# APPENDIX I

# PBA08 Remedial Investigation Summary

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AOC | Area of Concern |
| Army | U.S. Department of the Army |
| bgs | Below Ground Surface |
| DoD | U.S. Department of Defense |
| DQO | Data Quality Objective |
| FWCUG | Facility-wide Cleanup Goal |
| FWSAP | *Facility-wide Sampling And Analysis Plan* |
| IDW | Investigation-Derived Waste |
| ISM | Incremental Sampling Method |
| Ohio EPA | Ohio Environmental Protection Agency |
| PBA08 RI | Performance-Based Acquisition 2008 Remedial Investigation |
| PBA08 SAP | Performance Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1 |
| QA | Quality Assurance |
| QC | Quality Control |
| RI | Remedial Investigation |
| RVAAP | Ravenna Army Ammunition Plant |
| TAL | Target Analyte List |
| TestAmerica | TestAmerica Laboratories, Inc. |
| USACE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| VOC | Volatile Organic Compound |

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# I.0 REMEDIAL INVESTIGATION

This section presents the methods used for developing data quality objectives (DQOs), collecting field data, and managing analytical data and laboratory programs for the Performance-based Acquisition 2008 Remedial Investigation (PBA08 RI) at Wet Storage Area. The PBA08 RI was implemented in accordance with the Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1 (PBA08 SAP) to supplement historical data and complete the remedial investigation (RI) phase of the Comprehensive Environmental Response, Compensation, and Liability Act process. The results of the PBA08 RI sampling completed in 2010 are combined with the results of 2000 B5301 IRA, 2002 Phase II RI, and 2004 Characterization of 14 areas of concern (AOCs) to further evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct human health risk assessments and ecological risk assessments, and evaluate the need for remedial alternatives.

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

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

| Surface Soil | Subsurface Soil | Sediment | Surface Water |
|---|---|---|---|
| Arsenic<br>Chromium<br>Cobalt<br>Benz(a)anthracene<br>Benzo(a)pyrene<br>Benzo(b)fluoranthene<br>Benzo(k)fluoranthene<br>Dibenz(a,h)anthracene<br>Indeno(1,2,3-cd)pyrene | Not previously sampled | Not previously sampled | Not previously sampled |

Source: Characterization of 14 Areas of Concern (MKM 2007).

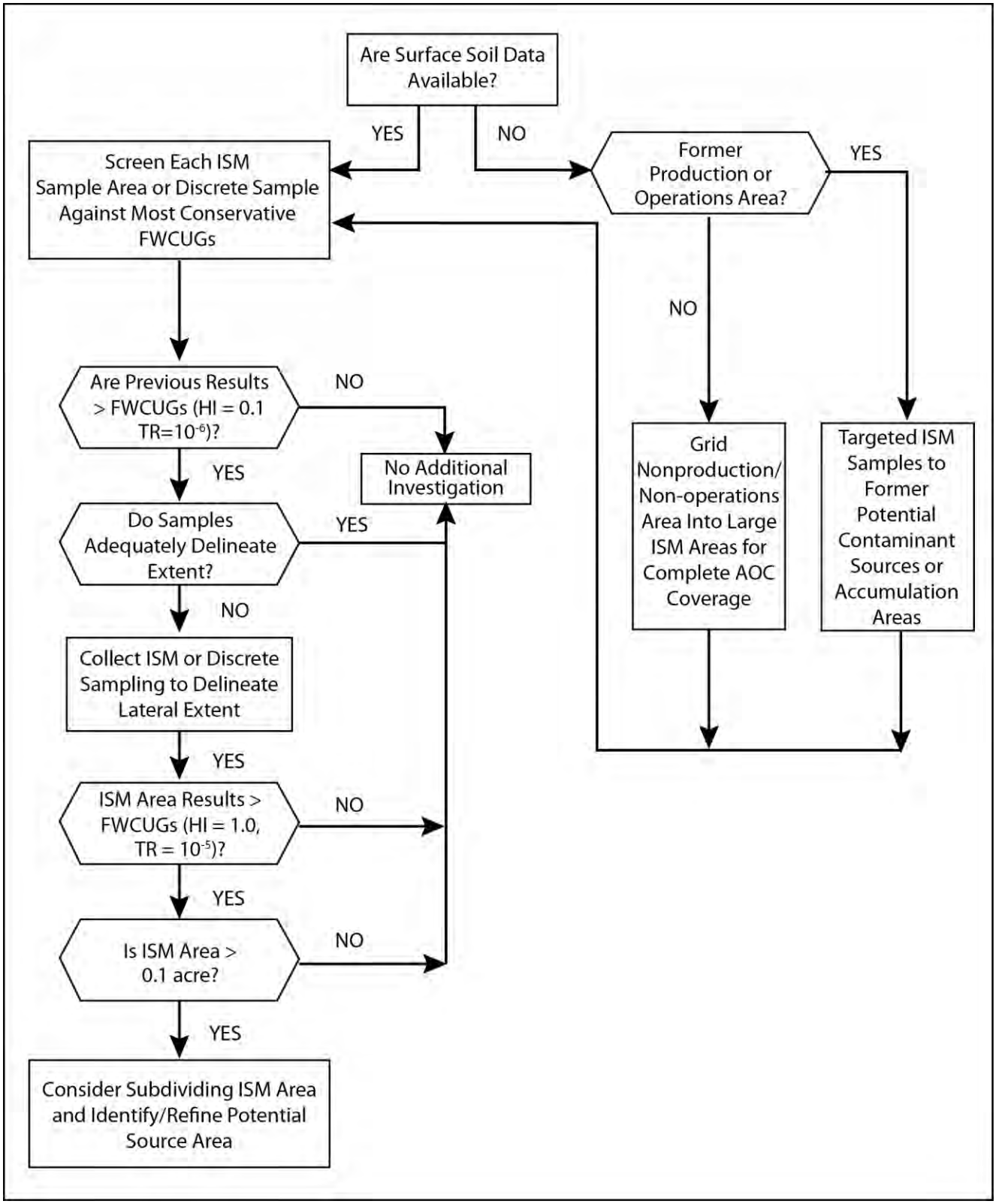


**Figure I-1. PBA08 RI Surface Soil Sampling Decision Flowchart**

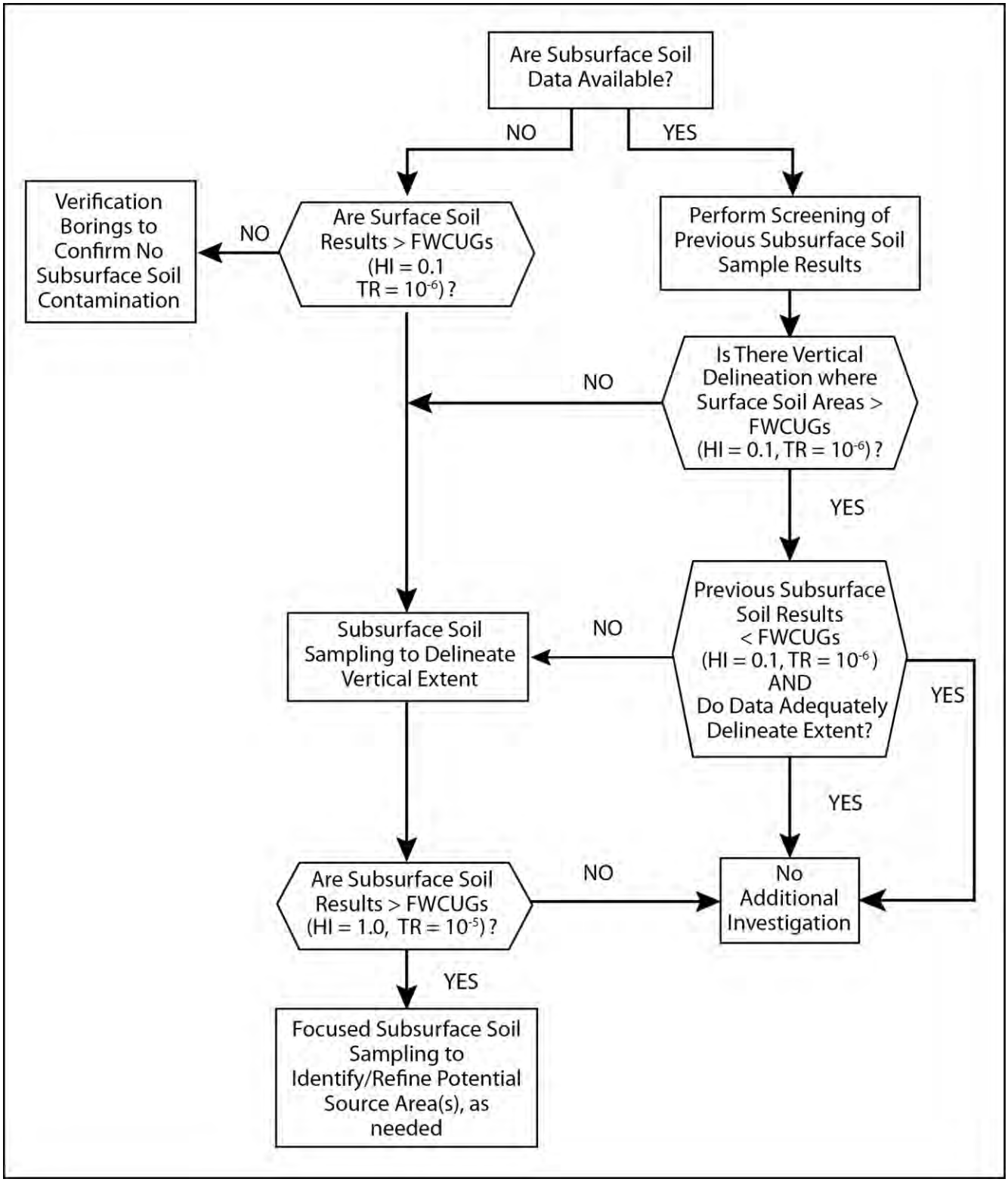


**Figure I-2. PBA08 RI Subsurface Soil Sampling Decision Flowchart**

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

The PBA08 RI was conducted from February through April 2010 and includedcollecting surface water, sediment, surface soil, and subsurface soil using discrete and incremental sampling methodology (ISM) sampling techniques.

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

## I.1 SOIL CHARACTERIZATION

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

### I.1.1 Surface Soil Sampling Rationale and Methods

Since ISM was used for surface soil [0–1 ft below ground surface (bgs)] as part of the Characterization of 14 AOCs, ISM was also used for surface soil sampling during the PBA08 RI. The PBA08 RI sampled locations with the greatest likelihood of contamination (e.g., adjacent to production buildings or within sediment accumulation areas, such as ditches). Each ISM result was evaluated separately against the screening criteria for each chemical analyzed. Surface soil sampling to define the lateral extent of contamination was conducted according to the decision rules approved in the PBA08 SAP and is depicted in Figure I-1. All PBA08 RI surface soil samples were collected using ISM or discrete sampling techniques.

Seven surface soil (four ISM and three discrete) samples were collected at Wet Storage Area during the PBA08 RI in 2010. One ISM sample was collected around igloos WS-2, WS-2A, and their associated drainage ditches to delineate lateral extent of previously identified surface soil contamination (Figure I-3). A second ISM sample was collected around igloo WS-3A and its associated drainage ditches to delineate lateral extent of previously identified surface soil contamination (Figure I-3). A third ISM sample was collected at a drainage ditch downstream of igloo WS-3A and Building PS-7 to delineate lateral extent of previously identified surface soil contamination (Figure I-3). The final ISM sample was collected around igloos WS-1 and WS-1A, and associated drainage ditches to delineate lateral extent of previously identified surface soil contamination (Figure I-3). Four multi-acre ISM samples, including quality assurance (QA)/quality control (QC) samples, were collected to characterize the AOC. Additionally, three discrete samples were collected to evaluate chromium speciation.

ISM samples were analyzed for target analyte list (TAL) metals, explosives, and polycyclic aromatic hydrocarbons. Discrete samples for chromium speciation were analyzed for total and hexavalent

chromium. One ISM sample (25% of the total number of ISM samples collected) was analyzed for RVAAP full-suite analytes. References to "RVAAP full-suite analytes" generally include analyses of TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compounds, volatile organic compounds (VOCs), polychlorinated biphenyls, and pesticides. If an ISM sample was analyzed for RVAAP full-suite analytes, all parameters except VOCs were collected and analyzed as part of the ISM sample process, and VOCs were analyzed from a discrete soil sample collected from within the ISM sample area. Nitroglycerin was analyzed under U.S. Environmental Protection Agency (USEPA) Method 8330 and was reported as an explosive chemical. Table I-2 presents the specific rationale for each surface soil sample collected for the PBA08 RI.

For the PBA08 RI, the corners of each of the designated ISM sampling areas were located using a digital global positioning system and were marked using wooden stakes. Sampling crews selected aliquot locations by walking over the entire ISM sampling area and marking the requisite number of points using flagging. At least 30 aliquots were collected for each ISM sample. Aliquot locations were randomly selected in the field and were not predetermined using a grid.

Approximately equal sample volume aliquots were collected from a depth of 0–1 ft bgs using a decontaminated ⅝-inch-diameter push probe. A soil description was completed for each ISM sample and is included in Appendix A.

All aliquots collected from a given ISM sample area were combined in a labeled container for transport to the laboratory in accordance with the PBA08 SAP. At the laboratory, each sample was air-dried, sieved, and ground for specified non-volatile chemical analyses.

Two QC field duplicate and QA split samples were collected from ISM sample areas. The QC field duplicate samples were submitted to the laboratory as "blind" and were used to determine whether the field sampling technique was reproducible, and as an indicator of sample heterogeneity. The QA split samples were sent to a U.S. Army Corps of Engineers (USACE) QA laboratory for independent analysis and evaluation of analytical results obtained by the primary laboratory.

QA/QC samples were collected as replicate ISM samples requiring three separate ISM samples from the same sample area. The QA/QC samples were collected from a set of 30 aliquot locations that were positioned adjacent to the location used for the initial ISM sample. Aliquots for QA/QC samples were collected in separate stainless steel bowls and placed into separate labeled containers.

ISM was not utilized for samples collected for VOC analysis because the air drying, mixing, and sieving of aliquots required by the method could result in the loss of VOCs from the sample. For ISM sample areas designated for VOC analysis, one discrete sample was collected from a depth of 0–1 ft bgs within the ISM sample area using the bucket hand auger method described in the PBA08 SAP. The specific location of the discrete sample was randomly chosen. Soil portions designated for VOC analyses were not homogenized in the field but were placed directly in the sample container and compacted to zero headspace.

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

| PBA08 RI Station | Targeted Area | Purpose | Analyses Performed | | | | |
|---|---|---|---|---|---|---|---|
| | | | Metals | Explosives | VOCs | Pesticides/ PCBs | SVOC |
| WSAss-033M | ISM area around igloos WS-2 and WS-2A, and drainage ditches | Delineate lateral extent of previously identified surface soil contamination | Y | Y | N | N | PAH |
| WSAss-034M | ISM area around igloo WS-3A and drainage ditches | Delineate lateral extent of previously identified surface soil contamination | Y | Y | N | N | PAH |
| | | QA/QC | Y | Y | N | N | PAH |
| | | | Y | Y | N | N | PAH |
| WSAss-035M | Drainage ditch downstream of igloo WS-3A and Building PS-7 | Delineate lateral extent of previously identified surface soil contamination | Y | Y | N | N | PAH |
| WSAss-036M | ISM area around igloos WS-1 and WS-1A, and associated drainage ditches | Delineate lateral extent of previously identified surface soil contamination, analyzed for RVAAP full-suite analytes | Y | Y | Y | Y | Y |

PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
ISM = Incremental sampling methodology.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

In addition to the ISM surface soil samples, 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 *Facility-wide Sampling and Analysis Plan* (USACE 2001) (herein referred to as the FWSAP). 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. 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 background concentrations. Field duplicate samples were not collected for chromium speciation samples. A sample log including soil description was completed for each sample, and all logs are included in Appendix A.

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

### I.1.2 Subsurface Soil Sampling Rationale and Methods

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

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

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

**Table I-3. Subsurface Soil Rationale and Analyses**

| PBA08 RI Location | Comments/Rationale | Sample Type | Depth (ft bgs) | Analyses Performed | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Metals | Explosives | VOCs | Pesticides/ PCBs | SVOC |
| WSAsb-021 | Delineate vertical extent of previously identified surface soil contamination | 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 | Y | Y | N | N | N |
| | QA/QC | Discrete | 4–7 | Y | Y | N | N | PAH |
| | | NA | 7–13 | Y | Y | N | N | PAH |
| | | Discrete | 4–7 | Y | Y | N | N | PAH |
| | | NA | 7–13 | N | N | N | N | N |
| WSAsb-022 | Delineate vertical extent of previously identified surface soil contamination, analyzed for RVAAP full-suite analytes | Discrete | 0–1 | Y | Y | Y | Y | Y |
| | | Discrete | 1–4 | Y | Y | Y | Y | Y |
| | | Discrete | 4–7 | Y | Y | Y | Y | Y |
| | | NA | 7–13 | N | N | N | N | N |
| | QA/QC | Discrete | 1–4 | Y | Y | N | N | PAH |
| | | Discrete | 1–4 | Y | Y | N | N | PAH |
| WSAsb-023 | Delineate vertical extent of previously identified surface soil contamination | Discrete | 0–1 | Y | Y | N | N | PAH |
| | | Discrete[b] | 1–4 | Y | Y | N | N | PAH |
| | | Discrete | 4–7 | Y | Y | N | N | PAH |
| | | Discrete | 7–13 | Y | Y | N | N | PAH |
| WSAsb-024 | Delineate vertical extent of previously identified surface soil contamination | 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 | 7–13 | Y | Y | N | N | PAH |
| | QA/QC | Discrete | 1–4 | Y | Y | N | N | PAH |
| | | Discrete[a] | 1–4 | Y | Y | N | N | PAH |
| WSAsb-025 | Geotechnical | Discrete | 4–5.2 | Y | Y | N | N | PAH |
| | | Discrete | 12–13.1 | Y | Y | N | N | PAH |

**Table I–3. Subsurface Soil Rationale and Analyses (continued)**

| PBA08 RI Location | Comments/Rationale | Sample Type | Depth ft (bgs) | Analyses Performed | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Metals | Explosives | VOCs | Pesticides/ PCBs | SVOC |
| WSAsb-026 | Delineate vertical extent of previously identified surface soil contamination | 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 |
| WSAsb-027 | Delineate vertical extent of previously identified surface soil contamination | 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 |
| WSAsb-028 | Delineate vertical extent of previously identified surface soil contamination, analyzed for RVAAP full-suite analytes | Discrete | 0–1 | Y | Y | Y | Y | Y |
| | | Discrete | 1–4 | Y | Y | Y | Y | Y |
| | | Discrete | 4–7 | Y | Y | Y | Y | Y |
| | | Discrete[b] | 7–13 | Y | Y | Y | Y | Y |
| WSAsb-029 | Delineate vertical extent of previously identified surface soil contamination. Bedrock encountered at 7 ft | 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 bgs sample interval.
[b] Two samples (10%) from 7–13 ft bgs were 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 results 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 = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army and Ammunition Plant.
SVOC = Semi-volatile organic compound.
VOC = Volatile organic compound.

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

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

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

Three samples collected from the 7–13 ft bgs sample interval were submitted for laboratory analysis for Wet Storage Area. One sample (WSAsb-026-5632-SO) from 7–13 ft bgs was analyzed due to preliminary screening criteria exceedances for arsenic within the 4–7 ft bgs interval. Samples from the 7–13 ft bgs interval (WSAsb-024-5626-SO and WSAsb-028-5640-SO) were analyzed to ensure the 7–13 ft bgs was adequately characterized.

All subsurface soil samples were analyzed for TAL metals, explosives, and polycyclic aromatic hydrocarbons. A minimum of 15% of samples (seven) were analyzed for RVAAP full-suite analytes. Three QC field duplicate and three QA split samples were collected to satisfy the QA/QC sample requirements of 10% frequency for subsurface soil samples. A lithologic soil description was completed for each soil boring and is included in Appendix A.

Two geotechnical samples were collected from one boring location, WSAsb-025, to provide soil data for fate and transport modeling. A pilot boring was installed with a Geoprobe® to a depth of 6.5 ft bgs to allow lithologic characterization of the soil above bedrock and determine the appropriate geotechnical sample intervals (Appendix A). The geotechnical sample location was offset from the pilot boring and drilled with hollow stem auger attachments. Geotechnical samples were collected from 4–5.2 and 12–13.1 ft bgs through the hollow stem augers directly into the Shelby tube.

The undisturbed Shelby tube was sealed with wax, capped, and submitted for laboratory geotechnical analysis for porosity, bulk density, moisture content, total organic carbon, grain size fraction analysis, and permeability. Laboratory analytical results for geotechnical samples are presented in Appendix D. QA/QC samples were not collected for the geotechnical sample.

After the discrete samples were collected, excess soil was designated as IDW and placed in lined, labeled 55-gal drums that were sealed after use and staged at Building 1036. IDW management

practices for all media are discussed in Appendix F. Hand auger borings were backfilled to ground surface with dry bentonite chips while being hydrated with project-approved potable water.

## I.2 SURFACE WATER AND SEDIMENT CHARACTERIZATION

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

Surface water and sediment samples were collected to characterize current conditions and assess potential entrance and exit pathways from the AOC (Figure I-3). Four co-located surface water and sediment samples were collected during the PBA08 RI: two samples from Sand Creek upstream and downstream of the AOC, and two samples from a tributary entering and exiting the AOC.

### I.2.1 Surface Water and Sediment Sampling Methods

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. Water quality parameters for temperature, pH, conductivity, dissolved oxygen, and turbidity were collected using calibrated water quality meters (Hanna Instrument Models 9828 and 98703). A surface water and sediment sample collection sheet was completed for each sample location and is included in Appendix A.

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. The aliquots were homogenized in a stainless steel bowl, transferred to the appropriate, labeled sample container, and analyzed for RVAAP full-suite analytes. For VOC analysis, one discrete sample collected from 0–0.5 ft bgs was collected within the 5 ft sampling radius and placed directly in the appropriate, labeled sample container.

### I.2.2 Wet Storage Area Surface Water and Sediment Sampling Rationale

During previous investigations, surface water or sediment samples were collected for characterization purposes at Wet Storage Area. Four co-located surface water and sediment samples were collected during the PBA08 RI at Wet Storage Area. The samples were collected in accordance with the following decision rules approved in the PBA08 SAP:

- At AOCs where overland flow of contaminants could occur to nearby perennial streams, those streams will be sampled. The sample locations may be outside of the AOC boundaries but the samples represent the areas potentially impacted by the AOCs (Load Lines 5, 6, 7, 9, 10, and Wet Storage Area).
- At points where contamination may migrate out of the AOC area, such as a ditch or a stream near the AOC boundary, samples will be collected to characterize current conditions and determine whether contaminant migration may occur at surface water runoff exit points.

Table I-4 presents the specific rationale for the surface water and sediment samples collected for the PBA08 RI.

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

| PBA08 RI Location | Targeted Area | Comments/Rationale | Sample Type | Depth (ft bgs) | Analyses Performed | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Metals | Explosives | VOCs | Pesticides/ PCBs | SVOC |
| WSAsd-037 | Unnamed tributary to Sand Creek | Ingress of tributary on west side of AOC, analyzed for RVAAP full-suite analytes | Composite | 0–0.5 | Y | Y | Y | Y | Y |
| WSAsw-037 | | | Grab | NA | Y | Y | Y | Y | Y |
| WSAsd-038 | Unnamed tributary to Sand Creek | Egress of tributary on west side of AOC prior to confluence with Sand Creek | Composite | 0–0.5 | Y | Y | N | N | Y |
| WSAsw-038 | | | Grab | NA | Y | Y | Y | Y | Y |
| WSAsd-039 | Sand Creek upstream of AOC | Sand Creek upstream of confluence with tributary near DA2sd/sw-102. | Composite | 0–0.5 | Y | Y | N | N | Y |
| WSAsw-039 | | | Grab | NA | Y | Y | Y | Y | Y |
| WSAsd-040 | Sand Creek downstream of AOC | Sand Creek east of George Road downstream of confluence with tributary | Composite | 0–0.5 | Y | Y | N | N | Y |
| WSAsw-040 | | | Grab | NA | Y | Y | Y | Y | Y |
| | | QA/QC | Grab | NA | Y | Y | Y | Y | Y |
| | | | Grab | NA | 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.
QA = Quality assurance.
QC = Quality control.
RVAAP = Ravenna Army Ammunition Plant.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.

## I.3 CHANGES FROM THE WORK PLAN

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

**Table I-5. Changes from the PBA08 SAP**

| Location | Affected Sample | Date Sampled | Change/Rationale |
|---|---|---|---|
| WSAsw-038 | WSASW-038-5657-SW | 3/23/2010 | The original sample location was moved to collect a sample downgradient of the unnamed tributary bifurcation. |
| WSAsb-021 | WSASB-021-5611-SO | 3/23/2010 | Sample location moved to the center of a ditch in an attempt to capture potential contaminants accumulated in the ditch. |
| | WSASB-021-5612-SO | 3/23/2010 | |
| | WSASB-021-5613-SO | 3/23/2010 | |
| | WSASB-021-5614-SO | 3/23/2010 | |
| | WSASB-021-6205-QA | 3/23/2010 | |
| | WSASB-021-6206-QA | 3/23/2010 | |
| | WSASB-021-6201-FD | 3/23/2010 | |
| | WSASB-021-6202-FD | 3/23/2010 | |
| WSAsb-022 | WSASB-022-5615-SO | 3/23/2010 | Sample location moved to the center of a ditch in an attempt to capture potential contaminants accumulated in the ditch |
| | WSASB-022-5616-SO | 3/23/2010 | |
| | WSASB-022-5617-SO | 3/23/2010 | |
| | WSASB-022-5618-SO | 3/23/2010 | |
| | WSASB-022-6204-QA | 3/23/2010 | |
| | WSASB-022-6200-FD | 3/23/2010 | |
| WSAsb-027 | WSASB-027-5633-SO | 3/23/2010 | Original location on steep slope; relocated approximately 20 ft north to allow access with drilling equipment. |
| | WSASB-027-5634-SO | 3/23/2010 | |
| | WSASB-027-5635-SO | 3/23/2010 | |
| | WSASB-027-5636-SO | 3/23/2010 | |

ft = Feet.

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

## I.4 ANALYTICAL PROGRAM OVERVIEW

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

### I.4.1 Data Quality Objectives

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

accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix C presents an assessment of the analytical program objectives.

### I.4.2 Quality Assurance and Quality Control

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

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

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

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

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

### I.4.3 Field Analyses

No field laboratory analyses (i.e., field explosives testing or ISM processing) were conducted for the PBA08 RI. However, water quality parameters were recorded using water quality meters (Hanna Instrument Models 9828 and 98703) that were calibrated daily. Additionally, field screening for organic

vapors was not used to guide sampling or analytical efforts. Organic vapors were monitored in the breathing zone during drilling for health and safety purposes at each subsurface soil boring location.

### I.4.4 Laboratory Analyses

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

All analytical procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, DoD Quality Systems Manual Version 3, USACE Louisville District analytical QA guidelines, and specific project goals and requirements. In addition to these standards, the analytical laboratories were required to strictly adhere to the requirements set forth in the FWSAP and PBA08 SAP so that conditions adverse to data quality would not arise. Project quantitation level goals for analytical methods were listed in the Quality Assurance Project Plan. These levels were achieved or exceeded throughout the analytical process, with the exception of a few pesticide and semi-volatile organic compound, soil, or sediment samples, which were analyzed at diluted levels; all but one analyte had maximum detection limits (MDLs) below the FWCUG. These goals and exceptions are further discussed in Appendix C. While some quantitation levels were elevated above FWCUGs, all MDLs for undetected analytes remained below these levels. Preparation and analyses for chemical parameters were performed according to the methods listed in Table I-7.

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

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

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

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

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

### I.4.5 Data Review, Verification, and Quality Assessment

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

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

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

Leidos performed a systematic process utilizing automated data review software for data verification to ensure the precision and accuracy of the analytical data were adequate for their intended use. The automated data review outlier reports are included as Attachment 1 to Appendix C. This verification also attempted to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected chemicals). This approach was consistent with the DQOs for the project and with the analytical methods used for determining chemicals of concern and calculating risk. "Definitive data" were reported consistent with the deliverables identified in the project sampling and analysis plan. These definitive data were then verified through the review process outlined in the project sampling and analysis plan and presented in Appendix C. During the review process no data were rejected for any reason. Some results were qualified as estimated, indicating accuracy, precision, or sensitivity were less than desired but adequate for their intended use. The completeness goal for analytical data is 90% as defined in Tables 3-1 and 3-2 of the FWQAPP. The project achieved this goal by collecting all samples presented in the PBA08 SAP and producing usable results for 100% of all sample analyses performed. In addition to the Leidos data review, a 10% validation of all data was performed by USACE to evaluate data usability.

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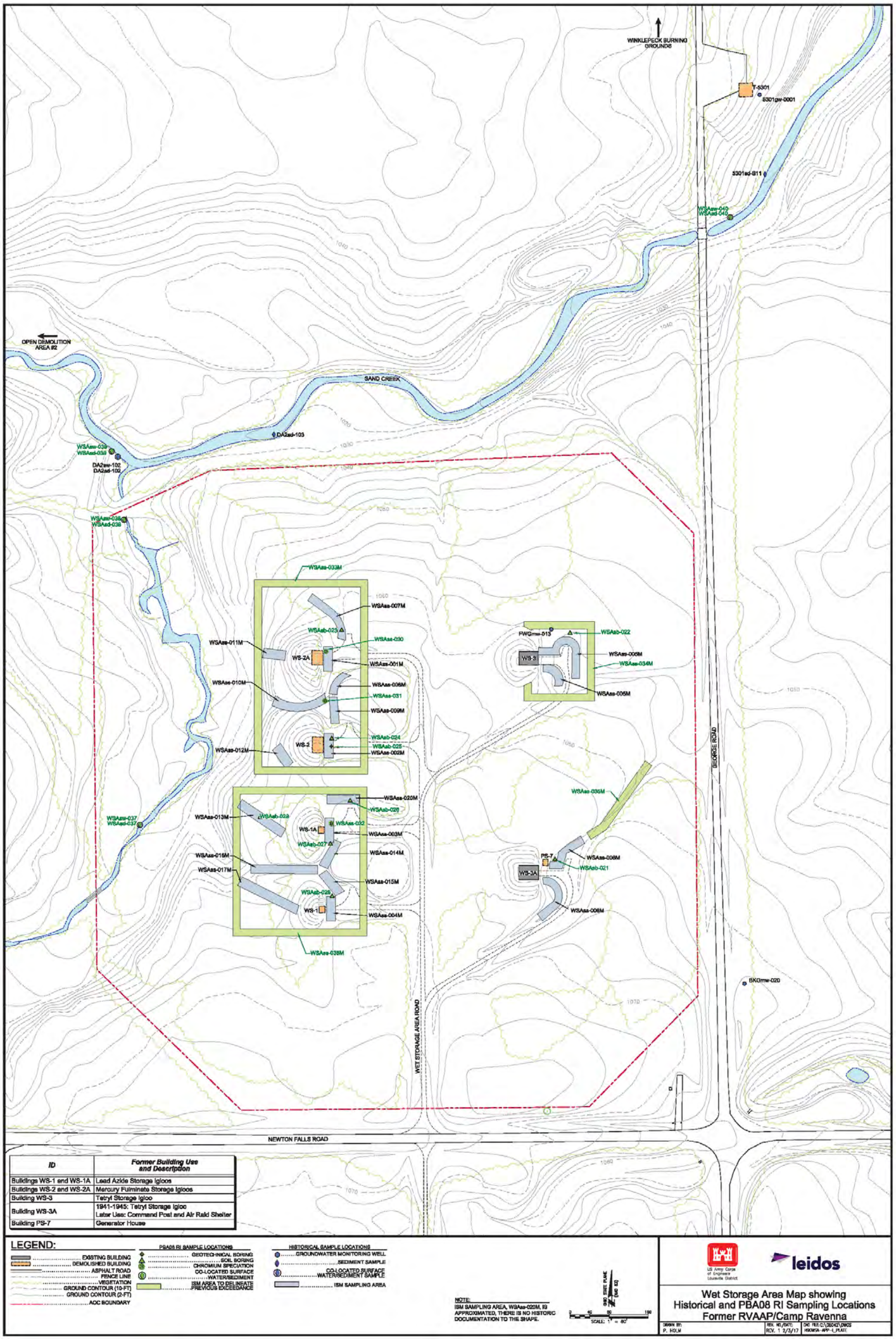


| ID | Former Building Use and Description |
|---|---|
| Buildings WS-1 and WS-1A | Lead Azide Storage Igloos |
| Buildings WS-2 and WS-2A | Mercury Fulminate Storage Igloos |
| Building WS-3 | Tetryl Storage Igloo |
| Building WS-3A | 1941-1945: Tetryl Storage Igloo<br>Later Use: Command Post and Air Raid Shelter |
| Building PS-7 | Generator House |



**Figure I-3. Wet Storage Area Map Showing Historical and PBA08 RI Sampling Locations – Former RVAAP/Camp Ravenna**

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# REFERENCES

USACE (U.S. Army Corps of Engineers) 2001. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. March 2001.

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

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