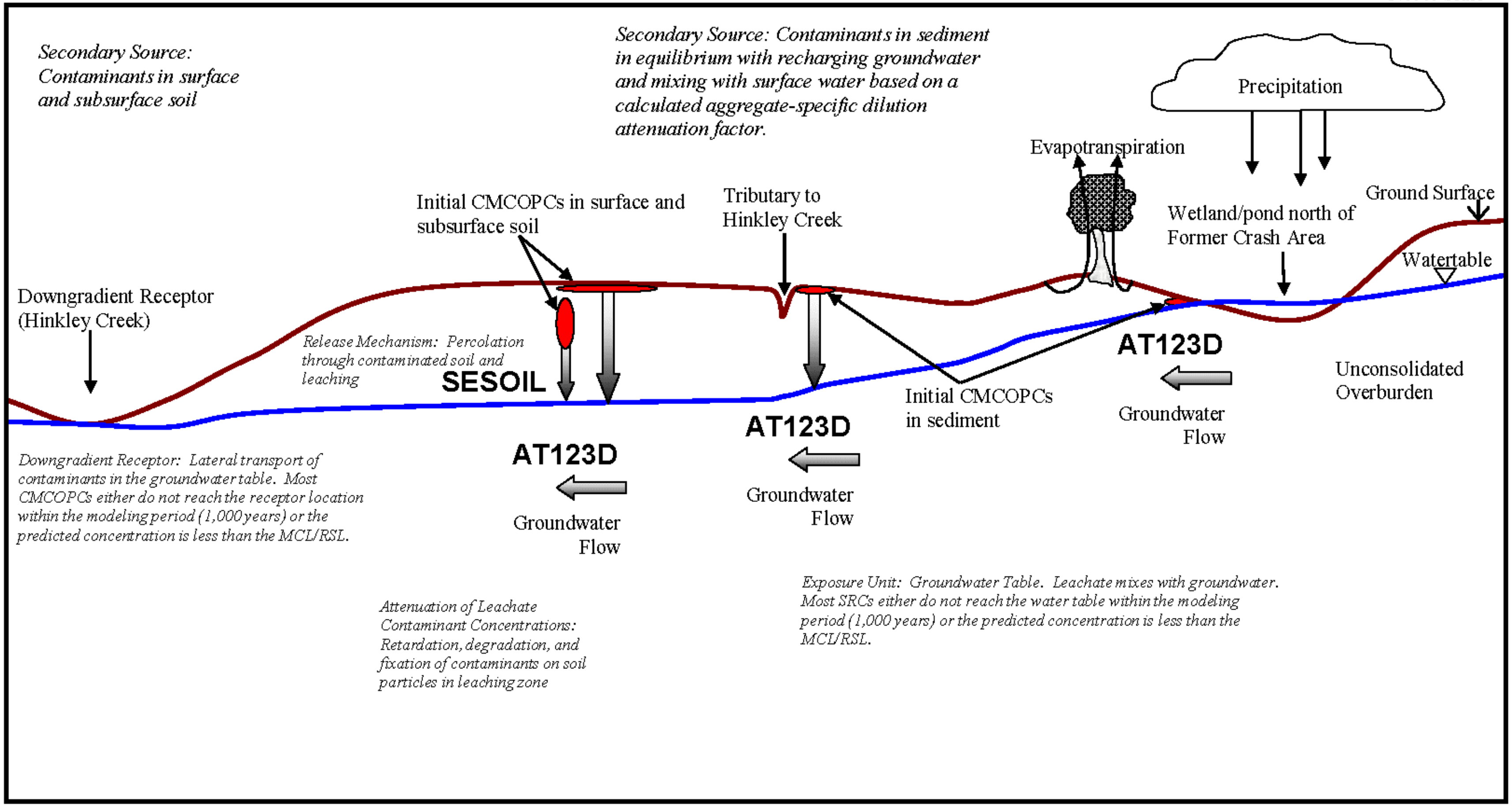


Figure 6–1. Contaminant Migration Conceptual Model

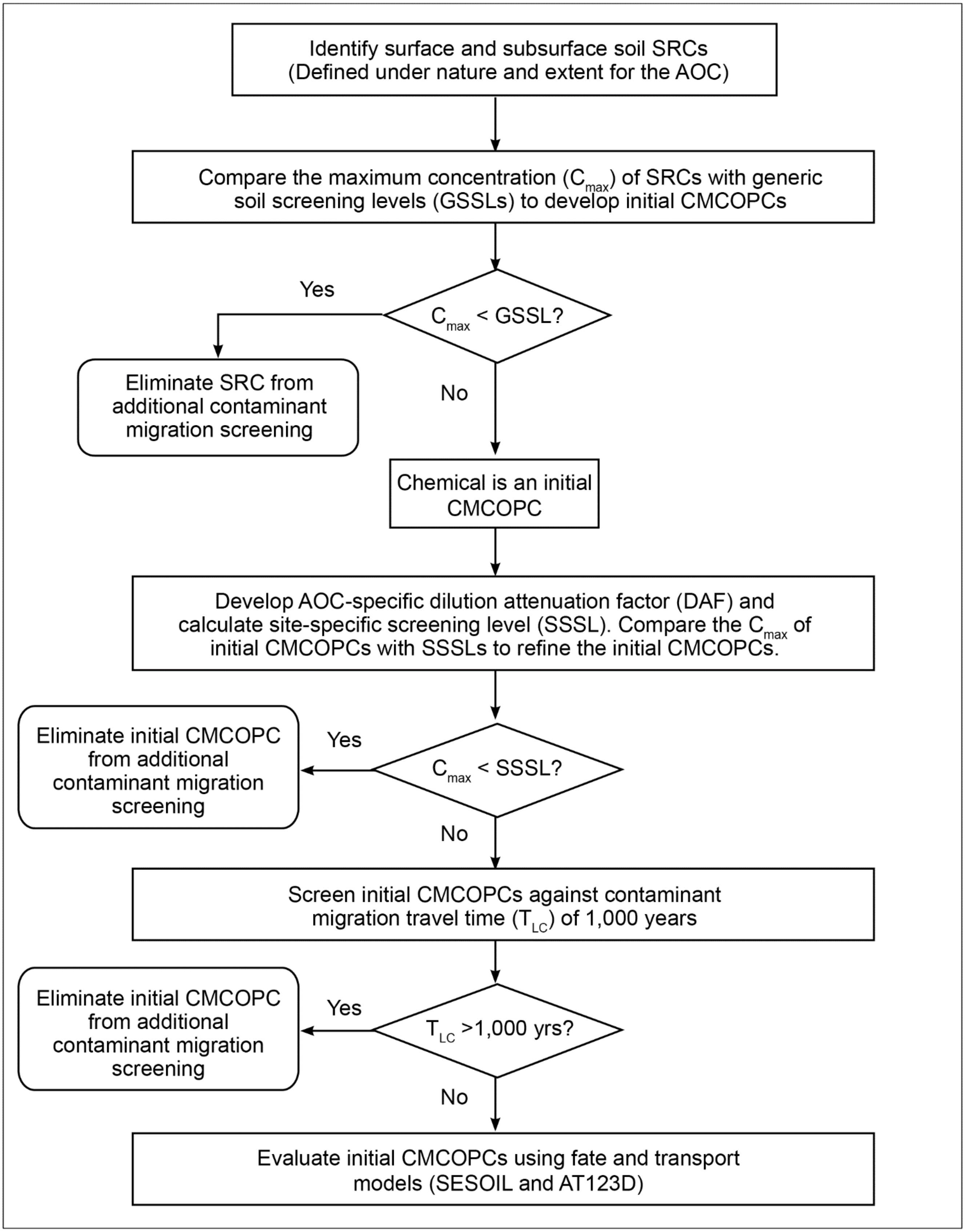


Figure 6–2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation

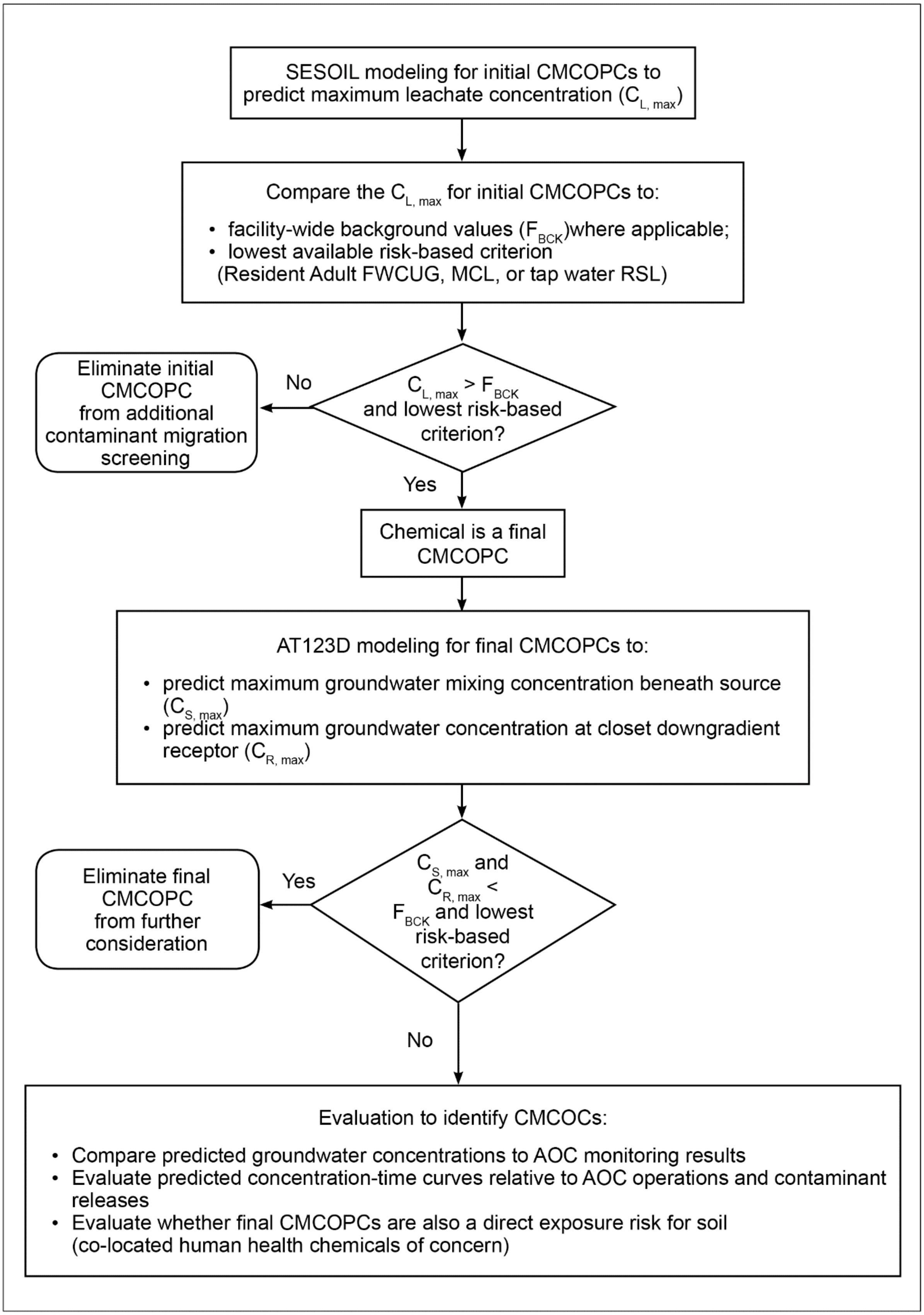


Figure 6–2. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation (continued)

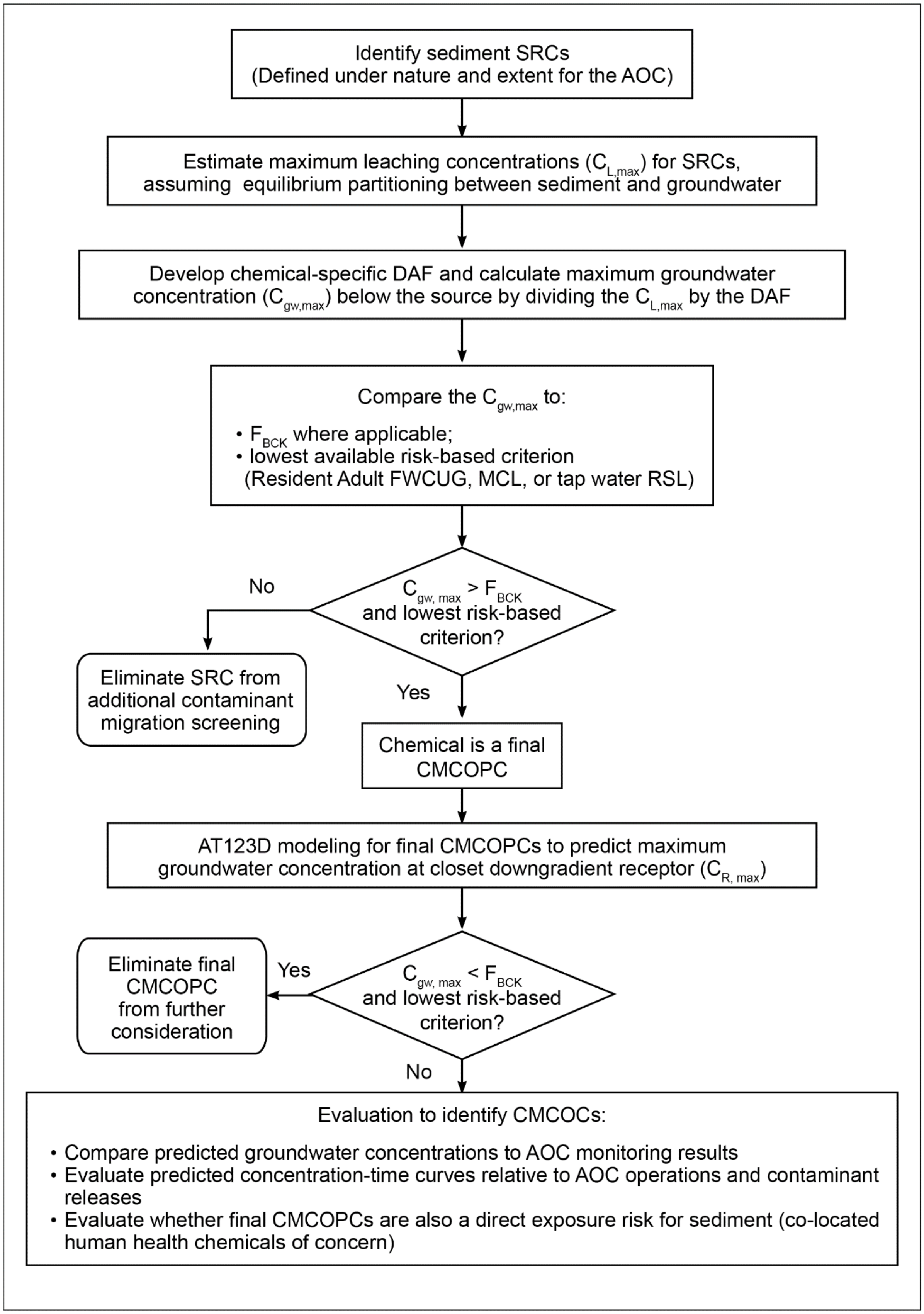


Figure 6–3. AOC Fate and Transport Modeling Approach - Sediment

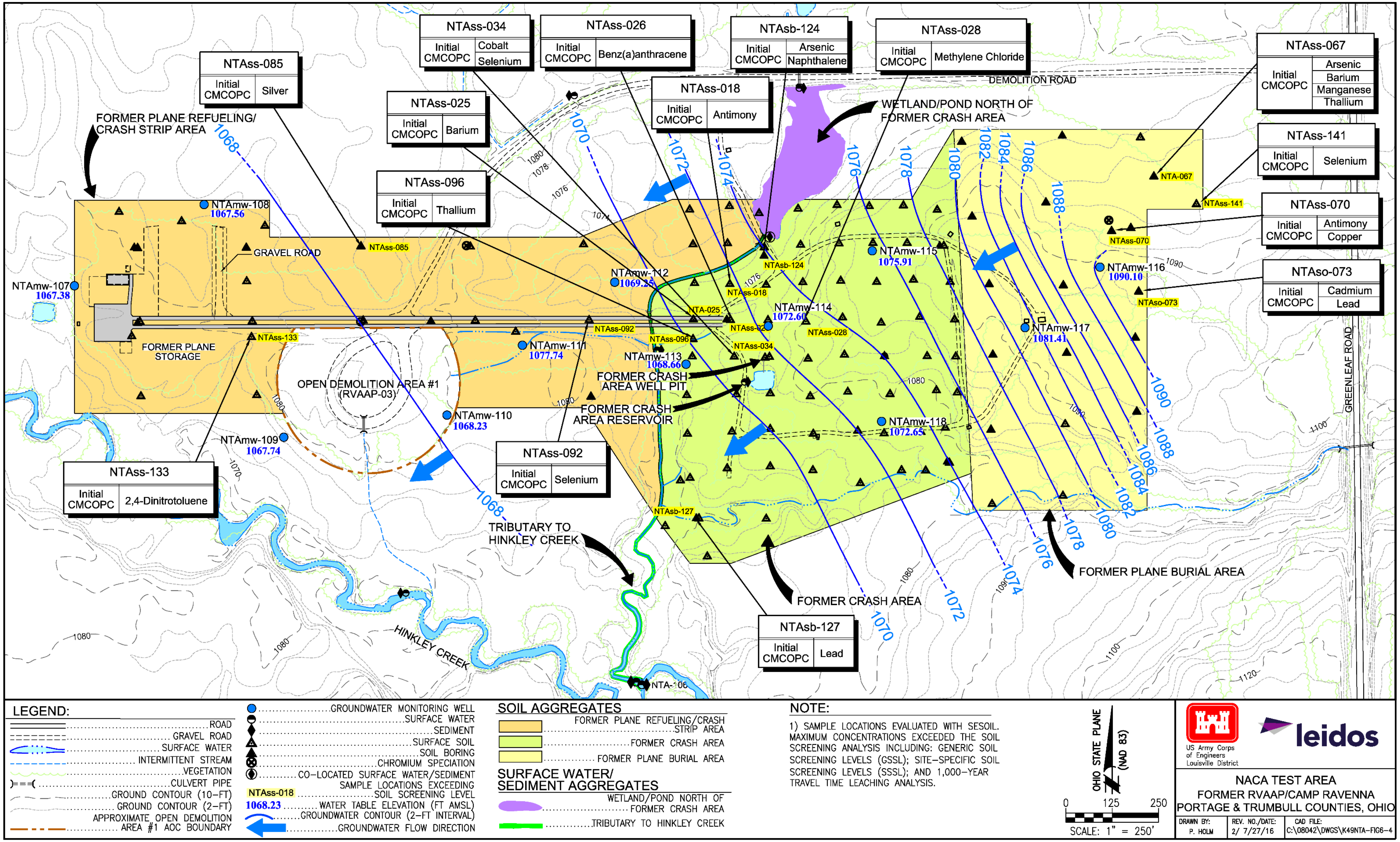
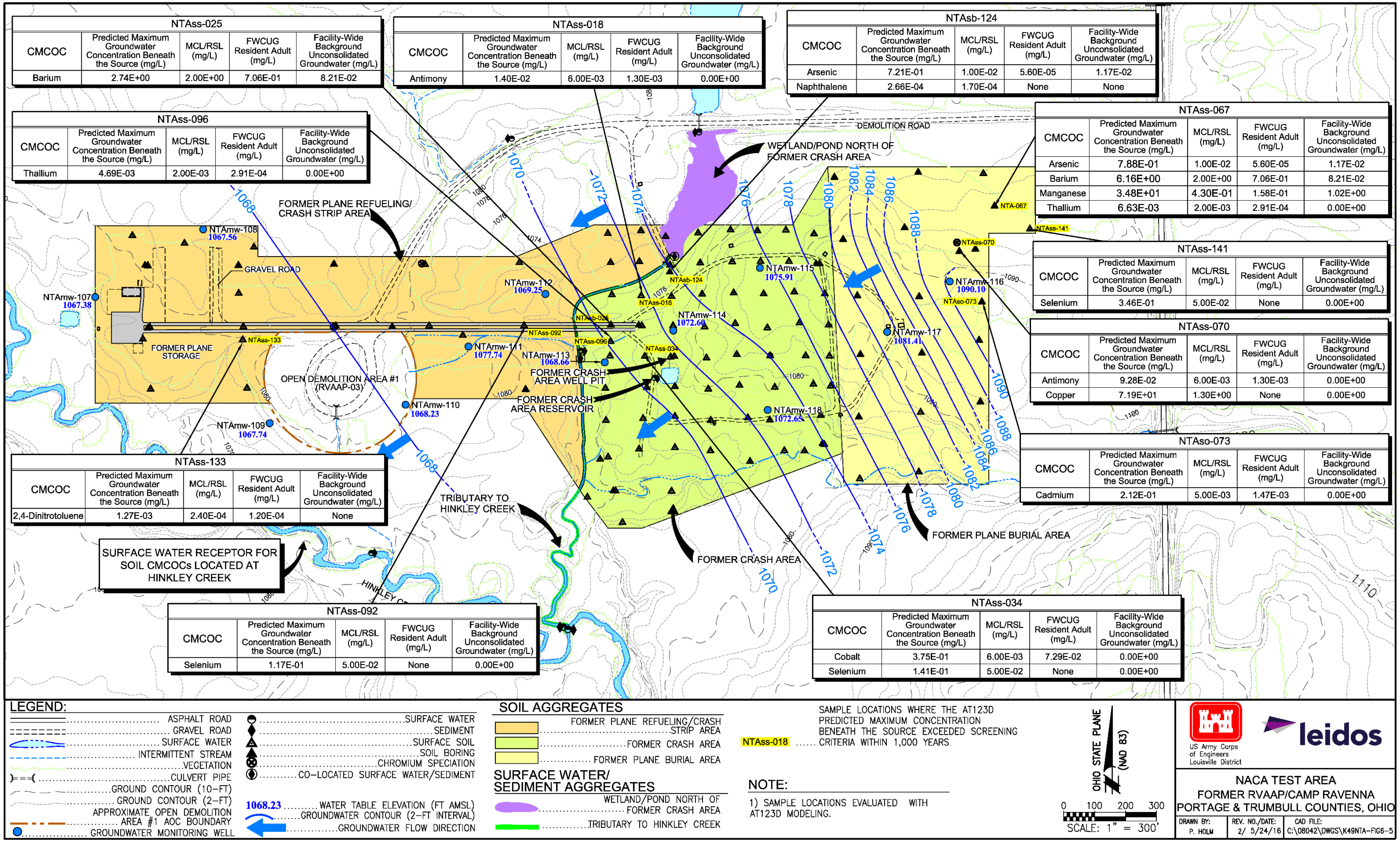


Figure 6–4. Initial CMCOPCs Identified in Soil Screening Analysis for SESOIL Evaluation



NTAss-025

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)
Barium	2.74E+00	2.00E+00	7.06E-01	8.21E-02

NTAss-018

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)
Antimony	1.40E-02	6.00E-03	1.30E-03	0.00E+00

NTAsb-124

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	7.21E-01	1.00E-02	5.60E-05	1.17E-02
Naphthalene	2.66E-04	1.70E-04	None	None

NTAss-096

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	4.69E-03	2.00E-03	2.91E-04	0.00E+00

NTAss-067

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	7.88E-01	1.00E-02	5.60E-05	1.17E-02
Barium	6.16E+00	2.00E+00	7.06E-01	8.21E-02
Manganese	3.48E+01	4.30E-01	1.58E-01	1.02E+00
Thallium	6.63E-03	2.00E-03	2.91E-04	0.00E+00

NTAss-141

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)
Selenium	3.46E-01	5.00E-02	None	0.00E+00

NTAss-070

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)
Antimony	9.28E-02	6.00E-03	1.30E-03	0.00E+00
Copper	7.19E+01	1.30E+00	None	0.00E+00

NTAso-073

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)
Cadmium	2.12E-01	5.00E-03	1.47E-03	0.00E+00

NTAss-133

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)
2,4-Dinitrotoluene	1.27E-03	2.40E-04	1.20E-04	None

NTAss-092

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)
Selenium	1.17E-01	5.00E-02	None	0.00E+00

NTAss-034

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)
Cobalt	3.75E-01	6.00E-03	7.29E-02	0.00E+00
Selenium	1.41E-01	5.00E-02	None	0.00E+00

Figure 6–5. CMCOCs Identified for Further Weight-of-Evidence Evaluation Based on AT123D Modeling

7.0 RISK ASSESSMENT

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 to use for the HHRA and ERA. Data were evaluated to establish data aggregates and identify a list of SRCs.

7.1.1 Data Aggregates

This section provides a description of 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 includes a summary of available data. Data collected at NACA Test Area were grouped (aggregated) by environmental medium, exposure depth (e.g., surface soil), and EU. Samples included in the risk assessment data sets for surface soil, deep surface soil, subsurface soil, surface water, and sediment are listed in Tables 7-1 through 7-5.

EUs were established at NACA Test Area as part of the data aggregation prior to the risk assessment evaluations. The EUs take into account how the areas were previously used and the extent of potential contamination within a given area.

7.1.1.1 Soil Data

From 1947–1953, the site was used to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft (AGOH 1997, NACA 1953). Excess airplanes were flown to the former RVAAP under their own power, taxied along installation roads, and staged at NACA Test Area. Seventeen excess aircraft were used during NACA Test Area operations. The planes were fueled and then propelled under their own power on a guide monorail. The planes were then crashed into a concrete barrier at speeds from 80–105 miles per hour. During the tests, high-speed films were made to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters. Explosives were burned and demolished in ODA1, south of the crash strip. Soil samples at the NACA Test Area were aggregated to the following EUs presented from west to east (Figure 2-3):

- Former Plane Refueling/Crash Strip Area EU,
- Former Crash Area EU, and
- Former Plane Burial Area EU.

In addition to these three EUs, the Former Crash Area Well Pit was evaluated as a potential soil hot spot.

Soil data were further 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), Industrial Receptor, and for potential risk to ecological receptors, as this layer is the most active biological zone (USACE 2003b). Table 7-1 presents the risk assessment data set for surface soil (0–1 ft bgs) data. For this risk assessment, 123 discrete surface soil samples collected during the October through November 1999 Phase I RI and March through April 2010 PBA08 RI were used to characterize surface soil.
- Deep surface soil is defined as 0–4 ft bgs for the National Guard Trainee. Discrete data from samples collected in October 1999 through November 1999 and March through April 2010 with a starting depth within this interval were used to evaluate deep surface soil for the National Guard Trainee. Table 7-2 presents the risk assessment data for deep surface soil.
- Subsurface soil with an exposure depth of 1–13 ft bgs was evaluated for the Resident Receptor (Adult and Child) and Industrial Receptor. Subsurface soil with an exposure depth of 4–7 ft bgs was evaluated for the National Guard Trainee. Discrete data from samples collected in March 2010 through April 2010 (no subsurface samples were collected in 1999) with a starting depth within these intervals were used to evaluate these exposure depths. Table 7-3 presents the risk assessment data for subsurface soil.

7.1.1.2 Surface Water and Sediment Data

The HHRA evaluated surface water at NACA Test Area in two EUs: Wetland/Pond North of the Former Crash Area and Tributary to Hinkley Creek. The Wetland/Pond North of the Former Crash Area flows into the Tributary to Hinkley Creek, as shown in Figure 2-3.

Surface water and sediment samples collected per the PBA08 SAP in February–March 2010 were used to characterize risk from exposure to chemicals in these EUs. Three surface water and sediment samples collected in October 1999 (Phase I RI) were not used in the risk assessment because more recent (2010) data were collected from these sample locations and are more representative of current AOC conditions. Historical data not included in the risk assessment were used to characterize nature and extent of contamination (Section 5.0) to evaluate trends over time.

In addition to these two EUs, the Former Crash Area Reservoir was evaluated in the risk assessment as a potential sediment hot spot using a sediment sample collected from this small area in 1999. Although not included in the risk assessment, surface water was also sampled in 1999 at the Former Crash Area Reservoir. As summarized in Section 5.0, no inorganic chemicals were identified as SRCs from this surface water sample, and the surface water sample had no detections of SVOCs, VOCs, explosives, propellants, pesticides, or PCBs.

The Off-AOC EU sample collected upgradient of NACA Test Area was only evaluated in the nature and extent of contamination.

Samples included in the risk assessment data sets for surface water and sediment are listed in Tables 7-4 (surface water) and 7-5 (sediment). The small size of the surface water and sediment data sets is reflective of the small size of these EUs.

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.

Using available process knowledge and previous investigation results, the Phase I RI Report established anticipated primary COPCs that include inorganic chemicals (metals), SVOCs, and VOCs, as shown in Table 2-2 of this Phase II RI Report. These chemical groups are associated with burned or partly combusted fuels, deicing compounds, lubricants, hydraulic fluids, as well as fire extinguishing agents (specifically bromochloromethane) (AGOH 1997, NACA 1953). Explosives, such as TNT and its associated degradation products and propellants are not directly related to past operations. However, because of the proximity of ODA1, explosives and propellants are also considered to be potential contaminants, especially in the southern portion of the crash strip area.

The SRC screen was not limited to only contaminants identified as anticipated primary COPCs in the Phase I RI Report or the final COPCs identified in the Phase I RI Report. Rather, the SRC screen followed the current 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 chemicals 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, phosphorus, 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 so long as they are: (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at 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 *Final (Revised) U.S. Army Corps of Engineers RVAAP Position Paper for the Application and Use of Facility-wide Human Health Cleanup Goals* (USACE 2012a) (hereafter referred to as the Position Paper for Human Health CUGs), 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 surface soil (0–1 ft bgs) and deep surface soil (0–4 ft bgs) at the three soil EUs. No frequency of detection

screening was performed for surface soil at the potential hot spot area, subsurface soil (4–7 and 1–13 ft bgs), surface water, or sediment because fewer than 20 discrete samples were available for these data sets.

Details of the SRC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-6. The SRCs identified for NACA Test Area are summarized in Table 7-6.

7.2 HUMAN HEALTH RISK ASSESSMENT

The Phase I RI Report identified anticipated primary COPCs for NACA Test Area based on previous use. In addition, the Phase I RI Report presented a risk evaluation process using the Phase I sampling results to determine the potential magnitude or risk and COPCs. The HHRA in this Phase II RI Report uses the SRC screen presented in Section 4.0 that included newly acquired chemical data from NACA Test Area and followed the current three steps outlined in the FWCUG Report, as discussed in Section 7.1.2. This HHRA identifies Phase II RI COPCs and COCs that may pose potential health risks to humans resulting from exposure to contamination at NACA Test Area. 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),
- Position Paper for Human Health CUGs (USACE 2012a), and
- Technical Memorandum (ARNG 2014).

To accomplish the goal of streamlined risk-based 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 the 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 through the application of the CERCLA process at the former RVAAP.

Most of the agreed upon risk assessment methodology has been documented in the FWHHRAM (USACE 2005b) and follows standard USEPA-approved risk assessment guidance. This includes the process to identify RVAAP COPCs (presented in Figure 4-5), a TR of 1E-06 and HQ of 0.1 to identify COPCs, and a TR of 1E-05 and HQ of 1 to identify COCs.

Other approaches, such as calculating the sum-of-ratios (SOR), were developed in the FWCUG Report (USACE 2010a) and Position Paper for Human Health CUGs (USACE 2012a). The Technical Memorandum (ARNG 2014) amends the risk assessment process to establish future Land Uses and applicable receptors to be evaluated in an RI.

The approach to risk-based decision making is as follows:

1. **Develop FWCUGs** – Use the risk assessment process presented in the FWHHRAM to develop FWCUGs for all COPCs identified from the facility-wide data set at RVAAP. This process has been completed in the FWCUG Report.
2. **RI Characterization Sampling** – Perform sampling and analysis to characterize an AOC and establish baseline chemical concentrations. A summary and the results of the RI characterization sampling for NACA Test Area are presented in Section 4.0.
3. **Mapping and Data Analysis to Identify SRCs and COPCs** – Follow the requirements specified in the FWHHRAM and the Position Paper for Human Health CUGs (USACE 2012a), perform data analysis and mapping to identify SRCs and COPCs, establish EUs, and calculate exposure point concentrations (EPCs) for each COPC. The results of the mapping and data analysis for NACA Test Area to identify SRCs are presented in Sections 4.0 and 5.0 and are summarized in Section 7.1.
4. **Identification of COCs** – Compare EPCs to FWCUGs to determine COCs.
5. **Address Identified COCs** – Develop FS, PP, and ROD to address any COCs requiring remedy.

Identifying Phase II RI COPCs and COCs follows the four steps for a streamlined risk assessment established in the FWCUG Report: identify media of concern, identify COPCs, present AOC land use and appropriate receptors, and compare to appropriate FWCUGs to identify COCs. These steps are discussed in the following subsections.

7.2.1 Identify Media of Concern

Media of concern at NACA Test Area are surface and subsurface soil, surface water, and sediment, as defined in Section 7.1.1. Groundwater is present at this AOC and will be evaluated (including risk assessment) in a separate document, as explained in Section 1.2.

7.2.2 Identify COPCs

Section 4.4 presents the statistical methods and screening criteria used to identify SRCs. Phase II RI COPCs are a subset of the SRCs in each exposure medium present at concentrations that indicate the potential for impacts to human receptors. The COPC screen follows the approach specified in the FWCUG Report and is summarized in this section.

To identify COPCs, the MDC of all SRCs was 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 existed for an SRC, the USEPA residential RSL (from RSL table dated June 2015) was used for this screen. No reference dose (RfD) or cancer potency factors are available for acenapthylene, benzo(ghi)perylene, and phenanthrene; therefore, the RSL for pyrene was used for these PAHs (NDEP 2006).

FWCUGs are available for both hexavalent chromium and trivalent chromium. Existing historical data at other AOCs indicate chromium exists predominantly in the trivalent state, rather than the more toxic hexavalent state. To determine whether the FWCUG for trivalent or hexavalent chromium is most applicable to NACA Test Area and to support risk management decisions, three discrete surface soil samples were collected and analyzed for hexavalent chromium and total chromium per the PBA08 SAP, as described in Sections 4.2.3.1 and 5.1.5. Two samples were collected from areas identified as having total chromium concentrations above background criteria, and one sample was collected from an area identified as having total chromium below the background criterion. This process has been approved and was documented in the *Remedial Investigation Report Addendum No. 1 for the RVAAP-49 Central Burn Pits* (USACE 2008). Hexavalent chromium was not detected in any of the speciation samples collected at NACA Test Area; therefore, the FWCUGs for trivalent chromium were used at this AOC.

Details of the COPC screening for each exposure medium are provided in Appendix G, Tables G-1 through G-6. The COPCs identified for the media of concern at NACA Test Area are presented in Table 7-7 and are summarized below.

7.2.2.1 COPCs in Surface Soil

Surface Soil (0–1 ft bgs)

- **Former Plane Refueling/Crash Strip Area** – Of the 50 chemicals detected in surface soil (0–1 ft bgs) samples, 44 of these chemicals (18 inorganic chemicals, 5 explosives, 19 SVOCs, and 2 VOCs) were identified as SRCs. Risk-based screening identified 14 COPCs in surface soil, 6 inorganic chemicals (aluminum, arsenic, barium, cobalt, cyanide, and manganese), 1 explosive (TNT), and 7 SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].
- **Former Crash Area –** Of the 45 chemicals detected in surface soil (0–1 ft bgs) samples, 32 of these chemicals (16 inorganic chemicals, 2 explosives, 12 SVOCs, and 2 VOCs) were identified as SRCs. Risk-based screening identified nine COPCs in surface soil: four inorganic chemicals (aluminum, arsenic, cobalt, and manganese) and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].
- **Former Plane Burial Area –** Of the 40 chemicals detected in surface soil (0–1 ft bgs) samples, 29 of these chemicals (18 inorganic chemicals, 1 explosive, 6 SVOCs, and 4 VOCs) were identified as SRCs. Risk-based screening identified seven inorganic chemicals as COPCs in surface soil (aluminum, antimony, arsenic, cadmium, cobalt, copper, and manganese).
- **Former Crash Area Well Pit –** Of the 21 chemicals detected in surface soil (0–1 ft bgs) samples, 11 of these chemicals (9 inorganic chemicals, 1 explosive, and 1 VOC) were identified as SRCs. Risk-based screening identified two inorganic chemicals as COPCs in surface soil (barium and lead).

Deep Surface Soil (0–4 ft bgs)

- **Former Plane Refueling/Crash Strip Area –** Of the 50 chemicals detected in deep surface soil (0–4 ft bgs) samples, 42 of these chemicals (18 inorganic chemicals, 5 explosives, and 19 SVOCs) were identified as SRCs. Risk-based screening identified 14 COPCs in deep surface soil: 6 inorganic chemicals (aluminum, arsenic, barium, cobalt, cyanide, and manganese), 1 explosive (TNT), and 7 SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].
- **Former Crash Area –** Of the 46 chemicals detected in deep surface soil (0–4 ft bgs) samples, 33 of these chemicals (16 inorganic chemicals, 2 explosives, 1 pesticide, 12 SVOCs, and 2 VOCs) were identified as SRCs. Risk-based screening identified 10 COPCs in deep surface soil: 4 inorganic chemicals (aluminum, arsenic, cobalt, and manganese), 1 pesticide (delta-BHC), and 5 SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].
- **Former Plane Burial Area –** Of the 41 chemicals detected in deep surface soil (0–4 ft bgs) samples, 29 of these chemicals (18 inorganic chemicals, 1 explosive, 6 SVOCs, and 4 VOCs) were identified as SRCs. Risk-based screening identified seven inorganic chemicals as COPCs in deep surface soil (aluminum, antimony, arsenic, cadmium, cobalt, copper, and manganese).
- **Former Crash Area Well Pit –** One surface soil sample was collected from 0–1 ft bgs. Therefore, the same two COPCs (barium and lead) identified for surface soil (0–1 ft bgs) above were identified in deep surface soil (0–4 ft bgs).

7.2.2.2 COPCs in Subsurface Soil

Subsurface Soil (1–13 ft bgs)

- **Former Plane Refueling/Crash Strip Area** – Of the 37 chemicals detected in subsurface soil (1–13 ft bgs) samples, 17 of these chemicals (3 inorganic chemicals and 14 SVOCs) were identified as SRCs. Risk-based screening identified five COPCs (all SVOCs) in subsurface soil: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.
- **Former Crash Area –** Of the 34 chemicals detected in subsurface soil (1–13 ft bgs) samples, 16 of these chemicals (5 inorganic chemicals, 1 pesticide, and 10 SVOCs) were identified as SRCs. Risk-based screening identified arsenic and delta-BHC as COPCs in subsurface soil.
- **Former Plane Burial Area** – Of the 25 chemicals detected in subsurface soil (1–13 ft bgs) samples, 10 of these chemicals (5 inorganic chemicals, 1 SVOC, and 4 VOCs) were identified as SRCs. Risk-based screening identified two inorganic chemicals (cadmium and copper) as COPCs in subsurface soil.
- **Former Crash Area Well Pit** – No samples were collected in the 1–13 ft bgs interval.

Subsurface Soil (4–7 ft bgs)

- **Former Plane Refueling/Crash Strip Area** – Of the 21 chemicals detected in subsurface soil (4–7 ft bgs) samples, only cadmium was identified as an SRC. No COPCs were identified.
- **Former Crash Area** – Of the 27 chemicals detected in subsurface soil (4–7 ft bgs) samples, 8 of these chemicals (3 inorganic chemicals and 5 SVOCs) were identified as SRCs. Risk-based screening identified only arsenic as a COPC in subsurface soil.
- **Former Plane Burial Area** – No samples were collected in the 4–7 ft bgs interval. Two samples were collected from 3–5 ft bgs. These samples were included in the deep surface soil (0–4 ft bgs) interval based on the starting depth of the samples.
- **Former Crash Area Well Pit** – No samples were collected in the 4–7 ft bgs interval.

7.2.2.3 COPCs in Sediment

- **Wetland/Pond North of Former Crash Area** – Of the 24 chemicals detected in the sediment sample collected at the Wetland/Pond North of Former Crash Area, 6 of these chemicals (3 inorganic chemicals and 3 VOCs) were identified as SRCs. Risk-based screening did not identify any COPCs in Wetland/Pond North of Former Crash Area sediment.
- **Tributary to Hinkley Creek** – Of the 39 chemicals detected in sediment samples collected at the Tributary to Hinkley Creek, 23 of these chemicals (6 inorganic chemicals, 1 explosive, 15 SVOCs, and 1 VOC) were identified as SRCs. Risk-based screening identified two COPCs in sediment: one inorganic chemical (cobalt) and one SVOC [benzo(a)pyrene].
- **Former Crash Area Reservoir** – Of the 18 chemicals detected in the sediment sample collected at the Former Crash Area Reservoir, 2 VOCs were identified as SRCs. No COPCs were identified in sediment at this area.

7.2.2.4 COPCs in Surface Water

- **Wetland/Pond North of Former Crash Area** – Of the 14 chemicals detected in the surface water sample collected at the Wetland/Pond North of Former Crash Area, 6 of these chemicals (5 inorganic chemicals and 1 VOC) were identified as SRCs. Cobalt and manganese were identified as COPCs by risk-based screening in Wetland/Pond North of Former Crash Area surface water.
- **Tributary to Hinkley Creek** – Of the 19 chemicals detected in surface water samples collected at the Tributary to Hinkley Creek, 10 of these chemicals (9 inorganic chemicals and 1 SVOC) were identified as SRCs. Risk-based screening identified only bis(2-ethylhexyl)phthalate as a COPC in surface water.

7.2.3 Land Use and Representative Receptors

Camp Ravenna is a controlled-access facility. NACA Test Area is currently designated as Training Area 29 and is used as part of the land navigation course, to draw water from the wetland (outside the AOC boundary) for water purification training, and for helicopter “touch and go” training for hasty landing zones. 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.

As stated in Paragraph 6.d of the Technical Memorandum, if an AOC fails to meet the Unrestricted (Residential) Land Use, then an FS will be completed that evaluates cleanup options for all three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use]. Remedial alternatives for meeting each Land Use are to be evaluated per the current guidelines for selecting a remedy for the AOC.

7.2.4 Compare to Appropriate FWCUGs

Previous sections have outlined the process for identifying SRCs and Phase II RI COPCs. Comparing COPC exposure concentrations to FWCUGs and determining COCs follows guidance presented in the Position Paper for Human Health CUGs (USACE 2012a) and Technical Memorandum (ARNG 2014).

The COC determination process is as follows:

- Report all carcinogenic and non-carcinogenic based SLs for each COPC for the Representative Receptors: Unrestricted (Residential) Land Use [Resident Receptor (Adult and Child)], Military Training Land Use (National Guard Trainee), and Commercial/Industrial Land Use [Industrial Receptor (USEPA's Composite Worker)]. SLs for the Resident Receptor (Adult and Child) and National Guard Trainee are the FWCUGs corresponding to a TR of 1E-05 and target HQ of 1. If no FWCUG is available for a COPC, the residential and industrial RSLs, adjusted to represent a TR of 1E-05 or target HQ of 1, are used for the Resident Receptor and National Guard Trainee, respectively. SLs for the Industrial Receptor are the industrial RSLs adjusted to represent a TR of 1E-05 or target HQ of 1.
- Report critical effect and target organ for each non-carcinogenic based FWCUG and RSL.
- Compare the selected FWCUG or RSL to the EPC, including an SOR.
    - For non-carcinogens, compare the EPC to the target HQ SL. Sum the ratios of EPC/SL for COPCs that affect similar target organs or do not have an identified target organ.
    - For carcinogens, compare the EPC to the TR SL. Sum the ratios of EPC/SL for all carcinogens.
- Identify the COPC as a COC for a given receptor if:
    - The EPC exceeds the most stringent SL for either the 1E-05 target cancer risk or the 1 target HQ; 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 Position Paper for Human Health CUGs (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 and RSLs 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 below 10^{-6} are considered acceptable; 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 the 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 toxic (i.e., non-carcinogenic) chemicals is evaluated by comparing an estimated exposure (i.e., intake or dose) from AOC media to an acceptable exposure expressed as an 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 SL to determine a ratio. The sum of these individual ratios is then compared to one. The SOR method is based on the principle that a ratio greater than one represents unacceptable cumulative exposure (i.e., above FWCUGs or

RSLs if adjusted for exposure to multiple COPCs), and a ratio less than or equal to one represents acceptable cumulative exposure (i.e., below FWCUGs or RSLs 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 or RSLs are further evaluated in an uncertainty analysis to identify COCs requiring evaluation in the FS.

Selecting FWCUGs, calculating EPCs for comparison to the FWCUGs, and the resulting risk-based COCs are detailed in the following sections.

7.2.4.1 Selection of Appropriate FWCUGs

Unrestricted (Residential) Land Use is evaluated using FWCUGs for the Resident Receptor (Adult and Child). Military Training Land Use is evaluated using FWCUGs for the National Guard Trainee. Commercial/Industrial Land Use is evaluated using RSLs for the Industrial Receptor (USEPA's Composite Worker).

The SLs provided in Tables 7-8 (soil and sediment) and 7-9 (surface water) for the Resident Receptor (Adult and Child) and National Guard Trainee are FWCUGs corresponding to a TR of 1E-05 and target HQ of 1. If no FWCUG is available for a COPC, the residential and industrial RSLs, adjusted to represent a TR of 1E-05 or target HQ of 1 are used for the Resident Receptor and National Guard Trainee, respectively. SLs for the Industrial Receptor are the industrial RSLs adjusted to represent a TR of 1E-05 or target HQ of 1. The critical effect or target organ associated with the toxicity values used to calculate the FWCUGs and RSLs are also provided.

7.2.4.2 Exposure Point Concentrations for Comparison to FWCUGs

Surface and Subsurface Soil

EPCs were calculated for each depth interval and EU using analytical results from the discrete samples presented in Tables 7-1 through 7-3. Per the FWHHRAM, the EPC was either the 95% upper confidence limit (UCL) of the mean or the MDC, whichever value was lowest. If the 95% UCL could not be determined, the EPC is the MDC.

In addition to the three EUs, one sample from the small, potential hot spot area was evaluated. This sample was evaluated separately (i.e., the individual sample results were used as the EPCs).

Sediment

Two discrete sediment samples collected from the Tributary to Hinkley Creek, one discrete sediment sample collected from the Wetland/Pond North of Former Crash Area, and one discrete sediment sample collected from the Former Crash Area Reservoir were used to characterize risk from exposure to sediment. Because of the small number of samples, each sample was evaluated individually, and the EPC was equal to the detected concentration in each sample.

Surface Water

Two discrete surface water samples collected from the Tributary to Hinkley Creek and one discrete surface water sample collected from the Wetland/Pond North of Former Crash Area were used to characterize risk from exposure to surface water. Because of the small number of samples, each sample was evaluated individually, and the EPC was equal to the detected concentration in each sample.

7.2.4.3 Identification of COCs for Unrestricted (Residential) Land Use

NACA Test Area 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 the surface soil interval (0–1 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-7 though G-9. The identification of soil COCs for the Resident Receptor (Adult and Child) at the three soil EUs and potential hot spot area is summarized below and in Table 7-10.

No COCs were identified for the Former Plane Burial Area. Several PAHs in the Former Plane Refueling/Crash Strip Area and Former Crash Area, and lead in the Crash Area Well Pit 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, antimony, barium, cadmium, cobalt, copper, cyanide, manganese, TNT, benzo(k)fluoranthene, and chrysene EPCs are lower than the Resident Receptor (Adult and Child) FWCUG.
- **COPCs with EPCs Exceeding the Resident Receptor (Adult and Child) FWCUG –** EPCs of arsenic, several PAHs, and lead exceed the FWCUG at one or more EU, as summarized below:
    - The EPCs for arsenic in surface soil at the Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane Burial Area range from 9.47 mg/kg (Former Crash Area) to 11 mg/kg (Former Plane Burial Area) and exceed the FWCUG for the Resident Receptor of 4.25 mg/kg. Because the FWCUG is less than the facility-wide background concentration of 15.4 mg/kg in surface (0–1 ft bgs) soil, the background concentrations are used as the FWCUG for this inorganic chemical. Based on these results, arsenic is not identified as a COC in surface soil.
    - The EPCs for benz(a)anthracene (4.09 mg/kg), benzo(a)pyrene (4.7 mg/kg), benzo(b)fluoranthene (6.17 mg/kg), dibenz(a,h)anthracene (0.737 mg/kg), and indeno(1,2,3-cd)pyrene (2.81 mg/kg) at the Former Plane Refueling/Crash Strip Area

exceed the FWCUGs for these PAHs. The EPC for benzo(a)pyrene (4.7 mg/kg) exceeds the FWCUG (0.221 mg/kg) by more than an order of magnitude. The EPCs are strongly influenced by elevated PAH concentrations in four samples collected in 1999: NTA-088, NTA-089, and NTA-090, located in the grass median of the western portion of the crash test strip and NTA-083, located north of the crash strip in the northwestern portion of the Former Plane Refueling/Crash Strip Area EU. For example, the concentrations of benzo(a)pyrene in these samples range from 3.5–41 mg/kg. Detected benzo(a)pyrene concentrations in the other Former Plane Refueling/Crash Strip Area samples ranged from 0.0097–0.62 mg/kg. These five PAHs are COCs at the Former Plane Refueling/Crash Strip Area. The EPC for benzo(a)pyrene (0.254 mg/kg) at the Former Crash Area slightly exceeds the FWCUG of 0.221 mg/kg. Benzo(a)pyrene was identified as a COC at the Former Crash Area. PAHs are not COPCs at the Former Plane Burial Area or the Crash Area Well Pit.

  - The detected concentration for lead in the Former Crash Area Well Pit (13,200 mg/kg) is above its facility-wide background concentration (26.1 mg/kg). Because no FWCUGs are available for lead, the residential RSL of 400 mg/kg was used as the FWCUG for this inorganic chemical. The detected concentration of lead at the Former Crash Area Well Pit (13,200 mg/kg) is well above this RSL and may represent a hot spot of this inorganic chemical. Therefore, lead is identified as a COC in the Former Crash Area Well Pit.

SOR Analysis. Three additional COCs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at the Former Crash Area] were identified based on the SOR analysis, as summarized below:

- No FWCUG is available for lead and the residential RSL is based on an acceptable blood-lead level, not a specific target organ. Therefore, lead was not included in the SOR analysis.
- A total of 10 COPCs (aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, cyanide, manganese, and TNT) identified in the surface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, antimony, arsenic, and cobalt are less than the facility-wide background concentrations for surface soil; therefore, these metals were not included in the SOR. SORs were calculated for the remaining chemicals (see Appendix G, Table G-8). Four COPCs (barium, cyanide, manganese, and TNT) have EPCs above background concentrations at the Former Plane Refueling/Crash Strip Area. The total SOR for these COPCs is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate. Two COPCs (cadmium and copper) have EPCs above background concentrations at the Former Plane Burial Area. The total SOR for these COPCs is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate. Only barium has an EPC above background at the Crash Area Well Pit; therefore, no SOR was calculated for this area.
- The cancer risk-based 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 SORs for carcinogens and is not included in the count of COPCs with a FWCUG for the cancer endpoint (discussed below).
- Nine surface soil COPCs [cobalt, TNT, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and

indeno(1,2,3-cd)pyrene] at the Former Plane Refueling/Crash Strip Area have FWCUGs for the cancer endpoint. The EPC for cobalt is less than its facility-wide background concentration; therefore, this inorganic chemical was not included in the SOR. An SOR was calculated for the remaining chemicals (see Appendix G, Table G-9). The calculated SOR is 31, due primarily to benzo(a)pyrene. The ratio for three other PAHs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] also contribute at least 5% to the SOR. All of these PAHs were previously identified as COCs. The ratios for all other carcinogenic COPCs contribute less than 5% to the SOR; therefore, no additional COCs were identified for this aggregate based on the SOR analysis.

- Six surface soil COPCs [cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] at the Former Crash Area have FWCUGs for the cancer endpoint. The EPC for cobalt is less than its facility-wide background concentration; therefore, this inorganic chemical was not included in the SOR. An SOR was calculated for the remaining chemicals (see Appendix G, Table G-9). The calculated SOR is two, due primarily to benzo(a)pyrene. The ratio for three other PAHs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] also contribute at least 5% to the SOR. Benzo(a)pyrene was previously identified as a COC; therefore, the SOR identifies three additional PAHs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] as COCs at this EU.
- Two surface soil COPCs (cadmium, and cobalt) at the Former Plane Burial Area have FWCUGs for the cancer endpoint. The EPC for cobalt is less than its facility-wide background concentration; therefore, this inorganic chemical was not included in the SOR. At the Former Plane Burial Area, only one COPC with a cancer endpoint is present above background concentrations; therefore, no SOR was calculated for this EU.

COCs in surface soil (0–1 ft bgs) for the Resident Receptor (Adult and Child) are summarized in Table 7-10.

COCs for Subsurface Soil (1–13 ft bgs)

COC screening for the subsurface soil interval (1–13 ft bgs) for the Resident Receptor (Adult and Child) is detailed in Appendix G, Tables G-10 though G-12. The identification of soil COCs for the Resident Receptor (Adult and Child) at the three soil EUs is summarized below and in Table 7-10.

No COCs were identified for the Former Plane Burial Area. Four PAHs in the Former Plane Refueling/Crash Strip Area 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 cadmium, copper, 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** – EPCs of arsenic, one PAH, and delta-BHC exceed the FWCUG at one or more sample locations.

  - The EPC for benzo(a)pyrene (0.255 mg/kg) at the Former Plane Refueling/Crash Strip Area slightly exceeds the FWCUG (0.221 mg/kg). Benzo(a)pyrene was identified as a COC at the Former Plane Refueling/Crash Strip Area.
  - The EPC for arsenic in subsurface soil at the Former Crash Area (14 mg/kg) exceeds the FWCUG for the Resident Receptor of 4.25 mg/kg. Because the FWCUG is less than the facility-wide background concentration of 19.8 mg/kg in subsurface (1–13 ft bgs) soil, the background concentration is used as the FWCUG for this inorganic chemical. Based on this result, arsenic is not identified as a COC in subsurface soil.
  - Delta-BHC was identified as a COPC in subsurface soil at the Former Crash Area because no FWCUGs are available for this chemical. No USEPA-approved toxicity values are available to calculate an FWCUG for delta-BHC; however, information is available for other BHC isomers. The Resident Receptor (Adult and Child) FWCUG for exposure to beta-BHC in surface soil is 7.7 mg/kg. The USEPA residential RSLs (at a TR of 1E-06) for alpha, beta, gamma, and technical grade (which is a mixture of all BHC isomers including delta) BHC are 0.086, 0.3, 0.57, and 0.3 mg/kg respectively. Delta-BHC was detected in one subsurface soil sample at a concentration of 0.0044 mg/kg. Because the single detected concentration is less than the RSLs for any of the other isomers and technical grade BHC, delta-BHC is not a COC in subsurface soil.

SOR Analysis. Three additional COCs were identified based on the SOR analysis, as summarized below:

- Three COPCs (arsenic, cadmium, and copper) identified in subsurface soil have FWCUGs for non-cancer endpoints. The EPC for arsenic is less than the facility-wide background concentration for subsurface soil; therefore, this metal was not included in the SOR. An SOR was calculated for the remaining COPCs at the Former Plane Burial Area (Appendix G, Table G-11). The calculated SOR is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate.
- Seven COPCs [arsenic, cadmium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] at one or more EU have FWCUGs for the cancer endpoint. Arsenic is the only COPC with a cancer endpoint at the Former Crash Area. The FWCUG for arsenic is less than the background concentration for this inorganic chemical; therefore, the background concentration is used as the CUG, and no SOR was calculated for this EU. At the Former Plane Burial Area, only one COPC (cadmium) with a cancer endpoint is present; therefore, no SOR was calculated for this EU. An SOR was calculated for the remaining COPCs at the Former Plane Refueling/Crash Strip Area (see Appendix G, Table G-12). The calculated SOR is two, due primarily to benzo(a)pyrene. Benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene also contribute at least 5% to the SOR. These PAHs were identified as COCs at this EU.

COCs for Sediment

COC screening for sediment for the Resident Receptor (Adult and Child) is detailed in Appendix G, Table G-13. No COCs were identified in sediment.

Detected concentrations of all COPCs are lower than the FWCUGs.

SOR Analysis. No COCs were identified based on the SOR analysis, as summarized below:

- Only one COPC (cobalt) having an FWCUG for a non-cancer endpoint was identified at one sediment EU (at Tributary to Hinkley Creek); therefore, no SOR was calculated.
- Two COPCs [cobalt and benzo(a)pyrene] identified in sediment in the Tributary to Hinkley Creek have FWCUGs for the cancer endpoint. An SOR was calculated for these two chemicals for each sample (Appendix G, Table G-13). The calculated SORs are less than or equal to one; therefore, no COCs were identified.

COCs for Surface Water

COC screening for surface water for the Resident Receptor (Adult and Child) is detailed in Appendix G, Table G-14. No COCs were identified in surface water.

Detected concentrations of all COPCs are lower than the FWCUGs.

SOR Analysis. No COCs were identified based on the SOR analysis, as summarized below:

- Two COPCs (cobalt and manganese) having FWCUGs for non-cancer endpoints were identified at the Wetland/Pond North of Former Crash Area. An SOR was calculated for these two chemicals for the sample (Appendix G, Table G-15). The calculated SOR is less than or equal to one; therefore, no COCs were identified.
- Only one COPC [bis(2-ethylhexyl)phthalate] was identified in the Tributary to Hinkley Creek; therefore, no SOR was calculated for that EU.

7.2.4.4 Identification of COCs for Commercial/Industrial Land Use

NACA Test Area COCs for Commercial/Industrial Land Use, as represented by the Industrial Receptor, are presented below.

COCs for Surface Soil (0–1 ft bgs)

COC screening for surface soil (0–1 ft bgs) for the Industrial Receptor is detailed in Appendix G, Tables G-16 through G-18. The identification of soil COCs for the Industrial Receptor at the three soil EUs and potential hot spot area is summarized below and in Table 7-10.

No COCs were identified at the Former Plane Burial Area and Former Crash Area. Several PAHs in the Former Plane Refueling/Crash Strip Area and lead in the Crash Area Well Pit were identified as COCs for the Industrial Receptor, as explained below:

- **COPCs with EPCs Lower than the Industrial RSL** – All aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, cyanide, manganese, TNT, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene EPCs are lower than the Industrial RSLs.
- **COPCs with EPCs Exceeding the Industrial RSL** – EPCs of arsenic, benzo(a)pyrene, and lead exceed the FWCUG at one or more EU, as summarized below:
    - The EPC for benzo(a)pyrene (4.7 mg/kg) at the Former Plane Refueling/Crash Strip Area exceeds the FWCUG (2.9 mg/kg). The EPC is strongly influenced by elevated PAH concentrations in four samples collected in 1999: NTA-088, NTA-089, and NTA-090, located in the grass median of the western portion of the crash test strip and NTA-083, located northwest of the crash strip. The concentrations of benzo(a)pyrene in these samples range from 3.5 to 41 mg/kg. Detected benzo(a)pyrene concentrations in the other Former Plane Refueling/Crash Strip Area samples ranged from 0.0097–0.62 mg/kg. Benzo(a)pyrene is a COC at the Former Plane Refueling/Crash Strip Area. The EPC for benzo(a)pyrene (0.254 mg/kg) at the Former Crash Area is below the FWCUG of 2.9 mg/kg. Benzo(a)pyrene was not identified as a COC at the Former Crash Area. Benzo(a)pyrene is not a COPC at the Former Plane Burial Area or the Crash Area Well Pit.
    - The detected concentration for lead in the Former Crash Area Well Pit (13,200 mg/kg) is well above its facility-wide background concentration (26.1 mg/kg) and the industrial RSL of 800 mg/kg and may represent a hot spot of this inorganic chemical. Therefore, lead is identified as a COC in the Former Crash Area Well Pit.

SOR Analysis. Three additional COCs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] at the Former Plane Refueling/Crash Strip Area were identified based on the SOR analysis, as summarized below:

- The Industrial RSL for lead is based on an acceptable blood-lead level, not a specific target organ. Therefore, lead was not included in the SOR analysis.
- A total of 10 COPCs (aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, cyanide, manganese, and TNT) identified in the surface soil have FWCUGs for non-cancer endpoints. The EPCs for aluminum, antimony, arsenic, and cobalt are less than the facility-wide background concentrations for surface soil; therefore, these metals were not included in the SOR. SORs were calculated for the remaining chemicals (see Appendix G, Table G-17). Four COPCs (barium, cyanide, manganese, and TNT) have EPCs above background concentrations at the Former Plane Refueling/Crash Strip Area. The total SOR for these COPCs is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate. Two COPCs (cadmium and copper) have EPCs above background concentrations at the Former Plane Burial Area. The total SOR for these COPCs is less than or equal to one; therefore, no

COCs are identified based on the SOR for this soil aggregate. Only barium has an EPC above background at the Crash Area Well Pit; therefore, no SOR was calculated for this area.

- A total of 10 surface soil COPCs [arsenic, cobalt, TNT, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] at the Former Plane Refueling/Crash Strip Area have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than their facility-wide background concentrations; therefore, these inorganic chemicals were not included in the SOR. An SOR was calculated for the remaining chemicals (Appendix G, Table G-18). The calculated SOR is two, due primarily to benzo(a)pyrene. The ratio for three other PAHs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] also contribute at least 5% to the SOR. Benzo(a)pyrene was previously identified as a COC; therefore, the SOR identifies three additional PAHs [benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] as COCs at this EU.
- Seven surface soil COPCs [arsenic, cobalt, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] at the Former Crash Area have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than their facility-wide background concentrations; therefore, these inorganic chemicals were not included in the SOR. An SOR was calculated for the remaining chemicals (Appendix G, Table G-18). The total SOR for these COPCs is less than or equal to 1; therefore, no COCs are identified based on the SOR for this EU.
- Three surface soil COPCs (arsenic, cadmium, and cobalt) at the Former Plane Burial Area have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than their facility-wide background concentrations; therefore, these inorganic chemicals were not included in the SOR. As only one COPC with a cancer endpoint was present in the Former Plane Burial Area with an EPC above facility-wide background concentrations, no SOR was calculated for this EU.

COCs for Subsurface Soil (1–13 ft bgs)

COC screening for subsurface soil (1–13 ft bgs) for the Industrial Receptor is detailed in Appendix G, Tables G-20 through G-21. No COCs were identified for the Industrial Receptor, as explained below:

- **COPCs with EPCs Lower than the Industrial RSL** – All arsenic, cadmium, copper, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene EPCs are lower than the Industrial RSL.
- **COPCs with EPCs Exceeding the Industrial RSL** – Delta-BHC was identified as a COPC in subsurface soil at the Former Crash Area because an industrial RSL is not available for this chemical; however, information is available for other BHC isomers. The USEPA industrial RSLs (adjusted to represent a TR of 1E-05) for alpha, beta, gamma, and technical grade (which is a mixture of all BHC isomers including delta) BHC are 3.6, 13, 25, and 13 mg/kg, respectively. Delta-BHC was detected in one subsurface soil sample at a concentration of 0.0044 mg/kg. Because the single detected concentration is less than the RSLs for any of the other isomers and technical grade BHC, delta-BHC is not a COC in subsurface soil.

SOR Analysis. No COCs were identified based on the SOR analysis, as summarized below:

- Three COPCs (arsenic, cadmium, and copper) identified in subsurface soil have RSLs for non-cancer endpoints. The EPC for arsenic is less than the facility-wide background concentrations for subsurface soil; therefore, this metal was not included in the SOR. An SOR was calculated for the remaining COPCs at the Former Plane Burial Area (Appendix G, Table G-20). The calculated SOR is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate.
- Five COPCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] identified in subsurface soil at the Former Plane Refueling/Crash Strip Area have RSLs for the cancer endpoint. The calculated SOR for these chemicals is less than or equal to one; therefore, no COCs are identified based on the SOR for this EU. Arsenic is the only COPC with a cancer endpoint at the Former Crash Area and cadmium is the only COPC with a cancer endpoint at the Former Plane Burial Area; therefore, no SORs were calculated for these EUs.

COCs for Sediment and Surface Water

Industrial RSLs are not available for sediment or surface water. As noted in Section 7.2.4.3, all COPCs in sediment and surface water are at concentrations less than Resident Receptor (Adult and Child) FWCUGs.

7.2.4.5 Identification of COCs for Military Training Land Use

NACA Test Area COCs for Military Training Land Use, as represented by the National Guard Trainee, are presented below.

COCs for Deep Surface Soil (0–4 ft bgs)

COC screening for deep surface soil (0–4 ft bgs) for the National Guard Trainee is detailed in Appendix G, Tables G-22 through G-24. No COCs were identified at the Former Plane Refueling/Crash Strip Area, Former Plane Burial Area, and Former Crash Area. Lead was identified as a COC in the Crash Area Well Pit for the National Guard Trainee, as explained below:

- **COPCs with EPCs Lower than the National Guard Trainee FWCUG** – All aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, cyanide, manganese, TNT, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene EPCs are lower than the National Guard Trainee FWCUGs.
- **COPCs with EPCs Exceeding the National Guard Trainee FWCUG** – EPCs of lead and delta-BHC exceed the FWCUG at one or more EU.
    - Delta-BHC was identified as a COPC in subsurface soil at the Former Crash Area because no FWCUGs are available for this chemical. No USEPA-approved toxicity values are available to calculate an FWCUG for delta-BHC; however, information is available for

other BHC isomers. The National Guard Trainee FWCUG for exposure to beta-BHC in surface soil is 74.2 mg/kg. The USEPA residential RSLs (at a TR of 1E-06) for alpha, beta, gamma, and technical grade (which is a mixture of all BHC isomers including delta) BHC are 0.086, 0.3, 0.57, and 0.3 mg/kg, respectively. Delta-BHC was detected in one subsurface soil sample at a concentration of 0.0044 mg/kg. Because the single detected concentration is less than the RSLs for any of the other isomers and technical grade BHC, delta-BHC is not a COC in subsurface soil.

  - The detected concentration for lead in the Former Crash Area Well Pit (13,200 mg/kg) is above its facility-wide background concentration (26.1 mg/kg). Because no FWCUGs are available for lead, the industrial RSL of 800 mg/kg was used as the FWCUG for this inorganic chemical. The detected concentration of lead at the Former Crash Area Well Pit (13,200 mg/kg) is well above this RSL and may represent a hot spot of this inorganic chemical. Therefore, lead is identified as a COC in the Former Crash Area Well Pit for the National Guard Trainee.

SOR Analysis. No additional COCs were identified based on the SOR analysis, as summarized below:

- No FWCUG is available for lead; therefore, the industrial RSL is used for comparison. The RSL is based on an acceptable blood-lead level, not a specific target organ; therefore, lead was not included in the SOR analysis
- A total of 10 COPCs (aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, cyanide, manganese, and TNT) identified in deep surface soil (0–4 ft bgs) have FWCUGs for non-cancer endpoints. The EPCs for aluminum, antimony, arsenic, barium, cobalt, and manganese are less than the facility-wide background concentrations for surface or subsurface soil; therefore, these metals were not included in the SOR. Two COPCs (cyanide and TNT) have EPCs above background concentrations at the Former Plane Refueling/Crash Strip Area. The calculated SOR is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate. Two COPCs (cadmium and copper) have EPCs above background concentrations at the Former Plane Burial Area. The calculated SOR is less than or equal to one; therefore, no COCs are identified based on the SOR for this soil aggregate. Only barium has an EPC above background at the Crash Area Well Pit; therefore, no SOR was calculated for this area.
- A total of 11 COPCs [arsenic, cadmium, cobalt, TNT, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] identified in deep surface soil (0–4 ft bgs) have FWCUGs for the cancer endpoint. The EPCs for arsenic and cobalt are less than the facility-wide background concentrations for surface soil; therefore, these metals were not included in the SOR. An SOR was calculated for the remaining COPCs at each EU (Appendix G, Table G-24). The calculated SORs are less than or equal to one; therefore, no COCs are identified based on the SORs.

COCs for Subsurface Soil (4–7 ft bgs)

COC screening for subsurface soil (4–7 ft bgs) for the National Guard Trainee is detailed in Appendix G, Table G-25. No COCs were identified for the National Guard Trainee, as explained below:

- **COPCs with EPCs Lower than the National Guard Trainee FWCUG** – Arsenic was the only COPC identified in subsurface soil (4–7 ft bgs). The EPC of this chemical was lower than the National Guard Trainee FWCUG.

SOR Analysis. Only one COPC was identified in subsurface soil (4–7 ft bgs); therefore, no SOR was calculated.

COCs for Sediment

COC screening for sediment for the National Guard Trainee is detailed in Appendix G, Table G-26. No COCs were identified in sediment because all detected concentrations of all COPCs [cobalt and benzo(a)pyrene] are lower than the FWCUGs.

SOR Analysis. No COCs were identified based on the SOR analysis, as summarized below:

- Only one COPC (cobalt at the Tributary to Hinkley Creek) having an FWCUG for non-cancer endpoint was identified; therefore, no SOR was calculated.
- Two COPCs [cobalt and benzo(a)pyrene] identified in sediment in the Tributary to Hinkley Creek have FWCUGs for the cancer endpoint. An SOR was calculated for these two chemicals for each sample (Appendix G, Table G-26). The calculated SORs are less than one; therefore, no COCs were identified.

COCs for Surface Water

COC screening for surface water for the National Guard Trainee is detailed in Appendix G, Table G-27. No COCs were identified in surface water because the detected concentrations all COPCs [cobalt and manganese in the Wetland/Pond North of the Former Crash Area and bis(2-ethylhexyl)phthalate in the Tributary to Hinkley Creek] are lower than the FWCUGs.

SOR Analysis. No COCs were identified based on the SOR analysis, as summarized below:

- Two COPCs [cobalt and manganese] identified in surface water in the Wetland/Pond North of the Former Crash Area sample have FWCUGs for a non-cancer endpoint. An SOR was calculated for these two chemicals for the sample (Appendix G, Table G-27). The calculated SOR is less than one; therefore, no COCs were identified.
- Only one COPC [bis(2-ethylhexyl)phthalate at Tributary to Hinkley Creek] having an FWCUG for the cancer endpoint was identified; therefore, no SOR was calculated.

7.2.5 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.

7.2.5.1 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. More than 120 surface soil (0–1 ft bgs) samples were available for the HHRA. 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. One potentially significant source of uncertainty at NACA Test Area is the age of much of the data. Most of the surface soil data are from samples collected in 1999. Samples collected in 2010 were targeted at confirming some of the previously detected concentrations and verifying the extent of contamination. NACA Test Area has been used for National Guard Training in recent years. Training activities may have resulted in disturbance of surface soil. The use of data from samples collected in 1999 introduces a significant level of uncertainty in the identification of PAHs as COCs at the Former Plane Refueling/Crash Strip Area. The EPCs of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene in surface soil at the Former Plane Refueling/Crash Strip Area exceed Resident Receptor (Adult and Child) FWCUGs and Industrial RSLs, and these PAHs are identified as COCs. The largest detected concentrations of PAHs are from four samples collected in 1999. Samples collected at or near the same locations in 2010 do not verify these high concentrations. For example, as noted in Table 7-11, the MDC of benzo(a)pyrene at the Former Plane Refueling/Crash Strip Area is 41 mg/kg reported at sample location NTA-088 in 1999. A sample collected at the same location in 2010 had a reported benzo(a)pyrene concentration of 0.3 mg/kg. The highest detected concentration of benzo(a)pyrene reported in samples collected in 2010 was 0.62 mg/kg at location NTAsb-120. A similar trend can be seen in the 1999 and 2010 data for all other PAHs.

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 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 NACA Test Area, 13 inorganic chemicals (aluminum, antimony, arsenic, beryllium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, and vanadium) had MDCs in surface soil at one or more EU that were one to two times the background concentration. The consequences of carrying most of these inorganic chemicals forward as SRCs, even if they are actually representative of background concentrations, is negligible because they are not toxic at near-background concentration levels. By contrast, naturally occurring (background) arsenic and manganese in soil exceed risk-based CUGs. Therefore, the consequence of identifying arsenic or manganese as an SRC if it is, in fact, representative of the background concentration, can have a significant impact on the conclusions of the risk assessment. The EPCs of these two metals are less than background concentrations.

The MDC of arsenic at NACA Test Area are 23 mg/kg in surface soil (0–1 ft bgs) and 24.7 mg/kg in subsurface soil (1–13 ft bgs). The RVAAP background concentration for arsenic in surface soil is 15.4 mg/kg and in subsurface soil is 19.8 mg/kg. Mixing soil during site activities likely resulted in mixing surface soil into the subsurface, thus blurring the distinction between surface and subsurface background concentrations. The reported arsenic concentration in 6 of 120 surface soil samples exceeds 15.4 mg/kg, and the reported concentration in 3 of these samples also exceeds 19.8 mg/kg. The reported arsenic concentration in just 1 of 39 subsurface soil samples exceeds 19.8 mg/kg. The EPCs of arsenic range from 10.6–14 mg/kg for the various EUs and exposure depths.

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). In addition, Vosnakis and Perry (2009) published the results of arsenic concentration 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 mg/kg for surface soil and 29.6 mg/kg for subsurface soil. 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 shale (USGS 2004). Based on this information, arsenic appears to be present at NACA Test Area at naturally occurring concentrations.

The MDCs of manganese at NACA Test Area are 6,240 mg/kg in surface soil (0–1 ft bgs) and 1,790 mg/kg in subsurface soil (1–13 ft bgs). The RVAAP background concentration for manganese in surface soil is 1,450 mg/kg and in subsurface soil is 3,030 mg/kg. Mixing soil during site activities likely resulted in mixing surface soil into the subsurface, thus blurring the distinction between surface and subsurface background concentrations. The reported manganese concentration in 13 of 120 surface soil samples exceeds 1,450 mg/kg, and the reported concentration in 6 of these samples also exceeds 3,030 mg/kg. The reported manganese concentration in all 39 subsurface soil samples is less than 3,030 mg/kg. The EPCs of manganese in surface soil range from 948–2,490 mg/kg for the various EUs. Manganese is not a COPC in subsurface soil.

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 CERCLA releases at 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 NACA Test Area, PAHs were detected across the AOC (i.e., in 33 of 119 soil sample locations analyzed for SVOCs). PAH concentrations were highest north of the crash strip and within the grassy median of the crash strip (in the Former Plane Refueling/Crash Strip Area EU) and at eastern end of the crash strip (in the Former Crash Area). Concentrations of PAHs in the remaining areas were generally low.

Although no background concentrations for PAHs were established for RVAAP, the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2001d), which established background concentrations for inorganic chemicals, included a characterization of naturally occurring background metal concentrations in surface and subsurface soil at Camp Ravenna using samples from outside the process areas. Surface soil samples were collected at 15 locations on the eastern half of Camp Ravenna. These background locations were chosen using aerial photographs and site visits with the concurrence of Ohio EPA and USACE to reflect areas not impacted by RVAAP activities and establish background values that are unaffected by any human activity. The background locations were situated upgradient and generally upwind of known or suspected contaminant sources.

Background sampling was conducted in April and May 1998. All background samples were analyzed for TAL metals, cyanide, and SVOCs. Two of the background samples were also analyzed for VOCs and pesticides/PCBs. The background soil sampling effort established concentrations for naturally occurring metals in soil at RVAAP.

In establishing background concentrations for naturally occurring metals, data were screened to identify outliers in the inorganic chemical results. Ohio EPA guidance (Comment Resolution Meeting, December 2, 1998) called for using upper and lower cutoff limits based on quartiles to identify outliers. The upper cutoff limit is the third quartile (75th percentile) plus one and a half times the interquartile range. All results that exceeded the upper cutoff limit were examined to determine if the results should be used in establishing background concentrations for naturally occurring metals. Outliers were removed so that background values would most nearly represent natural conditions and exclude human disturbance whether from RVAAP or pre-RVAAP activities.

Statistical outliers were identified in 5 surface soil and 15 subsurface soil samples. All analytical results for four of these samples [BKGss-011(b)-0794-SO, BKGss-012(b)-0795-SO, BKGss-015(b)-0798-SO, and BKGss-005(b)-0788-SO] were removed from the surface soil background data set.

The primary reason for eliminating these four samples from the surface soil background data set was that PAHs were elevated, and these sampling locations were near pre-existing homes or farms and could have been influenced by activities/materials associated with those structures (e.g., burning wood and fossil fuels, vehicle exhaust, or building materials such as slag used as fill or tar paper and shingles). The other 11 outlier samples were not excluded from the background calculations primarily because no SVOCs were detected in those samples and, thus, the outliers did not appear to be associated with human activities.

Concentrations of PAHs in surface soil at Camp Ravenna associated with pre-RVAAP anthropogenic sources calculated from the 15 RVAAP background surface soil samples are shown in Table 7-12. Since the purpose here is to identify PAH levels associated with anthropogenic activities unrelated to CERCLA releases from operations at RVAAP, it is appropriate to include all 15 background samples in these calculations. The following criteria were used per the method used in establishing the background concentrations for naturally occurring metals (USACE 2001d):

- For analytes with a frequency of detection greater than 50%, a distribution (determined using the Shapiro-Wilk test) that is neither normal nor log-normal, and a sample size of 59 or less, the maximum result represents the nonparametric 95% upper tolerance limit and was identified as the background concentration for naturally occurring metals. These conditions apply to four of the PAHs detected in background samples [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene].
- For analytes with a frequency of detection between 0 and 50% with a sample size of 15, the maximum result represents the 99th percentile value and was identified as the background concentration for naturally occurring metals. These conditions apply to the remainder of the PAHs detected in background samples.

These results demonstrate the large variability in environmental concentrations of PAHs. For example, benzo(a)pyrene was detected in 8 of 15 background surface soil samples at concentrations ranging from 0.058–3.7 mg/kg.

Other studies of environmental concentrations of PAHs in Ohio soils show similar variability. For example, in the environmental study of three locations in Cuyahoga County performed for Ohio EPA (Weston 2012), PAHs were detected in only 1 of 36 surface soil samples with a reported concentration of benzo(a)pyrene of 1.33 mg/kg. Aerial photographs indicate this sample was collected near an old road or trail, but no other sources of PAHs are apparent.

In addition to these RVAAP and Cuyahoga County studies, numerous other environmental 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 benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene from numerous studies are shown in Table 7-13. These studies further 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 NACA Test Area 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 above FWCUGs or RSLs are evaluated to identify whether potential hot spots are present as a result of specific source areas.

The EPCs of arsenic, manganese, and several PAHs [benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] are less than FWCUGs or RSLs, but the MDCs exceed FWCUGs or RSLs at NACA Test Area for one or more receptors in the soil. These results are described below.

Arsenic. The MDC of arsenic at NACA Test Area are 23 mg/kg in surface soil (0–1 ft bgs) and 24.7 mg/kg in subsurface soil (1–13 ft bgs). The RVAAP background concentration for arsenic in surface soil is 15.4 mg/kg and in subsurface soil is 19.8 mg/kg. As noted previously, mixing soil during site activities likely resulted in mixing surface soil into the subsurface, thus blurring the distinction between surface and subsurface background concentrations. The reported arsenic concentration in 3 of 120 surface soil and 1 of 39 subsurface soil samples exceeds 19.8 mg/kg. Other studies indicate arsenic may be naturally occurring in Ohio soils at greater than 20 mg/kg. Arsenic appears to be present at NACA Test Area at naturally occurring concentrations and there is no known source of arsenic at

NACA Test Area. Based on this evaluation, arsenic does not represent a hot spot and is not identified as a COC.

Manganese. The MDC of manganese in surface soil at NACA Test Area was 6,240 mg/kg at sample location NTA-084 in the Former Plane Refueling/Crash Strip Area EU. The RVAAP background concentration for manganese in surface soil is 1,450 and 3,030 mg/kg in subsurface soil. Mixing soil during construction and site activities likely resulted in mixing surface soil into the subsurface, thus blurring the distinction between surface and subsurface background concentrations. None of the detected concentrations of manganese in the subsurface at NACA Test Area exceeded the facility-wide background concentration of 3,030 mg/kg for manganese.

Manganese concentrations ranging from 3,230–6,080 mg/kg in four other samples (NTA-090, NTA-091, NTA-092, and NTAsb-121) within the grassy median of the crash strip were greater than 3,030 mg/kg. The reported concentrations in the remaining 23 of 28 samples are less than the subsurface soil background concentration of 3,030 mg/kg.

The MDC of manganese in surface soil at the Former Crash Area EU was 4,500 mg/kg at sample location NTA-034 in the Former Crash Area. Manganese in the remaining 69 of 70 surface soil samples and 12 subsurface soil samples were below the facility-wide background concentration of 3,030 mg/kg.

The MDCs of manganese in surface and subsurface soil at the Former Plane Burial Area EU (2,190 and 1,790 mg/kg) were below the facility-wide background concentration of 3,030 mg/kg for subsurface soil. There is no known source of manganese at NACA Test Area. Based on these data for the Former Plane Refueling/Crash Strip Area, Former Crash Area EU, and Former Burial Area EU, manganese does not represent a hot spot and is not identified as a COC.

PAHs. A point-by-point comparison was conducted for detected concentrations of PAHs to the Residential FWCUG, Industrial RSL, and National Guard Trainee FWCUG for each EU to determine COCs based on a hot spot analysis (Table 7-14).

Former Plane Refueling/Crash Strip Area (0–1 ft bgs). The EPCs of five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] in surface soil (0–1 ft bgs) exceeded FWCUGs for the Resident Receptor. The EPC of benzo(a)pyrene also exceeds the Industrial RSL and the EPCs of the other PAHs contribute significantly to an SOR greater than one. The EPCs of all PAHs were less than FWCUGs for the National Guard Trainee and the SOR is less than or equal to one; therefore, these PAHs were not identified as COCs for the National Guard Trainee.

Discrete sample locations having PAH concentrations above FWCUGs and RSLs are discussed below:

- ***NTA-088, NTA-089, NTA-090, NTAsb-121, and NTAsb-122 –*** NTA-088, NTA-089, and NTA-090 were collected from the western portion of the grassy crash strip median of the Former Plane Refueling/Crash Strip Area EU in October 1999. NTAsb-121 was collected in March 2010 at the same location as previous sample NTA-088. NTAsb-122 was collected from the grassy crash strip median of the Former Plane Refueling/Crash Strip Area east of sample NTA-090 in March 2010. The reported concentration of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceed Residential FWCUGs at NTA-088, NTA-089, and NTA-090. The MDC for all PAHs was at NTA-088. PAH concentrations in the other samples collected in 1999 were generally an order of magnitude lower [e.g., benzo(a)pyrene concentrations in NTA-088, NTA-089, and NTA-090 were 41, 5.1, and 7.6 mg/kg respectively]. Later samples collected near these locations do not support these high concentrations. For example benzo(a)pyrene concentrations at NTAsb-121 and NTAss-132 collected at and near NTA-088 are 0.3 and 0.093 mg/kg and the benzo(a)pyrene concentration at NTAss-133 collected at NTA-089 was 0.011 mg/kg. The benzo(a)pyrene concentration at NTAsb-122 is 0.27 mg/kg. The reported concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene also exceeded the Industrial RSLs at NTA-088 and the reported concentration of benzo(a)pyrene exceeded the Industrial RSL at NTA-089 and NTA-090. Activities in this area (i.e., crashing and burning planes and fuel) are a potential source of PAHs in this area. These PAHs were identified as COCs for the Resident Receptor and/or Industrial Receptor; thus, no new COCs are identified as a result of this hot spot analysis. However, the area around these samples (the Grass Median within the Crash Strip) is identified as a hot spot for these COCs. The reported concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene also exceeded the National Guard Trainee FWCUGs at NTA-088 and benzo(a)pyrene exceeded the National Guard Trainee FWCUG at NTA-089 and NTA-090. Unlike a hypothetical residential yard, military training activities are expected to occur over a larger area (e.g., the entire EU or more), making evaluation of a discrete hot spot less applicable. Given the low National Guard Trainee exceedance in NTA-089 and NTA-090, the low concentrations of PAHs in sample NTA-sb121 collected at NTA-088, and the EU-wide EPCs below the FWCUGs, no hot spots were identified in soil for this Land Use.
- ***NTA-083, NTAsb-120, and NTAss-129 –*** NTA-083 was collected from the northwestern portion of the Former Plane Refueling/Crash Strip Area EU in October 1999. NTAsb-120 was collected in March 2010 at the same location as NTA-083. NTA-ss129 was collected from the northwestern portion of the Former Plane Refueling/Crash Strip Area EU northeast of NTA-083 in March 2010. The reported concentration of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceed Residential FWCUGs at NTA-083. The reported concentration of benzo(a)pyrene exceeded the Residential FWCUG at NTAsb-120 and NTAsb-129. In 1999, the concentration of benzo(a)pyrene at NTA-083 was 3.5 mg/kg. In 2010, the reported concentration of benzo(a)pyrene at the same location (NTAsb-120) was 0.62 mg/kg. The reported concentration of benzo(a)pyrene at NTAss-129 collected in 2010 was 0.35 mg/kg. Because the EPCs for these PAHs exceeded their respective Resident Receptor FWCUGs and Industrial RSLs [for benzo(a)pyrene] at the

Former Plane Refueling/Crash Strip Area and were identified as COCs, no COCs were added as a result of the hot spot analysis. The area north of the crash strip in the northwestern portion of the Former Plane Refueling/Crash Strip Area EU was not identified as a hotspot because the elevated PAH concentrations identified in 1999 were not confirmed by later (2010) samples, there is no identifiable source (as there is for the crash strip median) and there is only one discrete sample (NTA-083) with elevated benzo(a)pyrene.

Former Plane Refueling/Crash Strip Area (1–13 ft bgs). The reported concentration of benzo(a)pyrene exceeded the Resident Receptor FWCUG in one soil sample collected from 1–3 ft bgs at NTA-083. NTA-083 was collected from the northwestern portion of the Former Plane Refueling/Crash Strip Area EU in October 1999. Benzo(a)pyrene was detected in NTA-083 in the 1–3 ft bgs interval at a concentration (0.7 mg/kg) above the Resident Receptor FWCUG (0.221 mg/kg). No deeper sample was collected at that time. Concentrations of five PAHs were above the Resident Receptor FWCUGs in the 0–1 ft bgs soil interval at sample NTA-083 (see discussion above). NTAsb-120 was collected in the same location as previous sample NTA-083 in March 2010. Benzo(a)pyrene was not detected in the samples collected from soil depth intervals of 1–4 or 4–7 ft bgs of NTAsb-120. Given the low magnitude of the exceedance in the 1999 sample and the absence of benzo(a)pyrene in soil samples collected in 2010 from this location, benzo(a)pyrene was not identified as a subsurface soil hot spot.

Former Crash Area (0–1 ft bgs). For the Former Crash Area, one or more of three PAHs [benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] exceeded FWCUGs for the Resident Receptor at one or more locations in soil collected from the 0–1 ft bgs soil interval. These PAH locations are discussed below:

- ***NTA-026 –*** NTA-026 was collected directly east of the crash strip where the crash strip terminated at a former concrete barrier structure. Concentrations of three PAHs [benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] exceed the FWCUGs for the Resident Receptor. The concentrations of PAHs at this location may be associated with site activities from use of the crash strip; therefore, this location was identified as a hot spot for benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene for the Resident Receptor. Concentrations of all COPCs were below Industrial RSLs and National Guard Trainee FWCUGs in all samples at this EU; no hot spots were identified at this location for those receptors.
- ***NTA-032 –*** The concentration of benzo(a)pyrene (0.43 mg/kg) in NTA-032 exceeds the FWCUG for the Resident Receptor of 0.221 mg/kg. The concentration of benzo(a)pyrene (0.14 mg/kg) in the field duplicate at this location was below the FWCUG for the Resident Receptor. No activities took place at this location and no source of PAHs other than the adjacent gravel road could be identified. The concentration of 0.43 mg/kg is comparable to PAH concentrations indicative of atmospheric deposition from sources such as vehicle traffic. Based on these data, this location was not identified as a hot spot.

7.2.5.2 Uncertainty in Use of FWCUGs and RSLs

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 and RSLs.

Selection of Representative Receptors. Camp Ravenna is a controlled-access facility. NACA Test Area is located in the south-west portion of Camp Ravenna and is currently used for training. 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 (ARNG 2014), 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 and RSLs, 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.

Toxicity Values. The toxicity of chemicals is under constant study and values change from time to time. The toxicity values used in calculating the 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 unit risk factor (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 to which the workers were exposed. As noted in IRIS, the assumption that the ratio of hexavalent to trivalent chromium was 1:6 in this study may lead to a seven-fold 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. Three discrete surface soil samples were collected and analyzed for hexavalent chromium and total chromium at NACA Test Area during the PBA08 RI. No hexavalent chromium was detected in any of the speciation samples. Based on these results, hexavalent chromium is not of concern at NACA Test Area; therefore, the use of the trivalent chromium FWCUG is appropriate for the identification of COCs. 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. The 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 (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 SLs 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).

7.2.5.3 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.

7.2.6 Identification of COCs for Potential Remediation

COCs were identified in Section 7.2.4 as any COPC having an EPC greater than an applicable FWCUG or RSL or contributing more than 5–10% to an SOR greater than one. For inorganic chemicals with FWCUGs or RSLs below background concentrations, the background concentration was used as the point of comparison. The TR for the FWCUGs and RSLs 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 7.2.4) are combined with the results of the uncertainty assessment (Section 7.2.5), including an evaluation for potential hot spots, to identify COCs to be carried forward for potential remediation. No COCs were identified for surface water or sediment, or for Former Plane Burial Area soil for any receptor.

Lead and several PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as soil COCs to be carried forward for potential remediation, as described below.

Lead in the Former Crash Area Well Pit

Lead is a COC to be carried forward for potential remediation at the Former Crash Area Well Pit for all three Land Uses. The EPC for lead in surface soil (0–1 ft bgs) (13,200 mg/kg) exceeds the Resident Receptor (Adult and Child) RSL of 400 mg/kg and the Industrial Receptor RSL of 800 mg/kg. No FWCUG or RSL is available for lead for the National Guard Trainee; therefore, the RSL of 800 mg/kg is assumed protective of the National Guard Trainee as well. Based on these data, lead represents a hot spot and is identified as a COC for potential remediation in the well pit for all three Land Uses.

PAHs in the Former Plane Refueling/Crash Strip Area

Resident Receptor. Several PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as soil COCs for the Unrestricted (Residential) Land Use, as summarized below:

- Surface Soil – The EPCs for benz(a)anthracene (4.09 mg/kg), benzo(a)pyrene (4.7 mg/kg), benzo(b)fluoranthene (6.17 mg/kg), dibenz(a,h)anthracene (0.737 mg/kg), and indeno(1,2,3-cd)pyrene (2.81 mg/kg) exceed the Resident Receptor (Adult and Child) FWCUGs for these PAHs. The EPCs are strongly influenced by elevated PAH concentrations in four samples: NTA-088, NTA-089, and NTA-090 along the grassy median of the crash strip, and NTA-083 north of the crash strip. For example, concentrations of benzo(a)pyrene in these samples range from 3.5–41 mg/kg. Detected benzo(a)pyrene concentrations in the other Former Plane Refueling/Crash Strip Area samples ranged from 0.0097–0.62 mg/kg. In addition to evaluating the EU-wide EPCs, the concentration of each COPC in each discrete sample was compared to Resident Receptor FWCUGs to check for the presence of potential hot spots. Concentrations of one or more of these PAHs exceed FWCUGs and are recognized as a hot spot within the EU at the Grass Median within the Crash Strip (Samples NTA-088, NTA-089, NTA-090, NTAsb-121, and NTAsb-122). The concentration of benzo(a)pyrene in one discrete sample (NTAsb-083) collected in 1999 was also elevated; however, later samples collected at the same location had much lower concentrations (e.g., maximum of 0.62 mg/kg) and are representative of vehicle traffic in this former plane storage area. Sample concentrations in the remainder of the EU are less than FWCUGs. Therefore, these five PAHs are recommended for potential remediation for Unrestricted Land Use at the Grass Median within the Former Plane Refueling/Crash Strip Area EU.
- Subsurface Soil – Four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] were identified as COCs in subsurface soil (1–13 ft bgs) for Unrestricted (Residential) Land Use at the Former Plane Refueling/Crash Strip Area. The EPC of benzo(a)pyrene (0.255 mg/kg) slightly exceeds the FWCUG of 0.221 mg/kg, the EPCs of the other three PAHs contribute to an SOR of two. The MDC of benzo(a)pyrene (0.7 mg/kg) at NTA-083 is the only subsurface concentration that exceeds the FWCUG. NTA-083 was collected in October 1999 in the 1–3 ft bgs soil depth interval. Soil boring NTAsb-120 was collected in March 2010 from the same location as previous sample NTA-083. Benzo(a)pyrene was not detected in the samples collected from the 1–4 ft bgs and 4–7 ft bgs soil intervals in NTAsb-120. Benzo(a)pyrene was detected in two other subsurface soil sample locations at concentrations (0.011 and 0.013 mg/kg) well below the FWCUG for the Resident Receptor. Given the slight exceedance of benzo(a)pyrene in NTA-083 collected in 1999, the absence of benzo(a)pyrene in subsequent sample NTAsb-120, and the absence of any other PAH exceedances of the FWCUG, these PAHs are not identified as COCs for potential remediation.

Industrial Receptor. Four PAHs (benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene) were identified as COCs for Commercial/Industrial Land Use at the Former Plane Refueling/Crash Strip Area. The EPC for benzo(a)pyrene (4.7 mg/kg) exceeds the Industrial RSL (2.9 mg/kg). Although the EPCs of benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene are below their industrial RSLs, these PAHs each contribute more than 5% to the SOR of two for the Industrial Receptor. In addition to evaluating the EU-wide EPCs, the concentration of each COPC in each discrete sample was compared to Industrial RSLs to check for the presence of potential hot spots. Concentrations of one or more of these PAHs exceed FWCUGs and are recognized as a hotspot within the EU at the Grass Median within the Crash Strip (Samples NTA-088, NTA-089, and NTA-090). The concentration of benzo(a)pyrene in one discrete sample (NTAsb-083) collected in 1999 was also elevated; however, later samples collected at the same location had much lower concentrations (e.g., maximum of 0.62 mg/kg) and are representative of vehicle traffic in this former plane storage area. Sample concentrations in the remainder of the EU are less than FWCUGs. Therefore, these four PAHs are recommended for potential remediation for Commercial/Industrial Land Use at the Grass Median within the Former Plane Refueling/Crash Strip Area EU. No COCs and no potential hot spots were identified in subsurface soil for Commercial/Industrial Land Use.

National Guard Trainee Receptor. The EU-wide EPCs of all COPCs were less than National Guard Trainee FWCUGs; therefore, no COCs were identified for Military Training Land Use. Evaluation of individual discrete sample results showed concentrations of one or more PAHs exceed National Guard Trainee FWCUGs in three samples collected from the Grass Median within the Crash Strip. Benzo(a)pyrene (41 mg/kg), benzo(b)fluoranthene (54 mg/kg), and dibenz(a,h)anthracene (5.7 mg/kg) were detected above their FWCUGs (4.77, 47.7, and 4.77 mg/kg, respectively) in NTA-088. NTA-088 was collected in October 1999. NTAsb-121 was subsequently collected from the same location in March 2010. The concentrations of benzo(a)pyrene (0.3 mg/kg), benzo(b)fluoranthene (0.43 mg/kg), and dibenz(a,h)anthracene (0.048 mg/kg) were below their FWCUGs in NTA-sb121. Concentrations of benzo(a)pyrene (5.1 and 7.6 mg/kg) slightly exceeded the National Guard Trainee FWCUG (4.77 mg/kg) in NTA-089 and NTA-090, both collected in 1999. Unlike a hypothetical residential yard, military training activities are expected to occur over a larger area (e.g., the entire EU or more), making evaluation of a discrete hot spot less applicable. Given the low National Guard Trainee exceedance in NTA-089 and NTA-090, the low concentrations of PAHs in sample NTA-sb121 collected at NTA-088, and the EU-wide EPCs below the FWCUGs, PAHs are not identified as COCs for potential remediation in the FS for Military Training Land Use. No COCs or hot spots were identified in subsurface soil for this land use.

Former Crash Area

Resident Receptor. Four PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] were identified as COCs for Unrestricted (Residential) Land Use at the Former Crash Area. The surface soil (0–1 ft bgs) EPC of benzo(a)pyrene in the Former Crash Area (0.254 mg/kg) just slightly exceeds the Resident Receptor FWCUG of 0.221 mg/kg. The MDCs of benzo(a)pyrene (1.9 mg/kg) and dibenz(a,h)anthracene (0.35 mg/kg) at sample location NTA-026 in the Former Crash Area exceed the Resident Receptor FWCUG of 0.221 mg/kg but are below the Industrial RSL (2.9 mg/kg) and the National Guard Trainee FWCUG (4.77 mg/kg). In addition, the MDC of benzo(b)fluoranthene (3.2 mg/kg) at sample location NTA-026 in the Former Crash Area exceeds the Resident Receptor FWCUG of 2.21 mg/kg but is below the Industrial RSL (29 mg/kg) and the National Guard Trainee FWCUG (47.7 mg/kg). Although the EPC (0.239 mg/kg) and MDC (1.5 mg/kg) of benz(a)anthracene is below the Resident Receptor FWCUG (2.21 mg/kg), Industrial RSL

(29 mg/kg), and National Guard Trainee FWCUG (47.7 mg/kg), benz(a)anthracene contributes at least 5% to an SOR of two for the Residential Receptor at the Former Crash Area. Benz(a)anthracene was identified as a COC in the Former Crash Area for the Residential Receptor at NTA-026. Because this location is directly east of the crash strip where the crash strip terminated at a former concrete barrier structure, this location was identified as a possible hotspot, and benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene are identified as COCs for potential remediation for Unrestricted (Residential) Land Use. For the remaining 69 surface soil samples in the Former Crash Area, benzo(a)pyrene was detected infrequently (in 6 of 69 samples) at concentrations ranging from 0.014–0.43 mg/kg. Although the concentration in NTA-032 (0.43 mg/kg) was above the Resident Receptor FWCUG (0.221 mg/kg), the concentration in the field duplicate at this location (0.14 mg/kg) and the remaining detected concentrations (0.014–0.12 mg/kg) were below the FWCUG. Concentrations of PAHs throughout the Former Crash Area, with the exception of the area directly east of the crash strip, are likely reflective of atmospheric deposition rather than a specific source at the AOC. As a result, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs to be carried forward for potential remediation in the surface soil area surrounding NTA-026 directly east of the crash strip. No COCs were identified in the subsurface soil.

Industrial and National Guard Trainee Receptors. PAHs were not identified as COCs for the Industrial or National Guard Trainee Receptors in the Former Crash Area.

7.2.7 Summary of HHRA

This HHRA documents COCs that may pose potential health risk to human receptors resulting from exposure to contamination at NACA Test Area. This HHRA was conducted as part of the RI/FS and was based on the streamlined approach described in the FWCUG Report (USACE 2010a), Position Paper for Human Health FWCUGs (USACE 2012a), and Technical Memorandum (ARNG 2014). The components of the risk assessment (receptors, exposure media, EPCs, and results) are summarized below.

Receptors. RVAAP is a controlled-access facility. NACA Test Area is located in the south-west portion of RVAAP. 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). Commercial/Industrial Land Use (Industrial Receptor) is considered protective of all uses other than Residential. Military Training Land Use is represented by the National Guard Trainee. All three Land Uses [i.e., Unrestricted (Residential) Land Use, Military Training Land Use, and Commercial/Industrial Land Use] are evaluated in this HHRA.

Exposure Media. Media of concern at NACA Test Area are surface soil, subsurface soil, surface water, and sediment. Soil data associated with the AOC were aggregated into surface and subsurface soil in each of the three EUs (Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane

Burial Area) and one potential hot spot area (Former Crash Area Well Pit). Sediment and surface water data associated with the AOC were aggregated into three EUs (Wetland/Pond North of Former Crash Area, Tributary to Hinkley Creek, and Former Crash Area Reservoir).

Exposure Point Concentration. The EPCs for soil 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 limited number of sediment and surface water samples were evaluated individually (i.e., the number of samples was too small to calculate 95% UCLs). In addition to calculating EPCs for each EU, individual discrete sample results above FWCUGs or RSLs were evaluated to identify whether potential hot spots are present as a result of specific source areas.

Results of Human Health Risk Assessment. Lead and five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified as COCs to be carried forward for potential remediation.

Lead was identified as a COC in surface soil at the small Former Crash Area Well Pit hot spot for all three receptors evaluated (Resident Receptor, Industrial Receptor, and National Guard Trainee).

The PAHs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were identified as COCs to be carried forward for potential remediation at the Former Plane Refueling/Crash Strip Area EU for the Resident Receptor (Adult and Child), and benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs for remediation in this area to be carried forward for potential remediation for Industrial Land Use. No COCs were identified for potential remediation in surface soil for the National Guard Trainee at the Former Plane Refueling/Crash Strip Area EU, and no COCs for potential remediation were identified in subsurface soil for any receptors.

The PAHs benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs to be carried forward for potential remediation at the Former Crash Area EU for the Resident Receptor (Adult and Child). Benz(a)anthracene is not a COC for potential remediation in the Former Crash Area, as the EPC (0.239 mg/kg) and MDC (1.5 mg/kg) are below the Resident Receptor FWCUG (2.21 mg/kg). No COCs were identified in surface soil for the Industrial Receptor or National Guard Trainee at the Former Crash Area EU and no COCs were identified in subsurface soil for any receptors.

No COCs were identified for any media or receptors in the Former Plane Burial Area. No COCs were identified in sediment or surface water. COCs identified for potential remediation at NACA Test Area are summarized in Table 7-15.

7.3 ECOLOGICAL RISK ASSESSMENT

7.3.1 Introduction

The ERA presented in this Phase II 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 *RVAAP Facility Wide Ecological Risk Work Plan* (USACE 2003b) (herein referred to as 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 Phase II 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 cooperation between USACE and Ohio EPA during the summer of 2011.

7.3.1.1 Scope and Objective

NACA Test Area contains habitat that supports ecological receptors. The habitat has known chemical contamination (USACE 2001a). Habitat types and an assessment of the ecological resources found at NACA Test Area are presented in subsequent subsections. Additionally, the results of an historical screening ERA [performed as part of the *Phase I RI Report for NACA Test Area* (USACE 2001a)] and the PBA08 RI are provided to determine whether a qualitative ERA (Level I) is sufficient, based on the quality of the habitat and the presence of contamination, or whether a more rigorous ERA (Level II or III) should be conducted. NACA Test Area was included in the Characterization of 14 AOCs; however, an ERA was not performed as part of that investigation.

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 or the potential for current contamination and if there are important ecological resources in 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 SLERA.

7.3.2.1 AOC Description and Land Use

NACA Test Area is approximately 47 acres and includes about 1 acre of the Wetland/Pond North of Former Crash Area. The habitat is mostly field, shrubland, and forest and is large enough to completely support cover and food for small birds and mammals that typically require approximately 1 acre of habitat (USEPA 1993). The habitat area at NACA Test Area represents 0.22% of the 21,683 acres at Camp Ravenna.

Future use at NACA Test Area is anticipated to be within the Military Training or Commercial/Industrial Land Use scenarios.

7.3.2.2 Evidence of Historical Chemical Contamination

Using available process knowledge and previous investigation results, the Phase I RI Report established anticipated primary COPCs. These anticipated primary COPCs include inorganic chemicals (metals), SVOCs, and VOCs and are shown in Table 2-2. These chemical groups are associated with burned or partly combusted fuels, deicing compounds, lubricants, and hydraulic fluids, as well as fire extinguishing agents (specifically bromochloromethane) (AGOH 1997, NACA 1953). Explosives, such as TNT and its associated degradation products and propellants are not directly related to past operations. However, because of the proximity of ODA1, explosives and propellants are also considered to be potential contaminants, especially in the southern portion of the crash strip area.

The goal of the historical ERA (USACE 2001a) was to identify COPECs in sediment and surface water for NACA Test Area. Soil was not assessed in the historical ERA. The Phase I RI followed instructions for sediment and surface water presented in the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003) and included the first two of six steps listed in Figure III of the FWERWP (USACE 2003b). 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 SRCs 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 the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003). Chemicals were retained as COPECs if they exceeded background concentrations and the ESV or if the chemical exceeded background concentrations and had no toxicity information.

Groundwater was not included in the Phase I RI (USACE 2001a). 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, initial depths to groundwater varied from 5.5–23 ft bgs.

The historical ERA tables for sediment and surface water are provided in Appendix H, Tables H-1 and H-2 and include the following applicable components to the Level I assessment:

- Analytes remaining after background and site-related screen (SRC determination),
- MDC,
- Screening values (ESVs),
- COPEC determination, and
- COPEC rationale.

Historical COPECs for Surface Soil. Soil was not assessed in the historical ERA.

Historical COPECs for Sediment. The historical ERA conducted as part of the Phase I RI reported 27 chemicals in sediment (USACE 2001a). Of the 27 chemicals detected, 16 inorganic chemicals and 5 organic chemicals were determined to be SRCs because they exceeded background concentrations, or they did not have an associated background concentration for comparison. Of the 21 SRCs, 8 inorganic chemicals (cadmium, copper, cyanide, iron, lead, manganese, nickel, and zinc) exceeded their ESVs and were identified as COPECs (Table 7-16). In addition, five inorganic chemicals (barium, beryllium, calcium, magnesium, and selenium) and one organic chemical (nitrocellulose) were selected as COPECs because they did not have an ESV for comparison. Essential nutrients were included in the COPEC screen. Appendix H, Table H-1 presents the ecological screening for sediment at NACA Test Area.

Historical COPECs for Surface Water. The historical ERA conducted as part of the Phase I RI reported 17 chemicals in surface water (USACE 2001a). Of the 17 chemicals detected, 12 inorganic chemicals and 3 organic chemicals were determined to be SRCs because they exceeded background concentrations, or they did not have an associated background concentration for comparison. Of the 15 SRCs, 8 inorganic chemicals (barium, cadmium, cobalt, iron, lead, manganese, nickel, and zinc) and 1 organic chemical [bis(2-ethylhexyl)phthalate] exceeded their ESVs and were identified as COPECs (Table 7-16). In addition, three inorganic chemicals (calcium, magnesium, and potassium) were selected as COPECs because they did not have an ESV for comparison. Essential nutrients were included in the COPEC screen. Appendix H, Table H-2 presents the ecological screening for surface water at NACA Test Area.

Summary of Historical ERA. An historical ERA was performed to determine COPECs in sediment and surface water at NACA Test Area (Appendix H, Tables H-1 and H-2). Soil was not assessed in the historical ERA. Table 7-16 summarizes the COPECs by media. Based on the identified COPECs, ecological risk in sediment and surface water was predicted in the historical investigation, and an additional investigation was recommended for NACA Test Area (USACE 2001a).

7.3.2.3 Ecological Significance

Sources of data and information about the ecological resources at NACA Test Area include the *Integrated Natural Resources Management Plan* (INRMP; OHARNG 2014), *Facility-Wide Biological* *and Water Quality Study* (USACE 2005a), previous characterization work (e.g., the Phase I RI), and visits to NACA Test Area 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 NACA Test Area. 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-3) 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 NACA Test Area with each of the important places and resources listed in Appendix H, Table H-3.

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-3 are elevated to ecologically significant when present in 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 NACA Test Area 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 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-4) benefit NACA Test Area. For example, Goal 1 states 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 NACA Test Area varies, all of the management goals are intended to monitor, maintain, or enhance a facility's natural resources and its ecosystem. While these goals are for managing all types of resources at and near the AOC, they do not affect the decisions concerning the presence or absence of important or significant ecological places or resources at NACA Test Area.

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-listed or federally listed species. An important resource becomes significant when found on an AOC and there is contaminant exposure. The wetlands, pond, two tributaries to Hinkley Creek, and the open water associated with the Former Crash Area Reservoir are important/significant ecological resources at NACA Test Area (Appendix H, Table H-3).

Terrestrial Resources. NACA Test Area is dominated by terrestrial resources, as described below.

Habitat Descriptions and Species. The INRMP and AOC visits by SAIC scientists indicated NACA Test Area consisted of several vegetation types, including herbaceous field, forest, and shrubland (Figure 7-1 and Photographs 7-1 and 7-2). The habitat area is dominated by dry, early-successional, herbaceous field in the north-central portion of the AOC. Two small areas of reed canary grass (*Phalaris arundinacea*), seasonally flooded, herbaceous alliance were present in the north-central portion and the southeastern corner of the AOC. Four forest communities bordered the southern, northwestern, and eastern sides of the AOC. The southwestern boundary included green ash (*Fraxinus pennsylvanica*)/American elm (*Ulmus americana*)/hackberry (*Celtis occidentali*s) temporarily flooded forest alliance. The south-central boundary included red maple (*Acer rubrum*) successional forest. The northwestern and southeastern boundary included the American beech (*Fagus grandifolia*)/oak (*Quercus* spp.)/maple (*Ace*r spp.) forest alliance. The eastern boundary included mixed, cold-deciduous, successional forest. Shrubland communities included small areas of buttonbush (*Cephalanthus occidentalis*), semi-permanently flooded, shrubland alliance in the north-central part of the AOC and dry, mid-successional, cold-deciduous, shrubland in the northeastern corner of the AOC. This characterization was originally established by a vegetation study using aerial photography and field verification (USACE 1999b) and was later used in the INRMP (OHARNG 2014).

Photograph 7-1. Mowed Grass Flanked by Red Maple Forest (Facing East Near Access Road in the Middle of the Former Plane Refueling/Crash Strip Area, August 18, 2008)

Photograph 7-2. Wetland Vegetation and Unnamed Tributary to Hinkley Creek (Facing South Near Southern Edge of Former Plane Refueling/Crash Strip Area, May 18, 2010)

On August 18, 2008 and May 18, 2010, SAIC scientists conducted field surveys at NACA Test Area and determined there have been small changes in vegetation at the AOC since 1999 (USACE 1999b), including the conversion of the dry, early-successional, herbaceous field habitat to a maintained grassland community; and a decrease in the forest habitat around ODA1 and the Former Plane Burial Area. The conversion of the dry, early-successional, herbaceous field habitat to a grass land community appears to be largely a result of periodic mowing (Photograph 7-1). Remediation activities at ODA1 in 2001 that involved removal of contaminated soil mass from an estimated 5-acre area contributed to the decrease in the forest habitat.

NACA Test Area is divided into four soil EUs: Former Plane Refueling/Crash Strip Area, Former Crash Area, Former Plane Burial Area, and Former Crash Area Well Pit. Table 7-17 summarizes the vegetation types present at these EUs, where the Former Crash Area Well Pit is included in the Former Crash Area.

Based on August 2008 and May 2010 observations (Photographs 7-1 and 7-2), SAIC scientists assessed the habitats at NACA Test Area 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 and Endangered and Other State-listed or Federally-listed Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat on Camp Ravenna. NACA Test Area has not been previously surveyed for rare, threatened, or endangered species; however, there have been no documented sightings of rare, threatened, or endangered species at the AOC (OHARNG 2014).

Other Terrestrial Resources. While there are no other known important terrestrial places and resources (Appendix H, Table H-3), there are other resources at or near NACA Test Area (e.g., vegetation, animals) that interact in their ecosystems and support nutrient cycling and energy flow. For example, wildlife such as wild turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*) 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 NACA Test Area beyond those summarized in the INRMP (OHARNG 2014).

Aquatic Resources. NACA Test Area has five types of aquatic resources, as described below.

Habitat Descriptions and Species. The water features at NACA Test Area are presented below:

- Former Crash Area Reservoir, which is a small, excavated basin located in the center of the Former Crash Area that was used to collect water for fire suppression following crash tests;
- An unnamed tributary to Hinkley Creek, which is a channelized stream colonized by wetland vegetation (Photograph 7-2) separating the Former Plane Refueling/Crash Strip Area and Former Crash Area;

- An unnamed tributary along the southern border of the Former Crash Area that joins the unnamed tributary between the Former Plane Refueling/Crash Strip Area and Former Crash Area and flows to Hinkley Creek;
- A pond formed on the unnamed tributary to Hinkley Creek between Demolition Road and the Former Crash Area; and
- Wetlands.

Wetlands. Important wetland resources exist at the AOC. Wetlands are important habitats 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 NACA Test Area perform these and other related functions.

There are nine planning level survey [i.e., based on desktop surveys conducted for OHARNG of wetland data and resources (e.g., NWI maps, aerials)] wetlands and wetland complexes at NACA Test Area (Figure 7-2). 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. Most of the wetlands are largely located around the periphery of the AOC, including portions of the Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane Burial Area.

An SAIC Professional Wetland Scientist used the Ohio Rapid Assessment Method (ORAM) (Ohio EPA 2001) in January and December 2011 to assess the condition of the wetlands and wetland complexes at NACA Test Area and to determine the potential ecological importance of those wetlands (Appendix H, Figures H-1 through H-9). The ORAM evaluation included the total area of a wetland or wetland complex (not just the portion of a wetland within the AOC boundary). 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 at NACA Test Area are presented in Appendix H, Figures H-1 through H-9. Table 7-18 summarizes ORAM scores and other characteristics for each wetland at NACA. Figure 7-2 shows the locations of the wetlands.

Wetland 1 is located along the north-central portion of NACA Test Area between Demolition Road and the crash strip. It straddles the boundary between the Former Plane Refueling/Crash Strip Area and Former Crash Area (Figure 7-2). It covers approximately 13 acres, with 5.2 acres within NACA Test

Area. Wetland 1 is associated with a pond near Demolition Road that is developing into a wetland and an unnamed tributary to Hinkley Creek. The wetland consists of aquatic bed, emergent, scrub-shrub, and forested habitat. Aquatic bed vegetation consists of wetland plants that grow principally on or below the surface of the water; they are rooted underwater in sediment or soil in shallow, inundated wetlands less than 6 ft deep. Based on the ORAM, Wetland 1 is classified as Category 2 (with a final score of 54), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-1).

Wetland 2 is located along the northeastern boundary of NACA Test Area. It covers approximately 3.8 acres, with 1.7 acres within NACA Test Area. The wetland consists of emergent, scrub-shrub, and forested habitat. Based on the ORAM, Wetland 2 is classified as Category 2 (with a final score of 36), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-2).

Wetland 3 is located along the eastern side of NACA Test Area. The wetland is located entirely within NACA Test Area. It appears to be an isolated wetland with no surface hydrologic connection to any streams or wetlands. The wetland covers 0.3 acres and consists of a mix of emergent and scrub-shrub habitat. Based on the ORAM, Wetland 3 is classified as Category 2 (with a final score of 30), which indicates moderately good wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-3).

Wetland 4 is located along the southeastern side of NACA Test Area. The wetland is associated with an unnamed tributary to Hinkley Creek. The wetland is 4.4 acres, with 3.6 acres inside NACA Test Area. The wetland consists of emergent, scrub-shrub, and forested habitat. Based on the ORAM, Wetland 4 is classified as Category 2 (with a final score of 45), which indicates moderate wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-4).

Wetland 5 is located at the Former Crash Area Reservoir of NACA Test Area. The wetland is located entirely within NACA Test Area and is associated with open water. The wetland/open water consists of emergent and scrub-shrub habitat. The wetland/open water covers 0.09 acres. Based on the ORAM, Wetland 5 is classified as Category 1 (with a final score of 20), which indicates low wetland quality with some impairment of wetland functions and conditions (Appendix H, Figure H-5).

Wetland 6 is in the south-central part of NACA Test Area along the unnamed tributary between the Former Plane Refueling/Crash Strip Area and Former Crash Area. It covers approximately 1.8 acres, with 0.9 acres in NACA Test Area. The wetland has formed in the drainage tributary between the crash strip and Hinkley Creek and receives surface water from Wetland 1. The crash strip separates Wetland 1 from Wetland 6. The tributary runs through the wetlands in a channelized ditch and crosses under the crash strip in a culvert. The wetland consists of emergent, scrub-shrub, and forested habitat. Based on the ORAM, Wetland 6 is classified as Category 2 (with a final score of 38), which indicates moderate wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-6).

Wetland 7 is located along the south-western side of NACA Test Area. The wetland is associated with Hinkley Creek. The wetland is 12.7 acres, but only 1.8 acres are inside NACA Test Area. The wetland consists of forested habitat. Based on the ORAM, Wetland 7 is classified as Category 2 (with a final score of 54), which indicates moderately good wetland quality with some minor impairment of wetland functions and conditions (Appendix H, Figure H-7).

Wetland 8 is located in the northwestern corner of NACA Test Area. The wetland is located entirely within NACA Test Area. It appears to be an isolated wetland with no surface hydrologic connection to any streams or wetlands. The wetland covers 0.15 acres and consists of a mix of emergent, scrub-shrub, and forested habitat. Based on the ORAM, Wetland 8 is classified as Category 2 (with a final score of 30), which indicates moderate wetland quality with some moderate impairment of wetland functions and conditions (Appendix H, Figure H-8).

Wetland 9 is located along the northwestern boundary of NACA Test Area. It appears to be an isolated wetland with no surface hydrologic connection to any streams or wetlands. It covers approximately 0.5 acres, with 0.16 acres within NACA Test Area. The wetland consists of forested habitat. Based on the ORAM, Wetland 9 is classified as Category 2 (with a final score of 30), which indicates moderate wetland quality with some moderate impairment of wetlands functions and conditions (Appendix H, Figure H-9).

Threatened and Endangered and Other State-listed or Federally-listed Species. The northern long-eared bat (*Myotis septentrionalis*; federally threatened) exists at Camp Ravenna. There are no other federally listed species and no critical habitat on Camp Ravenna. NACA Test Area has not been previously surveyed for rare, threatened, or endangered species; however, there have been no documented sightings of rare, threatened, or endangered species at the AOC (OHARNG 2014).

Other Aquatic Resources. There are no other known aquatic resources (Appendix H, Table H-3) at or near NACA Test Area (e.g., aquatic vegetation, animals). There are no other reported surveys of habitats and wildlife at NACA Test Area 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 NACA Test Area.

Biological/Water Quality Sampling Stations. Ohio EPA and USACE investigated several streams at RVAAP in a network of various biological/water quality sampling stations (USACE 2005a). The purpose of this investigation was to document ecological effects of AOCs on stream or pond biota and conditions. Upstream biological/water quality stations provide information about potential contamination from upstream AOCs that may be contributing to adverse biological, chemical, and physical measurements in the vicinity of NACA Test Area. Downstream sampling stations provide information about potential contamination from NACA Test Area and upstream AOCs. If the downstream sampling station has a positive rating (e.g., good, excellent, full attainment), it can be concluded means that NACA Test Area and other upstream AOCs are not adversely impacting the quality of Hinkley Creek. Three sampling stations (H-2, H-3, and H-4) were located in the vicinity of NACA Test Area.

According to the *Facility-Wide Biological and Water Quality Study* (USACE 2005a), each sampling location included sediment sampling/assessment, surface water sampling/assessment, fish and macroinvertebrate community assessment, and habitat assessment. The sampling reach for stream sampling stations ranged from 120–210 meters.

Sediment evaluations were conducted in June 2003 using guidelines established in *Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al. 2000), sediment reference values (SRVs) for inorganic chemicals (Ohio EPA 2003), and USEPA Region 5 ESLs (USEPA 2003a). 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 and September 2003 were evaluated using comparisons to Ohio Water Quality Standards (WQS) criteria, reference conditions, or cited in the *Facility-Wide Biological and Water Quality Study* (USACE 2005a). Surface water samples were analyzed for TAL metals, pesticides, PCBs, explosives, SVOCs, and several nutrients.

Fish and macroinvertebrate sampling and assessments occurred in August and September 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 *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).

The physical habitat assessment 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, 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.

Sampling Station Locations. Station H-2 [River Mile (RM) 5.2] is located upstream of NACA Test Area, at the intersection of Hinkley Creek and South Patrol Road. Station H-2 is northwest of NACA Test Area, approximately 3,700 ft upstream from Station H-3.

Station H-3 (RM 4.3) is located on Hinkley Creek, immediately southwest of NACA Test Area and 1,200 ft upstream of the unnamed tributaries to Hinkley Creek that reside in NACA Test Area. Station H-3 provides the closest upstream reference point for the eastern and the central two-thirds of the AOC. Only a small portion of the Former Plane Refueling/Crash Strip Area is upstream and may affect the water quality at Station H-3. For this evaluation, Station H-3 is considered upstream of NACA Test Area.

Station H-4 (RM 3.3) is located south of NACA Test Area near the southern fence line of RVAAP. Station H-4 is approximately 1,500 ft downstream from Station H-3 and provides the closest downstream sampling point to the AOC.

Summary of Sampling/Assessment Results. Table 7-19 shows the ratings of the attributes for Stations H-2, H-3, and H-4. Review of the *Facility-Wide Biological and Water Quality Study* (USACE 2005a) data from the three stations showed positive attribute ratings (e.g., good, excellent, full attainment) and no sign of aquatic impairment.

At H-2, all inorganic chemicals tested in sediment were below Ohio SRVs and threshold effect concentration (TEC) levels. Explosives and PCBs were not detected in sediment samples collected from H-2. The detected pesticides and SVOCs were at concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at H-2 exceeded Ohio WQS aquatic life maximum or average water quality criteria (WQC), and none of the chemicals measured exceeded criteria protective of the Warm Water Habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at H-2 was rated "excellent." The fish community at H-2 was rated "marginally good." The Index of Biotic Integrity (IBI) score was 38 and a total of 21 species were reported. The macroinvertebrate community at H-2 was rated "exceptional." The physical habitat was also evaluated at H-4, and the QHEI score was 71.0, indicating "good" stream habitat capable of supporting Warm Water Habitat biological communities.

At H-3, all inorganic chemicals tested in sediment were below Ohio SRVs and TEC levels. Explosives and PCBs were not detected in sediment samples collected from H-3. The detected pesticides and SVOCs were at concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at H-3 exceeded Ohio WQS aquatic life maximum or average WQC, and none of the chemicals measured exceeded criteria protective of the Warm Water Habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at H-3 was rated "excellent." The fish community at H-3 was rated "fair." The IBI score was 35 and a total of 19 species were reported. The macroinvertebrate community at H-3 was rated "exceptional." Based on the fish and macroinvertebrate community assessment, no biological impairment associated with chemical contaminants was observed at H-3. The physical habitat was also evaluated at H-3, and the QHEI score was 68.0, indicating "good" stream habitat capable of supporting Warm Water Habitat biological communities. The "partial" use attainment status at Station H-3 was based on the fish community IBI score of 35, which was only one point lower than the Ohio criterion of 36.

At H-4, all inorganic chemicals tested in sediment were below Ohio SRVs and TEC levels. Explosives and PCBs were not detected in sediment samples collected from H-4. The detected pesticides and SVOCs were at concentrations below TEC or ESL guidelines. Ammonia and total phosphorus levels were measured below screening guidelines. None of the surface water chemical concentrations at H-4 exceeded Ohio WQS aquatic life maximum or average WQC, and none of the chemicals measured exceeded criteria protective of the Warm Water Habitat aquatic life use (USACE 2005a). Overall, the sediment quality and water quality at H-4 was rated "excellent." The fish community at H-4 was rated "marginally good." The IBI score was 37, and a total of 24 species were reported. The macroinvertebrate community at H-4 was rated "exceptional." The physical habitat was also evaluated at H-4, and the QHEI score was 68.0, indicating "good" stream habitat capable of supporting Warm Water Habitat biological communities.

These favorable sediment/water quality findings at H-4 support the observation that NACA Test Area is not contributing contamination to Hinkley Creek.

Ecosystem and Landscape Roles and Relationships. There are four spatial areas to evaluate to assess the ecosystem and landscape roles and relationships at NACA Test Area: the actual AOC, the vicinity of the AOC, the entire Camp Ravenna, and the ecoregion of northeastern Ohio. Information about the AOC (as a spatial area) is provided in previous sections about terrestrial and aquatic resources.

Vicinity of the AOC. Eight vegetation communities border NACA Test Area (Figure 7-1), including herbaceous field, shrubland, and forest communities similar to the vegetation observed at NACA Test Area. Special Interest Area Unit 5, mixed swamp forest, stretches north of the AOC beginning approximately 200 ft north of the Former Plane Refueling/Crash Strip Area (OHARNG 2014). Other than Special Interest Area Unit 5, there are no apparent differences in habitat quality of the plant communities inside or in close proximity of the AOC. The types and qualities of habitat are not unique to NACA Test Area and can be found at many other areas at Camp Ravenna.

As previously discussed, all or portions of nine wetlands exist at NACA Test Area. In addition to those at NACA Test Area, many other wetlands exist in the vicinity of the AOC. Hinkley Creek is immediately west and south of the AOC. The two unnamed tributaries at NACA Test Area converge with Hinkley Creek directly south of the AOC.

The closest recorded state-listed or federally listed species [Yellow-bellied sapsucker (*Sphyrapicus varius*) and Eastern box turtle (*Terrapene carolina*)] are located approximately 200 ft east and 200 ft north of the AOC, respectively (Figure 7-1 and Table 7-20). They are both state species of concern. The next closest state-listed or federally listed species [Northern Harrier (*Circus cyaneus*)] is located about 400 ft northeast of the AOC. It is a state endangered species.

One beaver dam is located within the AOC along the Wetland/Pond North of the Former Crash Area. There is a 100-year floodplain along the southeastern portion of the AOC along the unnamed tributary to Hinkley Creek. There are biological and water quality stations (stream sampling stations) within 300 ft of the AOC.

Table 7-20 summarizes the geographical relationships of various ecological resources in the vicinity of the AOC.

The Entire Camp Ravenna. The habitat area at NACA Test Area is approximately 47 acres, which represents 0.22% of the total area of Camp Ravenna (21,683 acres). There are eight types of vegetation at NACA Test Area that are also found throughout Camp Ravenna. 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), representing 10.7% of the habitat at Camp Ravenna. There are approximately 2,290 acres of forest type FU2 (American beech, oak, maple) at Camp Ravenna (OHARNG 2014), representing 10.6% of the habitat at Camp Ravenna. There are approximately 3,510 acres of forest type FU4 (red maple, ash) (OHARNG 2014), representing 16.2% of the habitat at Camp Ravenna. There are approximately 1,650 acres of forest type FU5 (ash, cherry, maple) (OHARNG

2014), representing 7.6% of the habitat at Camp Ravenna. There are approximately 135 acres of forest type HL2 (red canary grass) (OHARNG 2014), representing 0.62% 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 55 acres of vegetation type SL3 (buttonbush, winterberry) (OHARNG 2014), representing 0.25% of the habitat at Camp Ravenna. There are approximately 2,900 acres of vegetation type SU1 (gray dogwood, northern arrow-wood) (OHARNG 2014), representing 13.4% of the habitat at Camp Ravenna. In addition to the eight types of vegetation, 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. Eight of the nine resources are abundant and are not unique to NACA Test Area at Camp Ravenna. SL3 represents a small area at NACA Test Area and especially 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 ecoregion is located in the northeastern part of Ohio and exhibits 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; 621,100 acres of forest type FU2; and 265,290 acres of forest type FU4 and FU5 were found throughout northwestern Ohio in Cuyahoga, Geauga, Mahoning, Portage, Stark, Summit, and Trumbull counties that surround Camp Ravenna (USFS 2011). The herbaceous field and shrubland was not individually found in this query because it is not classified as a main group of trees in the forest inventory data tool. However, herbaceous field (HL2 and HU1) 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 NACA Test Area are also found in the surrounding counties in the ecoregion of northeastern Ohio.

In summary, the current vegetation types of: (1) temporarily flooded, forest alliance; (2) American beech/oak/maple forest alliance; (3) red maple successional forest; (4) mixed, cold-deciduous, successional forest; (5) seasonally flooded, herbaceous alliance; (6) dry, early-successional, herbaceous field; (7) semipermanently flooded, shrubland alliance; (8) dry, mid-successional, cold-deciduous shrubland; and (9) wetlands are found in the vicinity of NACA Test Area. The forest, herbaceous fields, shrublands, and wetlands are in abundance at Camp Ravenna (with the exception of SL3) and the larger surrounding local ecoregion. There is one known unique resource (SL3) at NACA Test Area that cannot be found in the immediate vicinity of the AOC, is infrequently 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

Based on the historical ESV screening, 14 sediment and 12 surface water COPECs were identified at NACA Test Area. These COPECs are listed on Table 7-16.

The Army and Ohio EPA provide a checklist of important ecological places and resources to determine if such ecological resources are present in (or nearby) an AOC. There are nine wetlands and wetland complexes, two unnamed tributaries to Hinkley Creek, a pond, and open water associated with the Former Crash Area Reservoir at the AOC. Environmental management goals and objectives of OHARNG are applicable to NACA Test Area, including Goal 1 requiring management of natural resources to be compatible with military mission, and Goal 5 requiring the Army to sustain usable training grounds and natural resources.

The habitat area at NACA Test Area is made up of approximately 47 acres of herbaceous field, shrubland, forest communities, and water features. Most of the vegetation types and wetlands at NACA Test Area are found nearby, at RVAAP, and in the ecoregion. Only the SL3 vegetation is relatively limited and infrequently found at NACA Test Area, in the vicinity of the AOC, and at Camp Ravenna; it is not believed to be common across the ecoregion.

Because there is contamination at NACA Test Area and important or significant resources are present, this ERA will continue to a Level II SLERA.

7.3.3 Level II: Screening Level Ecological Risk Assessment

The Level II method follows the guidance documents listed in Section 7.3.1. The Level II method 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 use of mean exposure concentrations, discussion of 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 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 airplane crash tests conducted at NACA Test Area are the contaminant source (USACE 2001a). The operations contributed chemicals to the surrounding soil, sediment, and surface water.
- **Transport Mechanisms –** Material in soil can migrate via erosion and leaching. Migration to sediment and surface water via erosion and leaching is controlled by the amount of precipitation, type of ground cover, and topography of the AOC. Little erosion is expected to occur at the AOC because the land is relatively flat and has extensive vegetative cover. This

extensive vegetative cover includes mowed fields, herbaceous areas, forests, and wetlands. While much of the precipitation landing on this area is expected to infiltrate the soil, some rainfall likely runs off into the two unnamed tributaries to Hinkley Creek. Material from the soil could also leach into the two unnamed tributaries.

- **Exposure Media –** These are media where contaminants are available for exposure to ecological receptors. Potential exposure media at NACA Test Area are soil, sediment, surface water, vegetation, and animals. Groundwater is not evaluated as an exposure medium in the PBA08 RI; it will be evaluated in a separate document.
- **Exposure Pathways –** A main exposure pathway is ingestion of contaminated food. Other pathways may include ingestion of 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 and physiology) are assumed to represent these various plants and animals.

7.3.3.2 Habitats and Species (Including Generic Receptors)

Habitats, species, and other resources were analyzed in the Level I ERA (Section 7.3.2), and it was determined that important or significant ecological resources are present at NACA Test Area. Wetlands, unnamed tributaries to Hinkley Creek, a pond, and open water associated with the Former Crash Area Reservoir 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 for multiple generic receptors, including plants, microorganisms, and animals.

7.3.3.3 Procedure to Identify COPECs

The SL approach to evaluate sample results from the PBA08 RI followed a similar approach used in the historical ERA. Section 5 details chemical concentration data. The PBA08 RI included collection of discrete surface soil (0–1 ft bgs), sediment, and surface water samples. Most locations were different from the historical sample locations, and some were co-located with previous samples (Figure 4-6).

As discussed previously, the soil data within the geographic area of NACA Test Area were subdivided into four soil EUs: Former Plane Refueling/Crash Strip Area EU, Former Crash Area EU, Former Plane Burial Area EU, and Former Crash Area Well Pit EU (Figure 2-3). The sediment samples were divided into three sediment EUs: Wetland/Pond North of Former Crash Area EU, Tributary to Hinkley Creek EU, and Former Crash Area Reservoir EU. The surface water samples were divided into two surface water EUs: Wetland/Pond North of Former Crash Area EU and Tributary to Hinkley Creek EU. The Former Crash Area Reservoir was not evaluated as a surface water EU because the historical sample (NTAsw-102-0131-SW) showed no AOC-related COPECs. This ERA uses updated SRVs (Appendix H, Table H-5) and ESVs that follow the revised *Ecological Risk Assessment Guidance* (Ohio EPA 2008), as provided in Appendix H, Tables H-6 through H-8.

The hierarchy of ESVs is based on the information found in the Ohio EPA risk assessment guidance (Ohio EPA 2008) and FWERWP (USACE 2003b). 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 (and SRV for sediment). For all chemicals detected above background concentrations, the MDC is compared to the chemical-specific ESV. In addition to the ESV comparison, it was determined if the chemical is a persistent, bioaccumulative, and toxic (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 Outside Mixing Zone Average (OMZA) ESV at each EU when available (Appendix H, Tables H-17, H-19, and H-24). However, there is only one surface water sample for the Wetland/Pond North of the Former Crash Area at NACA Test Area, so average concentrations are not available to compare against the OMZA. As a result, only the MDC was compared against the OMZA and OMZM at the Wetland/Pond North of the Former Crash Area.

Maximum Detected Concentrations. The MDCs were compared to the background concentrations and ESVs (Appendix H, Tables H-9 through H-19) for detected chemicals. These comparisons are provided for soil in the Former Plane Refueling/Crash Strip Area (Appendix H, Table H-9), Former Crash Area (Appendix H, Table H-10), Former Plane Burial Area (Appendix H, Table H-11), and Former Crash Area Well Pit (Appendix H, Table H-12); sediment in the Wetland/Pond North of Former Crash Area (Appendix H, Table H-13), Tributary to Hinkley Creek (Appendix H, Table H-14), and Former Crash Area Reservoir (Appendix H, Table H-15); and surface water in the Wetland/Pond North of Former Crash Area (Appendix H, Tables H-16 and H-17) and Tributary to Hinkley Creek (Appendix H, Tables H-18 and H-19).

Ecological Screening Values. Although the historical ERA used ESVs from the draft version of the *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2003), this ERA uses updated ESVs from the 2008 version of the guidance document. The hierarchy for soil is ecological soil screening levels (EcoSSLs), PRGs, and ESLs. The hierarchy for sediment is the Sediment Quality Guidelines (SQGs), followed by ESLs. The hierarchy for surface water is the Ohio EPA WQC, National Recommended WQC, and ESLs. Appendix H provides values and sources for ESVs in Appendix H, Tables H-6 through H-8.

7.3.3.4 Integrated COPECs for Surface Soil (0–1 ft bgs)

A summary of the integrated COPECs identified in soil at the four soil EUs follows.

Integrated COPECs for Surface Soil (0–1 ft) at the Former Plane Refueling/Crash Strip Area. During the PBA08 RI, 50 chemicals were detected in surface soil at the Former Plane Refueling/Crash Strip Area. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 18 inorganic chemicals and 26 organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 44 SRCs, 15 inorganic chemicals (aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) and 3 organic chemicals [benz(a)anthracene, benzo(a)pyrene, and chrysene] exceeded their ESVs and are identified as integrated COPECs (Table 7-21). In addition, eight organic chemicals (TNT, HMX, nitrocellulose, carbazole, dibenzofuran, naphthalene, phenanthrene, and pyrene) were selected as integrated COPECs because they do not have an ESV for comparison. One integrated COPEC (mercury) was also a PBT compound. The calculated ratio of MDC to ESV is shown in Table 7-21 for each integrated COPEC. Appendix H, Table H-9 presents the details of the ESV comparisons for surface soil at the Former Plane Refueling/Crash Strip Area. No soil samples were evaluated during the historical ERA; therefore, no comparison to the historical results is available.

Integrated COPECs for Surface Soil (0–1 ft) at the Former Crash Area. During the PBA08 RI, 45 chemicals were detected in surface soil at the Former Crash Area. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 16 inorganic chemicals and 16 organic chemicals were determined to be SRCs because they either exceeded their background concentrations, did not have an associated background concentration for comparison, or they were detected in less than 5% of the samples. Of the 32 SRCs, 11 inorganic chemicals (aluminum, antimony, arsenic, cadmium, cobalt, copper, lead, manganese, mercury, selenium, and zinc) and two organic chemicals [benzo(a)pyrene and bis(2-ethylhexyl)phthalate] exceeded their ESVs and are identified as integrated COPECs (Table 7-22). In addition, two organic chemicals (TNT and nitrocellulose) were selected as integrated COPECs because they do not have an ESV for comparison. One integrated COPEC (mercury) was also a PBT compound. Table 7-22 shows the calculated ratio of MDC to ESV for each integrated COPEC. Appendix H, Table H-10 presents the details of the ESV comparisons for surface soil at the Former Crash Area. No soil samples were evaluated during the historical ERA; therefore, no comparison to the historical results is available.

Integrated COPECs for Surface Soil (0–1 ft) at the Former Plane Burial Area. During the PBA08 RI, 40 chemicals were detected in surface soil at the Former Plane Burial Area. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. A total of 18 inorganic chemicals and 11 organic chemicals were determined to be SRCs because they exceeded background concentrations, did not have an associated background concentration for comparison, or they were detected in more than 5% of the samples. Of the 29 SRCs, 13 inorganic chemicals (aluminum, antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) exceeded their ESVs and are identified as integrated COPECs (Table 7-23). In addition, one organic chemical (TNT) was selected as an integrated COPEC because it does not have an ESV for comparison. One integrated COPEC (mercury) was also a PBT compound. The calculated ratio of MDC to ESV is shown in Table 7-23 for each integrated COPEC. Appendix H, Table H-11 presents the details of the ESV comparisons for surface soil at the Former Plane Burial Area. No soil samples were evaluated during the historical ERA; therefore, no comparison to the historical results is available.

Integrated COPECs for Surface Soil (0–1 ft) at the Former Crash Area Well Pit. During the PBA08 RI, 21 chemicals were detected in surface soil at the Former Crash Area Well Pit. Four chemicals (calcium, iron, magnesium, and potassium) were essential nutrients and were excluded as SRCs. Nine inorganic chemicals and two organic chemicals were determined to be SRCs because they exceeded background concentrations or did not have an associated background concentration for comparison. Of the 11 SRCs, 5 inorganic chemicals (barium, cadmium, copper, lead, and zinc) exceeded their ESVs and are identified as integrated COPECs (Table 7-24). In addition, one organic chemical (nitrocellulose) was selected as an integrated COPEC because it does not have an ESV for comparison. None of the COPECs were identified as PBT compounds. The calculated ratio of MDC to ESV is shown in Table 7-24 for each integrated COPEC. Appendix H, Table H-12 presents the details of the ESV comparisons for surface soil at the Former Crash Area Well Pit. No soil samples were evaluated during the historical ERA; therefore, no comparison to the historical results is available.

7.3.3.5 Integrated COPECs for Sediment

A summary of the integrated COPECs identified in sediment in the three sediment EUs follows.

Integrated COPECs for Sediment at the Wetland/Pond North of Former Crash Area. During the PBA08 RI, 24 chemicals were detected in sediment at the Wetland/Pond North of Former Crash Area. Four chemicals (calcium, iron, magnesium, and potassium) were essential nutrients and were excluded as SRCs. One inorganic chemical and three organic chemicals were determined to be SRCs because they did not have an associated background concentration for comparison or they were identified as PBT compounds. Of the four SRCs, only mercury is identified as an integrated COPEC because it is a PBT compound (Table 7-25). Table 7-25 shows the calculated ratio of MDC to ESV for mercury. Appendix H, Table H-13 presents the details of the ESV comparisons for sediment at the Wetland/Pond North of Former Crash Area.

The historical ERA (USACE 2001a) identified 13 inorganic COPECs (barium, beryllium, cadmium, calcium, copper, cyanide, iron, lead, magnesium, manganese, nickel, selenium, and zinc) and one organic COPEC (nitrocellulose) that are not integrated COPECs for the Wetland/Pond North of Former Crash Area. Barium, beryllium, cadmium, copper, lead, manganese, nickel, selenium, and zinc were below their background concentrations or SRVs (Appendix H, Table H-13); cyanide and nitrocellulose were not detected; and calcium, iron, and magnesium were considered essential nutrients in the PBA08 data set. Mercury did not exceed its ESV but was identified as an integrated COPEC in the PBA08 RI because it is a PBT compound.

Integrated COPECs for Sediment at the Tributary to Hinkley Creek. During the PBA08 RI, 39 chemicals were detected in sediment at the Tributary to Hinkley Creek. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Three inorganic chemicals and 17 organic chemicals were determined to be SRCs because they exceeded background concentrations, did not have an associated background concentration for comparison, or were PBT compounds. Of the 20 SRCs, 1 inorganic chemical (nickel) and 2 organic chemicals [acenaphthene and bis(2-ethylhexyl)phthalate] exceeded their ESVs and are identified as integrated COPECs (Table 7-26). In addition, one organic chemical (HMX) was selected as an integrated COPEC because it does not have an ESV for comparison. Mercury did not exceed its ESV but was identified as an integrated COPEC in the PBA08 RI because it is a PBT compound. The calculated ratio of MDC to ESV is shown in Table 7-26 for each integrated COPEC. Appendix H, Table H-14 presents the details of the ESV comparisons for sediment at the Tributary to Hinkley Creek.

The historical ERA (USACE 2001a) identified 13 inorganic COPECs (barium, beryllium, cadmium, calcium, copper, cyanide, iron, lead, magnesium, manganese, nickel, selenium, and zinc) and 1 organic COPEC (nitrocellulose) (Table 7-16) that are not integrated COPECs for the Tributary to Hinkley Creek. Barium, beryllium, cadmium, copper, lead, manganese, selenium, and zinc were below their background concentrations or SRVs (Appendix H, Table H-14); cyanide and nitrocellulose were not detected; and calcium, iron, and magnesium were considered essential nutrients in the PBA08 data set. Two inorganic chemicals (mercury and nickel) and three organic chemicals [HMX, acenaphthene, and bis(2-ethylhexyl)phthalate] were identified as integrated COPECs in this ERA. Nickel is the only chemical identified as a COPEC in both the historical ERA and this ERA. Three new integrated COPECs [HMX, acenaphthene, and bis(2-ethylhexyl)phthalate] were identified due to detections of these organic chemicals in samples collected during the PBA08 RI. Mercury did not exceed its ESV but was identified as an integrated COPEC in the PBA08 RI because it is a PBT compound.

Integrated COPECs for Sediment at the Former Crash Area Reservoir. During the PBA08 RI, 17 chemicals were detected in sediment at the Former Crash Area Reservoir. Four chemicals (calcium, iron, magnesium, and potassium) were essential nutrients and were excluded as SRCs. Two organic chemicals were determined to be SRCs because they did not have associated background concentrations for comparison. Of the two SRCs, one organic chemical (acetone) exceeded its ESV and is identified as an integrated COPEC (Table 7-27). None of the detected chemicals were identified as PBT compounds. Appendix H, Table H-15 presents the details of the ESV comparisons for sediment at the Former Crash Area Reservoir. No COPECs were identified in sediment at the Former Crash Area Reservoir based on the single historical sample (NTAsd-102-0125-SD) (USACE 2001a). However, the new ESV for acetone is more conservative (Appendix H, Tables H-1 and H-7), and acetone is now identified as an integrated COPEC.

7.3.3.6 Integrated COPECs for Surface Water

As discussed in Section 5.2, the surface water data within the geographic area of NACA Test Area were subdivided into two EUs: Wetland/Pond North of Former Crash Area and Tributary to Hinkley Creek. A summary of the integrated COPECs identified in surface water is presented below. The Former Crash Area Reservoir was not evaluated as a surface water EU because the historical sample (NTAsw-102-0131-SW) showed no AOC-related COPECs.

Integrated COPECs for Surface Water at the Wetland/Pond North of Former Crash Area. During the PBA08 RI, 14 chemicals were detected in surface water at the Wetland/Pond North of Former Crash Area. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Five inorganic chemicals and one organic chemical were determined to be SRCs because they exceeded their background concentrations or did not have an associated background concentration for comparison. Of the six SRCs, only manganese is identified as an integrated COPEC. None of the detected chemicals were identified as PBT compounds. Table 7-28 shows the calculated ratio of MDC to ESV for manganese. Appendix H, Tables H-16 and H-17 present the details of the ESV comparisons for surface water at the Wetland/Pond North of Former Crash 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.

The historical ERA (USACE 2001a) identified 11 inorganic COPECs (barium, cadmium, calcium, cobalt, iron, lead, magnesium, manganese, nickel, potassium, and zinc) and 1 organic COPEC [bis(2-ethylhexyl)phthalate] (Table 7-16) that are not integrated COPECs for the Wetland/Pond North of Former Crash Area. Barium was below its background concentration (Appendix H, Tables H-16 and H-17); cadmium, zinc, and bis(2-ethylhexyl)phthalate were not detected; cobalt, lead, and nickel were below their ESVs; and calcium, iron, magnesium, and potassium were considered essential nutrients in the PBA08 data set. Manganese is the only chemical identified as a COPEC in both the historical ERA and this ERA.

Integrated COPECs for Surface Water at the Tributary to Hinkley Creek. During the PBA08 RI, 19 chemicals were detected in surface water at the Tributary to Hinkley Creek. Five chemicals (calcium, iron, magnesium, potassium, and sodium) were essential nutrients and were excluded as SRCs. Nine inorganic chemicals and one organic chemical were determined to be SRCs because they exceeded their background concentrations or they did not have an associated background concentration for comparison. Of the 10 SRCs, only manganese and bis(2-ethylhexyl)phthalate are identified as integrated COPECs. None of the detected chemicals were identified as PBT compounds. Table 7-29 shows the calculated ratios of MDC to ESV for manganese and bis(2-ethylhexyl)phthalate. Appendix H, Tables H-18 and H-19 present the details of the ESV comparisons for surface water at the Tributary to Hinkley Creek. 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.

The historical ERA (USACE 2001a) identified 11 inorganic COPECs (barium, cadmium, calcium, cobalt, iron, lead, magnesium, manganese, nickel, potassium, and zinc) (Table 7-16) that are not integrated COPECs for the Tributary to Hinkley Creek. Barium was below its background concentration (Appendix H, Tables H-18 and H-19); zinc was not detected; cadmium, cobalt, lead, and nickel were below their ESVs; and calcium, iron, magnesium, and potassium were considered essential nutrients in the PBA08 data set. Manganese and bis(2-ethylhexyl)phthalate are the only chemicals identified as COPECs in both the historical ERA and this ERA.

Integrated COPECs for Surface Water at the Former Crash Area Reservoir. The Former Crash Area Reservoir was not evaluated as a surface water EU because the historical sample (NTAsw-102-0131-SW) showed no AOC-related COPECs.

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 Level III or remediation to protect ecological receptors; or (2) integrated COPECs can be eliminated from further consideration. This section evaluates and applies refinement factors to the integrated COPECs for the AOC. This evaluation is an important part of Level II and is adapted from USEPA Step 3A, 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 baseline ecological risk assessment 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;
- Qualitative relationship of exposure area to general home range;
- 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 NACA Test Area is divided into four EUs: the Former Plane Refueling/Crash Strip Area EU, the Former Crash Area EU, the Former Plane Burial Area EU, and the Former Crash Area Well Pit EU (Figure 2-3). The Former Plane Refueling/Crash Strip Area EU has 26 integrated COPECs identified in surface soil, as presented in Table 7-21. The Former Crash Area EU has 15 integrated COPECs in surface soil, as presented in Table 7-22. The Former Plane Burial Area EU has 14 integrated COPECs in surface soil, as presented in Table 7-23. The Former Crash Area Well Pit EU has six integrated COPECs in surface soil, as presented in Table 7-24. The Former Crash Area Well Pit is an out-of-service water well with an associated concrete well pit, which is approximately 4 ft by 4 ft in size. The well pit has a cover. The single soil sample associated with this EU was collected from accumulated soil inside the small concrete enclosure. Because this soil EU is not ecological habitat, it is no longer evaluated in Step 3A.

Sediment at NACA Test Area is divided into three EUs: the Wetland/Pond North of Former Crash Area, the Tributary to Hinkley Creek, and the Former Crash Area Reservoir. In the Wetland/Pond North of Former Crash Area, there is one integrated COPEC in sediment (mercury), as presented in Table 7-25. Mercury did not exceed its ESV, but it was identified as an integrated COPEC because it is a PBT compound. In the Tributary to Hinkley Creek, there are five integrated COPECs [mercury, nickel, HMX, acenaphthene, and bis(2-ethylhexyl)phthalate], as presented in Table 7-26. Nickel, acenaphthene, and bis(2-ethylhexyl)phthalate were integrated COPECs because they exceeded their background concentrations and ESVs; HMX was an integrated COPEC because the chemical does not have an ESV; and mercury was a PBT compound. In the Former Crash Area Reservoir, there is one integrated COPEC in sediment (acetone), as presented in Table 7-27. Acetone was identified as an integrated COPEC because it exceeded its ESV.

Surface water at NACA Test Area is divided into two EUs: Wetland/Pond North of Former Crash Area and the Tributary to Hinkley Creek. Manganese is an integrated COPEC in both surface water EUs because it exceeded its background concentration and ESV, and bis(2-ethylhexyl)phthalate is an integrated COPEC at the Tributary to Hinkley Creek because the MDC exceeded the OMZA ESV (Tables 7-28 and 7-29).

Chemicals with no ESVs are discussed later in Step 3A and in the uncertainty section (Section 7.3.3.10). 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 (i.e., 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 7-30).

Comparison of background concentration to ESV is also an important consideration in this part of the evaluation. Additionally, frequency of detection is provided. The evaluations are presented by type of decision (Table 7-30) on a COPEC-by-COPEC basis. These evaluations are followed by the application of additional evaluation and refinement factors, when necessary.

The COPECs for each soil EU are defined separately.

Former Plane Refueling/Crash Strip Area – Comparison of Mean Concentration to ESV. A total of 11 integrated COPECs [arsenic, barium, chromium, cobalt, copper, cyanide, nickel, benz(a)anthracene, chrysene, phenanthrene, and pyrene] in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-20). Each eliminated integrated COPEC is discussed below relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-31 shows the relevant data and various comparisons.

Arsenic. Arsenic was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Only two samples had detections above the background concentration and the ESV (Table 7-31). 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 concentration. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Barium. Barium was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Only 10 samples exceeded the background concentration, and only 1 sample had a barium concentration exceeding the ESV (Table 7-31). Although the MDC for barium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and close to the background concentration. Therefore, barium is eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Only seven samples exceeded the background concentration, and only one sample had a chromium concentration exceeding the ESV (Table 7-31). Although the MDC for chromium in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV and close to the background concentration. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Cobalt. Cobalt was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Seven samples had detections above the background concentration, but only four of these samples had cobalt concentrations exceeding the ESV (Table 7-31). Although the MDC for cobalt in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, cobalt is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Only two samples were above the background concentration, and only one sample had a copper concentration exceeding the ESV (Table 7-31). Although the MDC for copper in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, copper is eliminated from further consideration and will not be a final COPEC.

Cyanide. Cyanide was detected in 4 of 18 discrete soil samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. All four detections were above the background concentration, but only one sample had a cyanide concentration exceeding the ESV (Table 7-31). Although the MDC for cyanide in surface soil exceeds the background concentration and ESV, the mean concentration is less than the ESV. Therefore, cyanide is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all 28 discrete samples analyzed for inorganic chemicals at the Former Plane Refueling/Crash Strip Area. Only four samples were above the background concentration, and only one sample had a nickel concentration exceeding the ESV (Table 7-31). Although the MDC for nickel in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Benz(a)anthracene. Benz(a)anthracene was detected in 13 of 28 discrete samples analyzed for SVOCs at the Former Plane Refueling/Crash Strip Area. There is no background concentration for comparison, but only two samples had concentrations exceeding the ESV (Table 7-31). Although the MDC for benz(a)anthracene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, benz(a)anthracene is eliminated from further consideration and will not be a final COPEC.

Chrysene. Chrysene was detected in 16 of 28 discrete samples analyzed for SVOCs at the Former Plane Refueling/Crash Strip Area. There is no background concentration for comparison, but only three samples had concentrations exceeding the ESV (Table 7-31). Although the MDC for chrysene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, chrysene is eliminated from further consideration and will not be a final COPEC.

Phenanthrene. Phenanthrene was detected in 14 of 28 discrete samples analyzed for SVOCs at the Former Plane Refueling/Crash Strip Area. There is no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-31). Although the MDC for phenanthrene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, phenanthrene is eliminated from further consideration and will not be a final COPEC.

Pyrene. Pyrene was detected in 17 of 28 discrete samples analyzed for SVOCs at the Former Plane Refueling/Crash Strip Area. There is no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-31). Although the MDC for pyrene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, pyrene is eliminated from further consideration and will not be a final COPEC.

Of the 26 integrated Former Plane Refueling/Crash Strip Area surface soil COPECs with MDCs exceeding the ESV, 11 COPECs [arsenic, barium, chromium, cobalt, copper, cyanide, nickel, benz(a)anthracene, chrysene, phenanthrene, and pyrene] were eliminated from further consideration. A total of 10 remaining integrated COPECs with MDCs greater than the ESV [aluminum, cadmium, lead, manganese, mercury, selenium, vanadium, zinc, benzo(a)pyrene, and naphthalene] in the Former Plane Refueling/Crash Strip Area surface soil have mean concentrations greater than the ESV.

Former Plane Refueling/Crash Strip Area – Comparison of Mean Concentration Above ESV to Background Concentration. Six integrated COPECs (aluminum, lead, manganese, selenium, vanadium, and zinc) in surface soil at the Former Plane Refueling/Crash Strip Area have mean concentrations greater than the ESV but are eliminated in this step because the mean concentration is less than the background concentration. Each eliminated integrated COPEC is discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in surface soil at the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration (Table 7-31). 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 28 discrete samples at concentrations above the ESV, only 4 samples had detections exceeding the background concentration. Having only four samples exceed the background concentration suggests the concentration of aluminum in surface soil is not likely a concern. Additionally, aluminum is not a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6.0–7.0 at one of the nearby load lines at RVAAP (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, USEPA states, “aluminum is identified as a COPC only for soil with a pH less than 5.5” (USEPA 2003b). Therefore, because the mean concentration is less than the background concentration, the ESV is rather conservative, and the soil pH at RVAAP 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 in the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration, and the background concentration is more than twice the ESV (Table 7-31). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Lead was detected in 21 of 28 discrete samples at concentrations above the ESV; however, only 1 sample had a detection exceeding the background concentration. Although the MDC for lead in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in surface soil in the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-31). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 20 of 28 discrete samples at concentrations above the ESV; however, only 7 samples had detections that exceeded the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium in surface soil in the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration, and the background concentration is approximately three times greater than the ESV (Table 7-31). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Selenium was detected in 21 of 28 discrete samples at concentrations above the ESV; however, only 4 samples had detections that exceeded the background concentration. Although the MDC for selenium in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Vanadium. Vanadium in surface soil in the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration, and the background concentration is approximately four times greater than the ESV (Table 7-31). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Vanadium was detected in all 28 discrete samples at concentrations above the ESV; however, only 1 sample had a detection that (slightly) exceeded the background concentration. Although the MDC for vanadium in surface soil exceeds the background concentration and the ESV, the MDC is just slightly greater than background, the mean concentration is below background, and the ESV is conservative. Therefore, vanadium is eliminated from further consideration and will not be a final COPEC.

Zinc. Zinc in surface soil in the Former Plane Refueling/Crash Strip Area has a mean concentration less than the background concentration, and the background concentration is more than 1.3 times greater than the ESV (Table 7-31). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Zinc was detected in 16 of 28 discrete samples at concentrations above the ESV; however, only 9 samples had detections that exceeded the background concentration. Although the MDC for zinc in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, zinc is eliminated from further consideration and will not be a final COPEC.

Former Plane Refueling/Crash Strip Area – Continued Evaluations. The remaining four integrated COPECs [cadmium, mercury, benzo(a)pyrene, and naphthalene] at the Former Plane Refueling/Crash Strip Area in surface soil have mean concentrations greater than the ESV and the background concentration (Table 7-31). Each remaining integrated COPEC is discussed below relative to the first four and related evaluation and refinement factors.

Cadmium. Cadmium in Former Plane Refueling/Crash Strip Area surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. It was detected above the ESV in 2 of 28 discrete samples (Table 7-31). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, cadmium requires further evaluation as a COPEC.

Mercury. Mercury in Former Plane Refueling/Crash Strip Area surface soil has a mean concentration greater than the background concentration and ESV. Mercury was detected above the background concentration in 13 of 28 discrete samples and above the ESV in 27 of 28 samples (Table 7-31). This is because 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.

Benzo(a)pyrene. Benzo(a)pyrene in Former Plane Refueling/Crash Strip Area surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. It was detected above the ESV in only 4 of 28 discrete samples (Table 7-31). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, benzo(a)pyrene requires further evaluation as a COPEC.

Naphthalene. Naphthalene in Former Plane Refueling/Crash Strip Area surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. It was detected above the ESV in only 2 of 28 discrete samples (Table 7-31). Because the mean concentration in surface soil exceeds the ESV and there is not a background concentration for comparison, naphthalene requires further evaluation as a COPEC.

Former Crash Area – Comparison of Mean Concentration to ESV. Six integrated COPECs [arsenic, cadmium, cobalt, copper, benzo(a)pyrene, and bis(2-ethylhexyl)phthalate] in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-21). Each eliminated integrated COPEC is discussed relative to the mean concentration being smaller than the ESV and the related evaluation and refinement factors. Table 7-32 shows the relevant data and various comparisons.

***Arsenic*.** Arsenic was detected in all 70 discrete samples analyzed for inorganic chemicals at the Former Crash Area. Only three samples had detections above the background concentration, and only two samples had arsenic concentrations exceeding the ESV (Table 7-32). 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 concentration. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Cadmium. Cadmium was detected in 13 of 70 discrete soil samples analyzed for inorganic chemicals at the Former Crash Area. All 13 detections were above the background concentration, but only 5 samples had cadmium concentrations exceeding the ESV (Table 7-32). 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 70 discrete samples analyzed for inorganic chemicals at the Former Crash Area. Seven samples had detections above the background concentration, but only three of these samples had a cobalt concentration exceeding the ESV (Table 7-32). Although the MDC for cobalt in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, cobalt is eliminated from further consideration and will not be a final COPEC.

Copper. Copper was detected in all 70 discrete samples analyzed for inorganic chemicals at the Former Crash Area. Only 11 samples were above the background concentration, and only 1 sample had a copper concentration exceeding the ESV (Table 7-32). Although the MDC for copper in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, copper is eliminated from further consideration and will not be a final COPEC.

Benzo(a)pyrene. Benzo(a)pyrene was detected in 7 of 70 discrete samples analyzed for SVOCs at the Former Crash Area. There is no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-32). Although the MDC for benzo(a)pyrene in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, benzo(a)pyrene is eliminated from further consideration and will not be a final COPEC.

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate was detected in 7 of 64 discrete samples analyzed for SVOCs at the Former Crash Area. There is no background concentration for comparison, but only one sample had a concentration exceeding the ESV (Table 7-32). Although the MDC for bis(2-ethylhexyl)phthalate in surface soil exceeds the ESV, the mean concentration is less than the ESV. Therefore, bis(2-ethylhexyl)phthalate is eliminated from further consideration and will not be a final COPEC.

Of the 13 integrated Former Crash Area surface soil COPECs with MDCs exceeding the ESV, 6 COPECs [arsenic, cadmium, cobalt, copper, benzo(a)pyrene, and bis(2-ethylhexyl)phthalate] were eliminated from further consideration. Seven remaining integrated COPECs with MDCs greater than the ESV (aluminum, antimony, lead, manganese, mercury, selenium, and zinc) in Former Crash Area surface soil have mean concentrations greater than the ESV.

Former Crash Area – Comparison of Mean Concentration Above ESV to Background Concentration. Seven integrated COPECs (aluminum, antimony, lead, manganese, mercury, selenium, and zinc) in surface soil at the Former Crash Area are eliminated in this step because the mean concentration is greater than the ESV but less than the background concentration. Each eliminated integrated COPEC is discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in surface soil at the Former Crash Area has a mean concentration less than the background concentration (Table 7-32). 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 70 discrete samples at concentrations above the ESV, only 4 samples had detections exceeding the background concentration. Having only four samples exceed the background concentration suggests the concentration of aluminum in surface soil is not likely a concern. Additionally, aluminum is not a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6.0–7.0 at one of the nearby load lines at RVAAP (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, USEPA states, “aluminum is identified as a COPC only for soil with a pH less than 5.5” (USEPA 2003b). Therefore, because the mean concentration is less than the background concentration, the ESV is rather conservative, and the soil pH at RVAAP is higher than the USEPA dissociation limit, aluminum is eliminated from further consideration and will not be a final COPEC.

Antimony. Antimony in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is more than three times the ESV (Table 7-32). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Antimony was detected in 13 of 60 discrete samples at concentrations above the ESV; however, only 1 sample had a detection which (slightly) exceeded the background concentration. Although the MDC for antimony in surface soil exceeds the background concentration and the ESV, the MDC is just slightly greater than background, the mean concentration is below background, and the ESV is conservative. Therefore, antimony is eliminated from further consideration and will not be a final COPEC.

Lead. Lead in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is more than twice the ESV (Table 7-32). Because the ESV is less than the background concentration, the ESV can be considered conservative. Lead was detected in 63 of 70 discrete samples at concentrations above the ESV; however, only 8 samples had detections exceeding the background concentration. Although the MDC for lead in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-32). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Manganese was detected in 45 of 70 discrete samples at concentrations above the ESV; however, only 4 samples had detections exceeding the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Mercury. Mercury in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is 70 times greater than the ESV (Table 7-32). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Mercury was detected in 48 of 70 discrete samples, with all detections above the ESV; however, only 22 samples had detections exceeding the background concentration. Although the MDC for mercury in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, mercury is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is approximately three times greater than the ESV (Table 7-32). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Selenium was detected in 51 of 70 discrete samples at concentrations above the ESV; however, only 5 samples had detections that exceeded the background concentration. Although the MDC for selenium in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Zinc. Zinc in surface soil in the Former Crash Area has a mean concentration less than the background concentration, and the background concentration is more than 1.3 times greater than the ESV (Table 7-32). Because the ESV is slightly lower than the background concentration, the ESV can be considered conservative. Zinc was detected in 38 of 70 discrete samples at concentrations above the ESV; however, only 16 samples had detections that exceeded the background concentration. Although the MDC for zinc in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, zinc is eliminated from further consideration and will not be a final COPEC.

Former Crash Area – Continued Evaluations. All integrated COPECs with ESVs were eliminated from further consideration for the Former Crash Area in the first four evaluation and refinement factors (Table 7-32). Two detected chemicals (TNT and nitrocellulose) without ESVs are discussed later in Step 3A. Mercury, which was eliminated as an integrated COPEC because the mean concentration is below the background concentration and the ESV is conservative, is also discussed later in Step 3A because mercury is a PBT compound.

Former Plane Burial Area – Comparison of Mean Concentration to ESV. Three integrated COPECs (arsenic, chromium, and nickel) in soil are eliminated in this step because the mean concentration is smaller than the ESV (Appendix H, Table H-22). Each eliminated integrated COPEC is discussed below relative to the mean concentration being less than the ESV and the related evaluation and refinement factors. Table 7-33 shows the relevant data and various comparisons.

Arsenic. Arsenic was detected in all 21 discrete samples analyzed for inorganic chemicals at the Former Plane Burial Area. Only one sample had a detected concentration above the background concentration and the ESV (Table 7-33). 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 concentration. Therefore, arsenic is eliminated from further consideration and will not be a final COPEC.

Chromium. Chromium was detected in all 21 discrete samples analyzed for inorganic chemicals at the Former Plane Burial Area. Only four samples exceeded the background concentration, and only one sample had a chromium concentration exceeding the ESV (Table 7-33). Although the MDC for chromium in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, chromium is eliminated from further consideration and will not be a final COPEC.

Nickel. Nickel was detected in all 21 discrete samples analyzed for inorganic chemicals at the Former Plane Burial Area. Only three samples were above the background concentration, and only one sample had a nickel concentration exceeding the ESV (Table 7-33). Although the MDC for nickel in surface soil exceeds the background concentration and ESV, the mean concentration is less than both the ESV and background concentration. Therefore, nickel is eliminated from further consideration and will not be a final COPEC.

Of the 13 integrated Former Plane Burial Area surface soil COPECs with MDCs exceeding the ESV, 3 COPECs (arsenic, chromium, and nickel) were eliminated from further consideration. A total of 10 remaining integrated COPECs with MDCs greater than the ESV (aluminum, antimony, cadmium, copper, lead, manganese, mercury, selenium, vanadium, and zinc) in Former Plane Burial Area surface soil have mean concentrations greater than the ESV.

Former Plane Burial Area – Comparison of Mean Concentration Above ESV to Background Concentration. Six integrated COPECs (aluminum, antimony, lead, manganese, selenium, and vanadium) in surface soil at the Former Plane Burial Area are eliminated in this step because the mean concentration is greater than the ESV but less than the background concentration. Each eliminated integrated COPEC is discussed relative to the various evaluation and refinement factors.

Aluminum. Aluminum in surface soil at the Former Plane Burial Area has a mean concentration less than the background concentration (Table 7-33). 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 21 discrete samples at concentrations above the ESV, only 2 samples had detections exceeding 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 a concern because the soil pH is too high to dissociate the chemical. A typical soil pH is 6.0–7.0 at one of the nearby load lines at RVAAP (USACE 2004). Regarding aluminum chemistry and ecological risk in soil, USEPA states, "aluminum is identified as a COPC only for soil with a pH less than 5.5" (USEPA 2003b). Therefore, because the mean concentration is less than the background concentration, the ESV is rather conservative, and the soil pH at RVAAP is higher than the USEPA dissociation limit, aluminum is eliminated from further consideration and will not be a final COPEC.

Antimony. Antimony in surface soil in the Former Plane Burial Area has a mean concentration less than the background concentration, and the background concentration is more than three times the ESV (Table 7-33). Because the ESV is less than the background concentration, the ESV can be considered conservative. Antimony was detected in only 1 of 21 discrete samples at concentrations above both the ESV and the background concentration. Although the MDC for antimony in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, antimony is eliminated from further consideration and will not be a final COPEC.

Lead. Lead in surface soil in the Former Plane Burial Area has a mean concentration less than the background concentration, and the background concentration is more than twice the ESV (Table 7-33). Because the ESV is less than the background concentration, the ESV can be considered conservative. Lead was detected in 19 of 21 discrete samples at concentrations above the ESV; however, only 2 samples had detections exceeding the background concentration. Although the MDC for lead in surface soil exceeds the background concentration and the ESV, the mean concentration is below the background concentration, and the ESV is conservative. Therefore, lead is eliminated from further consideration and will not be a final COPEC.

Manganese. Manganese in surface soil in the Former Plane Burial Area has a mean concentration less than the background concentration, and the background concentration is more than six times greater than the ESV (Table 7-33). Because the ESV is less than the background concentration, the ESV can be considered conservative. Manganese was detected in 16 of 21 discrete samples at concentrations above the ESV; however, only 2 samples had detections exceeding the background concentration. Although the MDC for manganese in surface soil exceeds the background concentration and the ESV, the mean concentration is below background, and the ESV is conservative. Therefore, manganese is eliminated from further consideration and will not be a final COPEC.

Selenium. Selenium in surface soil in the Former Plane Burial Area has a mean concentration less than the background concentration, and the background concentration is approximately three times greater than the ESV (Table 7-33). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Selenium was detected in 10 of 21 discrete samples at concentrations above the ESV; however, only 1 sample had a detection that (slightly) exceeded the background concentration. Although the MDC for selenium in surface soil exceeds the background concentration and the ESV, the MDC is just slightly greater than background, the mean concentration is below background, and the ESV is conservative. Therefore, selenium is eliminated from further consideration and will not be a final COPEC.

Vanadium. Vanadium in surface soil in the Former Plane Burial Area has a mean concentration less than the background concentration, and the background concentration is approximately four times greater than the ESV (Table 7-33). Because the ESV is lower than the background concentration, the ESV can be considered conservative. Vanadium was detected in all 21 discrete samples at concentrations above the ESV; however, only 2 samples had detections that (slightly) exceeded the background concentration. Although the MDC for vanadium in surface soil exceeds the background concentration and the ESV, the MDC is just slightly greater than background, the mean concentration is below background, and the ESV is conservative. Therefore, vanadium is eliminated from further consideration and will not be a final COPEC.

Former Plane Burial Area – Continued Evaluations. The remaining four integrated COPECs (cadmium, copper, mercury, and zinc) in surface soil at the Former Plane Burial Area have mean concentrations greater than the ESV and the background concentration (Table 7-33). Each remaining integrated COPEC is discussed below relative to the first four and related evaluation and refinement factors.

Cadmium. Cadmium in Former Plane Burial Area surface soil has a mean concentration greater than the ESV. There is no background concentration for comparison. Cadmium was detected above the ESV in 5 of 21 discrete samples (Table 7-33). Because the mean concentration in surface soil exceeds the ESV, and there is not a background concentration for comparison, cadmium requires further evaluation as a COPEC.

Copper. Copper in Former Plane Burial Area surface soil has a mean concentration greater than the background concentration and ESV. Copper was detected above the background concentration in 5 of 21 discrete samples and above the ESV in 1 of 21 samples (Table 7-33). Because the mean concentration in surface soil exceeds the ESV and the background concentration, copper requires further evaluation as a COPEC.

Mercury. Mercury in Former Plane Burial Area surface soil has a mean concentration greater than the background concentration and ESV. Mercury was detected above the background concentration in 14 of 21 discrete samples and above the ESV in all 21 samples (Table 7-33). This is because 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 in Former Plane Burial Area surface soil has a mean concentration greater than the background concentration and ESV. It was detected above the background concentration in 9 of 21 discrete samples, and it was detected at concentrations above the ESV in 11 of 21 samples (Table 7-33). This is because 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 the background concentration evaluates how much higher the mean soil concentration is than the background concentration. Four COPECs [cadmium, mercury, benzo(a)pyrene, and naphthalene] at the Former Plane Refueling/Crash Strip Area and four COPECs (cadmium, copper, mercury, and zinc) at the Former Plane Burial Area 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 will not be considered a final COPEC. Table 7-34 shows that while the mean concentration exceeds the background concentration, the exceedances for mercury and zinc in the Former Plane Burial Area are relatively small. Cadmium was not detected in background and benzo(a)pyrene and naphthalene do not have established background concentrations; therefore, a comparison of mean concentration to background concentration is not available for these chemicals.

Additional Technical and Refinement Factors. The next three evaluation and refinement factors include:

- Magnitude of ESV exceedance (ratio of ESV to chemical concentrations),
- Discussion of Ohio EPA approved and preferred ESVs, and
- Qualitative relationship of exposure area to general home range.

Former Plane Refueling/Crash Strip Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for cadmium (1.3), mercury (74.7), benzo(a)pyrene (1.4), and naphthalene (3.35) indicate a possibility of risk, the ratios for cadmium and benzo(a)pyrene are small (Appendix H, Table H-20). The ratios for cadmium and benzo(a)pyrene indicate the potential for toxicity is relatively low, and this likely supports elimination of cadmium and benzo(a)pyrene as integrated COPECs.

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."

Former Crash Area – Magnitude of ESV Exceedance. All integrated COPECs with ESVs were eliminated from further consideration for the Former Crash Area in the first two evaluation and refinement factors (Table 7-32).

Former Plane Burial Area – Magnitude of ESV Exceedance. Although the mean concentration to ESV ratios for cadmium (3.3), copper (3.4), mercury (87.1), and zinc (1.8) indicate a possibility of risk, the ratio for zinc is small (Appendix H, Table H-22). The ratio for zinc indicates the potential for toxicity is relatively low, and this supports elimination of zinc as an integrated COPEC.

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives specific guidance on selection of 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 2003a). 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 two of the four remaining integrated COPECs at the Former Plane Refueling/Crash Strip Area and the four integrated COPECs at the Former Plane Burial Area. There are no alternative Ohio EPA approved ESVs for benzo(a)pyrene or naphthalene (Appendix H, Table H-6.)

The Ohio EPA approved and preferred cadmium ESV used in this ERA is 0.36 mg/kg. This ESV is from the USEPA EcoSSLs (Appendix H, Table H-6). The cadmium ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for cadmium include 0.77, 32, and 140 mg/kg (USEPA 2005). The ESV of 0.36 mg/kg is about 10 times lower than the ESV (4 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-6) (DOE 1997). This information indicates the Ohio EPA approved and preferred ESV for cadmium is conservative; thus, including cadmium as a COPEC is conservative.

The Ohio EPA approved and preferred copper ESV used in this ERA is 28 mg/kg. This ESV is from the USEPA EcoSSL (Appendix H, Table H-6). The copper ESV used in this ERA is the most conservative ESV of the USEPA EcoSSLs. Other EcoSSLs for copper include 49, 70, and 80 mg/kg (USEPA 2006). The ESV of 28 mg/kg is about two times lower than the ESV (60 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-6) (DOE 1997). The preferred ESV for copper (28 mg/kg) is close to the background concentration (17.7 mg/kg). This information indicates the Ohio EPA approved and preferred ESV for copper is conservative; thus, including copper as a COPEC is conservative.

The Ohio EPA approved and preferred mercury ESV used in this ERA is 0.00051 mg/kg (Appendix H, Table H-6). The ESV is lower than other ESVs for mercury (0.1 mg/kg), the ESV for methylmercury (0.0016 mg/kg) (USEPA 2003a) (Appendix H, Table H-6), and the background concentration (0.036 mg/kg) (Appendix H, Tables H-9 and H-11). 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 and accounts for bioaccumulation; therefore, including 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 from the USEPA EcoSSLs (Appendix H, Table H-6). 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 2007a). The ESV of 46 mg/kg is about five times greater than the ESV (8.5 mg/kg) from the next source of ESVs preferred by Ohio EPA (Appendix H, Table H-6) (DOE 1997). The preferred ESV used for zinc is also lower than the background concentration of 61.8 mg/kg (Appendix H, Tables H-11 and H-12), while all of the other EcoSSLs are above the background concentration. These factors indicate the Ohio EPA approved and preferred ESV for zinc is somewhat conservative; thus, including zinc as a COPEC is somewhat conservative.

The above information about alternative ESVs shows there are less conservative ESVs that could be chosen for the Level II work. Table 7-35 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 four remaining integrated COPECs at the Former Plane Refueling/Crash Strip Area, use of the alternative ESV would decrease ratios to less than one for cadmium and mercury. The remaining two integrated COPECs [benzo(a)pyrene and naphthalene] in the Former Plane Refueling/Crash Strip Area do not have alternative ESVs and would need further evaluation. For the four remaining integrated COPECs at the Former Plane Burial Area, use of the alternative ESV would decrease ratios to less than one for mercury. Using the alternative ESVs, the remaining three integrated COPECs (cadmium, copper, and zinc) in the Former Plane Burial Area would have ratios greater than one and would need further evaluation.

Qualitative Relationship of Exposure Area to General Home Range. All integrated COPECs with ESVs were eliminated for the Former Crash Area in the discussion of the first four evaluation and refinement factors (Table 7-30) prior to this step. The remaining integrated COPECs for the Former Plane Refueling/Crash Strip Area and Former Plane Burial Area are discussed separately below.

Former Plane Refueling/Crash Strip Area. The two highest concentrations of cadmium, mercury, benzo(a)pyrene, and naphthalene in surface soil (0–1 ft bgs) at the Former Plane Refueling/Crash Strip Area are located in the northwestern corner of the AOC and along the western half of the crash strip (Figure 7-3). The two highest concentrations are as follows:

- Cadmium: 5.2 mg/kg at NTA-083 and 0.62 mg/kg at NTA-084,
- Mercury: 0.073 mg/kg at NTA-084 and 0.066 mg/kg at NTA-088,
- Benzo(a)pyrene: 41 mg/kg at NTA-088 and 7.6 mg/kg at NTA-090, and
- Naphthalene: 2.8 mg/kg at NTA-088 and 0.18 mg/kg at NTA-089.

Cadmium was detected in surface soil at the Former Plane Refueling/Crash Strip Area above its preferred ESV (0.36 mg/kg) in only 2 of 28 discrete sample locations. Only the MDC exceeded the alternative ESV of 0.77 mg/kg. The single detection of cadmium (5.2 mg/kg at NTA-083) above the alternative ESV is located in the northwestern portion of the Former Plane Refueling/Crash Strip Area, approximately 220 ft north of the crash strip. The eight surrounding samples have concentrations that range from below the detection limit to 0.62 mg/kg. The second highest detection of cadmium is at NTA-084 (0.62 mg/kg); it is about 300 ft east of the MDC. In addition, sample NTAsb-120 is less than 15 ft west of the MDC and is only detected at a concentration of 0.2 mg/kg, which is less than the alternative ESV (0.77 mg/kg). Based on the low concentrations of the surrounding samples, the area of exceedance of the alternative ESV is expected to be smaller than 1 acre. It is assumed that elevated cadmium concentrations are restricted to a small area around the sample. Accordingly, the area of elevated cadmium is estimated to be a 50- by 50-ft square (2,500 ft^2) or 0.06 acres.

Mercury was detected in surface soil at the Former Plane Refueling/Crash Strip Area above its preferred ESV (0.00051 mg/kg) in 27 of 28 discrete sample locations and above its background concentration (0.036 mg/kg) in 13 of 28 samples. However, none of the mercury detections exceeded the alternative ESV of 0.1 mg/kg. The two highest concentrations of mercury (0.073 mg/kg at NTA-084 and 0.066 mg/kg at NTA-088) were detected in the western portion of the Former Plane Refueling/Crash Strip Area. Location NTA-088 is at the western edge of the crash strip. Location NTA-084 is approximately 220 ft north of the crash strip. However, because none of the concentrations exceed the alternative ESV, mercury is eliminated from further consideration and will not be a final COPEC.

Benzo(a)pyrene was detected in surface soil at the Former Plane Refueling/Crash Strip Area above its ESV (1.52 mg/kg) in only 4 of 28 discrete sample locations. There is no alternative ESV available for benzo(a)pyrene. The three highest concentrations of benzo(a)pyrene (41 mg/kg at NTA-088, 7.6 mg/kg at NTA-090, and 5.1 mg/kg at NTA-089) were detected along the western portion of the crash strip. The fourth elevated benzo(a)pyrene concentration (3.5 mg/kg at NTA-083) was detected in the northwestern portion of the Former Plane Refueling/Crash Strip Area approximately 220 ft north of the crash strip. With the exception of the crash strip, the sample concentrations surrounding NTA-083 range from 0.014–0.62 mg/kg. The second highest detection of benzo(a)pyrene is at NTAsb-120 (0.62 mg/kg); it is less than 15 ft west of the MDC and is less than the ESV (1.52 mg/kg). Based on the low concentrations of the surrounding samples, the area of exceedance of the ESV is expected to be smaller than 1 acre. It is assumed elevated COPEC concentrations are restricted to a small area around the sample. Accordingly, the area of elevated benzo(a)pyrene above the ESV in the vicinity of NTA-

083 is estimated to be a 50- by 50-ft square (2,500 ft^2) or 0.06 acres. The three highest concentrations are found in the grassy median of the western portion of the crash strip. The median is bounded by the concrete of the crash strip. Sample concentrations surrounding the crash strip range from 0.011–0.3 mg/kg. In addition, sample NTAsb-121 is less than 10 ft west of the MDC and is only detected at a concentration of 0.3 mg/kg, which is less than the ESV (1.52 mg/kg). The area of exceedance of the ESV in the grassy median of the concrete crash strip is very narrow and less than 1 acre. Accordingly, the area of elevated benzo(a)pyrene at the crash strip is estimated to be 0.54 acres.

Naphthalene was detected in surface soil at the Former Plane Refueling/Crash Strip Area above its ESV (0.0994 mg/kg) in only 2 of 28 discrete sample locations. There is no alternative ESV available for naphthalene. These two elevated concentrations of naphthalene (2.8 mg/kg at NTA-088 and 0.18 mg/kg at NTA-089) are found in the grassy median of the western portion of the crash strip. The median is bounded by the concrete of the crash strip (Figure 7-3; Photograph 7-1). Samples surrounding the crash strip had concentrations ranging from below the detection limit to 0.018 mg/kg. In addition, sample NTAsb-121 is less than 10 ft west of the MDC and is only detected at a concentration of 0.018 mg/kg, which is less than the ESV (0.0994 mg/kg). Therefore, the area of exceedance of the ESV in the grassy median of the concrete crash strip is very narrow and less than 1 acre. Accordingly, the area of elevated naphthalene at the crash strip is estimated to be 0.37 acres.

The highest concentrations of these four COPECs occur in relatively small areas. These areas range from approximately 0.06–0.54 acres and are smaller than the usual 1-acre home range of a small bird or small mammal (USEPA 1993). A larger receptor (e.g., turkey and deer) that uses this area as a small part of its home range would, on average, be exposed to concentrations even lower than the mean concentration for cadmium (0.449 mg/kg), mercury (0.0381 mg/kg), benzo(a)pyrene (2.19 mg/kg), and naphthalene (0.333 mg/kg). The narrow grassy median of the crash strip where several exceedances occur is assumed to be unattractive foraging habitat to most wildlife. Thus, the exposure of wildlife species to these high concentration areas would be relatively small and of limited consequence. This evaluation and refinement factor provides supporting evidence that cadmium, mercury, benzo(a)pyrene, and naphthalene should not be final COPECs at the Former Plane Refueling/Crash Strip Area.

Former Plane Burial Area. The two highest concentrations of cadmium, copper, mercury, and zinc in surface soil (0–1 ft bgs) are located in the northeastern corner of the Former Plane Burial Area (Figure 7-4). The highest concentrations are as follows:

- Cadmium: 14.5 mg/kg at NTA-070 and 2.4 mg/kg at NTA-100,
- Copper: 1,760 mg/kg at NTA-070 and 27.2 mg/kg at NTA-072,
- Mercury: 0.073 mg/kg at NTA-082 and NTA-100 and 0.068 mg/kg at NTA-069, and
- Zinc: 603 mg/kg at NTA-070 and 102 mg/kg at NTAss-141.

Cadmium was detected in surface soil at the Former Plane Burial Area above its preferred ESV (0.36 mg/kg) at 5 of 21 discrete sample locations. However, only the three highest cadmium detections (14.5 mg/kg at NTA-070, 2.4 mg/kg at NTA-100, and 1.6 mg/kg at NTA-073) exceeded the alternative ESV of 0.77 mg/kg. These highest concentrations of cadmium are located in the northeastern portion of the Former Plane Burial Area (Figure 7-4). The six surrounding samples had concentrations ranging from below the detection limit to 0.74 mg/kg. A roughly triangular area comprising the samples with cadmium elevated above the alternative ESV is expected to be smaller than 1 acre. Accordingly, the area of elevated cadmium above the alternative ESV is estimated to be 0.31 acres.

Copper was detected in surface soil at the Former Plane Burial Area above its preferred ESV (28 mg/kg) in only 1 of 21 discrete sample locations and above its background concentration (17.7 mg/kg) in 5 of 21 samples. The MDC also exceeded its alternative ESV of 49 mg/kg. The single detection of copper above the ESV (1,760 mg/kg at NTA-070) is located in the northeastern portion of the Former Plane Burial Area. The six surrounding samples have concentrations that range from 7.1–27.2 mg/kg. The second highest detection of copper is at NTA-072 (27.2 mg/kg); it is located about 200 ft southwest of the MDC. In addition, sample NTA-100 is approximately 50 ft east of the MDC and is only detected at a concentration of 24.4 mg/kg, which is less than the preferred ESV (28 mg/kg). Based on the low concentrations of the surrounding samples, the area of exceedance of the preferred ESV is expected to be smaller than 1 acre. It is assumed elevated COPEC concentrations are restricted to a small area around the sample. Accordingly, the area of elevated copper is estimated to be a 50- by 50-ft square (2,500 ft^2) or 0.06 acres.

Mercury was detected above its preferred ESV (0.00051 mg/kg) in all 21 discrete sample locations in surface soil at the Former Plane Burial Area and above its background concentration (0.036 mg/kg) in 14 of 21 samples. However, none of the mercury detections exceed the alternative ESV of 0.1 mg/kg. Two of the three highest concentrations of mercury (0.073 mg/kg at NTA-100 and 0.068 mg/kg at NTA-069) were detected in the north/northeastern portion of the Former Plane Burial Area. The remaining elevated concentration (0.073 mg/kg at NTA-082) is located in the southeastern portion of the Former Plane Burial Area. However, because none of the concentrations exceed the alternative ESV, mercury is eliminated from further consideration and will not be a final COPEC.

Zinc was detected in surface soil at the Former Plane Burial Area above its preferred ESV (46 mg/kg) in 11 of 21 discrete sample locations and above its background concentration (61.8 mg/kg) in 9 of 21 samples. However, only the four highest zinc detections (603 mg/kg at NTA-070, 102 mg/kg at NTAss-141, 97.1 mg/kg at NTA-067, and 93.2 mg/kg at NTA-080) exceeded the alternative ESV of 79 mg/kg. Three of the four highest concentrations of zinc were detected in the north/northeastern portion of the Former Plane Burial Area. The fourth elevated concentration is located in the southwestern portion of the Former Plane Burial Area. The six samples nearest the elevated area of zinc depicted on Figure 7-4 have concentrations that range from 38.3–65.3 mg/kg. The highest detection near the northeastern elevated area of zinc is at NTA-066 (65.3 mg/kg); it is about 300 ft northwest of the MDC. In addition, sample NTA-100 is approximately 50 ft east of the MDC and is only detected at a concentration of 38.3 mg/kg, which is less than the alternative ESV (79 mg/kg). Based on the low concentrations of the surrounding samples, the area of exceedance of the alternative ESV is expected to be smaller than 1 acre. It is assumed the distribution of elevated zinc is restricted to a small area around the three highest zinc concentrations. Accordingly, the area of elevated zinc is estimated to be 0.47 acres.

The locations of the highest concentrations of these four COPECs define three relatively small overlapping areas. They range in size from 0.06–0.47 acres, which is smaller than the usual 1-acre home range of a small bird or small mammal (USEPA 1993). A larger receptor (e.g., turkey and deer) that uses this area as a small part of its home range would, on average, be exposed to concentrations even lower than the mean concentration for cadmium (1.18 mg/kg), copper (95.3 mg/kg), mercury (0.0444 mg/kg), and zinc (82.6 mg/kg). Thus, the exposure of wildlife species to these areas would be relatively small and of limited consequence. This evaluation and refinement factor provides supporting evidence that cadmium, copper, mercury, and zinc should not be final COPECs for surface soil at the Former Plane Burial Area.

Evaluation of Integrated COPECs in Sediment and Surface Water. Integrated COPECs in sediment and surface water were subjected to 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 will be discussed later. The evaluation of sediment and surface water includes chemical-specific evaluation and refinement factors.

Sediment. One sediment sample was collected in the Wetland/Pond North of Former Crash Area, and the only integrated COPEC was mercury (Table 7-25). Mercury did not exceed its ESV but was retained as a COPEC because it is a PBT compound; it is discussed later in Step 3A.

Two sediment samples were collected in the Tributary to Hinkley Creek; the five integrated COPECs are mercury, nickel, HMX, acenaphthene, and bis(2-ethylhexyl)phthalate (Table 7-26). Mercury did not exceed its ESV, but it was retained as a COPEC because it is a PBT compound; it is discussed later in Step 3A. HMX was identified as an integrated COPEC because the chemical did not have an ESV and is discussed later in Step 3A and in the uncertainty section (Section 7.3.3.10). Nickel, acenaphthene, and bis(2-ethylhexyl)phthalate had MDCs that exceeded their ESVs and are discussed below.

Nickel. Nickel was detected in both discrete sediment samples collected in the Tributary to Hinkley Creek, and one detection (33.6 mg/kg) exceeded its background and ESV and slightly exceeded the SRV (33 mg/kg) (Table 7-26; Appendix H, Table H-14). The magnitude of SRV exceedance was very low, and the mean to ESV ratio (1.04) was also low (Appendix H, Table H-23). The small exceedances indicate risk to ecological receptors is small, and this supports elimination of nickel as an integrated COPEC for sediment in the Tributary to Hinkley Creek. In addition, the mean concentration (23.5 mg/kg) is below the SRV; therefore, nickel in sediment is eliminated from further consideration and will not be a final COPEC (Table 7-36).

Acenaphthene. Acenaphthene was detected in one of two discrete sediment samples collected in the Tributary to Hinkley Creek and exceeded its ESV with a fairly low ratio of 1.8 (Table 7-26; Appendix H, Table H-14). Acenaphthene does not have a background concentration for comparison. There is limited source material for the detection in the sediment; acenaphthene was only detected in one of four soil EUs, and all soil detections were below the soil ESV. The small ratio and lack of source material indicates risk to ecological receptors is small, and this supports elimination of acenaphthene as an integrated COPEC for sediment in the Tributary to Hinkley Creek. However, because the concentration exceeded its ESV, it is evaluated further with additional refinement factors.

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate was detected in one of two discrete sediment samples collected in the Tributary to Hinkley Creek and exceeded its ESV with a fairly low ratio of 1.9 (Table 7-26; Appendix H, Table H-14). Bis(2-ethylhexyl)phthalate does not have a background concentration for comparison. The small ratio indicates risk to ecological receptors is small, and this supports elimination of bis(2-ethylhexyl)phthalate as an integrated COPEC for sediment in the Tributary to Hinkley Creek. However, because the concentration exceeded its ESV, it is evaluated further with additional refinement factors.

One sediment sample was collected in the Former Crash Area Reservoir, and the only integrated COPEC was acetone (Table 7-27). Acetone had an MDC that exceeded its ESV and is discussed below.

Acetone. Acetone was detected in the one discrete sediment sample collected in the Crash Area Reservoir, and the single detection (0.061 mg/kg) exceeded its ESV (0.0099 mg/kg) (Table 7-27; Appendix H, Table H-15). Acetone does not have a background concentration for comparison. Detected concentrations of acetone in all soil EUs were below the ESV. This information suggests limited source material for the elevated detections in the sediment, and this chemical may not become a final COPEC; however, it is evaluated further with additional refinement factors.

Surface Water. One surface water sample from the Wetland/Pond North of Former Crash Area and two samples from the Tributary to Hinkley Creek were analyzed in this ERA. Water in the Crash Area Reservoir was not re-sampled or re-analyzed. Manganese was a COPEC in both surface water EUs, and bis(2-ethylhexyl)phthalate was an additional COPEC in the Tributary to Hinkley Creek only. They are discussed below.

Manganese. Manganese at the Wetland/Pond North of Former Crash Area (0.737 mg/L) was detected above its background concentration (0.391 mg/L) and ESV (0.12 mg/L) (Table 7-28). In the Tributary to Hinkley Creek, one of two samples (0.509 mg/L) exceeded the background concentration and ESV. Although the MDC to ESV ratio (4.2) for manganese in surface water at the Tributary to Hinkley Creek indicates a possibility of risk (Table 7-29), manganese had a mean concentration (0.32 mg/L) less than the background concentration in the Tributary to Hinkley Creek, which eliminates it as a risk to ecological receptors there. Manganese in co-located sediment of the Wetland/Pond North of Former Crash Area is below background and SRV (no ESV is available), which suggests limited source material for the elevated detections in the surface water. However, because the manganese concentration in surface water of the Wetland/Pond North of Former Crash Area is above the ESV, it is evaluated further with additional refinement factors.

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate was detected in one of two samples at the Tributary to Hinkley Creek (0.021 mg/L), at a concentration below the OMZM ESV (1.1 mg/L) but above the OMZA ESV (0.0084 mg/L). The laboratory qualifier for this sample indicates that bis(2-ethylhexyl)phthalate was also found in the blank, which means that the presence of bis(2-ethylhexyl)phthalate in the sample may be artificially high. Bis(2-ethylhexyl)phthalate does not have a background concentration for comparison. Although the MDC to OMZA ESV ratio (2.5) indicates a possibility of risk (Table 7-29), the MDC to OMZM ESV ratio is below 1 and the mean to OMZA ESV ratio is close to 1 (1.6; Appendix H, Table H-24). The small ratio indicates risk to ecological receptors is small, and this supports elimination of bis(2-ethylhexyl)phthalate as an integrated COPEC for surface water in the Tributary to Hinkley Creek. However, because the concentration exceeded its ESV, it is evaluated further with additional refinement factors.

Sediment and Surface Water Summary. In summary, acenaphthene and bis(2-ethylhexyl)phthalate in the Tributary to Hinkley Creek and acetone in the Crash Area Reservoir required further evaluation for sediment. Manganese in the Wetland/Pond North of Former Crash Area and bis(2-ethylhexyl)phthalate in the Tributary to Hinkley Creek required further evaluation for surface water.

Comparison of Ohio EPA Approved and Preferred ESVs. The *Guidance for Conducting Ecological Risk Assessments* (Ohio EPA 2008) gives guidance on selection of media screening values (ESVs) for Level II evaluation. There are no other ESVs for the three remaining sediment COPECs or one of the two remaining surface water COPECs (manganese) in the sources preferred by Ohio EPA (Appendix H, Tables H-7 and H-8). However, bis(2-ethylhexyl)phthalate in surface water has other available ESVs. For surface water, five possible sources of ESV values are listed in order of preference: (1) Ohio EPA Administrative Code OMZAs, (2) Ohio EPA Administrative Code OMZMs, (3) National Ambient WQC, (4) Tier II values (Suter and Tsao 1996), and (5) Region 5 ESLs (USEPA 2003a). It is possible that the chosen ESV is too conservative. Alternative ESVs are presented below for bis(2-ethylhexyl)phthalate in surface water at the Tributary to Hinkley Creek.

The Ohio EPA approved and preferred bis(2-ethylhexyl)phthalate ESV used in this ERA is 0.0084 mg/L. This ESV is from the Ohio EPA Administrative Code OMZAs (Appendix H, Table H-8). The bis(2-ethylhexyl)phthalate OMZA ESV used in this ERA is more than 100 times lower than the OMZM ESV (1.1 mg/L), about 3 times higher than the Tier II ESV (0.003 mg/L), and about 30 times higher than the USEPA Region 5 surface water ESV for bis(2-ethylhexyl)phthalate (0.0003 mg/L).

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 any remaining integrated COPECs in soil, sediment, and surface water at the AOC will not be of ecological concern to wetlands and do not need to be evaluated as final COPECs.

There are nine wetlands partially or completely inside NACA Test Area. They range in total size from 0.09–13 acres, with between 0.09 and 5.2 acres inside the AOC boundary. Eight of the nine wetlands are Category 2, while Wetland 5 is a Category 1 wetland (Table 7-18). Category 2 indicates moderate wetland quality, with some degradation of wetland functions. Category 1 indicates low wetland quality, with degradation of wetland functions. RVAAP contains about 1,970 acres of wetlands, and the 13.8 acres of wetlands inside the habitat boundary at NACA Test Area represent 0.7% of the total wetlands of RVAAP (OHARNG 2008). The moderate to low quality and availability of additional wetlands at RVAAP lowers the importance of the wetlands at NACA Test Area.

Wetlands 1, 2, 4, 6, and 7 are part of large interconnected complexes that are possible pathways for contaminant migration (Figure 7-2). Wetland 2 continues off-site and downgradient into the same complex that contains Wetland 1 and the Wetland/Pond North of the Former Crash Area. Wetland 1 also contains the northern portion of the Tributary to Hinkley Creek and connects to Wetland 6, which covers the remainder of the tributary. Wetland 4, at the southern boundary of the Former Plane Burial Area and the Former Crash Area, covers an unnamed tributary that flows west into the main Tributary to Hinkley Creek about 425 ft north of the confluence with Hinkley Creek. Wetland 7 is a large complex that covers part of Hinkley Creek to the west of the AOC in addition to continuing east into the Tributary to Hinkley Creek. Wetlands 8 and 9, although not directly connected to the wetland complexes at NACA Test Area, are only a few feet upgradient of Wetland 7, and contaminants could migrate downgradient to Wetland 7 and eventually to Hinkley Creek. Of the nine wetlands, only Wetland 3 and Wetland 5 (Former Crash Area Reservoir) are somewhat isolated. At the Former Crash Area Reservoir (Wetland 5), the remaining sediment COPEC (acetone) would be unlikely to migrate to other wetlands in NACA Test Area. The lack of migration pathway and the small area of the reservoir reduce ecological concern for this COPEC.

Several soil samples with elevated COPEC concentrations (e.g. NTA-70 and NTA-140) occur in the northeastern corner of the AOC, in or near Wetland 2 (Figure 7-4). This suggests COPECs from the AOC could migrate to the wetland. A few soil samples were collected in the southeastern portion of the AOC that overlaps Wetland 4. Although COPECs could migrate along the unnamed tributary and Wetland 4 into the Tributary to Hinkley Creek, the southeastern area lacks elevated concentrations of the soil COPECs (Figure 7-4). Additional elevated COPEC concentrations occur in the northwestern corner of NACA Test Area. These contaminants could migrate to Wetlands 7, 8, and 9. Elevated concentrations of cadmium and benzo(a)pyrene occur within a few feet of Wetland 8 (Figure 7-3). However, some of the highest concentrations of the remaining COPECs in the area occur in the median of the crash strip, which would impede contaminant migration because of the concrete pavement. No sediment or surface water samples were collected in Wetlands 2, 3, 4, 7, 8, or 9, but ORAM scores of 2 indicate some impairment with potential for recovery.

Except for one sample collected in the Former Crash Area Reservoir, all sediment/surface water samples at NACA Test Area were collected along the Tributary to Hinkley Creek (Figure 5-11), the main pathway for migration of contaminants. NTAsd/sw-144 was collected at the bottom of the Wetland/Pond North of Former Crash Area, just before entering the Tributary to Hinkley Creek; NTAsd/sw-143 was collected in the middle of the tributary, about 500 ft downstream; and NTAsd/sw-145 was collected about 850 ft farther downstream just above the confluence with Hinkley Creek. One of the two remaining surface water COPECs (manganese) shows a clear decrease in concentration moving downstream. The other surface water COPEC [bis(2-ethylhexyl)phthalate] was only detected in the farthest downstream location. Concentrations of the remaining two sediment COPECs in the Tributary to Hinkley Creek [acenaphthene and bis(2-ethylhexyl)phthalate] do not show a clear pattern along the path to Hinkley Creek, but chemicals at the downstream biological/water quality sampling station show little to no impairment of the various measurements.

Evaluation of Biological and Water Quality Sampling Stations. The final evaluation and refinement factor is:

- Evaluation of off-site migration of chemicals at biological/water quality stations.

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 upgradient and downgradient contamination. These studies were published in the *Facility-Wide Biological and Water Quality Study* (USACE 2005a). Monitoring stations are positioned in streams and ponds downgradient from several AOCs. Two sampling stations (H-2 and H-3) are upstream of NACA, and one station (H-4) is downstream from the AOC. When the assessment attributes are positively rated (e.g., "good," "excellent," "Full Attainment Status"), this is evidence that the downstream sampling station has not been impaired by upstream chemical conditions at the AOC.

The measurements taken at each station are sediment chemistry, surface water chemistry, fish community, benthic macroinvertebrate community, and habitat conditions. In addition, a statement about attainment status is provided. Table 7-19 shows the results of the attributes for the three sampling stations (H-2, H-3, and H-4). Review of the *Facility-Wide Biology and Water Quality Study* (USACE 2005a) data from the sampling stations showed many positive metrics and no sign of aquatic impairment due to activities at NACA Test Area.

The biological, sediment, and water quality attributes at the downstream location (H-4) indicate little to no impairment (i.e., Full Attainment Status) (Table 7-19). No inorganic or organic chemicals were detected above their screening criteria (Section 7.3.2.3); therefore, chemicals at NACA Test Area have not adversely affected downstream ecological conditions. This greatly reduces concern for the remaining COPECs in soil, sediment, and surface water at NACA Test Area.

Evaluation of PBT Compounds and COPECs Without ESVs. As discussed in Level II, there is one chemical that is a PBT compound in surface soil (mercury), one chemical that is a PBT compound in sediment (mercury), and no PBT compounds in surface water. Five chemicals in surface soil (TNT, HMX, nitrocellulose, carbazole, and dibenzofuran) are integrated COPECs because the chemicals did not have ESVs, and one chemical in sediment (HMX) is an integrated COPEC because it lacks an ESV. These chemicals are briefly evaluated below. There are no integrated COPECs without EVSs in surface water at NACA Test Area.

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 ingestion of soil or water (e.g., mammals, birds). For AOCs that move to a Level III baseline ERA, PBT compounds are evaluated in wildlife food chains. 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 (i.e., EcoSSLs and PRGs), bioaccumulation in higher trophic levels is considered in development of the ESV. According to 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 2007b). Derivation of EcoSSL values includes uptake equations that account for both direct ingestion and food chain bioaccumulation (USEPA 2007b). 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 2003a) are an Ohio EPA-approved source for soil, sediment, and surface water ESVs (see Appendix H, Tables H-6 to H-8 for hierarchies); they are a source of screening values for some PBT compounds not covered by the EcoSSLs or PRGs. The development of ESLs included bioaccumulation in higher trophic levels as a standard component in the equations, 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, ESLs also account for bioaccumulation in the food chain, 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.

Mercury is the only PBT compound found in soil at NACA Test Area. Mercury was detected in all soil EUs (excluding Former Crash Area Well Pit) above the ESV, which accounts for bioaccumulation (DOE 1997). These exceedances can be expected, considering the ESV is 70 times less than the background concentration. At the Former Plane Refueling/Crash Strip Area, the mean concentration of mercury (0.0381 mg/kg) is slightly above the background concentration (0.036 mg/kg) (Table 7-31); at the Former Crash Area, the mean concentration of mercury (0.0334 mg/kg) is slightly below the background concentration (Table 7-32); and at the Former Plane Burial Area, the mean concentration of mercury (0.0444 mg/kg) is slightly above the background concentration (Table 7-33). Thus, mercury at the Former Crash Area is eliminated from further consideration and will not be a final COPEC. Concern for mercury in soil at the Former Plane Refueling/Crash Strip Area and the Former Plane Burial Area is greatly reduced because the exposure and risk to wildlife would be similar to that from the background concentration.

In the Wetland/Pond North of Former Crash Area, mercury is the only chemical in the sediment identified as an integrated COPEC because it is a PBT compound. While the sediment ESV does not account for bioaccumulation, the MDC (0.023 mg/kg) is below the background concentration (0.059 mg/kg) (Appendix H, Table H-13). Because only one sample was collected in the Wetland/Pond North of Former Crash Area, frequency of occurrence and distribution of mercury in the wetland/pond are difficult to determine. However, because the sample is below background concentration, it indicates receptors are no more likely to be exposed to mercury in the wetland/pond than in background.

In the Tributary to Hinkley Creek, mercury is an integrated COPEC in sediment because it is a PBT compound. While both the mean concentration and MDC are below the ESV, the sediment ESV does not account for bioaccumulation. However, the MDC (0.032 mg/kg) is below the background concentration (0.059 mg/kg) (Appendix H, Table H-14), suggesting bioaccumulation of mercury in the Tributary to Hinkley Creek would be less than bioaccumulation from background conditions. In the Former Crash Area Reservoir (Appendix H, Table H-15), no PBT compounds were identified. These facts support the view that mercury does not need to be retained as a final COPEC. Therefore, mercury is eliminated from further consideration and will not be a final COPEC in sediment.

PBT compounds at NACA Test Area are mercury in surface soil and mercury in sediment. There are no PBT compounds for surface water. As discussed above, mercury is dismissed for Former Crash Area soil and all sediment EUs and will not be a final COPEC. Concern for mercury in soil at the Former Plane Refueling/Crash Strip Area and Former Plane Burial Area is greatly reduced because of the similarity to background concentration.

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 NACA Test Area, 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 soil at the Former Plane Refueling/Crash Strip Area, the integrated COPECs without ESVs are TNT, HMX, nitrocellulose, carbazole, and dibenzofuran. TNT was detected in 1 of 11 samples, HMX was detected in 3 of 11 samples, carbazole was detected in 3 of 19 samples, and dibenzofuran was detected in 2 of 19 samples. Thus, exposure to these chemicals would be limited. While nitrocellulose was detected in one of two samples, it is essentially non-toxic (USEPA 1987) and not expected to be an ecological concern.

For soil at the Former Crash Area, the integrated COPECs without ESVs are TNT and nitrocellulose. TNT was detected in 1 of 16 samples. Thus, exposure to TNT would be limited. While nitrocellulose was detected in 4 of 10 samples, it is essentially non-toxic (USEPA 1987) and not expected to be an ecological concern.

For soil at the Former Plane Burial Area, the only integrated COPEC without an ESV is TNT. TNT was detected in one of four samples. Thus, exposure to this chemical would be limited. For soil at the Former Crash Area Well Pit, the only integrated COPEC without an ESV is nitrocellulose. While nitrocellulose was detected in the one sample collected, it is essentially non-toxic (USEPA 1987) and not expected to be an ecological concern.

The only integrated COPEC without an ESV in sediment is HMX in the Tributary to Hinkley Creek. HMX was detected in one of two current sediment samples taken in the tributary, but it was not detected in the other seven historical and current sediment samples taken at NACA Test Area. HMX lacks a background concentration and SRV for comparison. Therefore, the relatively low frequency of detection throughout NACA Test Area and lack of available benchmark and toxicity information suggests HMX in sediment is not likely to be an issue for ecological receptors.

There are no integrated COPECs without ESVs in surface water.

7.3.3.8 Summary of Findings in Step 3A

Of the 28 integrated COPECs in surface soil at NACA Test Area, the 5 that did not have ESVs (TNT, HMX, nitrocellulose, carbazole, and dibenzofuran) were eliminated as COPECs because they had low frequency of detection or were assumed to have little to no toxicity. COPECs in the Former Crash Area Well Pit sample were dismissed because it is not ecological habitat. Additional integrated COPECs in the Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane Burial Area were eliminated from further consideration because the mean concentration is smaller than the ESV [arsenic, barium, chromium, cobalt, cyanide, nickel, benz(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene, phenanthrene, and pyrene] or the mean concentration is smaller than the background concentration (aluminum, antimony, lead, manganese, selenium, and vanadium). The remaining integrated COPECs in soil at the Former Plane Refueling/Crash Strip Area and Former Plane Burial Area [cadmium, copper, mercury, zinc, benzo(a)pyrene, and naphthalene] have a combination of factors that together eliminated them from further consideration. These factors are presented below:

1. Mean concentrations for mercury and zinc are only slightly higher than background concentrations.
2. Mean-to-ESV concentration ratios for cadmium, benzo(a)pyrene, and zinc are near 1.
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 current ESVs, ratios for cadmium, copper, mercury, and zinc would be near or below one.
4. Samples with elevated concentrations are limited to two relatively small areas on the AOC; therefore, exposure of ecological receptors to detected soil concentrations above the alternative ESVs is limited.
5. Wetland quality is medium or low. Migration of COPECs from AOC media to on-site wetlands is possible; however, naphthalene and benzo(a)pyrene are unlikely to migrate from the isolated, grassy median of the crash strip to on-site wetlands.
6. Off-site downstream sampling station indicates a healthy environment.

No final COPECs were identified for NACA Test Area surface soil. Of the six integrated COPECs in the three sediment EUs, HMX has no ESV. HMX was eliminated as a COPEC because it had low frequency of detection. Despite mercury being a PBT compound with an ESV that did not recognize bioaccumulation, mercury was eliminated because all detections were below the ESV and background concentration. Nickel was eliminated because the mean concentration was less than the SRV. Acenaphthene and bis(2-ethylhexyl)phthalate were eliminated due to a combination of factors, including low concentration-to-ESV ratio, low detections in soil, and the positive conditions in the downstream station in nearby Hinkley Creek. Acetone was similarly eliminated due to low detections in soil and the low quality, small, isolated habitat of the sampling location. No final COPECs were identified for NACA Test Area sediment.

Manganese and bis(2-ethylhexyl)phthalate were the only integrated COPECs in surface water. For manganese, the mean was below the background concentration in the Tributary to Hinkley Creek, and the manganese concentration in sediment is low in the Wetland/Pond North of Former Crash Area upstream of the Tributary to Hinkley Creek. Manganese shows a clear decrease in concentration along the downstream gradient through NACA Test Area, and conditions are positive in the nearest downstream station in Hinkley Creek. Therefore, manganese was eliminated as an integrated COPEC. For bis(2-ethylhexyl)phthalate, the MDC and mean were below the OMZM ESV and only slightly elevated above the OMZA ESV, and there is no background concentration for comparison. Bis(2-ethylhexyl)phthalate was only detected in one of three surface water samples, and conditions are positive in the nearest downstream station in Hinkley Creek. Therefore, bis(2-ethylhexyl)phthalate was eliminated as an integrated COPEC. No final COPECs were identified for NACA Test Area surface water.

7.3.3.9 Consideration of Human Health Driven Remediation

NACA Test Area has human health COCs (lead) identified as requiring remediation for Unrestricted (Residential) Land Use, Commercial/Industrial Land Use, and Military Training Land Use. In addition, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene are identified as COCs requiring remediation for Unrestricted (Residential) Land Use and Commercial/Industrial Land Use.

The HHRA recommends remediation of the following:

1. Lead contamination in the accumulated soil/sediment in the Former Crash Area Well Pit. The Former Crash Area Well Pit is not ecological habitat; therefore, human health driven remediation would not reduce exposure and risk to ecological receptors.
2. PAH contamination in surface soil (0–1 ft bgs) with concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene above CUGs within the runway median in the Former Plane Refueling/Crash Strip Area. The human health driven remediation would reduce exposure and risk to ecological receptors.
3. PAH contamination in surface soil (0–1 ft bgs) with concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene above CUGs in the Former Crash Area at sample location NTA-026. The human health driven remediation would reduce exposure and risk to ecological receptors.

7.3.3.10 Uncertainties and Mitigations

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 rare species sightings and jurisdictional wetlands was used (OHARNG 2014). In addition, the ORAM was applied to the wetlands. 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. These COPECs are assumed to have limited toxicity given the lack of cause-effect laboratory tests and field-observed effects in scientific literature. This is especially true of HMX in sediment, which has no available ESV, background concentration, or SRV.

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 provides an indication of 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).

7.3.3.11 Summary and Recommendations of Screening Level Ecological Risk Assessment

Integrated COPECs were identified in soil, sediment, and surface water at NACA Test Area. Soil was only evaluated in the PBA08 RI, whereas sediment and surface water COPECs were identified in both the historical and current ERAs. Those chemicals retained after screening historical and PBA08 RI data were termed integrated COPECs.

A total of 28 integrated soil COPECs, six integrated sediment COPECs, and one integrated surface water COPEC were further evaluated in Step 3A with evaluation and refinement factors. All integrated soil, sediment, and surface water COPECs were determined to be of no ecological concern and require no remediation or further evaluation. Consequently, the ERA for NACA Test Area can conclude with a Level II ERA that no further action is necessary to be protective of important ecological resources.

7.3.4 Conclusions

There is chemical contamination present in surface soil, sediment, and surface water at NACA Test Area. This contamination was identified using historical and PBA08 RI data. Dry, early-successional (dominant vegetation type) and seasonally flooded herbaceous fields; dry, mid-successional, cold deciduous and semi-permanently flooded shrublands; and four types of forests were observed on the 47 acres of the AOC. Wetlands, a pond, and streams are important and significant ecological resources near contamination in the AOC. 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 evaluation and refinement factors in Step 3A. The evaluation of these factors in Step 3A showed there is no further evaluation necessary for integrated COPECs, and there is no ecological COPC requiring remediation. Consequently, the ERA for NACA Test Area can conclude with a Level II ERA that no further action is necessary to be protective of important ecological resources.

Table 7–1. Risk Assessment Data Set for Surface Soil (0–1 ft bgs) Discrete Samples

Station	Sample ID	Date	Depth (ft bgs)
Former Plane Refueling/Crash Strip Area			
NTA-001	NTAss-001-0001-SO	10/20/1999	0 - 1
NTA-002	NTAss-002-0002-SO	10/21/1999	0 - 1
NTA-003	NTAss-003-0003-SO	10/21/1999	0 - 1
NTA-009	NTAss-009-0009-SO	10/20/1999	0 - 1
NTA-010	NTAss-010-0010-SO	10/21/1999	0 - 1
NTA-083	NTAss-083-0100-SO	10/19/1999	0 - 1
NTA-084	NTAss-084-0102-SO	10/19/1999	0 - 1
NTA-085	NTAss-085-0104-SO	10/19/1999	0 - 1
NTA-086	NTAss-086-0106-SO	10/19/1999	0 - 1
NTA-087	NTAss-087-0107-SO	10/19/1999	0 - 1
NTA-088	NTAss-088-0108-SO	10/19/1999	0 - 1
NTA-089	NTAss-089-0109-SO	10/19/1999	0 - 1
NTA-090	NTAss-090-0110-SO	10/19/1999	0 - 1
NTA-091	NTAss-091-0111-SO	10/19/1999	0 - 1
NTA-092	NTAss-092-0112-SO	10/19/1999	0 - 1
NTA-093	NTAss-093-0113-SO	10/19/1999	0 - 1
NTA-094	NTAss-094-0114-SO	10/19/1999	0 - 1
NTA-095	NTAss-095-0115-SO	10/19/1999	0 - 1
NTAsb-120	NTAsb-120-5293-SO	3/31/2010	0 - 1
NTAsb-121	NTAsb-121-5297-SO	3/31/2010	0 - 1
NTAsb-122	NTAsb-122-5301-SO	3/31/2010	0 - 1
NTAss-128	NTAss-128-5325-SO	4/8/2010	0 - 1
NTAss-129	NTAss-129-5326-SO	4/8/2010	0 - 1
NTAss-130	NTAss-130-5327-SO	4/8/2010	0 - 1
NTAss-131	NTAss-131-5328-SO	4/8/2010	0 - 1
NTAss-132	NTAss-132-5329-SO	4/8/2010	0 - 1
NTAss-133	NTAss-133-5330-SO	4/8/2010	0 - 1
NTAss-136	NTAss-136-5333-SO	4/8/2010	0 - 1
NTAss-134[a]	NTAss-134-5331-SO	4/8/2010	0 - 1
NTAss-135[a]	NTAss-135-5332-SO	4/8/2010	0 - 1
Former Crash Area			
NTA-004	NTAss-004-0004-SO	10/21/1999	0 - 1
NTA-005	NTAss-005-0005-SO	10/21/1999	0 - 1
NTA-006	NTAss-006-0006-SO	10/22/1999	0 - 1
NTA-007	NTAss-007-0007-SO	10/24/1999	0 - 1
NTA-008	NTAss-008-0008-SO	10/24/1999	0 - 1
NTA-011	NTAss-011-0011-SO	10/21/1999	0 - 1
NTA-012	NTAss-012-0012-SO	10/21/1999	0 - 1
NTA-013	NTAss-013-0013-SO	10/21/1999	0 - 1
NTA-014	NTAss-014-0014-SO	10/22/1999	0 - 1
NTA-015	NTAss-015-0015-SO	10/24/1999	0 - 1
NTA-016	NTAss-016-0016-SO	10/24/1999	0 - 1
NTA-017	NTAss-017-0017-SO	10/20/1999	0 - 1
NTA-018	NTAss-018-0018-SO	10/21/1999	0 - 1
NTA-019	NTAss-019-0019-SO	10/21/1999	0 - 1
NTA-020	NTAss-020-0020-SO	10/21/1999	0 - 1
NTA-021	NTAss-021-0021-SO	10/22/1999	0 - 1
NTA-022	NTAss-022-0022-SO	10/22/1999	0 - 1
NTA-023	NTAss-023-0023-SO	10/24/1999	0 - 1
NTA-024	NTAss-024-0024-SO	10/24/1999	0 - 1
NTA-025	NTAss-025-0025-SO	10/20/1999	0 - 1

Table 7–1. Risk Assessment Data Set for Surface Soil (0–1 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth (ft bgs)
NTA-026	NTAss-026-0026-SO	10/20/1999	0 - 1
NTA-027	NTAss-027-0027-SO	10/22/1999	0 - 1
NTA-028	NTAss-028-0028-SO	10/22/1999	0 - 1
NTA-029	NTAss-029-0029-SO	10/22/1999	0 - 1
NTA-030	NTAss-030-0030-SO	10/22/1999	0 - 1
NTA-031	NTAss-031-0031-SO	10/24/1999	0 - 1
NTA-032	NTAss-032-0032-SO	10/24/1999	0 - 1
NTA-033	NTAss-033-0033-SO	10/20/1999	0 - 1
NTA-034	NTAss-034-0034-SO	10/22/1999	0 - 1
NTA-035	NTAss-035-0035-SO	10/22/1999	0 - 1
NTA-036	NTAss-036-0036-SO	10/22/1999	0 - 1
NTA-037	NTAss-037-0037-SO	10/22/1999	0 - 1
NTA-038	NTAss-038-0038-SO	10/24/1999	0 - 1
NTA-039	NTAss-039-0040-SO	10/24/1999	0 - 1
NTA-040	NTAss-040-0041-SO	10/24/1999	0 - 1
NTA-041	NTAss-041-0042-SO	10/20/1999	0 - 1
NTA-042	NTAss-042-0043-SO	10/25/1999	0 - 1
NTA-043	NTAss-043-0044-SO	10/25/1999	0 - 1
NTA-044	NTAss-044-0045-SO	10/25/1999	0 - 1
NTA-045	NTAss-045-0046-SO	10/26/1999	0 - 1
NTA-046	NTAss-046-0047-SO	10/26/1999	0 - 1
NTA-048	NTAss-048-0049-SO	10/24/1999	0 - 1
NTA-049	NTAss-049-0050-SO	10/20/1999	0 - 1
NTA-050	NTAss-050-0051-SO	10/25/1999	0 - 1
NTA-051	NTAss-051-0052-SO	10/25/1999	0 - 1
NTA-047	NTAss-047-0048-SO	10/26/1999	0 - 1
NTA-052	NTAss-052-0053-SO	10/25/1999	0 - 1
NTA-053	NTAss-053-0054-SO	10/25/1999	0 - 1
NTA-054	NTAss-054-0055-SO	10/26/1999	0 - 1
NTA-055	NTAss-055-0056-SO	10/26/1999	0 - 1
NTA-056	NTAss-056-0057-SO	10/26/1999	0 - 1
NTA-057	NTAss-057-0058-SO	10/20/1999	0 - 1
NTA-058	NTAss-058-0060-SO	10/25/1999	0 - 1
NTA-059	NTAss-059-0061-SO	10/25/1999	0 - 1
NTA-060	NTAss-060-0062-SO	10/25/1999	0 - 1
NTA-061	NTAss-061-0063-SO	10/25/1999	0 - 1
NTA-062	NTAss-062-0064-SO	10/26/1999	0 - 1
NTA-063	NTAss-063-0065-SO	10/26/1999	0 - 1
NTA-064	NTAss-064-0066-SO	10/26/1999	0 - 1
NTA-096	NTAss-096-0117-SO	10/20/1999	0 - 1
NTA-097	NTAss-097-0118-SO	10/20/1999	0 - 1
NTA-098	NTAss-098-0119-SO	10/20/1999	0 - 1
NTAsb-123	NTAsb-123-5305-SO	3/31/2010	0 - 1
NTAsb-124	NTAsb-124-5309-SO	3/31/2010	0 - 1
NTAsb-125	NTAsb-125-5313-SO	3/31/2010	0 - 1
NTAsb-126	NTAsb-126-5317-SO	4/8/2010	0 - 1
NTAsb-127	NTAsb-127-5321-SO	4/8/2010	0 - 1
NTAss-137	NTAss-137-5334-SO	4/8/2010	0 - 1
NTAss-138	NTAss-138-5335-SO	4/8/2010	0 - 1
NTAss-139	NTAss-139-5336-SO	4/8/2010	0 - 1

Table 7–1. Risk Assessment Data Set for Surface Soil (0–1 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth (ft bgs)
Former Plane Burial Area			
NTA-065	NTAss-065-0067-SO	11/2/1999	0 - 1
NTA-066	NTAss-066-0069-SO	11/2/1999	0 - 1
NTA-067	NTAss-067-0071-SO	11/3/1999	0 - 1
NTA-068	NTAss-068-0073-SO	11/2/1999	0 - 1
NTA-069	NTAss-069-0075-SO	11/2/1999	0 - 1
NTA-070	NTAss-070-0078-SO	11/2/1999	0 - 1
NTA-071	NTAss-071-0080-SO	10/27/1999	0 - 1
NTA-072	NTAss-072-0082-SO	10/27/1999	0 - 1
NTA-073	NTAss-073-0084-SO	11/2/1999	0 - 1
NTA-074	NTAss-074-0086-SO	10/27/1999	0 - 1
NTA-075	NTAss-075-0088-SO	10/27/1999	0 - 1
NTA-076	NTAss-076-0090-SO	11/3/1999	0 - 1
NTA-077	NTAss-077-0092-SO	11/1/1999	0 - 1
NTA-078	NTAss-078-0094-SO	11/3/1999	0 - 1
NTA-079	NTAss-079-0095-SO	11/3/1999	0 - 1
NTA-080	NTAss-080-0097-SO	11/1/1999	0 - 1
NTA-081	NTAss-081-0098-SO	11/3/1999	0 - 1
NTA-082	NTAss-082-0099-SO	11/3/1999	0 - 1
NTA-100	NTAss-100-0122-SO	11/4/1999	0 - 1
NTAss-141	NTAss-141-5338-SO	4/8/2010	0 - 1
NTAss-142	NTAss-142-5339-SO	4/8/2010	0 - 1
NTAss-140[a]	NTAss-140-5337-SO	4/8/2010	0 - 1
Former Crash Area Well Pit			
NTA-101	NTAsd-101-0124-SD	10/22/1999	0 - 0.5

[a] Chromium speciation samples used to evaluate the presence of hexavalent chromium.
bgs = Below ground surface.
ft = Feet.
ID = Identification.

Table 7–2. Risk Assessment Data Set for Deep Surface Soil (0–4 ft bgs)
Discrete Samples

Station	Sample ID	Date	Depth[a] (ft bgs)
Former Plane Refueling/Crash Strip Area			
NTA-001	NTAss-001-0001-SO	10/20/1999	0 - 1
NTA-002	NTAss-002-0002-SO	10/21/1999	0 - 1
NTA-003	NTAss-003-0003-SO	10/21/1999	0 - 1
NTA-009	NTAss-009-0009-SO	10/20/1999	0 - 1
NTA-010	NTAss-010-0010-SO	10/21/1999	0 - 1
NTA-083	NTAss-083-0100-SO	10/19/1999	0 - 1
NTA-084	NTAss-084-0102-SO	10/19/1999	0 - 1
NTA-085	NTAss-085-0104-SO	10/19/1999	0 - 1
NTA-086	NTAss-086-0106-SO	10/19/1999	0 - 1
NTA-087	NTAss-087-0107-SO	10/19/1999	0 - 1
NTA-088	NTAss-088-0108-SO	10/19/1999	0 - 1
NTA-089	NTAss-089-0109-SO	10/19/1999	0 - 1
NTA-090	NTAss-090-0110-SO	10/19/1999	0 - 1
NTA-091	NTAss-091-0111-SO	10/19/1999	0 - 1
NTA-092	NTAss-092-0112-SO	10/19/1999	0 - 1
NTA-093	NTAss-093-0113-SO	10/19/1999	0 - 1
NTA-094	NTAss-094-0114-SO	10/19/1999	0 - 1
NTA-095	NTAss-095-0115-SO	10/19/1999	0 - 1
NTAsb-120	NTAsb-120-5293-SO	3/31/2010	0 - 1
NTAsb-121	NTAsb-121-5297-SO	3/31/2010	0 - 1
NTAsb-122	NTAsb-122-5301-SO	3/31/2010	0 - 1
NTAss-128	NTAss-128-5325-SO	4/8/2010	0 - 1
NTAss-129	NTAss-129-5326-SO	4/8/2010	0 - 1
NTAss-130	NTAss-130-5327-SO	4/8/2010	0 - 1
NTAss-131	NTAss-131-5328-SO	4/8/2010	0 - 1
NTAss-132	NTAss-132-5329-SO	4/8/2010	0 - 1
NTAss-133	NTAss-133-5330-SO	4/8/2010	0 - 1
NTAss-134[b]	NTAss-134-5331-SO	4/8/2010	0 - 1
NTAss-135[b]	NTAss-135-5332-SO	4/8/2010	0 - 1
NTAss-136	NTAss-136-5333-SO	4/8/2010	0 - 1
NTA-083	NTAso-083-0101-SO	10/19/1999	1 - 3
NTA-084	NTAso-084-0103-SO	10/19/1999	1 - 3
NTA-085	NTAso-085-0105-SO	10/19/1999	1 - 3
NTA-095	NTAso-095-0116-SO	10/19/1999	1 - 3
NTAsb-120	NTAsb-120-5294-SO	3/31/2010	1 - 4
NTAsb-121	NTAsb-121-5298-SO	3/31/2010	1 - 4
NTAsb-122	NTAsb-122-5302-SO	3/31/2010	1 - 4
Former Crash Area			
NTA-004	NTAss-004-0004-SO	10/21/1999	0 - 1
NTA-005	NTAss-005-0005-SO	10/21/1999	0 - 1
NTA-006	NTAss-006-0006-SO	10/22/1999	0 - 1
NTA-007	NTAss-007-0007-SO	10/24/1999	0 - 1
NTA-008	NTAss-008-0008-SO	10/24/1999	0 - 1
NTA-011	NTAss-011-0011-SO	10/21/1999	0 - 1
NTA-012	NTAss-012-0012-SO	10/21/1999	0 - 1
NTA-013	NTAss-013-0013-SO	10/21/1999	0 - 1
NTA-014	NTAss-014-0014-SO	10/22/1999	0 - 1
NTA-015	NTAss-015-0015-SO	10/24/1999	0 - 1
NTA-016	NTAss-016-0016-SO	10/24/1999	0 - 1
NTA-017	NTAss-017-0017-SO	10/20/1999	0 - 1

Table 7–2. Risk Assessment Data Set for Deep Surface Soil (0–4 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth[a] (ft bgs)
NTA-018	NTAss-018-0018-SO	10/21/1999	0 - 1
NTA-019	NTAss-019-0019-SO	10/21/1999	0 - 1
NTA-020	NTAss-020-0020-SO	10/21/1999	0 - 1
NTA-021	NTAss-021-0021-SO	10/22/1999	0 - 1
NTA-022	NTAss-022-0022-SO	10/22/1999	0 - 1
NTA-023	NTAss-023-0023-SO	10/24/1999	0 - 1
NTA-024	NTAss-024-0024-SO	10/24/1999	0 - 1
NTA-025	NTAss-025-0025-SO	10/20/1999	0 - 1
NTA-026	NTAss-026-0026-SO	10/20/1999	0 - 1
NTA-027	NTAss-027-0027-SO	10/22/1999	0 - 1
NTA-028	NTAss-028-0028-SO	10/22/1999	0 - 1
NTA-029	NTAss-029-0029-SO	10/22/1999	0 - 1
NTA-030	NTAss-030-0030-SO	10/22/1999	0 - 1
NTA-031	NTAss-031-0031-SO	10/24/1999	0 - 1
NTA-032	NTAss-032-0032-SO	10/24/1999	0 - 1
NTA-033	NTAss-033-0033-SO	10/20/1999	0 - 1
NTA-034	NTAss-034-0034-SO	10/22/1999	0 - 1
NTA-035	NTAss-035-0035-SO	10/22/1999	0 - 1
NTA-036	NTAss-036-0036-SO	10/22/1999	0 - 1
NTA-037	NTAss-037-0037-SO	10/22/1999	0 - 1
NTA-038	NTAss-038-0038-SO	10/24/1999	0 - 1
NTA-039	NTAss-039-0040-SO	10/24/1999	0 - 1
NTA-040	NTAss-040-0041-SO	10/24/1999	0 - 1
NTA-041	NTAss-041-0042-SO	10/20/1999	0 - 1
NTA-042	NTAss-042-0043-SO	10/25/1999	0 - 1
NTA-043	NTAss-043-0044-SO	10/25/1999	0 - 1
NTA-044	NTAss-044-0045-SO	10/25/1999	0 - 1
NTA-045	NTAss-045-0046-SO	10/26/1999	0 - 1
NTA-046	NTAss-046-0047-SO	10/26/1999	0 - 1
NTA-047	NTAss-047-0048-SO	10/26/1999	0 - 1
NTA-048	NTAss-048-0049-SO	10/24/1999	0 - 1
NTA-049	NTAss-049-0050-SO	10/20/1999	0 - 1
NTA-050	NTAss-050-0051-SO	10/25/1999	0 - 1
NTA-051	NTAss-051-0052-SO	10/25/1999	0 - 1
NTA-052	NTAss-052-0053-SO	10/25/1999	0 - 1
NTA-053	NTAss-053-0054-SO	10/25/1999	0 - 1
NTA-054	NTAss-054-0055-SO	10/26/1999	0 - 1
NTA-055	NTAss-055-0056-SO	10/26/1999	0 - 1
NTA-056	NTAss-056-0057-SO	10/26/1999	0 - 1
NTA-057	NTAss-057-0058-SO	10/20/1999	0 - 1
NTA-058	NTAss-058-0060-SO	10/25/1999	0 - 1
NTA-059	NTAss-059-0061-SO	10/25/1999	0 - 1
NTA-060	NTAss-060-0062-SO	10/25/1999	0 - 1
NTA-061	NTAss-061-0063-SO	10/25/1999	0 - 1
NTA-062	NTAss-062-0064-SO	10/26/1999	0 - 1
NTA-063	NTAss-063-0065-SO	10/26/1999	0 - 1
NTA-064	NTAss-064-0066-SO	10/26/1999	0 - 1
NTA-096	NTAss-096-0117-SO	10/20/1999	0 - 1
NTA-097	NTAss-097-0118-SO	10/20/1999	0 - 1
NTA-098	NTAss-098-0119-SO	10/20/1999	0 - 1
NTAsb-123	NTAsb-123-5305-SO	3/31/2010	0 - 1
NTAsb-124	NTAsb-124-5309-SO	3/31/2010	0 - 1

Table 7–2. Risk Assessment Data Set for Deep Surface Soil (0–4 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth[a] (ft bgs)
NTAsb-125	NTAsb-125-5313-SO	3/31/2010	0 - 1
NTAsb-126	NTAsb-126-5317-SO	4/8/2010	0 - 1
NTAsb-127	NTAsb-127-5321-SO	4/8/2010	0 - 1
NTAss-137	NTAss-137-5334-SO	4/8/2010	0 - 1
NTAss-138	NTAss-138-5335-SO	4/8/2010	0 - 1
NTAss-139	NTAss-139-5336-SO	4/8/2010	0 - 1
NTAsb-123	NTAsb-123-5306-SO	3/31/2010	1 - 4
NTAsb-124	NTAsb-124-5310-SO	3/31/2010	1 - 4
NTAsb-125	NTAsb-125-5314-SO	3/31/2010	1 - 4
NTAsb-126	NTAsb-126-5318-SO	4/8/2010	1 - 4
NTAsb-127	NTAsb-127-5322-SO	4/8/2010	1 - 4
Former Plane Burial Area			
NTA-065	NTAss-065-0067-SO	11/2/1999	0 - 1
NTA-066	NTAss-066-0069-SO	11/2/1999	0 - 1
NTA-067	NTAss-067-0071-SO	11/3/1999	0 - 1
NTA-068	NTAss-068-0073-SO	11/2/1999	0 - 1
NTA-069	NTAss-069-0075-SO	11/2/1999	0 - 1
NTA-070	NTAss-070-0078-SO	11/2/1999	0 - 1
NTA-071	NTAss-071-0080-SO	10/27/1999	0 - 1
NTA-072	NTAss-072-0082-SO	10/27/1999	0 - 1
NTA-073	NTAss-073-0084-SO	11/2/1999	0 - 1
NTA-074	NTAss-074-0086-SO	10/27/1999	0 - 1
NTA-075	NTAss-075-0088-SO	10/27/1999	0 - 1
NTA-076	NTAss-076-0090-SO	11/3/1999	0 - 1
NTA-077	NTAss-077-0092-SO	11/1/1999	0 - 1
NTA-078	NTAss-078-0094-SO	11/3/1999	0 - 1
NTA-079	NTAss-079-0095-SO	11/3/1999	0 - 1
NTA-080	NTAss-080-0097-SO	11/1/1999	0 - 1
NTA-081	NTAss-081-0098-SO	11/3/1999	0 - 1
NTA-082	NTAss-082-0099-SO	11/3/1999	0 - 1
NTA-100	NTAss-100-0122-SO	11/4/1999	0 - 1
NTAss-140[b]	NTAss-140-5337-SO	4/8/2010	0 - 1
NTAss-141	NTAss-141-5338-SO	4/8/2010	0 - 1
NTAss-142	NTAss-142-5339-SO	4/8/2010	0 - 1
NTA-065	NTAso-065-0068-SO	11/2/1999	1 - 3
NTA-066	NTAso-066-0070-SO	11/2/1999	1 - 3
NTA-067	NTAso-067-0072-SO	11/3/1999	1 - 3
NTA-068	NTAso-068-0074-SO	11/2/1999	1 - 3
NTA-069	NTAso-069-0076-SO	11/2/1999	1 - 3
NTA-070	NTAso-070-0079-SO	11/2/1999	1 - 3
NTA-071	NTAso-071-0081-SO	10/27/1999	1 - 3
NTA-072	NTAso-072-0083-SO	10/27/1999	1 - 3
NTA-073	NTAso-073-0085-SO	11/2/1999	1 - 3
NTA-074	NTAso-074-0087-SO	10/27/1999	1 - 3
NTA-075	NTAso-075-0089-SO	10/27/1999	1 - 3
NTA-076	NTAso-076-0091-SO	11/3/1999	1 - 3
NTA-077	NTAso-077-0093-SO	11/1/1999	1 - 3
NTA-079	NTAso-079-0096-SO	11/3/1999	1 - 3
NTA-100	NTAso-100-0123-SO	11/4/1999	1 - 3
NTA-070	NTAss-070-0120-SO	11/2/1999	3 - 5
NTA-073	NTAso-073-0121-SO	11/2/1999	3 - 5

Table 7–2. Risk Assessment Data Set for Deep Surface Soil (0–4 ft bgs) Discrete Samples (continued)

Station	Sample ID	Date	Depth[a] (ft bgs)
Former Crash Area Well Pit			
NTA-101	NTAsd-101-0124-SD	10/22/1999	0 - 0.5

[a] Samples were assigned to depth intervals based on starting depth. For example, a sample collected from 3–5 ft bgs is included in the 0–4 ft deep surface soil interval.

[b] Chromium speciation samples used to evaluate the presence of hexavalent chromium.

bgs = Below ground surface.

ft = Feet.

ID = Identification.

Table 7–3. Risk Assessment Data Set for Subsurface Soil Discrete Samples

Station	Sample ID	Date	Depth[a] (ft bgs)
National Guard Trainee[b]			
Former Plane Refueling/Crash Strip Area			
NTAsb-120	NTAsb-120-5295-SO	3/31/2010	4 - 7
NTAsb-121	NTAsb-121-5299-SO	3/31/2010	4 - 7
NTAsb-122	NTAsb-122-5303-SO	3/31/2010	4 - 7
Former Crash Area			
NTAsb-123	NTAsb-123-5307-SO	3/31/2010	4 - 7
NTAsb-124	NTAsb-124-5311-SO	3/31/2010	4 - 7
NTAsb-125	NTAsb-125-5315-SO	3/31/2010	4 - 7
NTAsb-126	NTAsb-126-5319-SO	4/8/2010	4 - 7
NTAsb-127	NTAsb-127-5323-SO	4/8/2010	4 - 7
Resident Receptor (Adult and Child)[c]			
Former Plane Refueling/Crash Strip Area			
NTAsb-120	NTAsb-120-5295-SO	3/31/2010	4 - 7
NTAsb-121	NTAsb-121-5299-SO	3/31/2010	4 - 7
NTAsb-122	NTAsb-122-5303-SO	3/31/2010	4 - 7
Former Crash Area			
NTAsb-123	NTAsb-123-5307-SO	3/31/2010	4 - 7
NTAsb-124	NTAsb-124-5311-SO	3/31/2010	4 - 7
NTAsb-125	NTAsb-125-5315-SO	3/31/2010	4 - 7
NTAsb-126	NTAsb-126-5319-SO	4/8/2010	4 - 7
NTAsb-127	NTAsb-127-5323-SO	4/8/2010	4 - 7
NTAsb-124	NTAsb-124-5312-SO	3/31/2010	7 - 13
NTAsb-125	NTAsb-125-5316-SO	3/31/2010	7 - 13

Samples were assigned to depth intervals based on starting depth. For example a sample collected from 3–5 ft bgs is included in the 0–4 ft deep surface soil interval.

[b] Subsurface soil defined as 4–7 ft bgs for National Guard Trainee.

[c] Subsurface soil defined as 1–13 ft bgs for Resident Receptor (Adult and Child).

bgs = Below ground surface.

ft = Feet.

ID = Identification.

Table 7–4. Risk Assessment Data Set for Surface Water

Station	Sample ID	Date
Wetland/Pond North of Former Crash Area		
NTAsw-144	NTAsw-144-5341-SW	3/9/2010
Tributary to Hinkley Creek		
NTAsw-143	NTAsw-143-5340-SW	3/9/2010
NTAsw-145	NTAsw-145-5342-SW	2/25/2010

ID = Identification.

Table 7–5. Risk Assessment Data Set for Sediment

Station	Sample ID	Date	Depth (ft bgs)
Wetland/Pond North of Former Crash Area			
NTAsd-144	NTAsd-144-5344-SD	3/9/2010	0 - 0.5
Tributary to Hinkley Creek			
NTAsd-143	NTAsd-143-5343-SD	3/9/2010	0 - 0.5
NTAsd-145	NTAsd-145-5345-SD	2/25/2010	0 - 0.5
Former Crash Area Reservoir			
NTA-102	NTAsd-102-0125-SD	10/22/1999	0 - 0.5

bgs = Below ground surface.
ft = Feet.
ID = Identification.

Table 7–6. Summary of SRCs

	Surface Soil (0–1 ft bgs)				**Deep Surface Soil (0–4 ft bgs)**				**Subsurface Soil (4–7 ft bgs)**			**Subsurface Soil (1–13 ft bgs)**			**Sediment**			**Surface Water**	
SRC	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CS**	**CA**	**PBA**	**WP**	**T**	**R**	**WP**	**T**
Inorganic Chemicals																			
Aluminum	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	X	X	--		X	X	--	--	--	--	--	--	--	--	--	--	--	X
Arsenic	X	X	X	--	X	X	X	--	--	X	--	--	X	--	--	--	--	--	--
Barium	X	X	X	X	X	X	X	X	--	--	--	--	X	X	--	--	--	--	--
Beryllium	X	X	X	--	X	X	X	--	--	--	--	--	X	--	X	X	--	--	--
Cadmium	X	X	X	X	X	X	X	X	X	X	--	X	X	X	X	X	--	--	X
Chromium	X	X	X	X	X	X	X	X	--	--	--	--	--	--	--	X	--	--	X
Cobalt	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	X	--	X	X
Copper	X	X	X	X	X	X	X	X	--	--	--	--	--	X	--	--	--	--	--
Cyanide	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	X	X	X	X	X	X	X	X	--	--	--	--	--	X	--	--	--	X	X
Manganese	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	X	X
Mercury	X	X	X	--	X	X	X	--	--	--	--	X	--	--	--	--	--	--	--
Nickel	X	X	X	X	X	X	X	X	--	--	--	--	--	--	--	X	--	X	X
Selenium	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	--	X
Silver	X	--	X	X	X	--	X	X	--	X	--	X	X	--	X	X	--	--	--
Thallium	X	X	X	X	X	X	X	X	--	--	--	--	--	--	--	--	--	X	--
Vanadium	X	--	X	--	X	--	X	--	--	--	--	--	--	--	--	--	--	--	X
Zinc	X	X	X	X	X	X	X	X	--	--	--	--	--	X	--	--	--	--	--
Explosives																			
1,3,5-Trinitrobenzene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trinitrotoluene	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
HMX	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	--	--	--
Nitrocellulose	X	X	--	X	X	X	--	X	--	--	--	--	--	--	--	--	--	--	--
Pesticide/PCB																			
delta-BHC	--	--	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	--

Table 7–6. Summary of SRCs (continued)

	Surface Soil (0–1 ft bgs)				Deep Surface Soil (0–4 ft bgs)				Subsurface Soil (4–7 ft bgs)			Subsurface Soil (1–13 ft bgs)			Sediment			Surface Water	
SRC	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CS**	**CA**	**PBA**	**WP**	**T**	**R**	**WP**	**T**
SVOCs																			
Acenaphthene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	--	--	--
Acenaphthylene	X	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	--	--
Anthracene	X	--	--	--	X	--	--	--	--	--	--	X	--	--	--	X	--	--	--
Benz(a)anthracene	X	X	--	--	X	X	--	--	--	--	--	X	X	--	--	X	--	--	--
Benzo(a)pyrene	X	X	--	--	X	X	--	--	--	--	--	X	X	--	--	X	--	--	--
Benzo(b)fluoranthene	X	X	X	--	X	X	X	--	--	X	--	X	X	--	--	X	--	--	--
Benzo(ghi)perylene	X	X	--	--	X	X	--	--	--	X	--	X	X	--	--	X	--	--	--
Benzo(k)fluoranthene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	X	--	--	--
Bis(2-ethylhexyl)phthalate	X	X	X	--	X	X	X	--	--	--	--	X	X	X	--	X	--	--	X
Carbazole	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysene	X	X	X	--	X	X	X	--	--	X	--	X	X	--	--	X	--	--	--
Dibenz(a,h)anthracene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	X	--	--	--
Dibenzofuran	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	X	X	X	--	X	X	X	--	--	--	--	X	X	--	--	X	--	--	--
Fluorene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	--	--	--
Indeno(1,2,3-cd)pyrene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	X	--	--	--
Naphthalene	X	--	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--
Phenanthrene	X	X	--	--	X	X	--	--	--	X	--	X	X	--	--	X	--	--	--
Pyrene	X	X	X	--	X	X	X	--	--	X	--	X	X	--	--	X	--	--	--

Table 7–6. Summary of SRCs (continued)

SRC	Surface Soil (0–1 ft bgs)				Deep Surface Soil (0–4 ft bgs)				Subsurface Soil (4–7 ft bgs)			Subsurface Soil (1–13 ft bgs)			Sediment			Surface Water	
	CS	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CS**	**CA**	**PBA**	**WP**	**T**	**R**	**WP**	**T**
VOCs																			
2-Butanone	X	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	--	--
Acetone	X	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--
Dimethylbenzene	--	X	--	X	--	X	--	X	--	--	--	--	--	X	--	--	--	--	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Methylene chloride	--	X	X	--	--	X	X	--	--	--	--	--	--	X	--	--	--	--	--
Styrene	--	--	X	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--
Toluene	--	--	X	--	--	--	X	--	--	--	--	--	--	X	X	--	--	X	--

bgs = Below ground surface.
CA = Former Crash Area.
CS = Former Plane Refueling/Crash Strip Area.
CWP = Former Crash Area Well Pit.
ft = Feet.
PBA = Former Plane Burial Area.
PCB = Polychlorinated biphenyl.
R = Former Crash Area Reservoir.
SRC = Site-related contaminant.
SVOC = Semi-volatile organic compound.
T = Tributary to Hinkley Creek.
VOC = Volatile organic chemical.
WP = Wetland/Pond North of Former Crash Area.
X = Chemical is an SRC at this depth interval.
-- = Chemical is not an SRC at this depth interval.

Table 7–7. Summary of COPCs for Each Exposure Medium

	Surface Soil (0–1 ft bgs)				Deep Surface Soil (0–4 ft bgs)				Subsurface Soil (4–7 ft bgs)			Subsurface Soil (1–13 ft bgs)			Sediment			Surface Water	
COPC	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CWP**	**CS**	**CA**	**PBA**	**CS**	**CA**	**PBA**	**WP**	**T**	**R**	**WP**	**T**
Inorganic Chemicals																			
Aluminum	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	X	X	X	--	X	X	X	--	--	X	--	--	X	--	--	--	--	--	--
Barium	X	--	--	X	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	X	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--
Cobalt	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	X	--	X	--
Copper	--	--	X	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--
Cyanide	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--
Manganese	X	X	X	--	X	X	X	--	--	--	--	--	--	--	--	--	--	X	--
Explosives																			
2,4,6-Trinitrotoluene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticide/PCB																			
delta-BHC	--	--	--	--	--	X	--	--	--	--	--	--	X	--	--	--	--	--	--
SVOCs																			
Benz(a)anthracene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	--	--	--	--
Benzo(a)pyrene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	X	--	--	--
Benzo(b)fluoranthene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	--	--	--	--
Benzo(k)fluoranthene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Chrysene	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	X	X	--	--	X	X	--	--	--	--	--	X	--	--	--	--	--	--	--

bgs = Below ground surface.
CA = Former Crash Area.
COPC = Chemical of potential concern.
CS = Former Plane Refueling/Crash Strip Area.
CWP = Former Crash Area Well Pit.
PBA = Former Plane Burial Area.
PCB = Polychlorinated biphenyl.
R = Former Crash Area Reservoir.
SVOC = Semi-volatile organic compound.
T = Tributary to Hinkley Creek.
WP = Wetland/Pond North of Former Crash Area.
X = Chemical is an SRC at this depth interval.
-- = Chemical is not an SRC at this depth interval.

Table 7–8. Screening Levels Corresponding to an HQ of 1 and TR of 1E-05 in Soil and/or Sediment

		Soil/Sediment Screening Level (mg/kg)					
		Resident Receptor[a] FWCUG		Industrial Receptor RSL		NGT Receptor FWCUG	
COPC	**Critical Effect or Target Organ**	**HQ=1**	**TR=1E-05**	**HQ =1**	**TR=1E-05**	**HQ=1**	**TR=1E-05**
Aluminum	Neurotoxicity in offspring	73,798	--	1,100,000	--	34,960	--
Antimony	Longevity, blood glucose, and cholesterol	28.2	--	470	--	1,753	--
Arsenic	Skin	20.2	4.25[b]	480	30	1,140	27.8
Barium	Nephropathy	14,129	--	220,000	--	3,506	--
Cadmium	Proteinuria	64.1	12,491	980	9,300	3,292	109
Cobalt[c]	NS	1,313	8,030	350	19,000	140	70.3
Copper	GI, kidney, liver	3,106	--	47,000	--	253,680	--
Cyanide	Decreased caudal epididymis weight	2.7[d]	--	12[d]	--	12[d]	--
Lead	--	400[e]	--	800[e]	--	800[e]	--
Manganese	CNS	2,927	--	26,000	--	351[b]	--
2,4,6-Trinitrotoluene	Liver	36.5	284	510		2,488	4643
Delta-BHC	--	--	--	--	--	--	--
Benz(a)anthracene	NA	--	2.21	--	29	--	47.7
Benzo(a)pyrene	NA	--	0.221	--	2.9	--	4.77
Benzo(b)fluoranthene	NA	--	2.21	--	29	--	47.7
Benzo(k)fluoranthene	NA	--	22.1	--	290	--	477
Chrysene	NA	--	221	--	2,900	--	4,774
Dibenz(a,h)anthracene	NA	--	0.221	--	2.9	--	4.77
Indeno(1,2,3-cd)pyrene	NA	--	2.21	--	29	--	47.7

[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), subsurface soil (19.8 mg/kg) and sediment (19.5 mg/kg) and for manganese in surface soil (1,450 mg/kg), subsurface soil (3,030 mg/kg), and sediment (1,950 mg/kg).

[c] No FWCUGs are available for cobalt in sediment. The sediment and surface soil FWCUGs are the same for these receptors; therefore, cobalt concentrations were compared to the FWCUG for soil for the identification of COCs in sediment.

[d] No FWCUG is available for cyanide; the RSL is used.

[e] No FWCUG is available for lead; the RSL is used. No endpoint is specified for this screening level.

CNS = Central Nervous System.
COC = Chemical of concern.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
GI = Gastrointestinal.
HQ = Hazard quotient.
NA = Not applicable, no non-cancer effects evaluated.
NGT = National Guard Trainee.
NS = Not specified.
RSL = Regional screening level.
TR = Target risk.
-- = No FWCUG available for this endpoint.

Table 7–9. FWCUGs Corresponding to an HQ of 1.0 and TR of 1E-05 in Surface Water

COPC	Critical Effect or Target Organ	FWCUG (mg/L)					
		Resident Receptor[a] FWCUG		Industrial Receptor RSL		NGT Receptor FWCUG	
		HQ=1	TR=1E-05	HQ=1	TR=1E-05	HQ=1	TR=1E-05
Cobalt	NS	0.006[b]	--	NA	NA	0.006[b]	--
Manganese	CNS	6.326	--	NA	NA	14.488	--
Bis(2-ethylhexyl)phthalate	Liver, kidney	0.223	0.0349	NA	NA	0.679	0.0679

[a] Resident Receptor FWCUGs are the smaller of the Adult or Child values for each COPC and endpoint (non-cancer and cancer).

[b] No FWCUG is available for cobalt. Value is the U.S. Environmental Protection Agency (USEPA) tap water RSL.

CNS = Central Nervous System.
COPC = Chemical of potential concern.
FWCUG = Facility-wide cleanup goal.
HQ = Hazard quotient.
mg/L = Milligrams per liter.
NA = Not applicable.
NGT = National Guard Trainee.
NS = Not specified.
RSL = Regional screening level.
TR = Target risk.
-- = No value available.

Table 7–10. COCs Exceeding FWCUGs or Contributing to an SOR Greater than One in Soil

	EPC (mg/kg)				Resident Receptor FWCUG (mg/kg)	Industrial Receptor RSL (mg/kg)	National Guard Receptor FWCUG (mg/kg)
	Surface Soil[a]		Subsurface Soil[b]				
COC	(0–1 ft bgs)	(0–4 ft bgs)	(1–13 ft bgs)	(4–7 ft bgs)			
Former Plane Refueling/Crash Strip Area							
Benz(a)anthracene	**4.09**	3.29	0.191	NA	2.21	29	47.7
Benzo(a)pyrene	**4.70***	3.79	**0.255**	NA	0.221	2.9	4.77
Benzo(b)fluoranthene	**6.17**	4.97	0.338	NA	2.21	29	47.7
Dibenz(a,h)anthracene	**0.737**	0.609	0.110	NA	0.221	2.9	4.77
Indeno(1,2,3-cd)pyrene	**2.81**	2.28	0.207	NA	2.21	29	47.7
Former Crash Area							
Benz(a)anthracene	0.239	0.224	NA	NA	2.21	29	47.7
Benzo(a)pyrene	**0.254**	0.239	NA	NA	0.221	2.9	4.7
Benzo(b)fluoranthene	0.300	0.281	NA	NA	2.21	29	47.7
Dibenz(a,h)anthracene	0.199	0.189	NA	NA	0.221	2.9	4.7
Former Plane Burial Area							
None							
Former Crash Area Well Pit							
Lead	**13200***	**13200****	NA	NA	400[c]	800	800[d]

[a] Surface soil (0–1 ft bgs) used to evaluate Resident Receptor and Industrial Receptor. Surface Soil (0–4 ft bgs) used to evaluate National Guard Trainee Receptor.

[b] Subsurface soil (1–13 ft bgs) used to evaluate Resident Receptor and Industrial Receptor. Subsurface soil (4–7 ft bgs) used to evaluate National Guard Trainee Receptor.

[c] No FWCUG available for Resident Receptor, value is Residential RSL.

[d] No FWCUG available for National Guard Trainee, value is Industrial RSL.

bgs = Below ground surface.
COC = Chemical of concern.
EPC = Exposure point concentration for the exposure unit.
FWCUG = Facility-wide cleanup goal.
mg/kg = Milligrams per kilogram.
NA = Chemical is not a COPC at this exposure depth.
RSL = Regional Screening Level.
SOR = Sum of ratios.

bold = Concentration exceeds Residential FWCUG
bold* = Concentration exceeds Residential FWCUG and Industrial RSL
bold** = Concentration exceeds National Guard Trainee FWCUG

Table 7–11. Benzo(a)pyrene Concentrations Reported in Surface Soil Samples Collected in 1999 and 2010

1999		2010		Comments
Sample Location[a]	**Concentration (mg/kg)**	**Sample Location**	**Concentration (mg/kg)**	
NTA-083	3.5J	NTAsb-120	0.62J	Soil boring at NTAsb-120 is at same location as previous sample NTA-083. This location had the highest reported concentration in 2010.
NTA-088	41	NTAsb-121	0.3	Soil boring at NTAsb-121 is at same location as previous sample NTA-088. This location had the highest reported concentration in 1999.
NTA-089	5.1	NTAss-133	0.011	NTAss-133 is located approximately 75 ft southeast of NTA-089.
NTA-090	7.6	None	--	No PAH analysis is available from this location in 2010.

[a] Sample locations with the highest reported PAH concentrations. The highest reported concentration of benzo(a)pyrene in all other Crash Site surface soil samples collected in 1999 was 0.35 mg/kg.

mg/kg = Milligrams per kilogram.

PAH = Polycyclic aromatic hydrocarbon.

-- = No value available.

Table 7–12. Environmental Concentrations of PAHs Measured in Background Surface Soil Samples at RVAAP

Analyte	% Detectectable Concentrations		Reported Concentration (mg/kg)	
			Minimum	**Maximum**
Acenaphthene	1/15	7%	0.88	0.88
Acenaphthylene	1/15	7%	0.07	0.07
Anthracene	2/15	13%	0.12	1
Benz(a)anthracene	10/15	67%	0.044	4.1
Benzo(a)pyrene	8/15	53%	0.058	3.7
Benzo(b)fluoranthene	10/15	67%	0.062	4.8
Benzo(ghi)perylene	6/15	40%	0.046	1.3
Benzo(k)fluoranthene	6/15	40%	0.053	2.6
Chrysene	10/15	67%	0.057	4
Dibenz(a,h)anthracene	2/15	13%	0.11	0.37
Indeno(1,2,3-cd)pyrene	5/15	33%	0.054	1.5

mg/kg = Milligrams per kilogram.

PAH = Polycyclic aromatic hydrocarbon.

RVAAP = Ravenna Army Ammunition Plant.

Table 7–13. Baseline Levels of Benzo(a)pyrene in Soil from Various 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 all studies except: (1) New England value is 95% upper confidence limit and (2) New York State Department of Environmental Conservation (NYSDEC) values are distribution-free 95th percentile.

[b] Data reported by Massachusetts Department of Environmental Protection (MADEP 2002). CA/T = Data collected by Massachusetts 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 background data submitted by its members in 2001.Water Town and Worcester Site-specific background samples.

[c] Data from three New England locations from Bradley et al. 1994.

[d] Background concentrations of PAHs in Illinois metropolitan statistical areas (urban) and non-metropolitan statistical areas (rural) as reported by Illinois EPA (IEPA 2005)

[e] Generic background data published by the Agency for Toxic Substances and Disease Registry (ATSDR) in Polycyclic Aromatic Hydrocarbons (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

-- = No value reported for this source.

Table 7–14. Hot Spot Analysis for of PAH Concentrations at NACA Test Area

COPC	Benz(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Dibenz(a,h) anthracene	Indeno(1,2,3-cd) pyrene
Resident Receptor FWCUG	2.21	0.221	2.21	0.221	2.21
Industrial RSL	29	2.9	29	2.9	29
National Guard Trainee FWCUG	47.7	4.77	47.7	4.77	47.7
Former Plane Refueling/Crash Strip Area (0–1 ft bgs)					
NTA-083	**2.4**	**3.5***	**4.7**	**0.65**	**2.7**
NTA-084	0.086	0.1	0.13	ND	0.082
NTA-088	**36***	**41****	**54****	**5.7****	**24**
NTA-089	**3.8**	**5.1****	**6.8**	**0.67**	**3.2**
NTA-090	**6.6**	**7.6****	**10**	**0.93**	**4.2**
NTA-091/(NTA-091D)	0.051/(ND)	0.079/(0.052)	0.1/(0.076)	ND/(ND)	0.065/(ND)
NTA-092	ND	0.052	0.06	ND	ND
NTA-095	ND	0.053	0.051	ND	ND
NTAsb-120	0.53	**0.62**	0.79	0.083	0.28
NTAsb-121	0.25	**0.3**	0.43	0.048	0.21
NTAsb-122	0.21	**0.27**	0.35	0.042	0.18
NTAss-128	0.012	0.014	0.02	ND	0.0087
NTAss-129	0.29	**0.35**	0.48	ND	0.2

Table 7–14. Hot Spot Analysis for of PAH Concentrations at NACA Test Area (continued)

COPC	Benz(a) anthracene	Benzo(a)pyrene	Benzo(b) fluoranthene	Dibenz(a,h) anthracene	Indeno(1,2,3-cd) pyrene
NTAss-131	0.048	0.058	0.083	ND	0.038
NTAss-132	0.082	0.093	0.11	ND	0.058
NTAss-133	ND	0.011	ND	ND	ND
NTAss-136	ND	0.0097	ND	ND	ND
Former Plane Refueling/Crash Strip Area (1–13 ft bgs)					
NTA-083	0.46	0.7	1	0.11	0.52
NTAsb-121	0.011	0.011	0.016	ND	0.0085
NTAsb-122	ND	0.013	0.02	ND	0.0084
Former Crash Area (0 to 1 foot bgs)					
NTA-021	ND	ND	ND	0.14	0.12
NTA-022	ND	ND	0.05	ND	ND
NTA-025	0.064	0.084	0.12	ND	0.068
NTA-026	1.5	**1.9**	**3.2**	**0.35**	1.2
NTA-029	ND	0.06	0.079	ND	ND
NTA-032/NTA-032D	0.46/(0.12)	**0.43**/(0.14)	0.61/(0.2)	0.075/(ND)	0.34/(0.12)
NTA-056	0.05	ND	0.058	ND	ND
NTA-062	ND	ND	0.092	ND	ND
NTAsb-123	0.091	0.12	0.17	0.021	0.072
NTAsb-124/(NTAsb-124D)	ND/(0.0092)	ND/(ND)	0.014/(0.013)	ND/(ND)	ND/(ND)
NTAsb-125	0.011	0.014	0.017	ND	ND
NTAsb-126	0.017	0.017	0.029	ND	0.011
NTA-021	ND	ND	ND	0.14	0.12

All units in mg/kg.

Only samples with detected concentrations of one or more of these PAHs are presented.

Soil Samples from the 1–13 ft bgs soil interval for the Former Crash Area and soil samples from the 0–1 and 1–13 ft bgs soil intervals for the Former Plane Burial Area are not shown as none of the detected concentrations exceed the Residential Receptor Facility-wide Cleanup Goals (FWCUGs).

bgs = Below ground surface.
COPC = Chemical of potential concern.
ft = Feet.
FWCUG = Facility-wide cleanup goal.
NACA = National Advisory Committee on Aeronautics.
ND = Not detected.
PAH = Polycyclic aromatic hydrocarbon.
RSL = Regional screening level at a target risk level of 1E-05 or target hazard index of 1.
XX/(XX) = Concentrations in parentheses are for the field duplicate.

Bold = Concentration exceeds Resident Receptor FWCUG.
Bold* = Concentration exceeds Resident Receptor FWCUG and Industrial RSL.
Bold** = Concentration exceeds Resident Receptor FWCUG, Industrial RSL, and National Guard Trainee FWCUG.

Table 7–15. Chemicals of Concern for Evaluation in the Feasibility Study

Exposure Unit and Sample Location		Benzo(a)pyrene	Benz(a) anthracene	Benzo(b) fluoranthene	Dibenz(a,h) anthracene	Indeno(1,2,3-cd) pyrene
		Cleanup Goal				
	Resident FWCUG	0.221	2.21	2.21	0.221	2.21
	Industrial RSL	2.9	29	29	2.9	29
	NGT FWCUG	4.77	47.7	47.7	4.77	47.7
		Exposure Point Concentration or Sample Result (mg/kg)				
Former Plane Refueling and Crash Strip Area (CS)						
EPC		**4.7***	**4.09**	**6.17**	**0.737**	**2.81**
NTA-088	Grass Median Within the Crash Strip	**41****	**36***	**54****	**5.7****	**24**
NTA-089		**5.1****	**3.8**	**6.8**	**0.67**	**3.2**
NTA-090		**7.6****	**6.6**	**10**	**0.93**	**4.2**
NTAsb-121		**0.3**	0.25	0.43	0.048	0.21
NTAsb-122		**0.27**	0.21	0.35	0.042	0.18
Former Crash Area (CA)						
EPC		**0.254**	0.239	0.3	0.199	0.227
NTA-026	East of Crash Strip	**1.9**	1.5	**3.2**	**0.35**	1.2

EPC = Exposure point concentration for the exposure unit.
FWCUG = Facility-wide cleanup goal.
mg/kg = Milligrams per kilogram.
NGT = National Guard Trainee.
RSL = Regional screening level.
bold = Concentration exceeds Residential FWCUG.
bold* = Concentration exceeds Residential FWCUG and Industrial RSL.
bold** = Concentration exceeds Residential FWCUG, Industrial RSL, and NGT FWCUG.

Table 7–16. Summary of Historical COPECs per the Phase I RI

Group	COPEC	Sediment	Surface Water
Inorganic chemicals	Barium	X	X
	Beryllium	X	--
	Cadmium	X	X
	Calcium	X	X
	Cobalt	--	X
	Copper	X	--
	Cyanide	X	--
	Iron	X	X
	Lead	X	X
	Magnesium	X	X
	Manganese	X	X
	Nickel	X	X
	Potassium	--	X
	Selenium	X	--
	Zinc	X	X
SVOCs	Bis(2-ethylhexyl)phthalate	--	X
Propellants	Nitrocellulose	X	--

Adapted from the Phase I RI Report for NACA Test Area (USACE 2001a).
-- = Chemical not identified as a COPEC in this data set.
X = Quantitative COPEC, exceeds ecological screening value (ESV) or does not have an ESV.
COPEC = Chemical of potential ecological concern.
SVOC = Semi-volatile organic compound.

Table 7–17. Vegetation Types Present at Primary Exposure Units at NACA Test Area

Exposure Unit	Vegetation Types Past and Present (Figure 7-1)
Former Plane Refueling/Crash Strip Area	• American beech (*Fagus grandifolia)*/oak (*Quercus* spp.)/maple (*Acer* spp.) forest alliance • Green ash (*Fraxinus pennsylvanica)*/American elm (*Ulmus americana)*/Hackberry (*Celtis occidentalis*) temporarily flooded forest alliance • Red maple (*Acer rubrum)* successional forest • Buttonbush (*Cephalanthus occidentalis)* semi-permanently flooded shrubland alliance • Maintained grassland (formerly dry, early-successional, herbaceous field) • Reed canary grass (*Phalaris arundinacea*), seasonally flooded, herbaceous alliance
Former Crash Area (including Former Crash Area Well Pit)	• American beech (*Fagus grandifolia)*/oak (*Quercus* spp.)/maple (*Acer* spp.) forest alliance • Red maple (*Acer rubrum)* successional forest • Buttonbush (*Cephalanthus occidentalis)* semi-permanently flooded shrubland alliance • Dry, mid-successional, cold-deciduous, shrubland • Maintained grassland (formerly dry, early-successional, herbaceous field) • Reed canary grass (*Phalaris arundinacea*), seasonally flooded, herbaceous alliance
Former Plane Burial Area	• American beech (*Fagus grandifolia)*/oak (*Quercus* spp.)/maple (*Acer* spp.) forest alliance • Mixed, cold-deciduous, successional forest • Dry, mid-successional, cold-deciduous, shrubland • Maintained grassland (formerly dry, early-successional, herbaceous field) • Reed canary grass (*Phalaris arundinacea*), seasonally flooded, herbaceous alliance

Sources: *Plant Community Survey for the Ravenna Army Ammunition Plant* (USACE 1999b) and *RVAAP Integrated Natural Resources Management Plan* (OHARNG 2008) as updated based on May 18, 2010 field survey.

Table 7–18. Wetlands (OHARNG 2008) at NACA Test Area

Wetland ID	Wetland Type[1]	Total Wetland Size	ORAM Score	ORAM Category
Wetland 1	PAB/PEM1/PSS1 /PFO1	13 acres	54	2
Wetland 2	PEM1/PSS1/PFO1	3.8 acres	36	2
Wetland 3	PEM1/PSS1	0.3 acres	30	2
Wetland 4	PEM1/PSS1/PFO1	4.4 acres	45	2
Wetland 5	PSS1	0.09 acres	20	1
Wetland 6	PEM1/PSS/PFO1	1.8 acres	38	2
Wetland 7	PFO1	12.7 acres	54	2
Wetland 8	PEM1/PSS1/PFO1	0.15 acres	30	2
Wetland 9	PFO1	0.5 acres	30	2

[1] Cowardin Classification:

PAB = palustrine, aquatic bed;
PEM1 = palustrine, persistent emergent;
PSS1 = palustrine, broad-leaved deciduous, scrub-shrub;
PFO1 = palustrine, broad -leaved deciduous, forested

Table 7–19. Comparison of Five Assessment Attributes at Sampling Stations near NACA Test Area

Attributes	H-2 (RM 5.2) (upstream)	H-3 (RM 4.3) (upstream)	H-4 (RM 3.3) (downstream)	Comments
Sediment quality	Excellent	Excellent	Excellent	Downstream station rating is equivalent to upstream stations, suggesting no negative impacts from the AOC.
Water quality	Excellent	Excellent	Excellent	Downstream station rating is equivalent to upstream stations, suggesting no negative impacts from the AOC.
Fish community (IBI)[a]	Marginally Good	Fair	Marginally Good	Downstream station rating is equivalent to upstream station (H-2) and better than upstream station (H-3), suggesting no negative impacts from the AOC.
Macroinvertebrate community (ICI)[b]	Exceptional	Exceptional	Exceptional	Downstream station rating is equivalent to upstream stations, suggesting no negative impacts from the AOC.
Habitat (QHEI)[c]	Good	Good	Good	Downstream station rating is equivalent to upstream stations, suggesting no negative impacts from the AOC.
Use Attainment Status[d]	Full	Partial	Full	Downstream station rating is equivalent to upstream station (H-2) and better than upstream station (H-3), suggesting no negative impacts from the AOC.

[a] Fish communities range from 0-60, with less than 18 being “very poor,” 18-27 being “poor,” 28-35 being “fair,” 36-39 being “marginally good,” 40-45 being “good,” 46-49 being “very good,” and 50-60 being “excellent” (Ohio EPA 2009a).

[b] Macroinvertebrate communities range from 0-60 with less than 2 being “very poor,” 2-12 being “poor,” 14-32 being “fair,” 34-46 being “good,” and 48-60 being “exceptional” (Ohio EPA 1988).

[c] Habitat ranges from 30 to less than 100 with less than 30 being “very poor,” 30-44 being “poor,” 45-59 being “fair,” 60-74 being “good” and 75-100 being “excellent” (Ohio EPA 2009a).

[d] Full-attainment means all of the applicable indices meet the Ohio EPA biocriteria (USACE 2005a).

AOC = Area of concern.
IBI = Index of biotic integrity.
ICI = Invertebrate community index.
Ohio EPA = Ohio Environmental Protection Agency.
QHEI = Qualitative habitat evaluation index.
RM = River mile.

Table 7–20. Survey of Proximity to the AOC of Various Ecological Resources

Natural Resource	Natural Resources Inside Habitat Area	Proximity Within or Near the AOC	Distances to Nearest Resources of the AOC[a]
Wetlands (Jurisdictional and Planning Level Survey)	Eight medium-quality (Category 2) wetlands and one low-quality (Category 1) wetland	Many other wetlands are in vicinity of AOC.	Figure 7-2 shows other wetlands in the vicinity of the AOC.
State-listed or federally-listed species	No known sightings	State-listed species of concern have been identified 200 ft east of the Former Plane Burial Area and 200 ft north of the Former Plane Refueling/Crash Strip Area. (See text for species names)	A state-listed endangered species has been identified 400 ft northeast of the Former Plane Burial Area. (See text for species name)
Special interest areas	None	Unit 5, mixed swamp forest, begins 200 ft north of the Former Plane Refueling/Crash Strip Area.	Unit 5 begins 200 ft north of the AOC and continues further north for 206 acres of swamp forest.
Beaver dams	Beaver dam identified at the Wetland/Pond North of the Former Crash Area EU.	Additional beaver dam immediately north of Demolition Road.	Beaver dam 25 ft north of habitat area, immediately north of Demolition Road.
100-year floodplain	Hinkley Creek 100-year floodplain along unnamed tributary in southwest portion of AOC.	Hinkley Creek 100-year floodplain south and west of AOC.	Nearest floodplain is located inside habitat area.
Stream sampling[b]	None	Upstream sampling station H-3 is 300 ft to the south at Hinkley Creek.	Sampling station H-4 is 1,500 ft downstream of AOC on Hinkley Creek. Sampling station H-2 is 3,700 ft upstream of sampling station H-3 on Hinkley Creek
Pond sampling[b]	None	None	Nearest pond sample is 2,600 ft northeast of AOC.

[a] Measurements of distance and direction are taken from the nearest boundary of the AOC to the resource being measured.
[b] Stream and pond sampling refers to *Facility-Wide Biological and Water Quality Study 2003* (USACE 2005a).
AOC = Area of concern.
ft = Feet.

Table 7–21. Summary of Integrated COPECs for Surface Soil at the Former Plane Refueling/Crash Strip Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	33,900	50	678	Highest ratio at 678x
Arsenic	22.1	18	1.2	None
Barium	359	330	1.1	None
Cadmium	5.2	0.36	14.4	None
Chromium	149	26	5.7	None
Cobalt	27.5	13	2.1	None
Copper	30.3	28	1.1	None
Cyanide	1.6	1.33	1.2	None
Lead	56.6	11	5.2	None
Manganese	6,240	220	28.4	None
Mercury	0.073	0.00051	143.1	Second highest ratio at about 143x, PBT compound
Nickel	64.7	38	1.7	None
Selenium	2.8	0.52	5.4	None
Vanadium	34.6	7.8	4.4	None
Zinc	158	46	3.4	None
2,4,6-Trinitrotoluene	5.5	No ESV	--	None
HMX	0.017	No ESV	--	None
Nitrocellulose	3.5	No ESV	--	None
Benz(a)anthracene	36	5.21	6.9	None
Benzo(a)pyrene	41	1.52	27.0	None
Carbazole	4.9	No ESV	--	None
Chrysene	46	4.73	9.7	None
Dibenzofuran	1.9	No ESV	--	None
Naphthalene	2.8	0.0994	28.2	None
Phenanthrene	83	45.7	1.8	None
Pyrene	93	78.5	1.2	None

Table excludes nutrients.
-- = Not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.

Table 7–22 Summary of Integrated COPECs for Surface Soil at the Former Crash Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	25,400	50	508	Highest ratio at 508x
Antimony	1.1	0.27	4.1	None
Arsenic	19	18	1.1	None
Cadmium	1.3	0.36	3.6	None
Cobalt	38.2	13	2.9	None
Copper	55.6	28	1.99	None
Lead	50.9	11	4.6	None
Manganese	4,500	220	20.5	None
Mercury	0.1	0.00051	196.1	Highest ratio at 196x, PBT compound
Selenium	2.6	0.52	5.0	None
Zinc	231	46	5.0	None
2,4,6-Trinitrotoluene	0.15	No ESV	--	None
Nitrocellulose	52.2	No ESV	--	None
Benzo(a)pyrene	1.9	1.52	1.3	None
Bis(2-ethylhexyl)phthalate	6.6	0.925	7.1	None

Table excludes nutrients.
-- = not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.

Table 7–23. Summary of Integrated COPECs for Surface Soil at the Former Plane Burial Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Aluminum	31,200	50	624	Highest ratio at 624x
Antimony	2.9	0.27	10.7	None
Arsenic	23	18	1.3	None
Cadmium	14.5	0.36	40.3	None
Chromium	54.2	26	2.1	None
Copper	1,760	28	62.9	None
Lead	149	11	13.6	None
Manganese	2,190	220	10.0	None
Mercury	0.073	0.00051	143.1	Second highest ratio at 143x, PBT compound
Nickel	41.4	38	1.1	None
Selenium	1.4	0.52	2.7	None
Vanadium	36.9	7.8	4.7	None
Zinc	603	46	13.1	None
2,4,6-Trinitrotoluene	0.11	No ESV	--	None

Table excludes nutrients.
-- = not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.

Table 7–24. Summary of Integrated COPECs for Surface Soil at the Former Crash Area Well Pit

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of MDC to ESV	Comments
Barium	436	330	1.32	None
Cadmium	5	0.36	13.89	Second highest ratio at 14x
Copper	155	28	5.54	None
Lead	13,200	11	1,200	Highest ratio at 1,200x
Zinc	631	46	13.72	None
Nitrocellulose	11	No ESV	--	None

Table excludes nutrients.
-- = not applicable, no ESV is available for comparison.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
x = Multiplier.

Table 7–25. Summary of Integrated COPECs in Sediment at the Wetland/Pond North of Former Crash Area

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Mercury	0.023	0.18	0.13	PBT compound

Table excludes nutrients.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
PBT = Persistent, bioaccumulative, and toxic.
MDC = Maximum detected concentration.

Table 7–26. Summary of Integrated COPECs in Sediment at the Tributary to Hinkley Creek

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Mercury	0.032	0.18	0.18	PBT compound
Nickel	33.6	22.7	1.5	None
HMX	0.013	No ESV	--	None
Acenaphthene	0.012	0.00671	1.8	Second highest ratio at 1.8x
Bis(2-ethylhexyl)phthalate	0.35	0.182	1.9	Highest ratio at 1.9x

Table excludes nutrients.
-- = not applicable, no ESV available.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic.
x = Multiplier.

Table 7–27. Summary of Integrated COPECs in Sediment at the Former Crash Area Reservoir

COPEC	MDC (mg/kg)	ESV (mg/kg)	Ratio of Maximum to ESV	Comments
Acetone	0.061	0.0099	6.16	None

Table excludes nutrients.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
MDC = Maximum detected concentration.

Table 7–28. Summary of Integrated COPECs Based on MDCs in Surface Water at the Wetland/ Pond North of Former Crash Area

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Manganese	0.737	0.12[a]	6.1	ESV is Tier II

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.
Table excludes nutrients.
ESV = Ecological screening value.
COPEC = Chemical of potential ecological concern.
MDC = Maximum detected concentration.

Table 7–29. Summary of Integrated COPECs Based on MDCs in Surface Water at the Tributary to Hinkley Creek

COPEC	MDC (mg/L)	ESV (mg/L)	Ratio of Maximum to ESV	Comments
Manganese	0.509	0.12[a]	4.2	ESV is Tier II
Bis(2-ethylhexyl)phthalate	0.021	0.0084[b]	2.5	Ratio is MDC/OMZA (MDC/OMZM<1)

[a] No Ohio EPA Administrative Code ESV (OMZM or OMZA) is available; ESV is next available in hierarchy of sources.
[b] ESV shown is OMZA. The analyte is not a COPEC when screened against OMZM (MDC<OMZM). See Appendix H, Table H-18 for OMZM screening of this analyte.
Table excludes nutrients.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
OMZA = Outside mixing zone average.
OMZM = Outside mixing zone maximum.

Table 7–30. 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 7–31. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at the Former Plane Refueling/Crash Strip 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	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	8.4	18	No	15.4	No	Yes	28 / 28	2 / 28	2/ 28	No
Barium	100	330	No	88.4	Yes	Yes	28 / 28	1 / 28	10/ 28	No
Chromium	18.4	26	No	17.4	Yes	Yes	28 / 28	1 / 28	7/ 28	No
Cobalt	7.84	13	No	10.4	No	Yes	28 / 28	4 / 28	7/ 28	No
Copper	10.1	28	No	17.7	No	Yes	28 / 28	1 / 28	2/ 28	No
Cyanide	0.495	1.33	No	0	Yes	Yes	4 / 18	1 / 4	4/ 4	No
Nickel	14.9	38	No	21.1	No	Yes	28 / 28	1 / 28	4/ 28	No
Benz(a)anthracene	1.89	5.21	No	0	Yes	Yes	13 / 28	2 / 13	NA	No
Chrysene	2.43	4.73	No	0	Yes	Yes	16 / 28	3 / 16	NA	No
Phenanthrene	3.73	45.7	No	0	Yes	Yes	14 / 28	1 / 14	NA	No
Pyrene	4.71	78.5	No	0	Yes	Yes	17 / 28	1 / 17	NA	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Aluminum	13900	50	Yes	17700	No	No	28 / 28	28 / 28	4 / 28	No
Lead	16.1	11	Yes	26.1	No	No	28 / 28	21 / 28	1 / 28	No
Manganese	1260	220	Yes	1450	No	No	28 / 28	20 / 28	7 / 28	No
Selenium	0.948	0.52	Yes	1.4	No	No	21 / 28	21 / 21	4 / 21	No
Vanadium	18.3	7.8	Yes	31.1	No	No	28 / 28	28 / 28	1 / 28	No
Zinc	53.3	46	Yes	61.8	No	No	28 / 28	16 / 28	9 / 28	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Cadmium	0.449	0.36	Yes	0	Yes	Yes	12 / 28	2 / 12	12 / 12	Yes
Mercury	0.0381	0.00051	Yes	0.036	Yes	No	27 / 28	27 / 27	13 / 27	Yes
Benzo(a)pyrene	2.19	1.52	Yes	0	Yes	Yes	17 / 28	4 / 17	NA	Yes
Naphthalene	0.333	0.0994	Yes	0	Yes	Yes	6 / 28	2 / 6	NA	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.
NA = Not available.

Table 7–32. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at the Former Crash 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	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	8.65	18	No	15.4	No	Yes	70 / 70	2 / 70	3 / 70	No
Cadmium	0.327	0.36	No	0	Yes	Yes	13 / 70	5 / 13	13 / 13	No
Cobalt	7.24	13	No	10.4	No	Yes	70 / 70	3 / 70	7 / 70	No
Copper	12.5	28	No	17.7	No	Yes	70 / 70	1 / 70	11 / 70	No
Benzo(a)pyrene	0.21	1.52	No	0	Yes	Yes	7 / 70	1 / 7	NA	No
Bis(2-ethylhexyl)phthalate	0.293	0.925	No	0	Yes	Yes	7 / 64	1 / 7	NA	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Aluminum	10800	50	Yes	17700	No	No	70 / 70	70 / 70	4 / 70	No
Antimony	0.61	0.27	Yes	0.96	No	No	15 / 60	13 / 15	1 / 15	No
Lead	17.3	11	Yes	26.1	No	No	70 / 70	63 / 70	8 / 70	No
Manganese	522	220	Yes	1450	No	No	70 / 70	45 / 70	4 / 70	No
Mercury	0.0334	0.00051	Yes	0.036	No	No	48 / 70	48 / 48	22 / 48	No
Selenium	0.775	0.52	Yes	1.4	No	No	54 / 70	51 / 54	5 / 54	No
Zinc	56.4	46	Yes	61.8	No	No	70 / 70	38 / 70	16 / 70	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
All integrated COPECs with ESVs were eliminated prior to this step.										

[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.
NA = Not available.

Table 7–33. Summary of Data for Step 3A Refinement of Integrated COPECs in Surface Soil at the Former Plane Burial 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	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	9.59	18	No	15.4	No	Yes	21 / 21	1 / 21	1 / 21	No
Chromium	14.8	26	No	17.4	No	Yes	21 / 21	1 / 21	4 / 21	No
Nickel	14.9	38	No	21.1	No	Yes	21 / 21	1 / 21	3 / 21	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration										
Aluminum	11200	50	Yes	17700	No	No	21 / 21	21 / 21	2 / 21	No
Antimony	0.699	0.27	Yes	0.96	No	No	2 / 21	1 / 2	1 / 2	No
Lead	23.8	11	Yes	26.1	No	No	21 / 21	19 / 21	2 / 21	No
Manganese	599	220	Yes	1450	No	No	21 / 21	16 / 21	2 / 21	No
Selenium	0.558	0.52	Yes	1.4	No	No	10 / 21	10 / 10	1 / 10	No
Vanadium	19.3	7.8	Yes	31.1	No	No	21 / 21	21 / 21	2 / 21	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration										
Cadmium	1.18	0.36	Yes	0	Yes	Yes	6 / 21	5 / 6	6 / 6	Yes
Copper	95.3	28	Yes	17.7	Yes	Yes	21 / 21	1 / 21	5 / 21	Yes
Mercury	0.0444	0.00051	Yes	0.036	Yes	No	21 / 21	21 / 21	14 / 21	Yes
Zinc	82.6	46	Yes	61.8	Yes	No	21 / 21	11 / 21	9 / 21	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.

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Table 7–34. 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
Former Plane Refueling/Crash Strip Area				
Cadmium	0.449	0	NA	Cadmium was not detected in background samples.
Mercury	0.0381	0.036	1.05	Concentrations are similar
Benzo(a)pyrene	2.19	0	NA	Benzo(a)pyrene does not have an established background concentration.
Naphthalene	0.333	0	NA	Naphthalene does not have an established background concentration.
Former Crash Area				
All integrated COPECs with ESVs were eliminated prior to this step.				
Former Plane Burial Area				
Cadmium	1.18	0	NA	Cadmium was not detected in background samples.
Copper	95.3	17.7	5.38	Concentrations are dissimilar
Mercury	0.0444	0.036	1.23	Concentrations are similar
Zinc	82.6	61.8	1.34	Concentrations are similar

COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
NA = Not available, ratio could not be calculated.

Table 7–35. Comparison of Mean Concentration to Alternative ESV for Remaining Integrated COPECs

COPEC	Mean 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
Former Plane Refueling/Crash Strip Area					
Cadmium	0.449	0.36	0.77	1.25	0.58
Mercury	0.0381	0.00051	0.1	74.71	0.381
Benzo(a)pyrene	2.19	1.52	NA	1.44	NA
Naphthalene	0.333	0.0994	NA	3.35	NA
Former Crash Area					
All integrated COPECs with ESVs were eliminated prior to this step.					
Former Plane Burial Area					
Cadmium	1.18	0.36	0.77	3.28	1.53
Copper	95.3	28	49	3.40	1.94
Mercury	0.0444	0.00051	0.1	87.06	0.444
Zinc	82.6	46	79	1.80	1.05

[a] The Alternative ESV is the ESV with the closest concentration to the preferred ESV that is above the background concentration.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
NA = Not available or ratio could not be calculated.

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Table 7–36. Summary of Data for Step 3A Refinement of Integrated COPECs in Sediment (Discrete Samples) at the Tributary to Hinkley Creek

COPEC	Mean Concentration (mg/kg)	ESV (mg/kg)	Mean Concentration > ESV? (Yes/No)	Background Concentration (mg/kg)	SRV (mg/kg)	Mean Concentration > Background Concentration and SRV? (Yes/No)	ESV > Background Concentration and SRV? (Yes/No)	Frequency of Detections	Frequency of Detections[a] > ESV	Frequency of Detections[a] > Background Concentration	Further Evaluation in Level II Required? (Yes/No)
COPEC with Mean Concentration < ESV											
Mercury	0.0485	0.18	No	0.059	0.12	No	Yes	1 / 2	0 / 1	0 / 1	No
COPEC with Mean Concentration > ESV and Mean Concentration < Background Concentration or SRV											
Nickel	23.5	22.7	Yes	17.7	33	No	No	2 / 2	1 / 2	1 / 2	No
COPEC with Mean Concentration > ESV and Mean Concentration > Background Concentration and SRV											
Acenaphthene	0.0223	0.00671	Yes	0	NA	Yes	Yes	1 / 2	1 / 1	NA	Yes
Bis(2-ethylhexyl)phthalate	0.293	0.182	Yes	0	NA	Yes	Yes	1 / 2	1 / 1	NA	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.
NA = Not available.
SRV = Sediment reference value.

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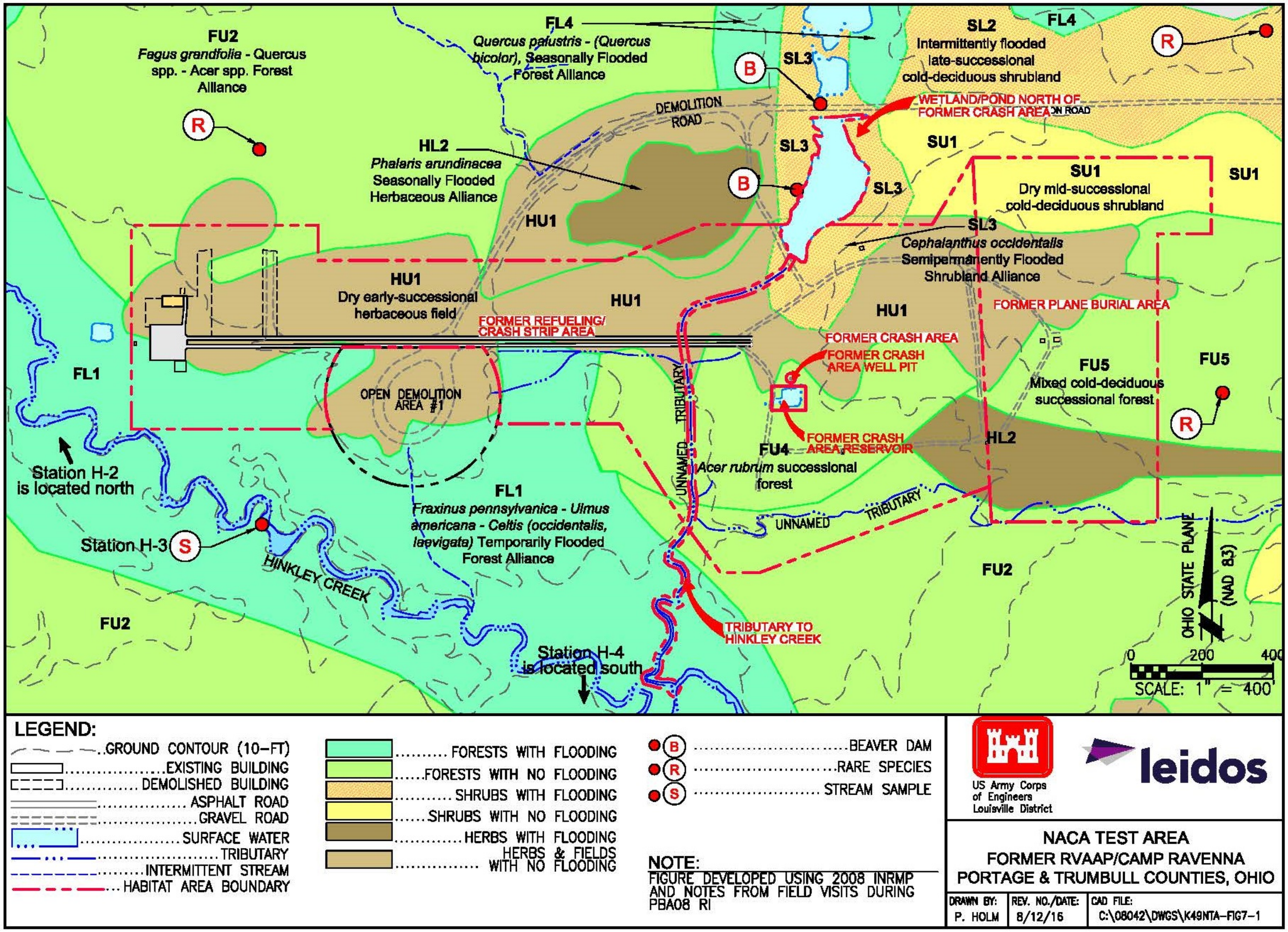

Figure 7-1. Natural Resources Inside and Near the Habitat Area at NACA Test Area

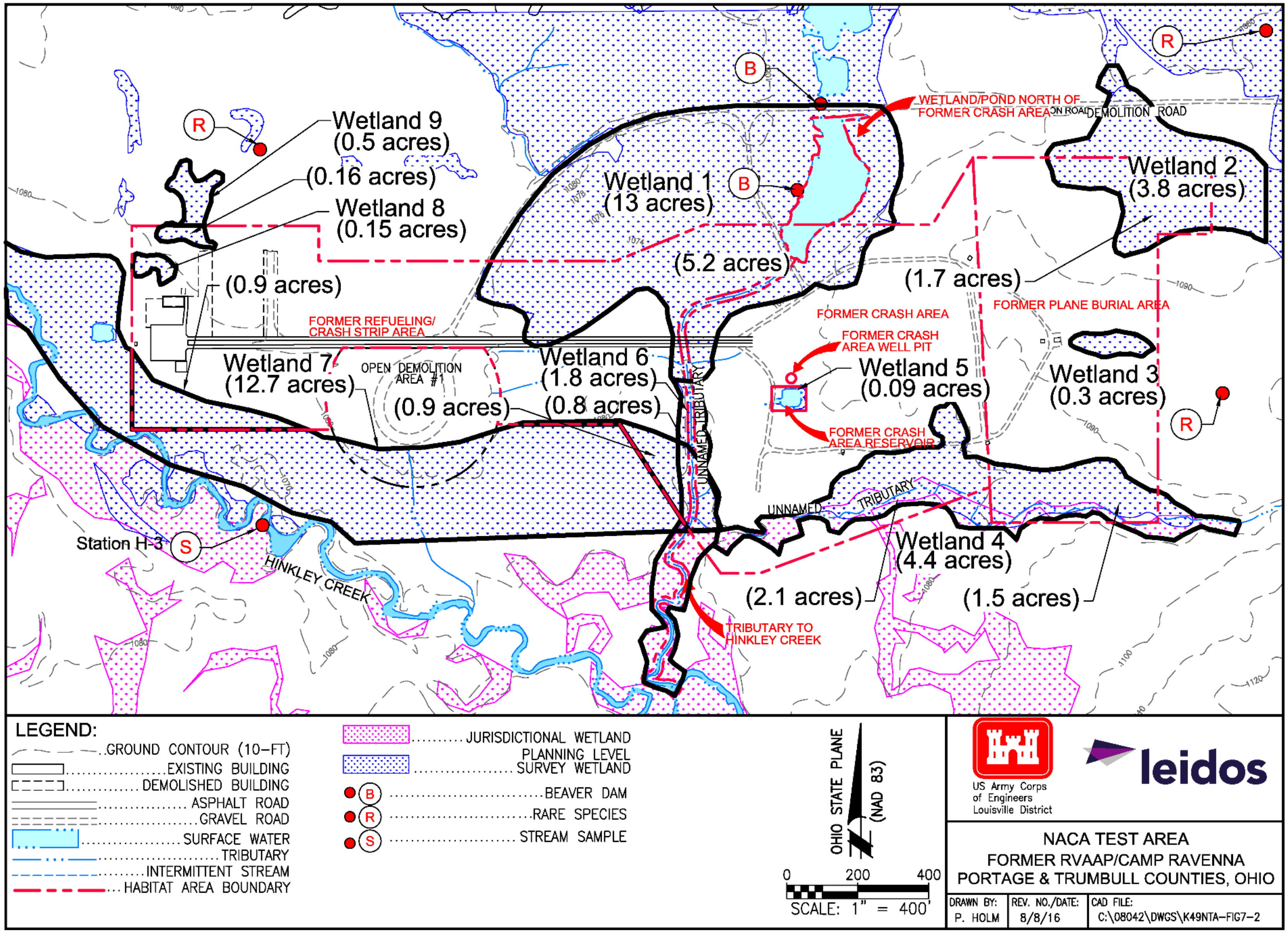

Figure 7-2. Wetlands and Water Features Near the Habitat Area at NACA Test Area

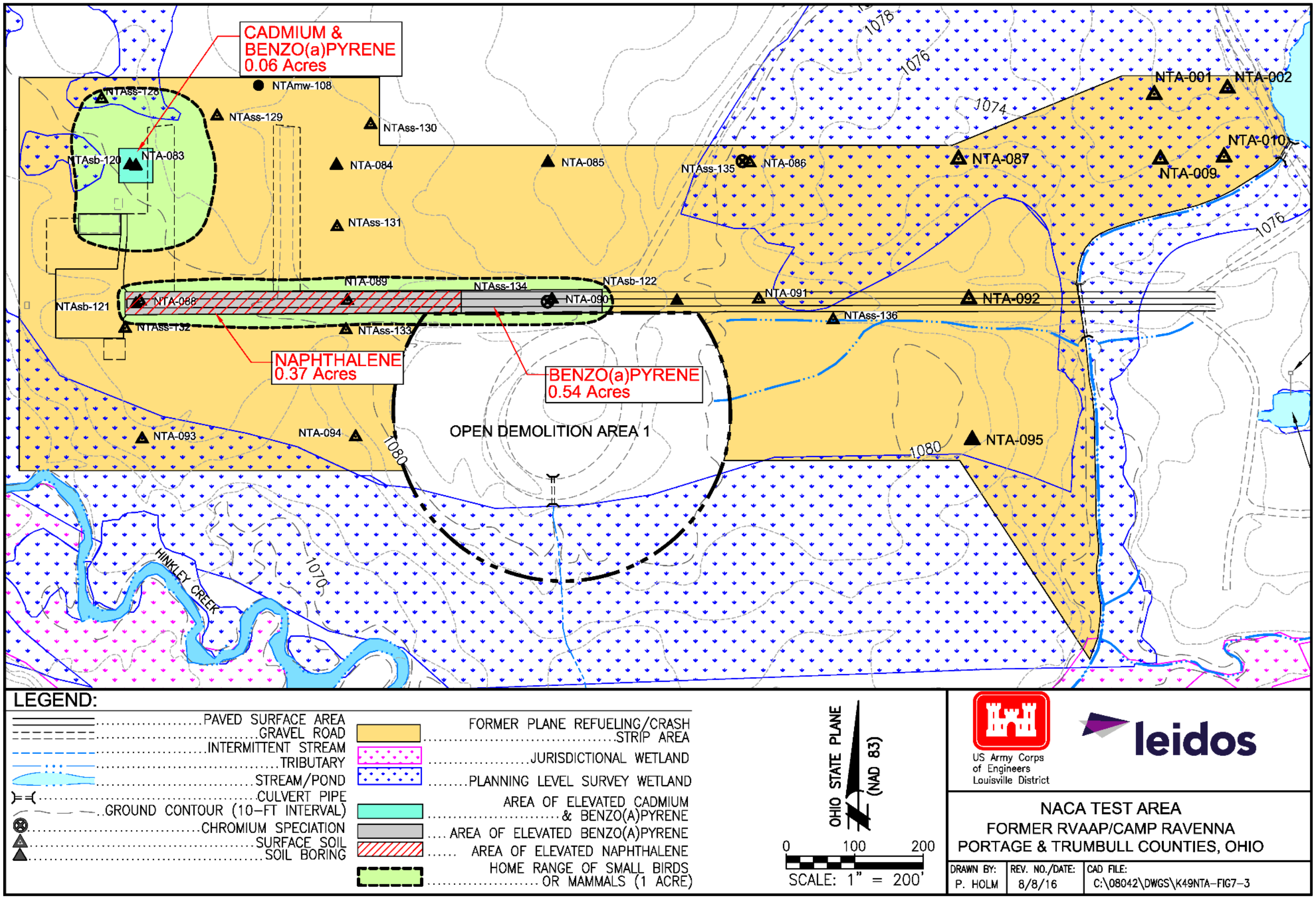

Figure 7-3. Relationship of Areas of Highest Concentration to General Home Range at the Former Plane Refueling/Crash Strip Area

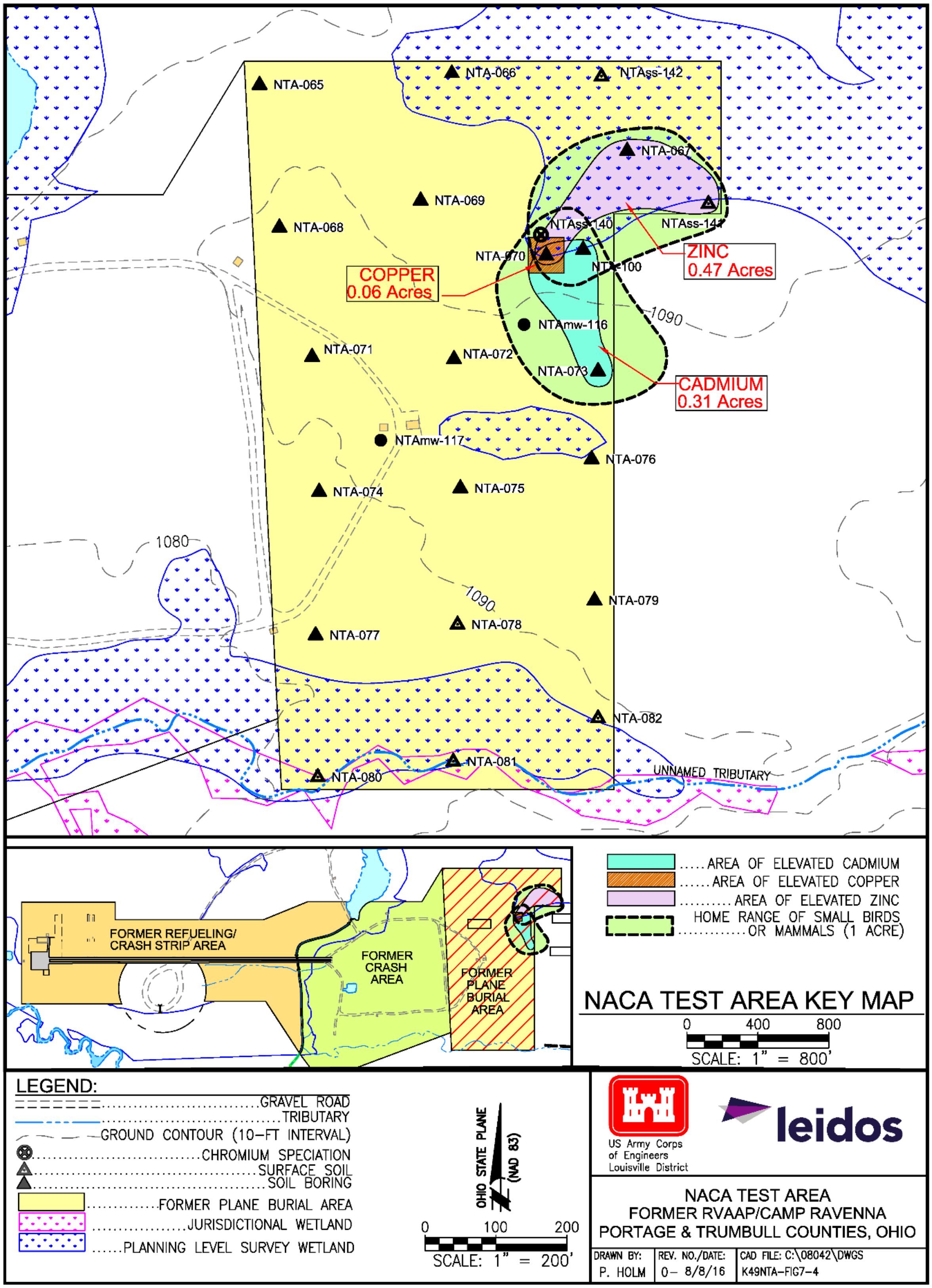

Figure 7-4. Relationship of Areas of Highest Concentration to General Home Range at the Former Plane Burial Area

8.0 REMEDIAL INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This Phase II RI for NACA Test Area 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 1999 Phase I RI and 2010 PBA08 RI were used to evaluate nature and extent of contamination at NACA Test Area. These investigations used discrete sampling methods. Surface water and sediment samples were collected at key surface water exit locations and sensitive habitats to obtain data representative of current conditions.

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, risk assessment). Evaluation of 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).

Samples from the 1999 Phase I RI data sets were evaluated to determine if conditions had changed substantively between earlier characterization efforts and the 2010 PBA08 RI. Physical conditions at the AOC did not change substantially during the intervening time between the Phase I RI and PBA08 RI. However, training activities have periodically been conducted on portions of the AOC and adjacent areas. Table 4-32 presents the results of the data usability evaluation for all available NACA Test Area samples. No samples from the 1999 data sets were eliminated from the screening process.

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) and subsurface soil (greater than 1 ft bgs) during the Phase I RI. All data collected during the PBA08 RI were deemed usable for this report as presented in Appendix C. All available surface and subsurface soil samples (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. Sediment and surface water samples collected during the Phase I RI were retained for nature and extent evaluation and evaluating temporal trends only. Only PBA08 RI sediment and surface water data were utilized in SRC screening, fate and transport evaluation, and risk assessment, as these data are considered representative of current conditions.

8.3 SUMMARY OF 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 Phase I RI and 2010 PBA08 RI effectively characterized the nature and extent of 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 (USACE 2010a). It can be concluded that the vertical and horizontal extent of contamination is defined, and no further sampling is needed to evaluate NACA Test Area.

8.3.1 Surface and Subsurface Soil

Locations where explosives were identified as potential contaminants from previous site use were thoroughly evaluated across each EU. The maximum concentrations of explosives and propellants were all below their respective SLs and were not considered COPCs, except one surface sample location at the Former Plane Refueling/Crash Strip Area. A concentration of 5.5 mg/kg of TNT exceeded the SL of 3.65 mg/kg and was considered a COPC for the EU. TNT was not detected in the subsurface samples collected at the Former Plane Refueling/Crash Strip.

A total of 12 inorganic chemicals (arsenic, aluminum, barium, cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc) were identified as potential inorganic SRCs and as potentially related to previous AOC operations. When evaluating these chemicals against their SLs (using the trivalent chromium FWCUG for chromium and the RSL of 400 mg/kg for lead), chromium, mercury, selenium, silver, and zinc concentrations were below their respective SLs; therefore, these chemicals were not considered COPCs at any of the EUs comprising NACA Test Area.

Aluminum, arsenic, and manganese were considered COPCs in surface soil at the Former Crash Area. Of these three inorganic chemicals, arsenic was the only COPC in subsurface soil in one PBA08 RI sample location (NTAsb-124, 4–7 ft bgs interval). Arsenic exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 in surface and subsurface soil with an MDC of 24.7J mg/kg at NTAsb-124 (in the 4–7 ft bgs interval). Arsenic was detected below the background concentration (13.9J mg/kg) in the next sample interval (from 7–13 ft bgs). Manganese exceeded the National Guard Trainee (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 in surface soil with an MDC of 4,500 mg/kg at NTA-034.

Barium and lead concentrations of 436 and 13,200 mg/kg, respectively, exceeded their respective SLs of 351 and 400 mg/kg in the one surface soil sample collected at the Former Crash Area Well Pit. Both inorganic chemicals were considered COPCs. Only lead exceeded the RSL, but barium was below the National Guard Trainee FWCUG at a TR of 1E-05, HQ of 1.

Five chemicals (aluminum, arsenic, cadmium, copper, and manganese) were considered COPCs in surface soil at the Former Plane Burial Area. In subsurface soil, cadmium and copper were considered COPCs. Although not identified as previously used during historical operations, antimony and cobalt also were considered COPCs in surface soil at the Former Plane Burial Area. Of the COPCs identified in surface and subsurface soil at the Former Plane Burial Area, only concentrations of arsenic and manganese in surface soil exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The MDC of arsenic and manganese was 23 mg/kg and 2,190 mg/kg, respectively, at Phase I RI sample location NTA-067.

Aluminum, arsenic, barium, and manganese were considered COPCs in surface soil at the Former Plane Refueling/Crash Strip Area. Although not identified as previously used during historical operations, cobalt and cyanide also were considered COPCs in surface soil. Arsenic and manganese exceeded the National Guard Trainee or Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The MDC of arsenic was 22.1 mg/kg at PBA08 RI sample location NTAss-128. Manganese was detected at a maximum concentration of 6,240J mg/kg at Phase I RI sample location NTA-084. No inorganic chemical COPCs were identified in subsurface soil.

SVOCs were not detected in surface soil at the Former Crash Area Well Pit. SVOCs were COPCs in surface and subsurface soil at the Former Plane Burial Area. Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected in Former Crash Area surface soil at Phase I RI sample location NTA-026, which exceeded the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1. The detected concentration of benzo(a)pyrene in the surface sample at Phase I RI sample location NTA-032 also exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1 at multiple surface soil sample locations at the Former Plane Refueling/Crash Strip Area. In subsurface soil, only benzo(a)pyrene exceeded the Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1 at one subsurface sample location. All other PAH concentrations detected in surface and subsurface soil at the Former Crash Area and Former Plane Refueling/Crash Strip Area were below the Resident Receptor (Adult and Child) FWCUGs at a TR of 1E-05, HQ of 1.

None of the detected VOC concentrations at NACA Test Area in surface or subsurface soil exceeded their respective SLs. Pesticides and PCBs were not detected in any of the surface or subsurface samples collected for the four EUs comprising NACA Test Area except for the pesticide delta-hexachlorobenzene which was identified as an SRC in subsurface soil at the Former Crash Area.

8.3.2 Sediment and Surface Water

The tributary to Hinkley Creek was evaluated using two sediment and two surface water samples. No explosives or propellants were detected in the surface water samples and no propellants were detected in the sediment samples. One explosive (HMX) was detected at a low, estimated concentration in one sediment sample, but was not detected at the downstream sample. The concentration was below the Resident Receptor (Adult and Child) FWCUG and RSL at a TR of 1E-06, HQ of 0.1. No sediment or surface water concentrations for inorganic chemicals in the tributary to Hinkley Creek exceeded the RSL at a TR of 1E-06, HQ of 0.1, except a sediment concentration of cobalt at NTAsd-145. One PAH, benzo(a)pyrene, exceeded its respective SL in sediment; however, the concentration was below the

Resident Receptor (Adult and Child) FWCUG at a TR of 1E-05, HQ of 1. Bis(2-ethylhexyl)phthalate was detected above its respective SL in a surface water sample. No pesticides or PCBs were detected in sediment and no VOCs, pesticides, or PCBs were detected in surface water at the Tributary to Hinkley Creek. One VOC (2-butanone) was detected at NTAsd-143 below the SL.

One sediment and one surface water sample were used to evaluate the Wetland/Pond North of the Former Crash Area. No explosives or propellants were detected in sediment or surface water. All of the detected concentrations of inorganic chemicals in sediment and surface water were below the RSL at a TR of 1E-06, HQ of 0.1. In surface water, cobalt and manganese exceeded the SL at a TR of 1E-06, HQ of 0.1 but not at a TR of 1E-05, HQ of 1. SVOCs, pesticides, and PCBs were not detected in sediment or surface water samples at the Wetland/Pond North of the Former Crash Area. Three VOCs (2-butanone, ethylbenzene, and toluene) were detected in sediment and one VOC (toluene) was detected in surface water. The detected concentrations were below the SL at a TR of 1E-06, HQ of 0.1.

Sediment and surface water samples collected during the Phase I RI at the Former Crash Reservoir were used to evaluate the nature and extent for comparison purposes only. No explosives, propellants, SVOCs, pesticides, or PCBs were detected in sediment or surface water. In addition, no inorganic chemicals were identified as SRCs in sediment or surface water. Two VOCs (2-butanone and acetone) were detected in sediment at concentrations below the RSL at a TR of 1E-06, HQ of 0.1. VOCs were not detected in surface water for the Former Crash Area Reservoir.

One sediment and one surface water sample were collected during the Phase I RI at a drainage conveyance upstream of NACA Test Area. These samples were included in the nature and extent evaluation to provide data on off-AOC conditions for comparison purposes. No explosives were detected in sediment at the off-AOC Phase I RI sample location; however, the propellant nitrocellulose was detected at a concentration of 4.8 mg/kg. The explosive DNT was detected at Phase I RI off-AOC surface water station NTA-104 at a concentration of 0.000051J mg/L. This explosive was not detected in any of the other surface water samples collected at NACA Test Area. Eight inorganic chemicals (barium, beryllium, cadmium, cobalt, cyanide, manganese, nickel, and selenium) were detected above background concentrations in sediment. Of these, barium, cobalt, cyanide, and manganese were detected at concentrations above their respective SLs in sediment. The concentrations detected at the upstream, off-AOC location were higher than those observed at either of the NACA Test Area sediment data EUs. VOCs were not detected in sediment, but acetone was detected in surface water below the RSL. SVOCs, pesticides, and PCBs were not detected in sediment and surface water at the off-AOC sample locations.

8.4 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

All SRCs identified in surface soil, subsurface soil, and sediment at NACA Test Area were evaluated through the stepwise contaminant fate and transport evaluation which 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 concentrations of SRCs identified in surface and subsurface soil were evaluated using a series of generic screening steps to identify initial CMCOPCs. These 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. 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 final CMCOPCs based on RVAAP facility-wide background concentrations and the lowest risk-based screening criteria. 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., stream).

The evaluation of modeling results with respect to current AOC groundwater data and model limitations did not identify CMCOPCs in sediment but identified the following CMCOPCs for soil:

- Antimony, arsenic, barium, cobalt, selenium, thallium, and naphthalene in the Former Crash Area;
- Antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium in the Former Plane Burial Area; and
- Selenium and 2,4-DNT in the Former Plane Refueling/Crash Strip Area.

These CMCOPCs were predicted to exceed the screening criteria in groundwater beneath the source area; however, none of these constituents were predicted to exceed the screening criteria in groundwater at the downgradient receptor location.

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 and sediment at NACA Test Area that may impact the groundwater beneath the source or at the downstream 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 downstream receptor location. No further action is required of soil and sediment at NACA Test Area for the protection of groundwater.

8.5 SUMMARY AND CONCLUSIONS OF THE HUMAN HEALTH RISK ASSESSMENT

The HHRA identified COCs and conducted a 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. However, if unacceptable risk is identified for the Resident Receptor, the risk to the National Guard Trainee and Industrial Receptor is evaluated.

Media of concern at NACA Test Area are surface soil, subsurface soil, surface water, and sediment. Soil data associated with NACA Test Area were aggregated into surface and subsurface soil in each of three EUs (Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Plane Burial

Area) and one potential hotspot (Former Crash Area Well Pit). Surface water and sediment data associated with NACA Test Area were aggregated into three EUs [Wetland/Pond North of Former Crash Area, Tributary to Hinkley Creek, and Former Crash Area Reservoir (sediment only)].

No COCs were identified for any receptor at any EU in subsurface soil, sediment, or surface water. Additionally, there were no COCs identified for any receptor for surface soil in the Former Plane Burial Area. Lead and five PAHs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were identified in surface soil at one or more EUs as COCs to be carried forward for potential remediation.

Lead was identified as a COC in surface soil to be carried forward for potential remediation at the Former Crash Area Well Pit for all three Land Uses. Lead within the Former Crash Area Well Pit is likely attributable to lead-based paint on the metal cover and/or former equipment and piping that used to be in the pit. The elevated concentration of lead (13,200 mg/kg) in the well pit represents a hotspot of lead contamination.

The PAHs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were identified as COCs to be carried forward for potential remediation at the Former Plane Refueling/Crash Strip Area EU for Unrestricted (Residential) Land Use. Additionally, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs for remediation in this area to be carried forward for potential remediation for Commercial/Industrial Land Use. Activities in this area (i.e., crashing and burning planes and fuel) are a potential source of PAHs in this area. No COCs were identified for potential remediation in surface soil in this area for Military Training Land Use.

The PAHs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were identified as COCs to be carried forward for potential remediation at the Former Crash Area for Unrestricted (Residential) Land Use. Concentrations of these PAHs at NTA-026 (located directly east of the crash strip where the crash strip terminated at a former concrete barrier structure) may be associated with site activities from use of the crash strip. No COCs were identified for potential remediation in surface soil for the Commercial/Industrial or Military Training Land Uses at the Former Crash Area EU.

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 NACA Test Area. This contamination was identified using historical and PBA08 RI data. Dry, early-successional, herbaceous field (dominant vegetation type), seasonally flooded herbaceous alliance, as well as dry and semi-permanently flooded shrublands and four types of forests were observed on the 47-acre AOC. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., pond, streams) are present and near contamination. These findings invoked 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 and historical data sets against ESVs. A total of 28 integrated COPECs were identified for soil, 6 were identified for sediment, and 2 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 NACA Test Area 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 NACA Test Area, 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 operational facilities representing primary contaminant sources are currently located at the AOC. Some minor residual infrastructure (e.g., Former Crash Area Well Pit and crash strip) and debris remains in place, but no primary sources or ongoing releases (e.g., leaking containers, electrical equipment) were observed during prior investigations and the PBA08 RI. Remnant contamination in soil and debris within the AOC is considered as a secondary source of contamination.

Lead and SVOCs, particularly PAHs, are the most extensive COCs within soil. Lead is only present above 400 mg/kg in the Former Crash Area Well Pit. The presence of PAHs requiring remediation was identified in the median of the crash strip and at the Former Crash Area. Concentrations of lead in the Former Crash Area Well Pit and PAHs in the Former Plane Refueling/Crash Strip Area and Former Crash Area are sufficiently high to present a risk to human health. In general, lower concentrations of inorganic chemicals and PAHs occur in subsurface soil than in associated surface soil.

The primary mechanisms for release of contaminants from secondary sources at the AOC occur from the following sources.

- Erosion of soil matrices with sorbed contaminants and mobilization in overland surface water from storm runoff during heavy rainfall conditions;
- Contaminant leaching to groundwater.

8.7.2 Contaminant Migration Pathways and Exit Points

8.7.2.1 Surface Water Pathways

Migration of contaminants from soil sources via surface water occurs primarily by movement of particle-bound contaminants in surface water runoff and transport of dissolved constituents in surface water. In the case of particle-bound contaminant migration, contaminants will be mobilized during periods of high flow (e.g., rain events) and upon reaching portions of surface water conveyances where flow velocities decrease, they will settle out as sediment accumulation. Sediment-bound contaminants may become re-suspended and migrate during storm events or may partition to dissolved phase in surface water.

At NACA Test Area, surface water runoff with entrained sediment enters directly into the Tributary to Hinkley Creek from portions of the Former Crash Area and Former Plane Refueling/Crash Strip Area. Most surface runoff flows overland to the center of the AOC into the tributary to Hinkley Creek. Surface runoff in the western portion of the Former Plane Refueling/Crash Strip Area flows southwest and drains into Hinkley Creek. Inflow into the Wetland/Pond North of the Former Crash Area also occurs from upstream, off-AOC sources via drainage culverts beneath the access road to NACA Test Area (Figure 3-1). Sediment accumulation points occur both within the Wetland/Pond North of the Former Crash Area and the Tributary to Hinkley Creek where flow velocities decrease due to blocked or constricted culverts, wetland vegetation, and beaver activity.

Sediment data indicate accumulated SRCs, PAHs in particular, in the Tributary to Hinkley Creek with the highest concentrations observed in the central portion of NACA Test Area. Comparatively few sediment SRCs were identified in the Wetland/Pond North of the Former Crash Area, indicating minimal impacts from runoff. Surface water data within these two aggregates indicate a lower number of inorganic SRCs as compared to sediment, and no PAHs were identified as SRCs. The number and concentrations of inorganic chemicals in surface water in the Tributary to Hinkley Creek were lower within NACA Test Area than at the junction with Hinkley Creek about 500 ft downstream of the AOC. These data indicate minimal partitioning of contaminants from sediment to surface water and migration beyond the AOC.

Dissolved phase contaminant migration in surface water is also relevant with respect to leaching processes to groundwater. The size and extent of surface water features within NACA Test Area promote groundwater-surface interactions. Temporary ponding of surface water in flow conveyances and wetland areas is likely during heavy rainfall events or periods of snowmelt, which would further recharge rates to the water table. This pathway was evaluated as part of fate and transport modeling and results did not indicate a sediment-to-groundwater leaching pathway was of concern.

8.7.2.2 Groundwater Pathways

The estimated direction of groundwater flow at the AOC is northeast to southwest. 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 2010). Water level elevations at the AOC range from 1067.38–1090.10 ft amsl, with the highest elevation at NTAmw-116. 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 streams or springs) does not occur within the AOC boundary. Rather, the closest potential groundwater discharge location is Hinkley Creek located along the southwest AOC boundary.

The FWGWMP was initiated in 2005 and involves quarterly sampling of selected wells within the former RVAAP. Between 2008–2014, several sampling events under the FWGWMP collected groundwater data at NACA.

Contaminant leaching pathways from soil and sediment 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 4.12E-04 cm/s. Conservative transport modeling indicated seven chemicals (antimony, arsenic, barium, cobalt, selenium, thallium, and naphthalene) in the Former Crash Area, eight chemicals (antimony, arsenic, barium, cadmium, copper, manganese, selenium, and thallium) in the Former Plane Burial Area, and two chemicals (selenium and 2,4-DNT) in the Former Plane Refueling/Crash Strip Area may leach from soil and migrate to the groundwater table at concentrations exceeding MCLs/RSLs beneath their respective sources; however, none of these constituents are predicted to migrate laterally and reach the nearest surface water receptor (i.e., the Tributary to Hinkley Creek located along the southwest boundary of NACA Test Area) at a concentration exceeding MCL/RSLs. 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 NACA Test Area 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 Receptors

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, as 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 identified COCs benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene in surface soil (0–1 ft bgs) and lead in soil that present unacceptable risk to the Resident Receptor and require remediation. As unacceptable risk was identified for the Resident Receptor, this RI includes an evaluation of the National Guard Trainee and Industrial Receptor. The HHRA also identified COCs requiring remediation in surface soil [benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] for the Industrial Receptor within the Former Plane Refueling/Crash Strip Area. Lead was identified as a COC for all three receptors in surface and subsurface soil.

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 NACA Test Area were compared to the list of important ecological places and resources. There are important and significant ecological resources in the AOC. Specifically, wetlands and surface water (i.e., pond, streams) are present and near contamination.

8.7.4 Uncertainties

Uncertainties are inherent in the CSM depending on the density and availability of data. The CSM for NACA Test Area is overall well defined using existing data, and major data gaps do not remain to be resolved. However, some uncertainties for the CSM for NACA Test Area include:

- Removal of primary contaminant sources, grading, and continuing vegetation succession likely have resulted in a lower overall degree of soil erosion and contaminant migration from the former operations area.
- Ongoing military training operations have the potential to introduce new contaminants.
- 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 and Facility-wide Sewers AOCs.

8.8 RECOMMENDATION OF THE REMEDIAL INVESTIGATION

Based on the investigation results, NACA Test Area has been adequately characterized, and further investigation is not warranted at this AOC. The nature and extent of potentially impacted media has been sufficiently characterized; the fate and transport modeling did not identify soil CMCOCs impacting groundwater; and no ecological risk was identified.

The HHRA identified the following to be carried forward for potential remediation:

- PAHs as surface soil COCs in the Former Plane Refueling/Crash Strip Area to be protective of the Resident Receptor and Industrial Receptor.
- PAHs as surface soil COCs in the Former Crash Area to be protective of the Resident Receptor.
- Lead as a soil COC in the Former Crash Area Well Pit to be protective of the Resident Receptor, Industrial Receptor, and National Guard Trainee.

The recommended path forward is to evaluate remedial alternatives in an FS for the identified COCs within the Former Plane Refueling/Crash Strip Area, Former Crash Area, and Former Crash Area Well Pit.

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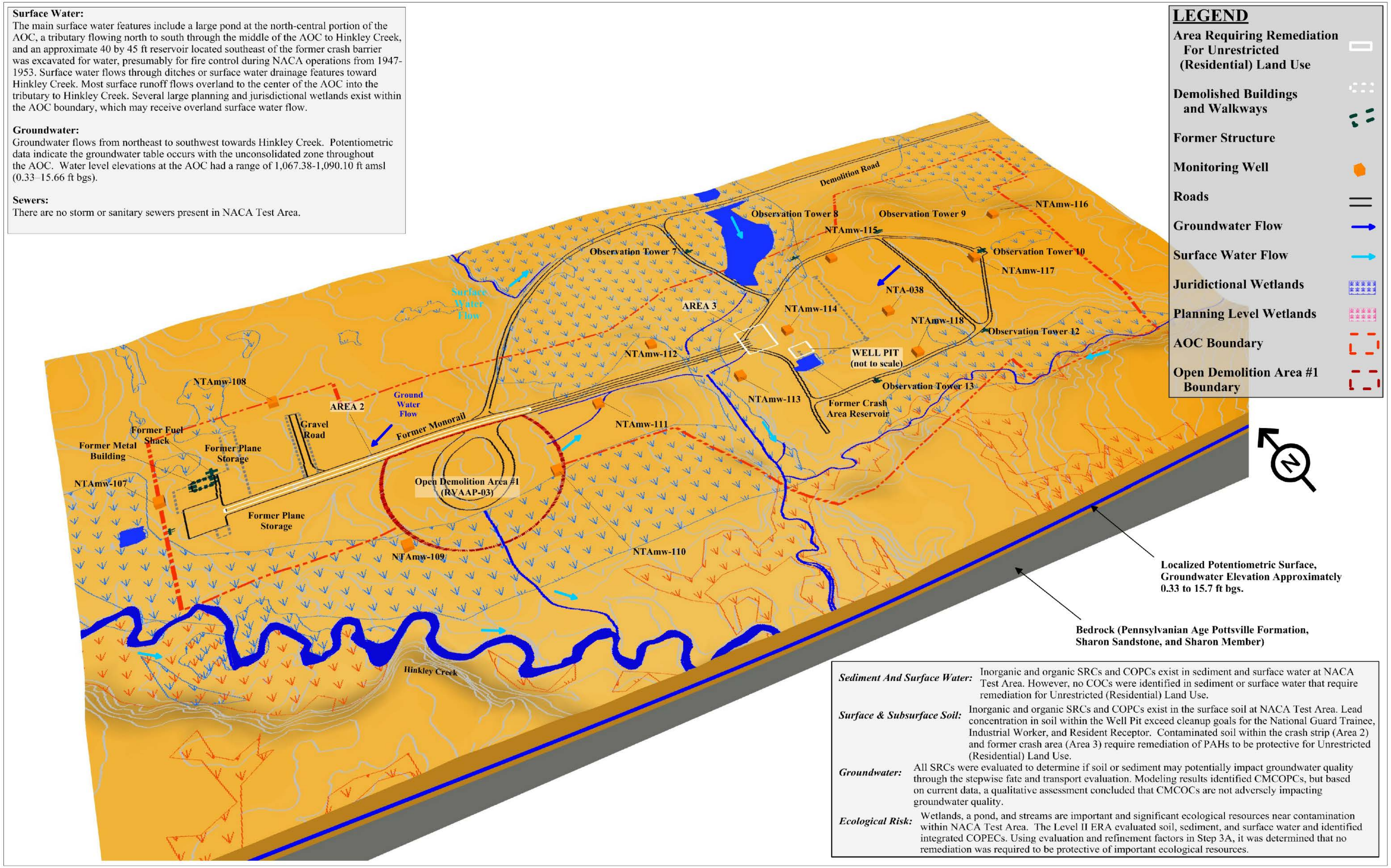

Surface Water:
The main surface water features include a large pond at the north-central portion of the AOC, a tributary flowing north to south through the middle of the AOC to Hinkley Creek, and an approximate 40 by 45 ft reservoir located southeast of the former crash barrier was excavated for water, presumably for fire control during NACA operations from 1947-1953. Surface water flows through ditches or surface water drainage features toward Hinkley Creek. Most surface runoff flows overland to the center of the AOC into the tributary to Hinkley Creek. Several large planning and jurisdictional wetlands exist within the AOC boundary, which may receive overland surface water flow.

Groundwater:
Groundwater flows from northeast to southwest towards Hinkley Creek. Potentiometric data indicate the groundwater table occurs with the unconsolidated zone throughout the AOC. Water level elevations at the AOC had a range of 1,067.38-1,090.10 ft amsl (0.33–15.66 ft bgs).

Sewers:
There are no storm or sanitary sewers present in NACA Test Area.

Sediment And Surface Water: Inorganic and organic SRCs and COPCs exist in sediment and surface water at NACA Test Area. However, no COCs were identified in sediment or surface water that require remediation for Unrestricted (Residential) Land Use.

Surface & Subsurface Soil: Inorganic and organic SRCs and COPCs exist in the surface soil at NACA Test Area. Lead concentration in soil within the Well Pit exceed cleanup goals for the National Guard Trainee, Industrial Worker, and Resident Receptor. Contaminated soil within the crash strip (Area 2) and former crash area (Area 3) require remediation of PAHs to be protective for Unrestricted (Residential) Land Use.

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: Wetlands, a pond, and streams are important and significant ecological resources near contamination within NACA Test Area. The Level II ERA evaluated soil, sediment, and surface water and identified integrated COPECs. Using evaluation and refinement factors in Step 3A, it was determined that no remediation was required to be protective of important ecological resources.

Figure 8–1. NACA Test Area Conceptual Site Model

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9.0 REMEDIAL ACTION OBJECTIVES, CLEANUP GOALS, AND VOLUME CALCULATIONS

This section presents the RAOs, appropriate CUGs for remedial actions, and volume estimates of media requiring remediation to attain specific Land Use scenarios. The RAO is in accordance with NCP and CERCLA RI/FS guidance, which specify receptors, exposure routes, and desired exposure levels. CUGs establish acceptable exposure levels to be protective of human health while considering potential Land Uses and provide the basis for screening, evaluating, and selecting a remedial alternative. This section also presents the estimated volume of soil exceeding the respective CUGs. The volume estimates present the estimated quantity and location of media requiring remediation to attain a specific Land Use scenario.

9.1 FUTURE USE

The potential future uses for NACA Test Area are Military Training Land Use or Commercial/Industrial Land Use. Although residential use is not anticipated at the former RVAAP or at this AOC, Unrestricted (Residential) Land Use was evaluated in this FS in accordance with Defense Environmental Restoration Program (DERP) Manual 4715.20 (DoD 2012). Descriptions of these Land Uses, as outlined in the Technical Memorandum (ARNG 2014), are provided in the following subsections.

9.1.1 Military Training Land Use

Military Training Land Use describes potential exposure for military and civilian personnel that would train or work on any AOC or MRS within the former RVAAP/Camp Ravenna. This Land Use is characterized by activities that are necessary to properly train soldiers and operate/maintain a training base as defined by the Army. This Land Use has specific assumptions that would require a land use control (LUC) to be enacted that would limit personnel exposure to the AOC for the duration assumed for the National Guard Trainee in the FWHHRAM. Given the requirements for monitoring and the documentation that lists site usage by the National Guard Trainee, the Army has elected to evaluate only the Commercial/Industrial and Unrestricted (Residential) Land Use alternatives in this FS.

9.1.2 Commercial/Industrial Land Use

Commercial/Industrial Land Use represents receptors who work full time at the former RVAAP/Camp Ravenna AOCs. The Industrial Receptor is the Representative Receptor for Commercial/Industrial Land Use.

This Land Use is characterized by activities consistent with full-time employees or career military personnel who are expected to work daily at the facility over their career. Activities can include work that would be conducted in office buildings, schools, maintenance buildings, as well as manufacturing facilities. Activities will also include outdoor work that will be conducted by full-time personnel to maintain military training lands. Commercial/Industrial Land Use or full-time, occupational, employee usage is likely to be a reasonable assumption where a site is, will be, or may be used for full-time commercial/industrial receptors without LUCs. This assumption is based upon shorter exposure durations as defined in the Military Training exposure assumptions and will provide protectiveness for on-site permanent and repeat users of the AOC.

9.1.3 Unrestricted (Residential) Land Use

Unrestricted (Residential) Land Use is considered protective for, and may be applied to, any and all categories of Land Use on the former RVAAP/Camp Ravenna, without further restriction. The Resident Receptor is the Representative Receptor for Unrestricted (Residential) Land Use.

9.2 REMEDIAL ACTION OBJECTIVES

The RI for NACA Test Area concluded that there is no unacceptable risk to the Resident Receptor from soil, sediment, and surface water within the EUs listed below. Therefore, these EUs require no further action to attain Unrestricted (Residential) Land Use.

- Former Plane Burial Area,
- Tributary to Hinkley Creek,
- Wetland/Pond North of the Former Crash Area,
- Former Crash Area Reservoir, and
- Off-AOC.

In addition, there is no unacceptable risk in subsurface soil at any EU within NACA Test Area. However, soil poses unacceptable risk to the Industrial Receptor and Resident Receptor at the Former Crash Area Well Pit, Former Plane Refueling/Crash Strip Area, and the Former Crash Area. The RAO for NACA Test Area is as follows:

- Prevent Industrial Receptor and Resident Receptor exposure to (1) lead in soil above the CUG at the Former Crash Area Well Pit and (2) surface soil (0–1 ft bgs) with concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene above CUGs in the Former Plane Refueling/Crash Strip Area and the Former Crash Area.

9.3 REMEDIAL ACTION CLEANUP GOALS

The HHRA recommends CUGs for COCs for the Industrial Receptor and Resident Receptor to support the remedial alternative selection process. Table 9-1 presents CUGs for each COC requiring remediation to attain Commercial/Industrial Land Use and Unrestricted (Residential) Land Use. Figures 9-1 and 9-2 present the estimated extent of contamination with unacceptable risk for each receptor.

9.4 VOLUME CALCULATIONS OF MEDIA REQUIRING REMEDIATION

Using recommendations from the HHRA for the Industrial Receptor and Resident Receptor, the following subsections present the estimated volumes of soil requiring remediation to attain each Land Use. Where appropriate, delineation sampling will be conducted before implementing the remedy and confirmation samples will be collected to confirm that CUGs were attained.

9.4.1 Commercial/Industrial Land Use

To achieve Commercial/Industrial Land Use, remediation in the following areas is required:

- Former Crash Area Well Pit – The Well Pit is concrete-walled and immediately southeast of the terminus of the crash strip. It is 4 ft long, 4 ft wide, 4 ft deep, and, based on field observations, contains approximately 0.15 yd^3 (4 ft^3) of contaminated soil.
- Former Plane Refueling/Crash Strip Area (Area 1) – The eastern lateral extent of contamination is determined to be half the distance between the sample with an Industrial Receptor RSL exceedance (NTA-090) and an adjacent sample without an exceedance (NTAsb-122). The western lateral extent of contamination is bound by the concrete pad immediately west of sample location NTA-088. The vertical extent is assumed to be 1 ft bgs, as concentrations at depths below 1 ft bgs were below the Industrial Receptor RSL.

The volume estimate of soil requiring remediation for Commercial/Industrial Land Use (assuming a soil depth of 1 ft bgs) is presented in Table 9-2 and Figure 9-1.

9.4.2 Unrestricted (Residential) Land Use

To achieve Unrestricted (Residential) Land Use, remediation in the following areas is required:

- Former Crash Area Well Pit – Removal of the Well Pit soil is required, as described in Section 9.4.1.
- Former Plane Refueling/Crash Strip Area (Area 2) – The eastern lateral extent of contamination was determined to be half the distance between the sample with a Resident Receptor FWCUG exceedance (NTAsb-122) and an adjacent sample without an exceedance (NTA-091). The western lateral extent of contamination is bound by the concrete pad immediately west of sample location NTA-088. The vertical extent is assumed to be 1 ft bgs, as concentrations at depths below 1 ft bgs were below the Resident Receptor CUG.
- Former Crash Area (Area 3) – At the east end of the Crash Strip, the lateral extent of contamination was determined to be half the distance between the sample with Resident Receptor FWCUG exceedances (NTA-026) and adjacent samples without exceedances (See Figure 9-2).

The estimated volume of soil requiring remediation for Unrestricted (Residential) Land Use (assuming a soil depth of 1 ft bgs) is presented in Table 9-3 and Figure 9-2.

Table 9–1. COCs for Potential Remediation and Cleanup Goals

Media	Chemical of Concern	Cleanup Goal (mg/kg) Commercial/Industrial Land Use (Industrial Receptor)	Cleanup Goal (mg/kg) Unrestricted (Residential) Land Use (Resident Receptor)
Former Crash Area			
Surface Soil (0–1 ft bgs)	Benzo(a)pyrene	NA	0.221
	Benzo(b)fluoranthene	NA	2.21
	Dibenz(a,h)anthracene	NA	0.221
Former Plane Refueling/Crash Strip Area			
Surface Soil (0–1 ft bgs)	Benz(a)anthracene	29	2.21
	Benzo(a)pyrene	2.9	0.221
	Benzo(b)fluoranthene	29	2.21
	Dibenz(a,h)anthracene	2.9	0.221
	Indeno(1,2,3-cd)pyrene	NA	2.21
Former Crash Area Well Pit			
Soil	Lead	800	400

Benz(a)anthracene is not a chemical of concern (COC) for potential remediation in the Former Crash Area, as the exposure point concentration (0.239 mg/kg) and maximum detected concentration (1.5 mg/kg) are below the Resident Receptor facility-wide cleanup goal (2.21 mg/kg).

There are no subsurface soil, sediment, or surface water COCs requiring remediation for Unrestricted (Residential) Land Use at NACA Test Area.

There are no COCs in the following exposure units within NACA Test Area: Former Plane Burial Area, Tributary to Hinkley Creek, Wetland/Pond North of the Former Crash Area, Former Crash Area Reservoir; and Off-AOC.

bgs = Below ground surface.

ft = Feet.

mg/kg = Milligrams per kilogram.

NA = Not applicable. The chemical of concern does not require remediation for the receptor within the specified EU.

Table 9–2. Estimated Volume Requiring Remediation for Commercial/Industrial Land Use

Areas Requiring Remediation	Media	Treatment Interval	Surface Area	In-situ		In-situ with Constructability[a]		Ex-situ[a,b]	
		(ft bgs)	(ft^{2})	Volume (ft^{3})	Volume (yd^{3})	Volume (ft^{3})	Volume (yd^{3})	Volume (ft^{3})	Volume (yd^{3})
Area 1 - Former Plane Refueling/Crash Strip Area	Surface Soil	0–1	8,800	8,797	330	11,000	405	13,200	490
Well Pit	Soil	VOLUME ESTIMATE BASED ON FIELD OBSERVATIONS						4	0.1
							TOTAL	13,204	490

[a] Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.

[b] Includes 20% swell factor.

bgs = Below ground surface.
ft = Feet.
ft^{2} = Square feet.
ft^{3} = Cubic feet.

Table 9–3. Estimated Volume Requiring Remediation for Unrestricted (Residential) Land Use

Areas Requiring Remediation	Media	Treatment Interval	Surface Area	In-situ		In-situ with Constructability[a]		Ex-situ[a,b]	
		(ft bgs)	(ft^{2})	Volume (ft^{3})	Volume (yd^{3})	Volume (ft^{3})	Volume (yd^{3})	Volume (ft^{3})	Volume (yd^{3})
Area 2 - Former Plane Refueling/Crash Strip Area	Surface Soil	0–1	10,430	10,430	385	13,040	485	15,645	580
Area 3 – Former Crash Area	Surface Soil	0–1	10,000	10,000	370	12,500	460	15,000	560
		SUBTOTALS	20,430	20,430	755	25,540	945	30,645	1,140
Well Pit	Soil	VOLUME ESTIMATE BASED ON FIELD OBSERVATIONS						4	0.1
							TOTAL	30,649	1,140

[a] Constructability factor accounts for over excavation, sloping of sidewalls, and addresses limitations of removal equipment. The in-situ volume is increased by 25% for a constructability factor.

[b] Includes 20% swell factor.

bgs = Below ground surface.
ft = Feet.
ft^{2} = Square feet.
ft^{3} = Cubic feet.

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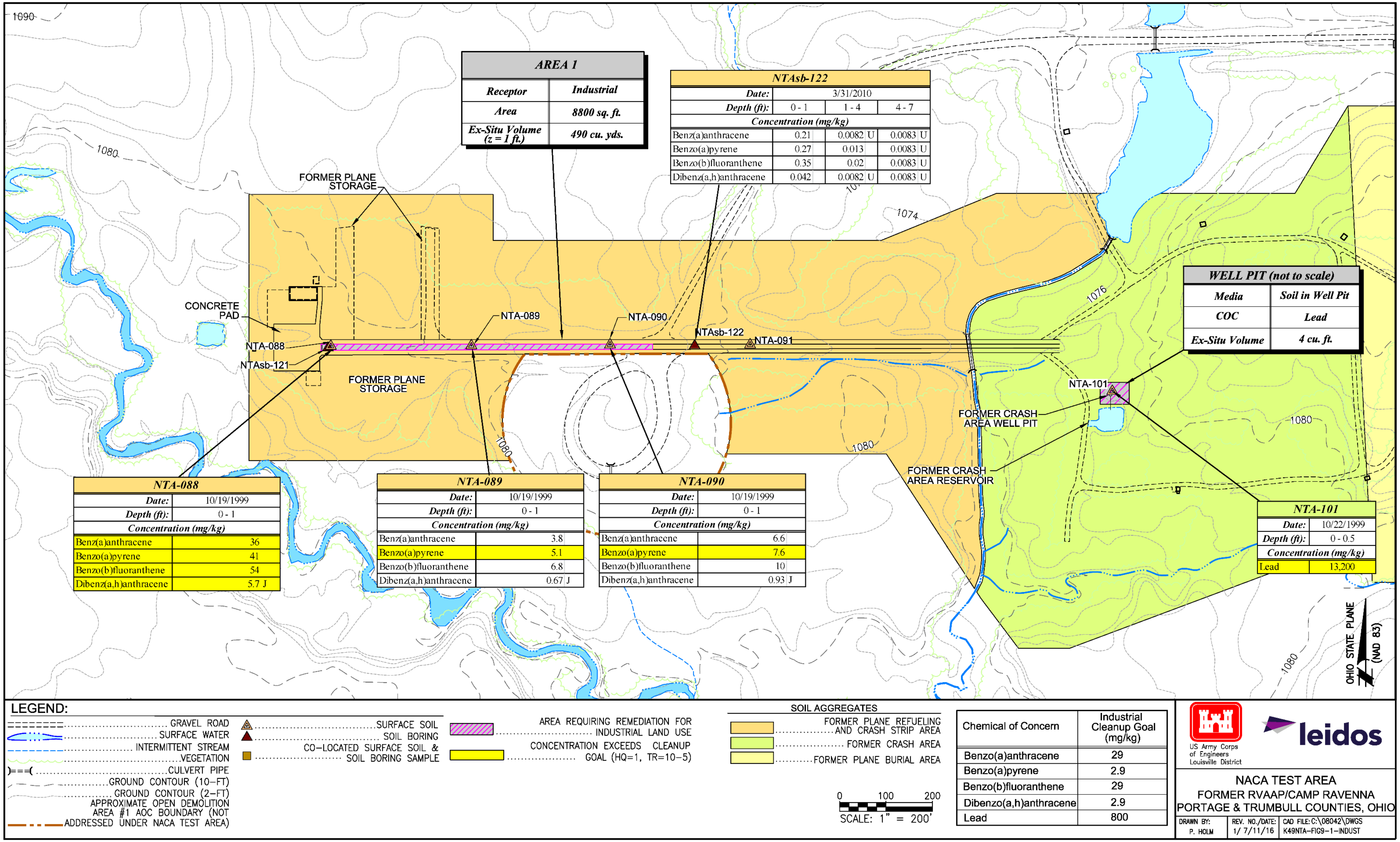


AREA 1

Receptor	**Industrial**
Area	**8800 sq. ft.**
Ex-Situ Volume (z = 1 ft.)	**490 cu. yds.**

NTAsb-122

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.21	0.0082 U	0.0083 U
Benzo(a)pyrene	0.27	0.013	0.0083 U
Benzo(b)fluoranthene	0.35	0.02	0.0083 U
Dibenz(a,h)anthracene	0.042	0.0082 U	0.0083 U

WELL PIT (not to scale)

Media	**Soil in Well Pit**
COC	**Lead**
Ex-Situ Volume	**4 cu. ft.**

NTA-088

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	36
Benzo(a)pyrene	41
Benzo(b)fluoranthene	54
Dibenz(a,h)anthracene	5.7 J

NTA-089

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	3.8
Benzo(a)pyrene	5.1
Benzo(b)fluoranthene	6.8
Dibenz(a,h)anthracene	0.67 J

NTA-090

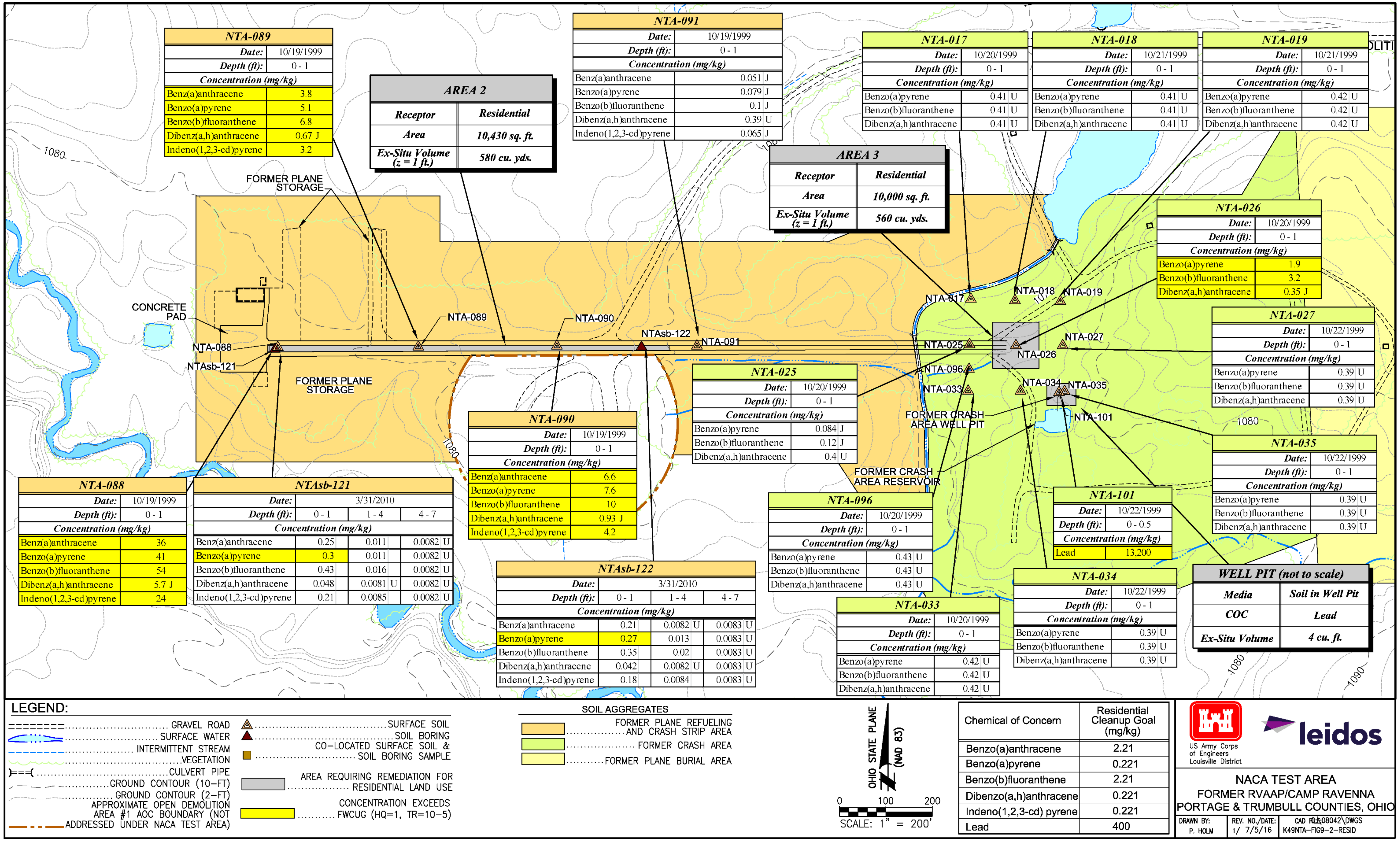
Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	6.6
Benzo(a)pyrene	7.6
Benzo(b)fluoranthene	10
Dibenz(a,h)anthracene	0.93 J

NTA-101

Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Lead	13,200

Chemical of Concern	Industrial Cleanup Goal (mg/kg)
Benzo(a)anthracene	29
Benzo(a)pyrene	2.9
Benzo(b)fluoranthene	29
Dibenzo(a,h)anthracene	2.9
Lead	800

Figure 9–1. Estimated Extent of Soil Requiring Remediation to Attain Commercial/Industrial Land Use



NTA-089

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	3.8
Benzo(a)pyrene	5.1
Benzo(b)fluoranthene	6.8
Dibenz(a,h)anthracene	0.67 J
Indeno(1,2,3-cd)pyrene	3.2

AREA 2

Receptor	Residential
Area	10,430 sq. ft.
Ex-Situ Volume (z = 1 ft.)	580 cu. yds.

NTA-091

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	0.051 J
Benzo(a)pyrene	0.079 J
Benzo(b)fluoranthene	0.1 J
Dibenz(a,h)anthracene	0.39 U
Indeno(1,2,3-cd)pyrene	0.065 J

AREA 3

Receptor	Residential
Area	10,000 sq. ft.
Ex-Situ Volume (z = 1 ft.)	560 cu. yds.

NTA-017

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.41 U
Benzo(b)fluoranthene	0.41 U
Dibenz(a,h)anthracene	0.41 U

NTA-018

Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.41 U
Benzo(b)fluoranthene	0.41 U
Dibenz(a,h)anthracene	0.41 U

NTA-019

Date:	10/21/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.42 U
Benzo(b)fluoranthene	0.42 U
Dibenz(a,h)anthracene	0.42 U

NTA-026

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	1.9
Benzo(b)fluoranthene	3.2
Dibenz(a,h)anthracene	0.35 J

NTA-027

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

NTA-025

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.084 J
Benzo(b)fluoranthene	0.12 J
Dibenz(a,h)anthracene	0.4 U

NTA-090

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	6.6
Benzo(a)pyrene	7.6
Benzo(b)fluoranthene	10
Dibenz(a,h)anthracene	0.93 J
Indeno(1,2,3-cd)pyrene	4.2

NTA-035

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

NTA-088

Date:	10/19/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benz(a)anthracene	36
Benzo(a)pyrene	41
Benzo(b)fluoranthene	54
Dibenz(a,h)anthracene	5.7 J
Indeno(1,2,3-cd)pyrene	24

NTAsb-121

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.25	0.011	0.0082 U
Benzo(a)pyrene	0.3	0.011	0.0082 U
Benzo(b)fluoranthene	0.43	0.016	0.0082 U
Dibenz(a,h)anthracene	0.048	0.0081 U	0.0082 U
Indeno(1,2,3-cd)pyrene	0.21	0.0085	0.0082 U

NTA-096

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.43 U
Benzo(b)fluoranthene	0.43 U
Dibenz(a,h)anthracene	0.43 U

NTA-101

Date:	10/22/1999
Depth (ft):	0 - 0.5
Concentration (mg/kg)	
Lead	13,200

NTAsb-122

Date:	3/31/2010		
Depth (ft):	0 - 1	1 - 4	4 - 7
Concentration (mg/kg)			
Benz(a)anthracene	0.21	0.0082 U	0.0083 U
Benzo(a)pyrene	0.27	0.013	0.0083 U
Benzo(b)fluoranthene	0.35	0.02	0.0083 U
Dibenz(a,h)anthracene	0.042	0.0082 U	0.0083 U
Indeno(1,2,3-cd)pyrene	0.18	0.0084	0.0083 U

NTA-034

Date:	10/22/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.39 U
Benzo(b)fluoranthene	0.39 U
Dibenz(a,h)anthracene	0.39 U

WELL PIT (not to scale)

Media	Soil in Well Pit
COC	Lead
Ex-Situ Volume	4 cu. ft.

NTA-033

Date:	10/20/1999
Depth (ft):	0 - 1
Concentration (mg/kg)	
Benzo(a)pyrene	0.42 U
Benzo(b)fluoranthene	0.42 U
Dibenz(a,h)anthracene	0.42 U

Chemical of Concern	Residential Cleanup Goal (mg/kg)
Benzo(a)anthracene	2.21
Benzo(a)pyrene	0.221
Benzo(b)fluoranthene	2.21
Dibenzo(a,h)anthracene	0.221
Indeno(1,2,3-cd) pyrene	0.221
Lead	400

Figure 9–2. Estimated Extent of Soil Requiring Remediation to Attain Unrestricted (Residential) Land Use

10.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

10.1 INTRODUCTION

CERCLA Section 121 specifies that remedial actions must comply with requirements or standards under federal or more stringent state environmental laws that are "applicable or relevant and appropriate to the hazardous substances or particular circumstances at the AOC." Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured. This section summarizes potential federal and state chemical-, location-, and action-specific ARARs for potential remedial actions at the AOC.

ARARs include those federal and state regulations that are designed to protect the environment. Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" [40 Code of Federal Regulations (CFR) 300.5]. USEPA has stated in the NCP that applicable requirements are those requirements that would apply if the response action were not taken under CERCLA.

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site such that their use is well suited to the particular site" (40 CFR 300.5).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs, but are to-be-considered guidance [40 CFR 300.400(g)(13)].

CERCLA remedial response actions at an AOC must comply only with the substantive requirements of a regulation [CERCLA Section 121(e)]. Substantive requirements are those that pertain directly to the actions or conditions at an AOC, while administrative requirements facilitate their implementation. USEPA recognizes that certain administrative requirements (e.g., consultation with state agencies, reporting) are accomplished through state involvement and public participation. These administrative requirements should also be observed if they are useful in determining cleanup standards at the AOC (55 CFR 8757).

Although remedial actions for AOCs at National Priorities List sites must comply only with the substantive requirements of federal or state environmental regulations, the Ohio Revised Code does not provide a similar permit waiver for actions conducted under the Ohio EPA Remedial Response Program

Policy. Ohio EPA's Division of Environmental Response and Revitalization (DERR) Policy DERR-00-RR-034 states "it has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including the substantive and administrative requirements." However, a DFFO was entered into on June 10, 2004 that provided certain exemptions from the Ohio Administrative Code (OAC) administrative requirements and required groundwater monitoring and remediation at RVAAP to be performed under the CERCLA process. The DFFO includes provisions for compliance that may result in the potential negation of all provided exemptions within the DFFO in the event non-compliant activities are identified.

10.2 POTENTIAL ARARS

USEPA classifies ARARs as chemical-, action-, and location-specific to provide guidance for identifying and complying with ARARs (USEPA 1988).

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, allow numerical values to be established. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (USEPA 1988).
- Action-specific ARARs are rules, such as performance-, design-, or other activity-based rules which place requirements or limitations on actions.
- Location-specific ARARs are rules that place restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations (USEPA 1988).

As explained in the following paragraph, rules from each of these categories are ARARs only to the extent that they relate to the degree of cleanup.

CERCLA Section 121 governs cleanup standards at CERCLA sites. ARARs originate in the subsection of CERCLA that specifies the degree of cleanup at each AOC: CERCLA Section 121(d). In Section 121(d)(2), CERCLA expressly directs that ARARs are to address specific contaminants of concern at each AOC, specifying the level of protection to be attained by any chemicals remaining at the AOC. CERCLA Section 121(d)(2) provides that, with respect to hazardous substances, pollutants, or contaminants remaining on site after completing a remedial action, ARARs are:

> "Any standard, requirement, criteria, or limitation under any Federal environmental law … or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation."

CERCLA Section 121(d)(2) further states that the remedial action must attain a level of control established in rules determined to be ARARs. CERCLA Section 121(d)(1) dictates that remedial actions enacted to achieve a degree of cleanup that is protective of human health and the environment are to be relevant and appropriate under the circumstances presented by the release. Accordingly, any chemical-, action-, or location-specific requirements are considered ARARs if they ensure the degree of cleanup will be protective of human health and the environment under the circumstances presented by the release. An evaluation of the regulatory requirements has shown there are no chemical-specific ARARs for the chemicals identified in various media at the AOC.

In summary, chemical-, action-, or location-specific requirements are considered ARARs when they establish standards that are protective of human health and the environment for chemicals that will remain on site after the remedial action and ensure protection of site works and the environment during remedy implementation. Requirements identified as chemical-specific ARARs must ensure a degree of cleanup that is protective of human health and the environment under the circumstances presented by the release.

10.2.1 Potential Chemical-Specific ARARs

A review of the regulations indicated there are no potential chemical-specific ARARs for any of the contemplated alternatives in soil for the site COCs. No regulations were identified that included specific chemical concentrations or requirements that would be a potential ARAR to drive the remedial action process.

10.2.2 Potential Action-Specific ARARs

Potential excavation and disposal of contaminated environmental media at the AOC will trigger potential ARARs associated with land disturbance and emission controls. OAC 3745-15-07 requires that nuisance air pollution emissions be controlled. This includes controlling potential fugitive dust from soil handling excavation activities. In addition, any construction (e.g., soil disturbance activities encompassing over an acre) would trigger the storm water requirements found at 40 CFR Part 450. These requirements mandate that erosion and sedimentation control measures be designed and implemented to control erosion and sediment runoff.

Because excavation would include generating and managing contaminated media, Resource Conservation and Recovery Act (RCRA) requirements would be considered potential ARARs for this activity. RCRA requirements mandate that a generator must determine whether a material is (or contains in the case of environmental media) a hazardous waste under OAC 3745-52-11. If a material is determined to be or contain a listed hazardous waste, or exhibits a hazardous waste characteristic, additional management requirements under RCRA must be followed as an ARAR under CERCLA.

These requirements include how hazardous waste is stored, treated, transported, and disposed. They are generally not considered to be chemical-specific ARARs because they do not relate directly to the degree of cleanup or to specific chemicals. In addition to the substantive requirements associated with managing and storing material that is also RCRA hazardous waste (or found to contain such waste), some RCRA requirements prescribe standards for disposing hazardous material, including (1) land disposal restrictions (LDRs) prohibiting disposal of specific chemicals until they are treated to a specified level, or by a specific treatment technology; and (2) minimum technical requirements (MTRs) for land disposal units.

USEPA cautions that LDRs should not be used to determine site-specific cleanup levels for soil (USEPA 2002). The purpose of LDRs is to require appropriate treatment of RCRA hazardous waste that is to be disposed to minimize short- and long-term threats to human health or the environment based upon available technology. Performing treatment to meet LDR standards is different from the CERCLA approach to remediation, which analyzes risk and develops soil cleanup standards based on the risk present. This approach may result in soil cleanup levels that are different from those of a risk-based approach. Nevertheless, if RCRA hazardous waste is generated from the CERCLA action and is disposed on site, the material must meet the established LDR standards.

In order for LDRs to be triggered as potential ARARs, RCRA hazardous waste must be present. This requires (1) that soil contain contaminants derived from RCRA-listed waste or exhibit a characteristic of RCRA hazardous waste, and (2) that soil is managed in a way that "generates" hazardous waste. Several methods of soil management that do not "generate" hazardous waste, and so do not trigger LDRs, are available for use. These methods include using the AOC approach, a staging pile, a storage or treatment corrective action management unit (CAMU), or a temporary unit.

If soil is managed in a manner that generates hazardous waste, such as removing it to an aboveground container and then redepositing it within the land unit for disposal, then LDRs become potential ARARs. LDRs are applied to the waste when it is removed from the unit under an AOC approach or when the soil is excavated and lifted out of the unit. Potential LDR ARARs in Ohio are variances from treatment standards in OAC Section 3745-700-44, LDR standards for contaminated debris in OAC Section 3745-47, Universal Treatment Standards (UTS) in OAC Section 3745-270-48, and Alternative Standards for Contaminated Soil in OAC Section 3745-270-49.

Ohio has adopted the alternative soil treatment standards promulgated by USEPA in its Phase IV LDR rule, in effect since August 1998. The rule provides that if RCRA hazardous waste is present, the material must meet one of two sets of LDRs before being disposed in a land unit: (1) the UTS; or (2) the contaminated soil (technology-based treatment) standards promulgated in Phase IV of the LDRs, whichever is greater. Or, if a generator so chooses, they may use the generic treatment standards in OAC Section 3745-270-40 which apply to all hazardous waste. Only the alternative soil treatment standards are explained in this document.

Under the alternative soil treatment standards, all soil subject to treatment must be treated as follows:

- For non-metals, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or inorganic underlying hazardous constituent), subject to item three below.
- For the inorganic chemicals carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations, as measured in leachate from the treated media [tested according to the toxicity characteristic leaching procedure (TCLP)], or 90% reduction in total constituent concentrations (when a inorganic chemical removal treatment technology is used), subject to item three below.
- When treating any constituent subject to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent

concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10xUTS."

- USEPA and Ohio EPA have established a site-specific variance from the soil treatment standards that can be used when treating concentrations of hazardous constituents higher than those specified in the soil treatment standards and that minimize short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede soil treatment standards. Any variance granted cannot rely on capping, containment, or other physical or institutional controls.

If CAMUs are used as disposal units at the AOC, the design and treatment standards established in OAC Section 3745-57-72 will be potentially relevant and appropriate to the response action. Only CAMU-eligible waste can be disposed in a CAMU. CAMU-eligible waste includes hazardous and non-hazardous wastes that are managed for implementing cleanup, depending on the Ohio EPA Director's approval or prohibition of specific waste or waste streams. Using a CAMU for disposal does not trigger LDRs or MTRs as long as the standards specified in the rule are observed. The Director will incorporate design and treatment standards into a permit or order. Design standards include a composite liner and a leachate collection system designed and constructed to maintain less than 30 cm of leachate over the liner. A composite liner entails a system consisting of two components which each have detailed specifications and installation requirements. The Director may approve alternate requirements if he can make the findings adhere to the requirements specified in the rule. Treatment standards are similar to LDR standards for contaminated soil, although alternative and adjusted standards may be approved or required by the Director as long as the adjusted standard is protective of human health and the environment.

If soil is found to be contaminated but not a RCRA hazardous waste, management and disposal of this material would be subject to the requirements associated with managing and disposing solid waste within the state of Ohio. The requirements found in OAC Section 3745-27-05 would be potential ARARs for disposing non-hazardous contaminated soil generated during excavation and subsequent disposal at an off-site location.

A permit-by-rule (PBR) is a specific permit exemption in the OAC that applies to certain types of low-emitting air pollution sources. Soil vapor emissions from a thermal treatment system would require exemption under OAC 3745-31-03 (PBR). The PBR contains qualifying criteria, emission limitations, conditions for operation, and requirements for record keeping and reporting which must be followed. Potential action-specific ARARs are listed in Table 10-1.

10.2.3 Potential Location-Specific ARARs

Location requirements include, but are not limited to, those established for potential remedial activities conducted within wetlands, within a floodplain area, or with respect to federal- or state-listed species. Generally, for wetlands and floodplains, alternatives are required to be developed to conduct remedial activities outside the sensitive area; if that is not feasible, adverse effects from any actions taken within the sensitive area must be mitigated to the extent possible. These requirements do not relate to specific chemicals, nor do they change the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. Rather, their purpose is to protect sensitive areas to the extent possible. Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of hazardous substances, with the goal of attaining a degree of cleanup and controlling further releases to ensure protection of human health and the environment.

No location-specific ARARs have been identified for NACA Test Area. However, because sensitive resources (e.g., wetlands) have been identified within NACA Test Area, if any remedial activities affect these wetlands, EO 11990 (40 CFR 6, Appendix A) and OAC 3745-1-54 would be to-be-considered guidance for the site. The following actions have the potential to minimize impact wetlands during the design and implementation of remedial actions:

- Identify potential wetland impacts caused by the selected remedial alternative:
    - Changes to wetlands hydrology
    - Impact to water quality
    - Impact to habitat quality
    - Impact to vegetative community
- Demonstrate compliance with mitigation provisions by:
    - Avoiding wetland and water impacts where practicable
    - Minimizing potential impacts to wetlands and water
    - Compensating for any remaining, unavoidable impacts to wetlands or waters through activities to enhance or create wetlands and/or waters

Although no location-specific standards have been identified as ARARs, any action taken by the federal government must be conducted in accordance with requirements established under the National Environmental Policy Act, Endangered Species Act, National Historic Preservation Act, Native American Graves Protection and Repatriation Act, state burial laws, and federal and state wetlands and floodplains construction and placement of materials considerations, even though these laws and rules do not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for chemicals remaining on site at the close of the response actions.

Table 10–1. Potential Action-Specific ARARs

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Prohibition of air pollution nuisances (e.g., fugitive dust) OAC Section 3745-15-07	These rules prohibit releasing nuisance air pollution that endangers health, safety, or welfare of the public or cause personal injury or property damage.	Applies to any activity that could result in the release of a nuisance air pollutant. This would include dust from excavation or soil management processes.	Any person undertaking an activity is prohibited from emitting nuisance air pollution.
Storm water requirements at construction sites 40 CFR Part 450	These rules require that storm water controls be employed at construction sites that exceed 1 acre.	Applies to any construction activity that exceeds 1 acre.	Persons undertaking construction activities (including grubbing and land clearing) at an AOC where the construction footprint is over 1 acre must design and implement erosion and runoff controls.
Generation of contaminated soil or debris OAC Section 3745-52-11	These rules require that a generator determine whether a material generated is a hazardous waste.	Applies to any material that is or contains a solid waste. Must be characterized to determine whether the material is or contains a hazardous waste.	Any person that generates a waste as defined must use prescribed methods to determine if waste is considered characteristically hazardous using the prescribed methods.
Management of contaminated soil or debris that is or contains a hazardous waste OAC Sections 3745-52-30 through 3745-52-34	These rules require that hazardous waste be properly packaged, labeled, marked, and accumulated on site pending on- or off-site disposal.	Applies to any hazardous waste, or media containing a hazardous waste that is generated from on-site activities.	All hazardous waste must be accumulated in a compliant manner that includes proper marking, labeling, and packaging in accordance with the specified regulations. This includes inspecting containers or container areas where hazardous waste is accumulated on site.
Acquisition and use of manifests for hazardous waste shipments to off-site treatment, storage or disposal facilities OAC Sections 3745-52-20 through 3745-52-23	These rules require that a Uniform Hazardous Waste Manifest be used for any off-site shipment of hazardous waste.	Applies to any shipment of hazardous waste to an off-site facility for treatment, storage, or disposal.	Requires a generator who transports or offers to transport hazardous waste for off-site treatment, storage, or disposal to prepare a uniform hazardous waste manifest.

Table 10-1. Potential Action-Specific ARARs (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Soil contaminated with RCRA hazardous waste OAC Section 3745-270-49 OAC Section 3745-270-48 UTS	These rules prohibit land disposal of RCRA hazardous wastes subject to them, unless the waste is treated to meet certain standards that are protective of human health and the environment. Standards for treating hazardous waste-contaminated soil prior to disposal are set forth in the two cited rules. Using the greater of either technology-based standards or UTS is prescribed.	LDRs apply only to RCRA hazardous waste. This rule is considered for ARAR status only upon generating a RCRA hazardous waste. If any soil is determined to be RCRA hazardous waste, and if it will be disposed of on site, this rule is potentially applicable to disposal of the soil.	All soil subject to treatment must be treated as follows: (1) For non-metals, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or inorganic UHC), subject to item 3 below. (2) For the inorganic chemicals carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the TCLP) or 90% reduction in total constituent concentrations (when a inorganic chemical removal treatment technology is used), subject to item 3 below. (3) When treating any constituent subject to achieve a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as “90% capped by 10xUTS.”

Table 10-1. Potential Action-Specific ARARs (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Soil/debris contaminated with RCRA hazardous waste – variance OAC Section 3745-270-44	The Ohio EPA Director will recognize a variance approved by the USEPA from the alternative treatment standards for hazardous contaminated soil or for hazardous debris.	Potentially applicable to RCRA hazardous soil or debris that is generated and placed back into a unit and that will be disposed of on site.	A site-specific variance from the soil treatment standards that can be used when treatment to concentrations of hazardous constituents higher than those specified in the soil treatment standards and minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards.
Soil/debris that is contaminated but not a hazardous waste for disposal. OAC Section 3745-27-05	Establishes standard for disposing solid waste within the state of Ohio.	Potentially applicable to contaminated soil disposed offsite under state solid waste disposal requirements.	Establishes allowable methods of solid waste disposal and prohibits management by open burning or dumping.
Permits-to-install, exemptions and permits-by-rule OAC Section 3745-31-03	A permit-by-rule (PBR) is a specific permit provision in the OAC that applies to certain types of low-emitting air pollution sources.	Potentially applicable if a thermal treatment system is selected for remedy.	Requires a generator to obtain a PBR exemption for low emitting air pollution sources prior to operating a thermal treatment system.

AOC = Area of concern.
ARAR = Applicable and Relevant or Appropriate Requirements.
CFR = Code of Federal Regulations.
LDR = Land disposal restrictions.
OAC = Ohio Administrative Code.
Ohio EPA = Ohio Environmental Protection Agency.
RCRA = Resource Conservation and Recovery Act.
TCLP = Toxicity characteristic leaching procedure.
UHC = Underlying hazardous constituent.
USEPA = U.S. Environmental Protection Agency.
UTS = Universal Treatment Standard.

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11.0 TECHNOLOGY TYPES AND PROCESS OPTIONS

This section identifies and describes GRAs which may be implemented to achieve CUGs. In addition, this section summarizes the remedial technologies and process options available to remediate COCs in soil as identified in Section 9.0.

The procedure for identifying and screening potential remedial technologies followed the method established in the USEPA guidance document, *Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA* (USEPA 1988). This guidance document provides the framework for identifying and screening all available remedial technologies with the most appropriate technologies available based on the COCs and AOC characteristics (e.g., soil type).

11.1 GENERAL RESPONSE ACTION

GRAs are actions which may be implemented to satisfy RAOs. The actions may be individual or a combination of responses. Soil in the Well Pit with lead contamination above CUGs requires remediating a small volume of contaminated soil (estimated ex-situ volume of 0.15 yd^3); therefore, the presumptive remedy is excavation and off-site disposal. No additional GRAs were considered for treating soil at this location.

The HHRA identified PAHs in surface soil contributing to human health risk for the Industrial Receptor and Resident Receptor. The following GRAs are applicable and are defined in greater detail for the PAHs in surface soil (0-1 ft bgs) at Areas 1, 2, and 3:

- No action,
- Institutional controls,
- Containment,
- Removal, and
- Treatment.

11.1.1 No Action

No action is required for evaluation under the NCP and is the baseline to which other remedial alternatives are compared. No action may be an appropriate alternative if no unacceptable risk is present at the AOC. This GRA provides a baseline against which to compare other more proactive alternatives. No action is taken at the AOC to reduce risk to human health or the environment. Any existing actions, such as restrictions or monitoring, are discontinued.

11.1.2 Institutional Controls

Institutional controls include engineering measures (i.e., fencing and warning signs) and non-engineering measures, such as administrative or legal controls, and are used to prevent or limit exposure to hazardous substances. Institutional controls do not reduce contaminant mobility, volume, or toxicity.

If institutional controls are selected as a component of a remedial alternative, the effectiveness of the remedy must undergo five-year reviews. The primary goal of the five-year reviews is to evaluate the implementation and performance of the remedy to determine if the remedy is or will be protective of human health and the environment. The five-year reviews are discontinued when the remedy achieves CUGs for Unrestricted (Residential) Land Use.

11.1.3 Containment

Containment technologies are often used to prevent, or significantly reduce, the migration of contaminants in soil or sediment. In general, containment is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards, technical impracticality, and/or unrealistic cost.

The main advantage of containment methods is that they can prevent further migration of contaminant plumes by minimizing infiltration and leaching. Containment requires periodic inspections for leaks and ponding of liquids and periodic sampling to confirm integrity of the containment system.

Common types of containment technologies include capping (i.e., a clay cap, a multi-layered cap that includes clay and synthetic liners, or an asphalt or concrete cap) and soil covers.

11.1.4 Removal

Removing contaminated media from the AOC reduces or eliminates the potential for long-term human and environmental exposure to chemicals exceeding concentrations determined to be protective for a given Land Use. Removing soil may be combined with pre-treatment prior to off-site disposal, or soil may be shipped without pre-treatment.

Disposal and handling, after removal, involve the final and permanent placement of waste material in a manner protective of human health and the environment. The impacted media is disposed on site in an engineered facility or offsite in a permitted or licensed facility such as a regulated landfill. Similarly, concentrated waste resulting from treatment processes is disposed on site in a permanent disposal cell or in an off-site approved disposal facility.

Transportation is accomplished utilizing various methods, including truck, railcar, and/or barge.

11.1.5 Treatment

Treatment is conducted either in- or ex-situ to reduce contaminant concentrations to acceptable levels. Common types of treatment include biological, chemical, physical, and thermal. Biological treatment involves using microbes to degrade contaminants. Chemical treatment processes add chemicals to react with contaminants to reduce their toxicity or mobility. Physical processes involve either physically binding the contaminant(s) to reduce mobility or the potential for exposure (e.g., encapsulation) or extracting the contaminant(s) from a medium to reduce volume. Thermal treatment, such as incineration, uses high temperatures to volatilize, decompose, or melt contaminants. For soil treated by ex-situ methods, the treatment may allow soil to be placed back into the excavation, or soil may be treated to reduce the chemical concentration or stabilize the soil prior to off-site disposal.

11.2 INITIAL SCREENING OF TREATMENT TECHNOLOGIES

Table 11-1 summarizes the remedial technologies and process options available for treating PAH COCs in surface soil at Areas 1, 2, and 3. The initial screening focuses on technology types capable of remediating the PAH COCs and evaluates the implementability of the technology. If treatment technologies are evaluated and retained as potentially viable treatment options for the AOC, the retained technology will undergo a more detailed evaluation described in Section 11.3.

11.3 DETAILED SCREENING OF TECHNOLOGIES

The remedial action technologies retained from the initial screening process are evaluated against criteria of effectiveness, implementability, and cost (three of the NCP balancing criteria). The rationale for either retaining or eliminating treatment options for the AOC is presented and summarized in Table 11-2. The remedial options retained from the detailed screening process used to develop the remedial alternatives are presented in Section 12.0.

11.3.1 Effectiveness

The effectiveness criterion assesses the ability of a remedial technology to protect human health and the environment by reducing the toxicity, mobility, or volume of contaminants. Each technology is evaluated for its ability to achieve RAOs, potential impacts to human health and the environment during construction and implementation, and overall reliability of the technology.

11.3.2 Implementability

Each process option/technology is evaluated for implementability in terms of technical feasibility, administrative feasibility, and availability of the necessary material, equipment, and work force. The assessment considers each technology’s short- and long-term implementability. Short-term implementability considers constructability of the remedial technology, near-term reliability, ability to obtain necessary approvals with other agencies, and likelihood of obtaining a favorable community response. Long-term implementability evaluates the ease of undertaking additional remedial actions (if necessary), monitoring the effectiveness of the remedy, and operations and maintenance (O&M).

11.3.3 Cost

The cost criterion evaluates each remedial process in terms of relative capital and O&M costs. Costs for each technology are rated qualitatively, on the basis of engineering judgment, in terms of cost effectiveness. Therefore, a low cost remedial technology is rated as highly cost effective, while a costly technology is evaluated as being of low cost effectiveness.

Table 11–1. Initial Screening of Technologies

General Response Actions	Technology Type	Process Options	Description	Screening Results
No Action	None	None	No action is taken at AOC. Current LUCs, access restrictions, and monitoring programs will be discontinued. No remedial technologies are implemented to reduce hazards to potential human or ecological receptors.	Retained. Required under NCP to be carried through CERCLA analysis.
Institutional Controls	Access Restrictions	LUCs with CERCLA Five-Year Reviews	Implement LUCs at the AOC to restrict access and Land Use. LUCs will be administered and enforced as part of the Property Management Plan and reviewed in CERCLA five-year reviews. Five-year reviews include reviewing sampling and monitoring plans and results of monitoring activities, conducting interviews and inspections, and reviewing AOC status.	Retained.
		Fencing	Place fencing around areas of contamination (at a minimum) to restrict access and exposure to contamination left in place.	Not retained. Fencing will inhibit active use of the site for Commercial/Industrial Land Use.
Containment	Capping	Native Soil/Sediment	Uses native soil or sediment to cover contamination and reduce migration by wind and water erosion.	Not retained. Using a cap, liner, or asphalt/concrete in areas with contamination will inhibit active use of the site for Commercial/Industrial Land Use.
		Clay	Clay layers are used to cover contamination and eliminate prevent exposure. Installing clay cap will limit water infiltration. Susceptible to weathering effects (e.g., cracking).	
		Synthetic Liner	A synthetic liner is used to cover contamination and prevent exposure. Synthetic material is used to limit water infiltration, which is not as susceptible to cracking as clay.	
		Multi-layered	Multiple layers of different soil types are used to limit water infiltration, which is not as susceptible to cracking as clay.	
		Asphalt/Concrete	Asphalt or concrete layers are used to cover contamination and prevent exposure. Additionally, this technology limits water infiltration; however, it is susceptible to cracking if not properly maintained.	
Removal	Bulk Removal	Excavation and Off-site Disposal	Contaminated material is removed and transported to permitted off-site treatment and disposal facilities.	Retained.

Table 11–1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
Treatment	In-situ Biological Treatment	Bioventing	Oxygen is delivered to contaminated unsaturated soil by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.	Not retained. Although the technology successfully remediates organic chemicals, the presence of saturated soil and shallow groundwater impacts performance. In addition, the soil at the site has lower permeability than needed for this treatment.
		Enhanced Bioremediation	Adding oxygen and nutrients aids indigenous or inoculated micro-organisms (e.g., fungi, bacteria, and other microbes) in degrading (metabolizing) organic contaminants found in soil and/or groundwater, converting them to innocuous end products.	Retained.
		Phytoremediation	Using plants to remove, transfer, stabilize, and destroy contaminants in soil and sediment.	Retained.
	In-situ Physical/Chemical Treatment	Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Not retained. The technology is not very effective for high molecular weight PAHs in soil.
		Electrokinetic Separation	Removing inorganic chemicals and organic contaminants from low permeability soil, mud, sludge, and marine dredging. Electrokinetic remediation uses electrochemical and electrokinetic processes to desorb and then remove inorganic chemicals and polar organic chemicals.	Not retained. The targeted contaminants for electrokinetics are heavy metals and polar organics. Technology is not effective for non-polar organics (e.g., PAHs).
		Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to soil or injected into groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and treated.	Not retained. The soil permeability at the site is not conducive for effective soil flushing contaminant removal.

Table 11–1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to be removed from soil through extraction wells. This technology is also known as in-situ soil venting, in-situ volatilization, enhanced volatilization, or soil vacuum extraction.	Not retained. Technology focuses on remediating media contaminated with VOCs and some fuels. Not applicable for contaminants with low volatilization (e.g., PAHs).
		Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Not retained. This technology has limited effectiveness for PAHs.
	In-situ Thermal Treatment	Thermal Treatment	Steam/hot air injection or electrical resistance/electromagnetic/fiber optic/radio frequency heating is used to increase the volatilization rate of semi-volatiles and facilitate extraction.	Not retained. Soil borings indicated debris exists within remediation areas. Debris or other large objects buried in the media can cause operating difficulties. Additionally, high moisture content has a reduced permeability to air, hindering the operation.
	Ex-situ Biological Treatment	Biopiles	Excavated soil is mixed with soil amendments and placed in aboveground enclosures. It is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps.	Retained.
		Landfarming	Contaminated soil, sediment, or sludge is excavated, applied into lined beds, and periodically turned over or tilled to aerate the waste.	Not retained. Technology focuses on remediating media contaminated with volatile petroleum hydrocarbons. Not applicable for PAHs, as volatility is limited. Also, there is a chance of contaminant movement to previously non-contaminated areas of the site.

Table 11–1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Slurry Phase Biological Treatment	Aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Upon completing the process, the slurry is dewatered, and the treated soil is disposed.	Not retained. Due to the estimated quantities of soil requiring remediation, development, and the need for construction of a treatment area to dewater the slurry, this is not a practical technology.
	Ex-situ Physical/Chemical Treatment	Chemical Extraction	Waste-contaminated soil and extractant are mixed in an extractor, thereby dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Not retained. Technology focuses on remediating media contaminated with PCBs, VOCs, halogenated solvents, and petroleum waste. Although the technology is considered suitable for PAHs, clay content (similar to site soil) reduces treatment efficiency.
		Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	Not retained. The target contaminant group for this technology are inorganic chemicals. It has low effectiveness for high molecular weight PAHs.
		Soil Washing	Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organic chemicals and heavy metals.	Retained.

Table 11–1. Initial Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Description	Screening Results
		Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	Not retained. This technology has limited effectiveness for PAHs.
	Ex-situ Thermal Treatment	Hot Gas Decontamination	Raises the temperature of the contaminated equipment or material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.	Not retained. The technology is specific to addressing contaminated equipment or material, as opposed to contaminated soil.
		Incineration	High temperatures, 870-1,200°C (1,600-2,200°F), are used to combust (in the presence of oxygen) organic constituents in hazardous waste.	Retained.
		Pyrolysis	Chemical decomposition is induced in organic material by heat in the absence of oxygen. Organic material is transformed into gaseous components and a solid residue (coke) containing fixed carbon and ash.	Retained.
		Thermal Treatment	Waste is heated in a mobile thermal treatment system to volatilize organic contaminants. The vapor emissions are treated using air filters, and the treated vapor is reused as an energy source for the operation of the thermal treatment system.	Retained.

AOC = Area of concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
LUC = Land use control.
NCP = National Contingency Plan.
PAH = Polycyclic aromatic hydrocarbon.
PCB = Polychlorinated biphenyl.
VOC = Volatile organic compound.

Table 11–2. Detailed Screening of Technologies

General Response Actions	Technology Type	Process Options	Effectiveness	Implementability	Cost	Screening Comments
No Action	None	None	Not effective. Exposure to contaminants left in place goes unsupervised and uncontrolled.	Easy to implement. No activities are implemented.	No cost. No activities driving cost.	Retained. Required by CERCLA.
Institutional Controls	Access Restrictions	LUCs with CERCLA Five-Year Reviews	Effective. Restricting exposure to contaminants is accomplished through training of people accessing the AOC. Enforcement comes from a Property Management Plan.	Easy to implement. LUCs and administrative controls currently take place at the former RVAAP. Most access to facility are trained National Guardsmen. A facility fence deters trespassers. Five-year reviews are conducted at other AOCs.	Moderate cost.	Retained.
Removal	Bulk Removal	Excavation and Off-site Disposal	Effective. Once the contaminated soil is removed to achieve goals of a specific receptor, contaminant exposure to human health and the environment are eliminated for that receptor.	Moderately easy to implement. Technology has been implemented at the former RVAAP in the past. Equipment for implementation is readily available and disposal facilities are available within a reasonable distance.	Moderate cost.	Retained.
Treatment	In-situ Biological Treatment	Enhanced Bioremediation	Moderate effectiveness. Requires applying and mixing amendments in-situ for treatment.	Requires moderate effort for implementation. Long treatment times are required for reducing the high molecular weight PAH concentrations to below CUGs. These treatment times may extend beyond desirable schedule for the Army to start using the site.	Moderate cost.	Not retained. The time required for enhanced bioremediation to reduce PAH concentrations in soil to below CUGs is not practical given the desired Army schedule to begin using the site.
		Phytoremediation	Moderate to low effectiveness. Phytoremediation can be designed to address PAH constituents; however, effectiveness is limited.	Not easy to implement. The time required for phytoremediation to reduce PAH concentrations in the soil may extend beyond desirable schedule for the Army to start using the site. Phytoremediation usually takes more than one growing season. This technology is currently at the demonstration stage and not widely recognized by regulators. Additionally, concentrations can be hazardous to plants and may be mobilized into groundwater or bioaccumulated in animals.	Moderate cost. The cost effectiveness increases as the remedial footprint increases. The area requiring remediation is small; therefore, there is not optimal cost effectiveness.	Not retained. The time required for phytoremediation to reduce PAH concentrations in soil to below CUGs is not practical given the desired Army schedule to begin using the site.
	Ex-situ Biological Treatment	Biopiles	Moderate to low effectiveness. Biopiles are generally applied to VOCs and fuel hydrocarbons. The effectiveness of this technology decreases when applied to PAHs.	Moderate to low implementability. The time required for implementing biopiles (including a treatability study) may extend beyond desirable schedule for the Army to start using the site.	Moderate cost relative to anticipated soil quantity.	Not retained. Technology is not very effective for PAHs. Additionally, the time required for biopile treatment (including a treatability study) may extend beyond desirable schedule for the Army to start using the site.
	Ex-situ Physical/ Chemical Treatment	Soil Washing	Moderate effectiveness. Soil washing is more effective at reducing soil with high concentrations of contaminants (e.g., hazardous waste levels). Only a moderate reduction in concentration is required to achieve CUGs.	Not easy to implement. Treatability study may be required to demonstrate effectiveness. Implementing a treatability study is not practical given time constraints to transfer the AOC to NGB. An additional treatment step of washing the solvent (potentially a hazardous waste) will be required.	High cost. Soil washing is cost effective with high soil volumes. However, a relatively low volume of soil requires remediation.	Not retained. The volume of soil requiring remediation does not result in cost efficiency for this technology.

Table 11–2. Detailed Screening of Technologies (continued)

General Response Actions	Technology Type	Process Options	Effectiveness	Implementability	Cost	Screening Comments
	Ex-situ Thermal Treatment	Incineration	Effective. PAHs are a main contaminant group for incineration.	Not easy to implement. Incineration uses combustors, fluidized beds, or kilns to combust the chemicals in soil. These are not readily available, nor would obtaining and installing the equipment be appropriate for a small removal quantity.	High cost. Incineration uses combustors, fluidized beds, or kilns to remediate the chemicals in soil. These are generally put in place for remediating large soil volumes and are not cost effective for the smaller volumes of soil requiring remediation.	Not retained. The technology is not easy to implement, as combustors, fluidized beds, or kilns are not readily available. There would be high cost relative to implementing incineration for the relatively small removal volume.
		Pyrolysis	Effective. PAHs are a main contaminant group for pyrolysis.	Not easy to implement. Pyrolysis uses kilns or furnaces to serve as a heating chamber for the contaminated soil. These are not readily available, nor would obtaining and installing a kiln or furnace be appropriate for a small removal quantity.	High cost. Pyrolysis includes a rotary kiln or fluidized bed furnace. These are generally put in place for remediating large soil volumes and are not cost effective for the smaller volumes of soil requiring remediation.	Not retained. The technology is not easy to implement, as kilns or furnaces are not readily available. There would be high cost relative to implementing pyrolysis for the relatively small removal volume.
		Thermal Treatment	Effective. PAH concentrations can be reduced to low levels meeting unrestricted use criteria. It is a green and sustainable technology that minimizes secondary waste generation and reduces carbon footprint.	Not easy to implement. However, the mobile treatment system is not as complex as the incineration or pyrolysis technology and can be easily mobilized onsite.	High cost if mobilization is required for such a small quantity. Thermal treatment is cost effective with high soil volumes; however, a relatively low volume of soil requires remediation. Cost can be considered low if on-site treatment system is readily available at the former RVAAP.	Retained. The volume of soil requiring remediation does not result in cost efficiency for this technology if mobilization of the thermal treatment system is required. However, if a treatment system is readily available at the former RVAAP, this alternative can be feasible.

AOC = Area of concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
CUG = Cleanup goal.
LUC = Land use control.
NACA = National Advisory Committee on Aeronautics.
NGB = National Guard Bureau.
PAH = Polycyclic aromatic hydrocarbon.
RVAAP = Ravenna Army Ammunition Plant.
VOC = Volatile organic compound.

12.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This section describes the remedial alternatives developed and retained from the initial and detailed technology screening process. The retained remedial alternatives are composed of implementable and cost-effective technology types and process options that address COCs in soil at NACA Test Area.

The retained remedial alternatives are:

- Alternative 1: No Action.
- Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.
- Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.

A detailed description of each remedial alternative is provided in the following sections.

12.1 ALTERNATIVE 1: NO ACTION

The no action alternative is required for evaluation under the NCP. This alternative is the baseline to which other remedial alternatives are compared. This alternative assumes all current actions (e.g., access restrictions and environmental monitoring) will be discontinued and no future actions will take place to protect human receptors or the environment. COCs at the AOC will not be removed or treated.

12.2 ALTERNATIVE 2: EXCAVATION AND OFF-SITE DISPOSAL OF SOIL AT AREA 1, WELL PIT REMOVAL, AND LUCS – ATTAIN COMMERCIAL/INDUSTRIAL LAND USE

Alternative 2 will achieve Commercial/Industrial Land Use at NACA Test Area by (1) removing the Well Pit in the Former Crash Area and (2) excavating surface soil (0–1 ft bgs) from Area 1 in the Former Plane Refueling/Crash Strip Area that exceeds the Industrial Receptor RSLs.

The lead concentration within the soil in the Well Pit (13,200 mg/kg) exceeds the CUG for the Industrial Receptor (800 mg/kg). This alternative assumes the soil within the Well Pit [approximately 0.15 yd^3 (4 ft^3)] will be completely removed. In addition, the heavily corroded, painted, steel lid on the Well Pit will be properly disposed. After the soil is disposed, the former production well will be plugged and abandoned, and the Well Pit will be infilled with soil from an approved, off-site source to eliminate potential physical hazard.

To achieve a scenario in which the AOC is protective for Commercial/Industrial Land Use, this alternative consists of excavating surface soil from Area 1 and disposing the soil at an off-site licensed disposal facility. The assumed extent of the excavation in these areas is depicted on Figure 9-1. The estimated total disposal volume (i.e., ex-situ) is approximately 490 yd^3.

Unacceptable risk will remain on site for the Resident Receptor in remaining portions of Area 2 and the entirety of Area 3; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to PAHs in surface soil (0-1 ft bgs) in those areas. It will be the Army's responsibility to implement, inspect, maintain and enforce LUCs at the former RVAAP.

This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. Components of this remedial alternative include:

- Waste characterization sampling,
- Remedial design (RD),
- Remedial activities at the Well Pit,
- Excavation and off-site disposal of soil from Area 1,
- Confirmation sampling,
- Restoration,
- Land use control remedial design (LUCRD), and
- Five-year reviews.

12.2.1 Waste Characterization Sampling

One waste characterization sample will be collected from the Well Pit soil contained in the 55-gal drum to provide data to properly profile the waste and determine if the soil is characteristically non-hazardous or hazardous. For purposes of this FS, the contaminated soil at the Well Pit is assumed to be characteristically hazardous, as the Phase I RI sample results had an elevated lead concentration of 13,200 mg/kg. The waste characterization sampling results will confirm or refute that assumption.

Waste characterization samples will be collected from Area 1 before remedial activities are conducted. These samples will be collected as composite samples from the area(s) undergoing this remedy to provide data to properly profile the waste and determine if it is characteristically non-hazardous or hazardous.

Each sample analysis may include (but is not limited to) TCLP metals, TCLP SVOCs, TCLP pesticides, TCLP herbicides, reactive cyanide, reactive sulfide, and PCBs.

12.2.2 Remedial Design

An RD will be developed prior to initiating remedial actions. This RD will outline construction permitting requirements; site preparation activities (e.g., staging and equipment storage areas, truck routes, storm water controls); the extent of the excavation; sequence and description of excavation and site restoration activities; decontamination; and segregation, transportation, and disposal of various waste streams. Erosion and health and safety controls will be enforced during the active construction period to ensure remediation workers and the environment are protected.

12.2.3 Remedial Activities at the Well Pit

An estimated 0.15 yd^3 (4 ft^3) of soil is in the Well Pit, which can be transferred to and contained in a 55-gal drum. Hand tools are expected to be used to remove the contaminated soil from the Well Pit.

As part of this alternative, the former production well will be abandoned in accordance with Section 5.4.2.3 of the FWSAP. The former production well is steel-cased and has an estimated depth of 78 ft bgs. The abandonment of the well will follow field procedures outlined in *Technical Guidance Manual for Ground Water Investigations Chapter 9 Sealing Abandoned Monitoring Wells and Boreholes* (Ohio EPA 2009b) and the *Regulations and Technical Guidance for Sealing Unused Water Wells and Boreholes* (OWRC 2015). Well abandonment will include removing the casing and screen, overdrilling the well borehole, and grouting to the surface.

12.2.4 Excavation and Offsite Disposal of Soil from Area 1

An estimated 490 yd^3 of soil will be removed from Area 1. Soil removal will be accomplished using conventional construction equipment such as backhoes, bulldozers, front-end loaders, and scrapers. Oversized debris will be crushed or otherwise processed to meet disposal facility requirements.

Excavated soil will be hauled by truck to a licensed and permitted disposal facility. All trucks will be inspected prior to exiting the AOC. Appropriate waste manifests will accompany each waste shipment. Only regulated and licensed transporters and vehicles will be used. All trucks will travel pre-designated routes within RVAAP.

Excavated soil will be disposed at an existing off-site facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the type of waste, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing different facilities for different waste streams.

12.2.5 Confirmation Sampling

Upon completing the excavation at Area 1, five confirmatory samples will be collected from the floor and sidewalls of the excavation to ensure PAH-contaminated soils have been successfully removed. The confirmatory soil samples will be analyzed for PAH COCs. The laboratory results will be compared to Industrial Receptor CUGs and additional excavation will be conducted at locations with failing results until CUGs are met. Once the laboratory analysis determines COCs are below CUGs, the AOC will meet requirements for Commercial/Industrial Land Use.

12.2.6 Restoration

Upon completing soil excavation and well abandonment, all disturbed and excavated areas will be backfilled with clean soil and graded to meet neighboring contours. The backfill soil will come from a clean source that was previously sampled and approved for use by Ohio EPA. After the area is backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

12.2.7 Land Use Control Remedial Design

Unacceptable risk will remain on site for the Resident Receptor in remaining portions of Area 2 and the entirety of Area 3; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to PAHs in surface soil (0–1 ft bgs) in those areas. An LUCRD will be developed to present the site's Land Use, activities, RAOs, and will specify the LUC requirements for NACA Test Area.

The LUC requirements will include LUC objectives, land restrictions, disturbance restrictions, potential modification and termination of LUCs, monitoring and reporting requirements, CERCLA five-year reviews, LUC enforcement, and property transfers. This information will be presented in an attachment to the *Property Management Plan for the Designated Areas of Concerns and Munitions Response Sites* (USACE 2012b). The Project Management Plan (PMP) identifies LUCs and restrictions for specific AOCs/MRSs within the former RVAAP. The procedures within the PMP are intended to comply with the Department of Defense Manual, DERP Management, Number 4715.20, March 9, 2012, (Department of Defense Office of the Under Secretary of Defense for Acquisition, Technology and Logistics) and Ohio Revised Code 5913.10.

12.2.8 Five-year Reviews

CERCLA Section 121(c) five-year reviews will be conducted for NACA Test Area to assess the effectiveness of LUCs and whether there is a need to modify them. The Army will verify whether the LUCs continue to be properly documented and maintained. Each review of the remedy will evaluate whether Land Use has changed. If the risk levels have changed since initial LUC implementation, LUC modifications will be considered, which may include a change in monitoring frequency. A five-year review report will be submitted.

12.3 ALTERNATIVE 3: EX-SITU THERMAL TREATMENT OF SOIL AT AREA 1, WELL PIT REMOVAL, AND LUCS – ATTAIN COMMERCIAL/INDUSTRIAL LAND USE

This alternative involves two remedial technologies: (1) excavation and off-site disposal of soil from the Well Pit in the Former Crash Area and (2) ex-situ thermal treatment, such as the Vapor Energy Generation (VEG©) treatment, for surface soil at Area 1 in the Former Plane Refueling/Crash Strip Area. Implementing these remedial technologies will attain Commercial/Industrial Land Use. The evaluation of this alternative assumes that a mobile thermal treatment system is already on site and readily available for use.

As discussed in previous sections, the lead concentration within the soil in the Well Pit (13,200 mg/kg) exceeds the CUG for the Industrial Receptor (800 mg/kg). This alternative assumes the soil within the Well Pit [approximately 0.15 yd^3 (4 ft^3)] will be completely removed. In addition, the heavily corroded, painted, steel lid on the Well Pit will be properly disposed. After the soil is disposed, the former production well will be plugged and abandoned, and the Well Pit will be infilled with soil from an approved, off-site source to eliminate potential physical hazard.

To achieve a scenario in which the AOC is protective for Commercial/Industrial Land Use, approximately 490 yd^3 of soil will be removed and thermally treated from Area 1.

Unacceptable risk will remain on site for the Resident Receptor in remaining portions of Area 2 and the entirety of Area 3; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to PAHs in surface soil (0–1 ft bgs) in those areas. It will be the Army's responsibility to implement, inspect, maintain and enforce LUCs at the former RVAAP.

This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. Components of this remedial alternative include:

- Waste characterization sampling,
- RD,
- Removal and off-site disposal of Well Pit,
- Thermal treatment of soil from Area 1,
- Confirmation sampling,
- Restoration,
- LUCRD,
- LUCs, and
- Five-year reviews.

12.3.1 Waste Characterization Sampling

One waste characterization sample will be collected from the Well Pit soil contained in the 55-gal drum to provide data to properly profile the waste and determine if the soil is characteristically non-hazardous or hazardous. For purposes of this FS, the contaminated soil at the Well Pit is assumed to be characteristically hazardous, as the Phase I RI sample results had an elevated lead concentration of 13,200 mg/kg. The waste characterization sampling results will confirm or refute that assumption. No waste characterization samples are required for the area (Area 1) undergoing thermal treatment, as the treated soil is being placed back in the excavation area.

Each sample analysis may include (but is not limited to) TCLP metals, TCLP SVOCs, TCLP pesticides, TCLP herbicides, reactive cyanide, reactive sulfide, and PCBs.

12.3.2 Remedial Design

An RD will be developed prior to initiating remedial actions. This RD will outline construction permitting requirements; site preparation activities (e.g., staging and equipment storage areas, truck routes, storm water controls); the extent of the excavation; sequence and description of excavation and site restoration activities; decontamination; and segregation, transportation, and disposal of various waste streams. Erosion and health and safety controls will be enforced during the active construction period to ensure remediation workers and the environment are protected. In addition to these planning activities, the estimated carbon dioxide emissions will be calculated, and a PBR will be acquired prior to full-scale implementation.

12.3.3 Remedial Activities at the Well Pit

An estimated 0.15 yd^3 (4 ft^3) of soil is in the Well Pit, which can be transferred to and contained in a 55-gal drum. Hand tools are expected to be used to remove the contaminated soil from the Well Pit.

As part of this alternative, the former production well will be abandoned in accordance with Section 5.4.2.3 of the FWSAP. The former production well is steel-cased and has an estimated depth of 78 ft bgs. The abandonment of the well will follow field procedures outlined in *Technical Guidance Manual for Ground Water Investigations Chapter 9 Sealing Abandoned Monitoring Wells and Boreholes* (Ohio EPA 2009b) and the *Regulations and Technical Guidance for Sealing Unused Water Wells and Boreholes* (OWRC 2015). Well abandonment will include removing the casing and screen, overdrilling the well borehole, and grouting to the surface.

12.3.4 Thermal Treatment of Soil from Area 1

To achieve Commercial/Industrial Land Use at NACA Test Area, the contaminated soil in Area 1 will undergo ex-situ thermal treatment. The treatment system, such as the VEG© treatment system, will be pre-heated to the optimal treatment temperature based on results of past bench- and pilot-scale tests previously conducted using VEG© technology at the former RVAAP. While the system is being heated, soil will be excavated using conventional construction equipment such as backhoes, bulldozers, front-end loaders, and scrapers and will be stockpiled immediately adjacent to the treatment system into approximately 50 yd^3 piles.

Contaminated soil will be fed directly into the fully enclosed, preheated chamber by being placed onto a conveyor. Steam at a temperature of 1,300°F will be vented into the renewal/treatment chamber, where it will serve as the heat source for thermally treating soils. As the soil moves through the system via a rotational auger, the soil contaminants will be desorbed at specified temperatures and residence times and passed as vapors into the box head space within the enclosed chamber.

Induced vapors from the contaminated soils will be routed through a filtration system to remove the acidic gases (i.e., nitrous oxides, sulfur oxides, and hydrogen chloride) and carbon dioxide components by using an engineered mixture of sodium hydroxide, lime, zero valent iron, steam, and water within a slender packed column. The filtration system converts remaining vapors into a synthetic gas to continue operating the VEG© treatment system, creating a renewable source of fuel to replace the propane that was used initially to generate steam.

Relying on this fully-enclosed looping system, there will be no emissions to the atmosphere, and the limited carbon dioxide generated through the process may be further reduced (by some 90% to levels below background) using the water-lime component of the patented filtration process. After treatment, the soil will be stockpiled into approximately 50 yd^3 stockpiles on tarp and covered with plastic sheeting.

12.3.5 Confirmation Sampling

Upon completing the excavation in Area 1, five confirmatory samples will be collected from the floor and sidewalls of the excavation to ensure PAH-contaminated soils have been successfully removed. The confirmatory soil samples will be analyzed for PAH COCs. The laboratory results will be compared to Industrial Receptor CUGs and additional excavations will be conducted at locations with failing results until CUGs are met. Once the laboratory analysis determines COCs are below CUGs, the AOC will meet requirements for Commercial/Industrial Land Use.

Soil samples also will be collected from the individual stockpiles of thermally treated soil and will be analyzed for COCs. The laboratory results will be compared to CUGs. Once the laboratory analysis determines COCs are below CUGs, the treated soil will be used for backfill and site restoration. Should confirmation samples indicate that any contaminants are not sufficiently treated, then those soils will be rerun through the VEG© system, likely at a higher temperature, until the target post-treatment levels are reached.

12.3.6 Restoration

Upon completing soil removal and well abandonment, the Well Pit will be infilled with clean soil. The surrounding area will be backfilled and graded to meet neighboring contours. The soil will come from a clean source that was previously sampled and approved for use by Ohio EPA. After the area is backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch.

After confirming that the treated soil from Area 1 is below CUGs, all treated soil will be placed back into the excavated area and graded to meet neighboring contours. To ensure adequate vegetation is established within the excavated area, a layer of topsoil from a clean source that was previously sampled and approved for use by Ohio EPA will be placed on the treated soil.

After the areas are backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

12.3.7 Land Use Control Remedial Design

Unacceptable risk will remain on site for the Resident Receptor in remaining portions of Area 2 and the entirety of Area 3; therefore, this alternative also will rely on LUCs to prevent Resident Receptor exposure to PAHs in surface soil (0–1 ft bgs) in those areas. An LUCRD will be developed to present the site's Land Use, activities, RAOs, and LUC requirements for NACA Test Area.

The LUC requirements will include LUC objectives, land restrictions, disturbance restrictions, potential modification and termination of LUCs, monitoring and reporting requirements, CERCLA five-year reviews, LUC enforcement, and property transfers. This information will be presented in an attachment to the *Property Management Plan for the Designated Areas of Concerns and Munitions Response Sites* (USACE 2012b). The PMP identifies LUCs and restrictions for specific AOCs/MRSs within the former RVAAP. The procedures within the PMP are intended to comply with the Department of Defense Manual, DERP Management, Number 4715.20, March 9, 2012 (Department of Defense Office of the Under Secretary of Defense for Acquisition, Technology and Logistics), and Ohio Revised Code 5913.10.

12.3.8 Five-year Reviews

CERCLA Section 121(c) five-year reviews will be conducted for NACA Test Area to assess the effectiveness of LUCs and whether there is a need to modify them. The Army will verify whether the LUCs continue to be properly documented and maintained. Each review of the remedy will evaluate whether Land Use has changed. If the risk levels have changed since initial LUC implementation, LUC modifications will be considered, which may include a change in monitoring frequency. A five-year review report will be submitted.

12.4 ALTERNATIVE 4: EXCAVATION AND OFF-SITE DISPOSAL OF SOIL AT AREAS 2 AND 3 AND WELL PIT REMOVAL - ATTAIN UNRESTRICTED (RESIDENTIAL) LAND USE

Alternative 4 will achieve Unrestricted (Residential) Land Use at NACA Test Area by (1) removing the Well Pit in the Former Crash Area and (2) excavating surface soil (0–1 ft bgs) from Areas 2 and 3 that exceeds Resident Receptor CUGs.

As discussed in previous sections, the lead concentration within the soil in the Well Pit (13,200 mg/kg) exceeds the CUG for the Resident Receptor (400 mg/kg). This alternative assumes the soil within the Well Pit [approximately 0.15 yd^3 (4 ft^3)] will be completely removed. In addition, the heavily corroded, painted, steel lid on the Well Pit will be properly disposed. After the soil is disposed, the former production well will be plugged and abandoned, and the Well Pit will be infilled with soil from an approved, off-site source to eliminate potential physical hazard.

To achieve a scenario in which the AOC is protective for Unrestricted (Residential) Land Use, this alternative consists of excavation and off-site disposal of surface soil from Areas 2 and 3. Pre-excavation delineation sampling will be conducted in Area 3. The assumed extent of the excavation in these areas is depicted on Figure 9-2. The estimated total disposal volume (i.e., ex-situ) is approximately 1,140 yd^3.

This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. The time period to complete this remedial action is relatively short and will not require long term management of the AOC associated with LUCs because Unrestricted (Residential) Land Use scenario will be achieved. Components of this remedial alternative include:

- Pre-excavation delineation sampling,
- Waste characterization sampling,
- RD,
- Pre-mobilization activities,
- Remedial activities at the Well Pit,
- Excavation and off-site disposal of soils from Areas 2 and 3, and
- Confirmation sampling, and
- Restoration.

12.4.1 Pre-Excavation Delineation Sampling

To coincide with and support development of the RD, pre-excavation delineation sampling will be conducted to refine the limits of soil excavation at Area 3. The pre-excavation delineation sampling plan will be implemented with the intent of (1) adequately defining the extent of soil requiring removal to support the direct loading of soil to trucks for off-site disposal, and (2) minimizing the time required to implement the remedial action by eliminating the need for post-excavation confirmation sampling in this area.

A pre-excavation delineation sampling plan will be presented to the Army and Ohio EPA for approval. This plan will present a scheme of discrete sample locations around NTA-026 to be analyzed for PAHs in soil.

A grid of pre-excavation delineation samples will be proposed, including an estimated eight borings. Soil samples from 0–1 and 1–2 ft bgs will be analyzed for COCs until the lateral and horizontal extents of contamination are established by soil samples with concentrations below the respective CUGs. When the delineation sampling is complete, the vertical and horizontal extents of soil removal will be defined, and post-excavation confirmation sampling will not be required for Area 3.

12.4.2 Waste Characterization Sampling

One waste characterization sample will be collected from the Well Pit soil contained in the 55-gal drum to provide data to properly profile the waste and determine if the soil is characteristically non-hazardous or hazardous. For purposes of this FS, the contaminated soil at the Well Pit is assumed to be characteristically hazardous, as the Phase I RI sample results had an elevated lead concentration of 13,200 mg/kg. The waste characterization sampling results will confirm or refute that assumption.

Waste characterization samples will be collected from Areas 2 and 3 before remedial activities are conducted. These samples will be collected as composite samples from the area(s) undergoing this remedy to provide data to properly profile the waste and determine if it is characteristically non-hazardous or hazardous.

Each sample analysis may include (but is not limited to) TCLP metals, TCLP SVOCs, TCLP pesticides, TCLP herbicides, reactive cyanide, reactive sulfide, and PCBs.

12.4.3 Remedial Design

An RD will be developed prior to initiating remedial actions. This RD will outline construction permitting requirements; site preparation activities (e.g., staging and equipment storage areas, truck routes, storm water controls); the extent of the excavation; sequence and description of excavation and site restoration activities; decontamination; and segregation, transportation, and disposal of various waste streams. Erosion and health and safety controls will be enforced during the active construction period to ensure remediation workers and the environment are protected.

12.4.4 Remedial Activities at the Well Pit

An estimated 0.15 yd^3 (4 ft^3) of soil is in the Well Pit, which can be transferred to and contained in a 55-gal drum. Hand tools are expected to be used to remove the contaminated soil from the Well Pit.

As part of this alternative, the former production well will be abandoned in accordance with Section 5.4.2.3 of the FWSAP. The former production well is steel-cased and has an estimated depth of 78 ft bgs. The abandonment of the well will follow field procedures outlined in *Technical Guidance Manual for Ground Water Investigations Chapter 9 Sealing Abandoned Monitoring Wells and Boreholes* (Ohio EPA 2009b) and the *Regulations and Technical Guidance for Sealing Unused Water Wells and Boreholes* (OWRC 2015). Well abandonment will include removing the casing and screen, overdrilling the well borehole, and grouting to the surface.

12.4.5 Excavation and Off-site Disposal of Soil from Areas 2 and 3

An estimated 1,140 yd^3 of soil will be removed from Areas 2 and 3. Soil removal will be accomplished using conventional construction equipment such as backhoes, bulldozers, front-end loaders, and scrapers. Oversized debris will be crushed or otherwise processed to meet disposal facility requirements.

Excavated soil will be hauled by truck to a licensed and permitted disposal facility. All trucks will be inspected prior to exiting the AOC. Appropriate waste manifests will accompany each waste shipment. Only regulated and licensed transporters and vehicles will be used. All trucks will travel pre-designated routes within RVAAP.

Excavated soil will be disposed at an existing off-site facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the type of waste, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing different facilities for different waste streams.

12.4.6 Confirmation Sampling

Upon completing the excavation in Area 2, five confirmatory samples will be collected from the floor and sidewalls of the excavation to ensure PAH-contaminated soils have been successfully removed. The confirmatory soil samples will be analyzed for PAH COCs. The laboratory results will then be compared to Resident Receptor CUGs and additional excavations will be conducted at locations with failing results until CUGs are met. Once the laboratory analysis determines COCs are below CUGs, the AOC will meet requirements for Unrestricted (Residential) Land Use.

Confirmation samples will not be required at Area 3, as the delineation sampling defined the vertical and horizontal extents of soil removal.

12.4.7 Restoration

Upon completing soil excavation and well abandonment, all disturbed and excavated areas will be backfilled with clean soil and graded to meet neighboring contours. The backfill soil will come from a clean source that was previously sampled and approved for use by Ohio EPA. After the area is backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

12.5 ALTERNATIVE 5: EX-SITU THERMAL TREATMENT OF SOIL AT AREAS 2 AND 3 AND WELL PIT REMOVAL – ATTAIN UNRESTRICTED (RESIDENTIAL) LAND USE

This alternative involves two remedial technologies: (1) excavation and off-site disposal of soil from the Well Pit in the Former Crash Area and (2) ex-situ thermal treatment, such as the VEG© treatment, for surface soil at Areas 2 and 3. Implementing these remedial technologies will attain Unrestricted (Residential) Land Use. The evaluation of this alternative assumes that a mobile thermal treatment system is already on site and readily available for use.

As discussed in previous sections, the lead concentration within the soil in the Well Pit (13,200 mg/kg) exceeds the CUG for the Resident Receptor (400 mg/kg). This alternative assumes the soil within the Well Pit [approximately 0.15 yd^3 (4 ft^3)] will be completely removed. In addition, the heavily corroded, painted, steel lid on the Well Pit will be properly disposed. After the soil is disposed, the former production well will be plugged and abandoned, and the Well Pit will be infilled with soil from an approved, off-site source to eliminate potential physical hazard.

To achieve a scenario in which the AOC is protective for Unrestricted (Residential) Land Use, approximately 1,140 yd^3 of soil will be removed and thermally treated from Areas 2 and 3. Pre-excavation delineation sampling will be conducted from Area 3. Post-excavation confirmation samples will be collected from Area 2.

This remedial alternative requires coordinating remediation activities with Ohio EPA, OHARNG, and the Army. Coordinating with stakeholders during implementation of the excavation will minimize health and safety risks to on-site personnel and potential disruptions of Camp Ravenna activities. The time period to complete this remedial action is relatively short and will not include an O&M period to assess impacts from soil, as an Unrestricted (Residential) Land Use scenario will be achieved. Components of this remedial alternative include:

- Pre-excavation delineation sampling,
- Waste characterization sampling,
- RD,
- Removal and off-site disposal of Well Pit,
- Thermal treatment of soil from Areas 2 and 3,
- Confirmation sampling, and
- Restoration.

12.5.1 Pre-Excavation Delineation Sampling

To coincide with and support development of the RD, pre-excavation delineation sampling will be conducted to refine the limits of soil excavation at the Area 3. The pre-excavation delineation sampling plan will be implemented with the intent of (1) adequately defining the extent of soil requiring removal to support the direct loading of soil to trucks for off-site disposal, and (2) minimizing the time required to implement the remedial action by eliminating the need for post-excavation confirmation sampling in this area.

A pre-excavation delineation sampling plan will be presented to the Army and Ohio EPA for approval. This plan will present a scheme of discrete sample locations around NTA-026 to be analyzed for PAHs in soil.

A grid of pre-excavation delineation samples will be proposed, including an estimated eight borings. Soil samples from 0–1 and 1–2 ft bgs will be analyzed for COCs until the lateral and horizontal extents of contamination are established by soil samples with concentrations below the respective CUGs. When the delineation sampling is complete, the vertical and horizontal extents of soil removal will be defined, and post-excavation confirmation sampling will not be required.

12.5.2 Waste Characterization Sampling

One waste characterization sample will be collected from the Well Pit soil contained in the 55-gal drum to provide data to properly profile the waste and determine if the soil is characteristically non-hazardous or hazardous. For purposes of this FS, the contaminated soil at the Well Pit is assumed to be characteristically hazardous, as the Phase I RI sample results had an elevated lead concentration of 13,200 mg/kg. The waste characterization sampling results will confirm or refute that assumption. No waste characterization samples are required for the areas (Areas 2 and 3) undergoing thermal treatment, as the treated soil is being placed back in the excavation area.

Each sample analysis may include (but is not limited to) TCLP metals, TCLP SVOCs, TCLP pesticides, TCLP herbicides, reactive cyanide, reactive sulfide, and PCBs.

12.5.3 Remedial Design

An RD will be developed prior to initiating remedial actions. This RD will outline construction permitting requirements; site preparation activities (e.g., staging and equipment storage areas, truck routes, storm water controls); the extent of the excavation; sequence and description of excavation and site restoration activities; decontamination; and segregation, transportation, and disposal of various waste streams. Erosion and health and safety controls will be enforced during the active construction period to ensure remediation workers and the environment are protected. In addition to these planning activities, the estimated carbon dioxide emissions will be calculated, and a PBR will be acquired prior to full-scale implementation.

12.5.4 Remedial Activities at the Well Pit

An estimated 0.15 yd^3 (4 ft^3) of soil is in the Well Pit, which can be transferred to and contained in a 55-gal drum. Hand tools are expected to be used to remove the contaminated soil from the Well Pit.

As part of this alternative, the former production well will be abandoned in accordance with Section 5.4.2.3 of the FWSAP. The former production well is steel-cased and has an estimated depth of 78 ft bgs. The abandonment of the well will follow field procedures outlined in *Technical Guidance Manual for Ground Water Investigations Chapter 9 Sealing Abandoned Monitoring Wells and Boreholes* (Ohio EPA 2009b) and the *Regulations and Technical Guidance for Sealing Unused Water Wells and Boreholes* (OWRC 2015). Well abandonment will include removing the casing and screen, overdrilling the well borehole, and grouting to the surface.

12.5.5 Thermal Treatment of Soil from Areas 2 and 3

To achieve Unrestricted (Residential) Land Use at NACA Test Area, the contaminated soil at Areas 2 and 3 will undergo ex-situ thermal treatment. The treatment system, such as the VEG© treatment system, will be pre-heated to the optimal treatment temperature based on results of past bench- and pilot-scale tests previously conducted using VEG© Technology at the former RVAAP. While the system is being heated, soil will be excavated using conventional construction equipment such as backhoes, bulldozers, front-end loaders, and scrapers and will be stockpiled immediately adjacent to the treatment system into approximately 50 yd^3 piles.

Contaminated soil will be fed directly into the fully enclosed, preheated chamber by being placed onto a conveyor. Steam at a temperature of 1,300°F will be vented into the renewal/treatment chamber, where it will serve as the heat source for thermally treating soils. As the soil moves through the system via a rotational auger, the soil contaminants will be desorbed at specified temperatures and residence times and passed as vapors into the box head space within the enclosed chamber.

Induced vapors from the contaminated soils will be routed through a filtration system to remove the acidic gases (i.e., nitrous oxides, sulfur oxides, and hydrogen chloride) and carbon dioxide components by using an engineered mixture of sodium hydroxide, lime, zero valent iron, steam, and water within a slender packed column. The filtration system converts remaining vapors into a synthetic gas to continue operating the VEG© treatment system, creating a renewable source of fuel to replace the propane that was used initially to generate steam.

Relying on this fully-enclosed looping system, there will be no emissions to the atmosphere, and the limited carbon dioxide generated through the process may be further reduced (by some 90% to levels below background) using the water-lime component of the patented filtration process. After treatment, the soil will be stockpiled into approximately 50 yd^3 stockpiles on tarp and covered with plastic sheeting.

12.5.6 Confirmation Sampling

Upon completion of the excavation in Area 2, 5 confirmatory samples will be collected from the floor and sidewalls of the excavation to ensure PAH-contaminated soils have been successfully removed. The confirmatory soil samples will be analyzed for PAH COCs. The laboratory results will be compared to Resident Receptor CUGs and additional excavation would be conducted at locations with failing results until the CUGs are met. Once the laboratory analysis determines COCs are below CUGs, the AOC will meet requirements for Unrestricted (Residential) Land Use.

Soil samples also will be collected from the individual stockpiles of thermally treated soil and will be analyzed for COCs. The laboratory results will be compared to CUGs. Once the laboratory analysis determines COCs are below CUGs, the treated soil will be used for backfill and site restoration. Should confirmation samples indicate that any contaminants are not sufficiently treated, then those soils will be rerun through the VEG© system, likely at a higher temperature, until the target post-treatment levels are reached.

Confirmation samples will not be required at Area 3, as the pre-excavation delineation sampling defined the vertical and horizontal extents of soil removal.

12.5.7 Restoration

Upon completing soil removal and well abandonment, the Well Pit will be infilled with clean soil. The surrounding area will be backfilled and graded to meet neighboring contours. The soil will come from a clean source that was previously sampled and approved for use by Ohio EPA. After the area is backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch.

After confirming that the treated soil from Areas 2 and 3 is below CUGs, all treated soil will be placed back into the excavated area and graded to meet neighboring contours. To ensure adequate vegetation is established within the excavated area, a layer of topsoil from a clean source that was previously sampled and approved for use by Ohio EPA will be placed on the treated soil.

After the areas are backfilled and graded, workers will apply a seed mixture (as approved by OHARNG) and mulch. Restored areas will be inspected and monitored as required in the storm water best management practices established in the RD.

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13.0 ANALYSIS OF REMEDIAL ALTERNATIVES

13.1 INTRODUCTION

This section presents a detailed analysis of the viable remedial alternatives retained and developed throughout the technology screening process. The purpose of this detailed analysis is to provide stakeholders ample information to identify and select an appropriate remedy and prepare the PP. Based on this detailed analysis of the retained alternatives, one or more is recommended for media requiring remediation at NACA Test Area.

CERCLA guidance suggests the principle element of the selected remedy should reduce volume, toxicity, or mobility. If the selected remedy's principle element does not meet this criterion, an explanation as to why must be presented. In addition, the remedy must meet the following four statutory requirements:

- Be protective of human health and the environment,
- Comply with ARARs (or provide justification for a waiver),
- Be cost effective, and
- Use permanent solutions and treatment or recovery technologies to the maximum extent practicable.

There are nine established NCP evaluation criteria used to perform a detailed analysis of remedial alternatives to ensure the selected alternative meets the above CERCLA statutory requirements. The nine criteria are grouped into three categories: threshold, balancing, and modifying criteria.

13.1.1 Threshold Criteria

There are two evaluation criteria classified as threshold criteria. This criteria group relates directly to statutory findings. Threshold criteria must be met by the selected remedy. The evaluation criteria in this group are:

1. Overall protection of human health and the environment, and
2. Compliance with ARARs.

Each alternative must be evaluated to determine how it achieves and maintains protection of human health and the environment. An alternative is considered to be protective of human health and the environment if it complies with medium-specific CUGs. Similarly, each remedial alternative must be assessed to determine how it complies with ARARs or, if a waiver is required, an explanation of why a waiver is justified.

13.1.2 Balancing Criteria

There are five evaluation criteria classified as balancing criteria. This group represents the primary criteria upon which the detailed and comparative analysis of each remedial alternative are based. The evaluation criteria in this group are:

1. Long-term effectiveness and permanence;
2. Reduction of toxicity, mobility, or volume through treatment;
3. Short-term effectiveness;
4. Implementability; and
5. Cost.

Long-term effectiveness and permanence evaluates the magnitude of residual risk (risk remaining after implementing the alternative) and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that provide the highest degree of long-term effectiveness and permanence leave little or no untreated waste at the AOC, make long-term maintenance and monitoring unnecessary, and minimize the need for LUCs.

Reduction of toxicity, mobility, or volume through treatment evaluates the ability of the alternative to reduce the toxicity, mobility, or volume of waste. The irreversibility of the treatment process and the type and quantity of residuals remaining after treatment are also assessed.

Short-term effectiveness addresses the protection of workers and the community during the remedial action, the environmental effects of implementing the action, and the time required to achieve media-specific preliminary CUGs.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal, state, and local agencies.

Cost analyses estimate the dollar cost of each alternative. The cost estimates in this report are based on reference manuals, historical costs, vendor quotes, and engineering estimates. Costs are reported in base year 2016 dollars. The cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range of -30% to +50%, in accordance with USEPA guidance (USEPA 1988). Actual costs could be higher than estimated due to unexpected conditions or potential delays. Details and assumptions used in developing cost estimates for each of the alternatives are provided in Appendix J.

13.1.3 Modifying Criteria

There are two evaluation criteria categorized as modifying criteria. Modifying criteria are formally evaluated as part of the ROD and after the public has had an opportunity to comment on the PP. This criteria group consists of:

1. State acceptance, and
2. Community acceptance.

State Acceptance considers comments received from agencies of the state of Ohio. Ohio EPA is the primary state agency supporting this investigation. Ohio EPA, as well as other state agencies, will provide comments on the FS and the preferred remedy presented in the PP. This criterion is addressed in the responsiveness summary of the ROD.

Community Acceptance considers comments made by the community, including stakeholders, on the alternatives being considered. Comments will be solicited and accepted from the community when the preferred remedy is presented in the PP. This criterion is addressed in the responsiveness summary of the ROD.

Modifying criteria are future activities. These actions are the same for the retained alternatives. Therefore, the detailed analysis of the remedial alternatives does not evaluate modifying criteria. The detailed analysis of the retained remedial alternatives for NACA Test Area is presented in the following sections. This analysis is based on seven evaluation criteria (two threshold and five balancing criteria).

13.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

A detailed analysis of each alternative against the seven NCP evaluation criteria is contained in the following sections. The detailed analysis further defines each alternative (if necessary), compares the alternatives against one another, and presents considerations common to the alternatives.

As presented in Section 12.0, the following remedial alternatives were retained for NACA Test Area:

- Alternative 1: No Action.
- Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.
- Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.

13.2.1 Alternative 1: No Action

Under this alternative, no remedial actions will take place for any media to meet the RAO. The media posing unacceptable risk will be left in place. Existing access restrictions (e.g., RVAAP perimeter fence) will not be continued. Environmental monitoring will not be performed, and no restrictions on Land Use will be implemented.

13.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 is not protective for the Industrial Receptor or Resident Receptor, as soil posing unacceptable risk at the Well Pit and surface soil (0-1 ft bgs) in Areas 1, 2 and 3 will remain on site.

The ERA (Section 7.3) determined no further action is required for protection of ecological resources. Current and future Land Uses allow for sustainability of terrestrial habitat for ecological receptors.

13.2.1.2 Compliance with ARARs

Potential ARARs for remediating soil at NACA Test Area are presented in Section 10.0. For Alternative 1, the ARARs are not applicable because no actions would be implemented.

13.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 has no long-term management measures to prevent Industrial Receptor or Resident Receptor exposure to COCs. Existing security will be discontinued under this alternative, and there will be no access controls or LUCs at NACA Test Area.

13.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 will not reduce the toxicity, mobility, or volume of COCs. This alternative will not remove or treat soil with concentrations of COCs above CUGs.

13.2.1.5 Short-Term Effectiveness

Alternative 1 will have no additional short-term health risks to the community, remediation workers, or the environment. This remedial alternative will offer no short-term benefits or progress to achieve the RAO.

13.2.1.6 Implementability

Since it does not change the existing condition at NACA Test Area, this alternative will not require any additional effort to implement.

13.2.1.7 Cost

The present value cost to complete Alternative 1 is $0. No capital and O&M costs are associated with this alternative.

13.2.2 Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use

Alternative 2 will achieve Commercial/Industrial Land Use by implementing excavation and off-site disposal of an estimated 490 yd^3 of contaminated soil from Area 1 and 0.15 yd^3 (4 ft^3) of contaminated soil from the Well Pit. The excavated soil will be transported via truck to an off-site permitted disposal facility. Other technologies required include monitoring, short-term containment, and waste handling via trucks. Upon removing the contaminated soil, no additional LUCs will be required for Commercial/Industrial Land Use. However, contaminated soil will be left in place to prevent Unrestricted (Residential) Land Use. Consequently, LUCs are put in place to restrict access and use of this AOC.

13.2.2.1 Overall Protection of Human Health and the Environment

Under this alternative, surface soil is excavated from Area 1 and soil from the Well Pit is removed prior to abandoning the former production well. Removing contamination from these locations, as described in the remedial alternative, results in the AOC being protective of human health for the Industrial Receptor. The inclusion of LUCs as part of this alternative ensures protectiveness for the Resident Receptor.

The ERA concluded there is contamination and ecological risk, and important and significant sensitive ecological resources exist at NACA Test Area such as wetlands, a pond, and streams. After the Level I and II assessments, including Step 3A, the recommendation is no further action for protection of ecological resources (Section 7.3). However, this alternative (specifically the PAH removal) will beneficially reduce existing chemical risks to ecological receptors by removing soil to attain human health CUGs. Implementing Alternative 2 will result in temporary vegetation loss which should recover from excavation activities in one to two years.

13.2.2.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 2. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and disposing contaminated soil generated from excavation. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially erosion control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 10.0.

13.2.2.3 Long-Term Effectiveness and Permanence

After this alternative is implemented, risks to the Industrial Receptor associated with surface soil at Area 1 would be eliminated. Resident Receptor exposure to surface soil containing COCs would be mitigated through administrative controls on soil use at the site. Long-term effectiveness and permanence would be achieved by effectively enforcing the LUCs.

Because Unrestricted (Residential) Land Use is not achieved, five-year reviews would be conducted. These reviews would review Land Use to ensure effectiveness over the long term.

13.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative includes removing contaminated material from the site, but in the absence of treatment, the toxicity and volume of excavated material will not be reduced. The mobility of contaminants will be reduced by placing the excavated material in an engineered disposal facility.

13.2.2.5 Short-Term Effectiveness

There will be potential short-term worker and community exposures associated with Alternative 2. Workers may be exposed during excavation activities. A health and safety plan that identifies appropriate personal protective equipment (PPE) for workers will minimize and/or eliminate exposures.

The community near the excavation area and along the route to the disposal facility may be exposed during removal and transportation activities. Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. The community will be protected during soil transport by inspecting vehicles before and after use, decontaminating as needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance to the disposal facility. Transportation risk associated with material leaks will increase with distance and volume of material. Transporting soil to an off-site disposal facility will comply with all applicable state and federal regulations. Pre-designated travel routes will be established, and an emergency response program will be developed to facilitate any potential accident response.

13.2.2.6 Implementability

Alternative 2 will be easily implemented after the RD is developed and approved by stakeholders and all appropriate coordination with local, state, and federal agencies is completed. Excavating soil, constructing temporary roads, and conducting waste handling are conventional, straightforward construction techniques and methods. Multiple off-site disposal facilities will be available to accept generated waste. Resources (e.g., equipment, material, trained personnel) to implement this alternative will be readily available.

Excavation activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and provide steps to minimize potential hazards to on-site personnel. Developing the RD, implementing and enforcing LUCs, and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 2.

13.2.2.7 Cost

The present value cost to complete Alternative 2 is approximately $389,664 (in base year 2016 dollars). See Appendix J for a detailed description of Alternative 2 costs.

13.2.3 Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use

Under this alternative, contaminated soil will undergo (1) excavation and off-site disposal for the Well Pit and (2) ex-situ thermal treatment of contaminated surface soil (0–1 ft bgs) at Area 1 that poses unacceptable risk to the Industrial Receptor. Upon removing the contaminated soil, no additional LUCs will be required for Commercial/Industrial Land Use. When Alternative 3 is complete, contaminated soil will be left in place to prevent Unrestricted (Residential) Land Use; consequently, LUCs will be put in place to restrict access and use of this AOC.

13.2.3.1 Overall Protection of Human Health and the Environment

Under this alternative, surface soil (0–1 ft bgs) from the Well Pit will be removed for off-site disposal and surface soil (0–1 ft bgs) from Area 1 will be thermally treated to concentrations that are protective for the Industrial Receptor. These remedial activities will result in the AOC being protective of human health for the Industrial Receptor. The inclusion of LUCs as part of this alternative ensures protectiveness for the Resident Receptor.

The ERA concluded there is contamination and ecological risk, and important and significant sensitive ecological resources exist at NACA Test Area such as wetlands, a pond, and streams, including two small wetlands located inside the proposed removal area. After the Level I and II assessments, including Step 3A, the recommendation is no further action for protection of ecological resources (Section 7.3). However, this alternative (specifically the PAH removal) will beneficially reduce existing chemical risks to ecological receptors by removing soil to attain human health CUGs. Implementing Alternative 3 will result in temporary vegetation loss and disruption of small wetlands and soil adjacent to excavation areas. The clearing area should recover from excavation activities in two to three years.

13.2.3.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 3. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and treating contaminated soil generated from excavation, as well as obtaining a PBR exemption for low-emitting air pollution sources prior to operating the thermal treatment system. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially may trigger ARARs for erosion-control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 10.0.

13.2.3.3 Long-Term Effectiveness and Permanence

After this alternative is implemented, risks to the Industrial Receptor associated with surface soil in Area 1 would be eliminated. Exposure of Resident Receptor to surface soil containing COCs would be mitigated through administrative controls on soil use at the site. Long-term effectiveness and permanence would be achieved by effectively enforcing LUCs. Because Unrestricted (Residential) Land Use is not achieved, five-year reviews would be conducted. These reviews would review Land Use to ensure effectiveness.

The VEG© technology thermal treatment is a green and highly sustainable alternative for on-site treatment. This technology converts contaminants into a renewable source of fuel to run treatment operations, and reduces or eliminates air emissions, including carbon dioxide, which may normally result if vehicles are used to transport contaminated soil to a disposal facility.

13.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 will involve excavating contaminated soil and on-site treatment. Although a small quantity of soil will be placed in an engineered, lined disposal cell at the landfill, a majority of the soil will be thermally treated on site. This alternative will reduce the toxicity, mobility, and volume of COCs through treatment.

13.2.3.5 Short-Term Effectiveness

Workers may be exposed during excavation activities, stockpiling soil, and loading soil into the treatment system with Alternative 3. A health and safety plan that identifies appropriate PPE for workers will minimize and/or eliminate exposures.

Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. Soil treatment will occur in a fully enclosed chamber, thus minimizing worker exposure to heat from the treatment process or resulting vapors. Treating the soil and restoring the AOC is estimated to be completed in less than one year. Storm water controls will be monitored weekly until the vegetation is 70% established. Upon completing the excavation and site restoration activities, NACA Test Area will be released for Commercial/Industrial Land Use.

13.2.3.6 Implementability

The implementability of Alternative 3 is predicated on having an existing on-site thermal treatment system performing remediation at other sites on the installation. The treatment system can efficiently mobilize from within the former RVAAP; however, this alternative may not be practical if a treatment system needs to mobilize solely for this remediation.

Alternative 3 will be implementable after using historic bench-scale tests to establish optimal treatment temperature and residence times; developing an RD that is approved by stakeholders; and completing all appropriate coordination with local, state, and federal agencies. Excavating soil, constructing temporary roads, and waste handling are conventional, straightforward construction techniques and methods. Implementing this alternative is predicated on the availability of an on-site thermal treatment system, thus resulting in readily available equipment and minimal mobilization.

Soil treatment activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and steps to minimize potential hazards to on-site personnel. Developing the RD, implementing and enforcing LUCs, and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 3.

13.2.3.7 Cost

The present value cost to complete Alternative 3 is approximately $345,530 (in base year 2016 dollars). See Appendix J for a detailed description of Alternative 3 costs.

This cost assumes an existing thermal treatment system is on site and ready for mobilization, incurring an estimated cost of $1,000. If no treatment system is on site and readily available, the mobilization cost may increase by an estimated $25,000, increasing the estimated cost of Alternative 3 to $370,530 (in base year 2016 dollars).

13.2.4 Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use

Implementing Alternative 4 results in attaining Unrestricted (Residential) Land Use at NACA Test Area. To achieve Unrestricted (Residential) Land Use, Alternative 4 implements excavation and off-site disposal of an estimated 1,140 yd^3 of contaminated soil from Areas 2 and 3, as well as 0.15 yd^3 (4 ft^3) of contaminated soil from the Well Pit. The excavated soil is transported via truck to an off-site permitted disposal facility. Other technologies required include monitoring, short-term containment, and waste handling via trucks.

13.2.4.1 Overall Protection of Human Health and the Environment

Under this alternative, surface soil is excavated and removed from Areas 2 and 3. In addition, the Well Pit soil is excavated and the former production well is abandoned. Removing contamination within these locations, as described in the remedial alternative, results in the AOC being protective of human health for Unrestricted (Residential) Land Use.

The ERA concluded there is contamination and ecological risk, and important and significant sensitive ecological resources exist at NACA Test Area such as wetlands, a pond, and streams. After the Level I and II assessments, including Step 3A, the recommendation is no further action for protection of ecological resources (Section 7.3). However, this alternative (specifically the PAH removal) will beneficially reduce existing chemical risks to ecological receptors by removing soil to attain human health CUGs. Implementing Alternative 4 will result in temporary vegetation loss which should recover from excavation activities in one to two years.

13.2.4.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 4. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and disposing contaminated soil generated from excavation. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially erosion control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 10.0.

13.2.4.3 Long-term Effectiveness and Permanence

Alternative 4 would provide a high degree of long-term effectiveness and permanence. Surface soil will be excavated and transported to an off-site disposal facility to result in Unrestricted (Residential) Land Use, thereby mitigating risks to human health and the environment. Consequently, LUCs are not required after removal activities are complete. No CERCLA five-year reviews or O&M sampling are required.

13.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

This alternative includes removing contaminated material from the site, thereby reducing toxicity, mobility, and volume of contaminants at the site. However, in the absence of treatment, the toxicity and volume of excavated material will not be reduced. The mobility of contaminants will be reduced by placing the excavated material in an engineered disposal facility.

13.2.4.5 Short-Term Effectiveness

There will be potential short-term worker and community exposures associated with Alternative 4. Workers may be exposed during excavation activities. A health and safety plan that identifies appropriate PPE for workers will minimize and/or eliminate exposures.

The community near the excavation area and along the route to the disposal facility may be exposed during removal and transportation activities. Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. The community will be protected during soil transport by conducting vehicles inspections before and after use, decontaminating as needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance to the disposal facility. Transportation risk associated with material leaks will increase with distance and volume of material. Transporting soil to an off-site disposal facility will comply with all applicable state and federal regulations. Pre-designated travel routes will be established, and an emergency response program will be developed to facilitate any potential accident response.

Excavating soil and restoring the AOC is estimated to be completed in less than one year. Storm water controls will be monitored weekly until the vegetation is 70% established. Upon completing the excavation activities, NACA Test Area will be released for Unrestricted (Residential) Land Use.

13.2.4.6 Implementability

Alternative 4 will be easily implemented after the RD is developed and approved by stakeholders and all appropriate coordination with local, state, and federal agencies is completed. Excavating soil, constructing temporary roads, and conducting waste handling are conventional, straightforward construction techniques and methods. Multiple off-site disposal facilities will be available to accept generated waste. Resources (e.g., equipment, material, trained personnel) to implement this alternative will be readily available.

Excavation activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and provide steps to minimize potential hazards to on-site personnel. Developing the RD and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 4.

13.2.4.7 Cost

The present value cost to complete Alternative 4 is approximately $337,124 (in base year 2016 dollars). See Appendix J for a detailed description of Alternative 4 costs.

13.2.5 Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use

Under this alternative, contaminated soil will undergo (1) excavation and off-site disposal for the Well Pit and (2) ex-situ thermal treatment of contaminated surface soil (0‒1 ft bgs) at Areas 2 and 3 that poses unacceptable risk to the Resident Receptor. Upon removing and treating the contaminated soil, no additional controls will be required for any receptor.

13.2.5.1 Overall Protection of Human Health and the Environment

Under this alternative, soil from the Well Pit will be removed for off-site disposal and surface soil (0-1 ft bgs) from Areas 2 and 3 will be thermally treated to concentrations that are protective for the Resident Receptor. These remedial activities will result in the AOC being protective of human health for Unrestricted (Residential) Land Use.

The ERA concluded there is contamination and ecological risk, and important and significant sensitive ecological resources exist at NACA Test Area such as wetlands, a pond, and streams. After the Level I and II assessments, including Step 3A, the recommendation is no further action for protection of ecological resources (Section 7.3). However, this alternative (specifically the PAH removal) will beneficially reduce existing chemical risks to ecological receptors by removing soil to attain human health CUGs. Implementing Alternative 5 will result in temporary vegetation loss which should recover from excavation activities in one to two years.

13.2.5.2 Compliance with ARARs

There are no identified chemical- or location-specific ARARs for Alternative 5. However, there are action-specific ARARs for this alternative. Those requirements identified as ARARs deal primarily with characterizing, managing, and treating contaminated soil generated from excavation, as well as obtaining a PBR exemption for low-emitting air pollution sources prior to operating the thermal treatment system. Disturbing the soil will also trigger ARARs for controlling fugitive dust emissions and potentially may trigger ARARs for erosion-control measures. Action-specific ARARs only apply if the action is taken. Potential ARARs for excavating soil are presented in Section 10.0.

13.2.5.3 Long-Term Effectiveness and Permanence

Alternative 5 will effectively reduce COC concentrations to below CUGs in soil and is protective over the long term. Surface soil from the Well Pit will be removed and disposed offsite, and surface soil at Areas 2 and 3 will be thermally treated to reduce COC concentrations, thereby mitigating risk to human health. Consequently, LUCs will not be required when removal activities are complete. No CERCLA five-year reviews or O&M sampling will be required.

In addition, the VEG© technology thermal treatment is a green and highly sustainable alternative for on-site treatment and unrestricted reuse of soils. This technology converts contaminants into a renewable source of fuel to run treatment operations, and reduces or eliminates air emissions, including carbon dioxide, which may normally result if vehicles are used to transport contaminated soil to a disposal facility.

13.2.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 5 will involve excavating contaminated soil and on-site treatment. Although a small quantity of soil will be placed in an engineered, lined disposal cell at the landfill, a majority of the soil will be thermally treated on site. This alternative will reduce the toxicity, mobility, and volume of COCs through treatment.

13.2.5.5 Short-Term Effectiveness

Workers may be exposed during excavation activities, stockpiling soil, and loading soil into the treatment system with Alternative 5. A health and safety plan that identifies appropriate PPE for workers will minimize and/or eliminate exposures.

Mitigation measures during excavation, such as erosion and dust control, will minimize/eliminate potential short-term impacts. Soil treatment will occur in a fully enclosed chamber, thus minimizing worker exposure to heat from the treatment process or resulting vapors. Treating the soil and restoring the AOC is estimated to be completed in less than one year. Storm water controls will be monitored weekly until the vegetation is 70% established. Upon completing the excavation and site restoration activities, NACA Test Area will be released for Unrestricted (Residential) Land Use.

13.2.5.6 Implementability

The implementability of Alternative 5 is predicated on having an existing on-site thermal treatment system performing remediation at other sites on the installation. The treatment system can efficiently mobilize from within the former RVAAP; however, this alternative may not be practical if a treatment system needs to mobilize solely for this remediation.

Alternative 5 will be implementable after using historic bench-scale tests to establish optimal treatment temperature and residence times; developing an RD that is approved by stakeholders; and completing all appropriate coordination with local, state, and federal agencies. Excavating soil, constructing temporary roads, and waste handling are conventional, straightforward construction techniques and methods. Implementing this alternative is predicated on the availability of an on-site thermal treatment system, thus resulting in readily available equipment and minimal mobilization.

Soil treatment activities will be coordinated with Camp Ravenna and OHARNG to minimize alterations and/or impacts to OHARNG proceedings. The RD will identify access routes to the AOC for heavy equipment and steps to minimize potential hazards to on-site personnel. Developing the RD and coordinating with local, state, and federal agencies will increase the implementation difficulty of Alternative 5.

13.2.5.7 Cost

The present value cost to complete Alternative 5 is approximately $234,732 (in base year 2016 dollars). This alternative does not include an O&M period subsequent to the soil treatment, as Unrestricted (Residential) Land Use is achieved. See Appendix J for a detailed description of Alternative 5 costs.

This cost assumes an existing thermal treatment system is on site and ready for mobilization, incurring an estimated cost of $1,000. If no treatment system is on site and readily available, the mobilization cost may increase by an estimated $25,000, increasing the estimated cost of Alternative 5 to $259,732 (in base year 2016 dollars).

13.3 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES USING NCP CRITERIA

The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Table 13-1 provides a comparative analysis of the alternatives conducted.

Overall protection and compliance with ARARs are threshold criteria that must be met by any alternative to be eligible for selection. If any alternative is considered “not protective” for overall protectiveness of human health and the environment or “not compliant” for compliance with ARARs, it is not eligible for selection as the recommended alternative.

Alternative 1 does not meet the threshold criteria because it is not protective of human health and is not compliant with ARARs. In addition, Alternative 1 does not meet the RAO to prevent Industrial Receptor and Resident Receptor exposure to (1) lead in soil above the CUG at the Former Crash Area Well Pit and (2) surface soil (0–1 ft bgs) with concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene above CUGs in the Former Plane Refueling/Crash Strip Area and the Former Crash Area. Therefore, Alternative 1 is not eligible for selection.

For the remaining alternatives, the balancing criteria (i.e., short- and long-term effectiveness; reduction of contaminant toxicity, mobility, or volume through treatment; ease of implementation; and cost) were used to select a recommended alternative among the alternatives that satisfy the threshold criteria. The remaining alternatives are ranked amongst one another for each of the balancing criteria and a total score is generated.

Alternatives 4 and 5 are effective in the long term and attain Unrestricted (Residential) Land Use. Alternatives 2 and 3 score lower, as residual risk for the Resident Receptor remains and LUCs would be required.

Alternatives 3 and 5 will reduce the toxicity, mobility, and volume of PAH contamination through treatment, with Alternative 5 scoring the highest as more contaminated soil is being treated. Alternatives 2 and 4 reduce the mobility of contaminants by placing contamination in an engineered landfill, with Alternative 4 scoring higher due to the larger quantity of contaminated soil being placed in the engineered landfill.

The short-term effectiveness of Alternatives 2, 3, 4, and 5 are nearly identical. In the excavation and off-site disposal alternatives (Alternatives 2 and 4), the community near the excavation area and along the route to the disposal facility may be exposed during removal and transportation activities. In the thermal treatment alternatives (Alternatives 3 and 5), workers may be exposed during excavation activities, stockpiling soil, and loading soil into the treatment system. The higher score was given to Alternatives 2 and 3, as smaller quantities of soil are being actively remediated.

Alternatives 2 and 4 are easily implementable since excavation and off-site disposal alternatives have been employed multiple times at the former RVAAP. Alternatives 3 and 5 are also easily implementable assuming the on-site availability of the thermal treatment system. Alternatives 2 and 3 score lower due to the requirement of LUCs.

Alternative 5 scores the highest and is the recommended alternative. Alternative 5 is effective in the long term, will attain Unrestricted (Residential) Land Use, and has the lowest cost. In addition, Alternative 5 is a green and highly sustainable alternative for on-site treatment and unrestricted reuse of soil and implements a treatment alternative to reduce the toxicity, mobility, and volume of contamination.

The implementability of Alternative 5 is predicated on the on-site availability of the thermal treatment system. In the event that a thermal treatment system is not available on site at the former RVAAP, Alternative 4 is readily available for implementation. Excavation and off-site disposal alternatives have been implemented multiple times during restoration efforts at the former RVAAP. As with Alternative 5, Alternative 4 is effective in the long term and attains Unrestricted (Residential) Land Use. Alternative 4 reduces the mobility of contaminants by placing contamination in an engineered landfill.

Table 13–1. Summary of Comparative Analysis of Remedial Alternatives

NCP Evaluation Criteria	**Alternative 1: No Action**	**Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use**	**Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use**	**Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal - Attain Unrestricted (Residential) Land Use**	**Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal - Attain Unrestricted (Residential) Land Use**
Threshold Criteria	***Result***	***Result***	***Result***	***Result***	***Result***
1. Overall Protectiveness of Human Health and the Environment	Not protective	Protective	Protective	Protective	Protective
2. Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant
Balancing Criteria	***Score***	***Score***	***Score***	***Score***	***Score***
3. Long-term Effectiveness and Permanence	Not applicable	1	1	3	3
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Not applicable	1	2	2	3
5. Short-term Effectiveness	Not applicable	3	3	2	2
6. Implementability	Not applicable	1	1	3	2
7. Cost	Not applicable ($0)	1 ($389,664)	2 ($345,530)	1 ($337,124)	3 ($234,732)
Balancing Criteria Score	*Not applicable*	*7*	*9*	*11*	*13*

Any alternative considered “not protective” for overall protectiveness of human health and the environment or “not compliant” for compliance with Applicable and Relevant or Appropriate Requirement is not eligible for selection as the recommended alternative. Therefore, that alternative is not ranked as part of the balancing criteria evaluation.

Scoring for the balancing criteria is on a 3=most favorable, 1=least favorable basis. The alternative with the highest total balancing criteria score is considered the most feasible.

LUC = Land use control.

NCP = National Contingency Plan.

14.0 CONCLUSIONS AND RECOMMENDED ALTERNATIVE

14.1 CONCLUSIONS

The primary purposes of this Phase II RI and FS are to review the history of NACA Test Area, summarize RI activities, evaluate results of the RI, develop RAOs and remedial alternatives, and present a recommended alternative to address soil, sediment, and surface water at the AOC.

An assessment of data collected at this AOC concluded remediation was not necessary for subsurface soil, sediment, or surface water for any receptor. Conclusions of the ERA indicate remedial actions are not needed to protect ecological receptors. Anticipated remedial activities to protect the human receptor will benefit ecological resources and reduce the potential for contaminant migration to groundwater. Fate and transport modeling indicates soil remediation to protect groundwater is not warranted. Remedial actions specific to groundwater media at NACA Test Area will be evaluated in a separate report.

The HHRA identified COCs in soil at the Former Crash Area Well Pit that posed unacceptable risk for all future receptors (Resident Receptor, National Guard Trainee, and Industrial Receptor). This risk prevents achieving Unrestricted (Residential) Land Use and planned future use (Military Training and Commercial/Industrial Land Use) without appropriate remedial actions.

The FS developed alternatives to meet Commercial/Industrial Land Use and Unrestricted (Residential) Land Use. To achieve Commercial/Industrial Land Use, soil within the Well Pit and surface soil (0–1 ft bgs) within the Former Plane Refueling/Crash Strip Area would require remediation. To achieve Unrestricted (Residential) Land Use, additional surface soil (0–1 ft bgs) would require treatment within the Former Crash Area. Alternatives were evaluated to determine the most feasible remedial alternative for NACA Test Area.

After COCs were identified and CUGs were established, remedial technologies were screened and the following viable remedial alternatives developed:

- Alternative 1: No Action.
- Alternative 2: Excavation and Off-site Disposal of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 3: Ex-situ Thermal Treatment of Soil at Area 1, Well Pit Removal, and LUCs – Attain Commercial/Industrial Land Use.
- Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.
- Alternative 5 Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use.

These alternatives are applicable and were compared against one another to provide information of sufficient quality and quantity to justify the selected remedy. The following section provides the recommended alternative for NACA Test Area soil.

14.2 RECOMMENDED ALTERNATIVE

The recommended alternative for NACA Test Area is Alternative 5: Ex-situ Thermal Treatment of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use. Alternative 5 meets the threshold and primary balancing criteria and is protective of the Resident Receptor by thermally treating PAH-contaminated soil and disposing the lead contaminated soil offsite at an engineered landfill. The cost of Alternative 5 is $234,732 and has no O&M costs, as implementing the alternative results in attaining Unrestricted (Residential) Land Use. In addition, Alternative 5 is a green and highly sustainable alternative for on-site treatment and unrestricted reuse of soil and implements a treatment alternative to reduce the toxicity, mobility, and volume of contamination.

The selection of Alternative 5 as a recommended alternative is predicated on the on-site availability of the thermal treatment system. In the event that a thermal treatment system is not on site at the former RVAAP, Alternative 4: Excavation and Off-site Disposal of Soil at Areas 2 and 3 and Well Pit Removal – Attain Unrestricted (Residential) Land Use would be readily available and may be implemented. Excavation and off-site disposal alternatives have been implemented multiple times during restoration efforts at the former RVAAP. As with Alternative 5, Alternative 4 is effective in the long term and attains Unrestricted (Residential) Land Use. Alternative 4 reduces the mobility of contaminants by placing contamination in an engineered landfill.

The next step in the CERCLA process is to prepare a PP to solicit public input on the remedial alternatives. The PP will present these alternatives with the preferred remedial alternative for NACA Test Area. Comments on the PP provided by state and federal agencies and the public will be presented in the responsiveness summary of the NACA Test Area ROD. The ROD will provide a brief summary of the history, characteristics, and risks of the AOC and will document the selected remedy.

15.0 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 NACA Test Area. 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 NACA Test Area environmental investigation, restoration efforts, and final selection of a remedy.

As described in Section 13.0, two of the nine NCP evaluation criteria are known as “modifying criteria” – state acceptance and community acceptance. These criteria provide a framework for obtaining the necessary agency coordination and public involvement in the remedy selection process.

15.1 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 NACA Test Area. This Phase II RI Report and FS 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 for NACA Test Area 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.

15.2 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 2015; herein known as the CRP) 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 CRP (Vista 2015), the Army will hold a public meeting and request public comments on the PP for NACA Test Area. 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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