APPENDIX I

PBA08 Remedial Investigation Summary

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ACRONYMS AND ABBREVIATIONS

ADR	Automated Data Review
AOC	Area of Concern
bgs	Below Ground Surface
DoD	U.S. Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objective
FCR	Field Change Request
FWCUG	Facility-wide Cleanup Goal
FWSAP	*Facility-Wide Sampling And Analysis Plan*
HQ	Hazard Quotient
IDW	Investigation-Derived Waste
Ohio EPA	Ohio Environmental Protection Agency
PAH	Polycyclic Aromatic Hydrocarbon
PBA08 RI	Performance-Based Acquisition 2008 Remedial Investigation
PBA08 SAP	Performance Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QC	Quality Control
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
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 Load Line 11. The PBA08 RI was implemented in accordance with the *Performance Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1* (PBA08 SAP) to supplement historical data and complete the remedial investigation (RI) phase of the Comprehensive Environmental Response, Compensation, and Liability Act process. The results of the PBA08 RI sampling completed in 2010 and 2012 were combined with the results of the Phase I RI and Interim Remedial Action completed in 2000 and 2001 to evaluate the nature and extent of contamination, assess potential future impacts to groundwater, conduct human health risk assessments and ecological risk assessments, and evaluate the need for remedial alternatives.

As part of the PBA08 RI DQOs, an initial screening approach was used to help focus the investigation on specific chemicals and areas to be further evaluated by assessing the nature and extent of contamination observed in historical samples (Section 3.2.2 of the PBA08 SAP). The screening approach presented in the PBA08 SAP compared sample results from previous investigations at Load Line 11 to the most protective chemical-specific facility-wide cleanup goals (FWCUGs) at the 1E-06 cancer risk level and non-carcinogenic risk hazard quotient (HQ) of 0.1, as presented in the *Ravenna Army Ammunition Plant (RVAAP) Facility-wide Human Health Risk Assessors Manual* (USACE 2005). The most protective FWCUGs are referred to as "screening criteria." Previous results were also compared to FWCUGs at the higher target risk of 1E-05 and HQ of 1 to facilitate identification of potential source areas that may require additional sampling to refine the extent of contamination. The decision rules for surface and subsurface soil sampling outlined in the PBA08 SAP are shown in Figures I-1 and I-2. Table I-1 lists the chemicals with detected concentrations that exceed screening criteria in historical soil samples.

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

Surface Soil	Subsurface Soil	Sediment	Surface Water
Aluminum	Aluminum	Aluminum	Antimony
Arsenic	Arsenic	Arsenic	Manganese
Chromium	Barium	Barium	Bis(2-ethylhexyl)phthalate
Cobalt	Colbalt	Chromium	Trichloroethene
Manganese	Thallium	Manganese	
Thallium	PCB-1254		
Benz(a)anthracene	Benzo(a)pyrene		
Benzo(a)pyrene			
Benzo(b)fluoranthene			
Indeno(1,2,3-cd)pyrene			

Note: This table was generated using data from the Report for the Remedial Investigation at Load Line 11 (AOC 44) (MKM 2005a).
PCB = Polychlorinated biphenyl.

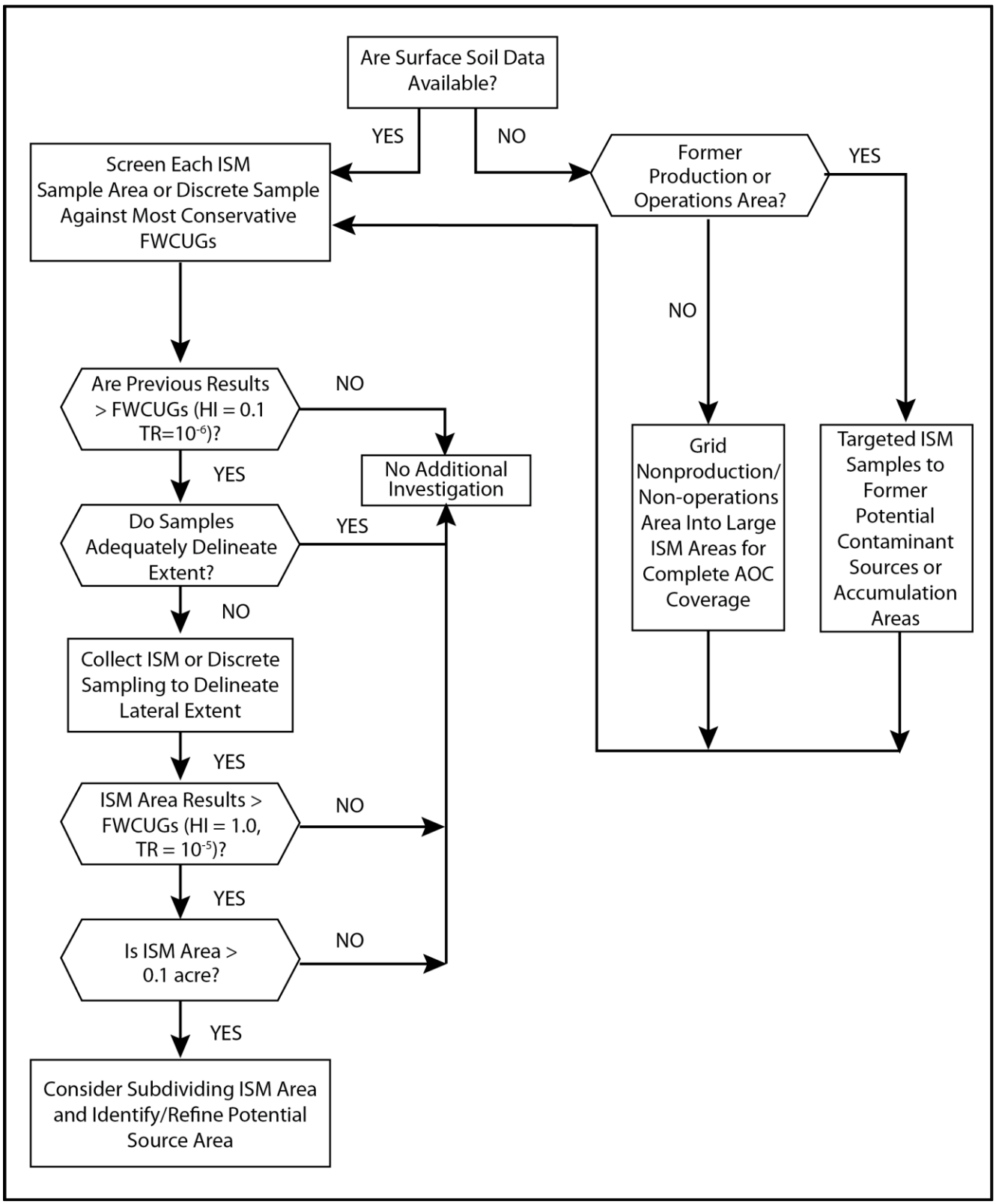

Figure I-1. PBA08 RI Surface Soil Sampling Decision Flowchart

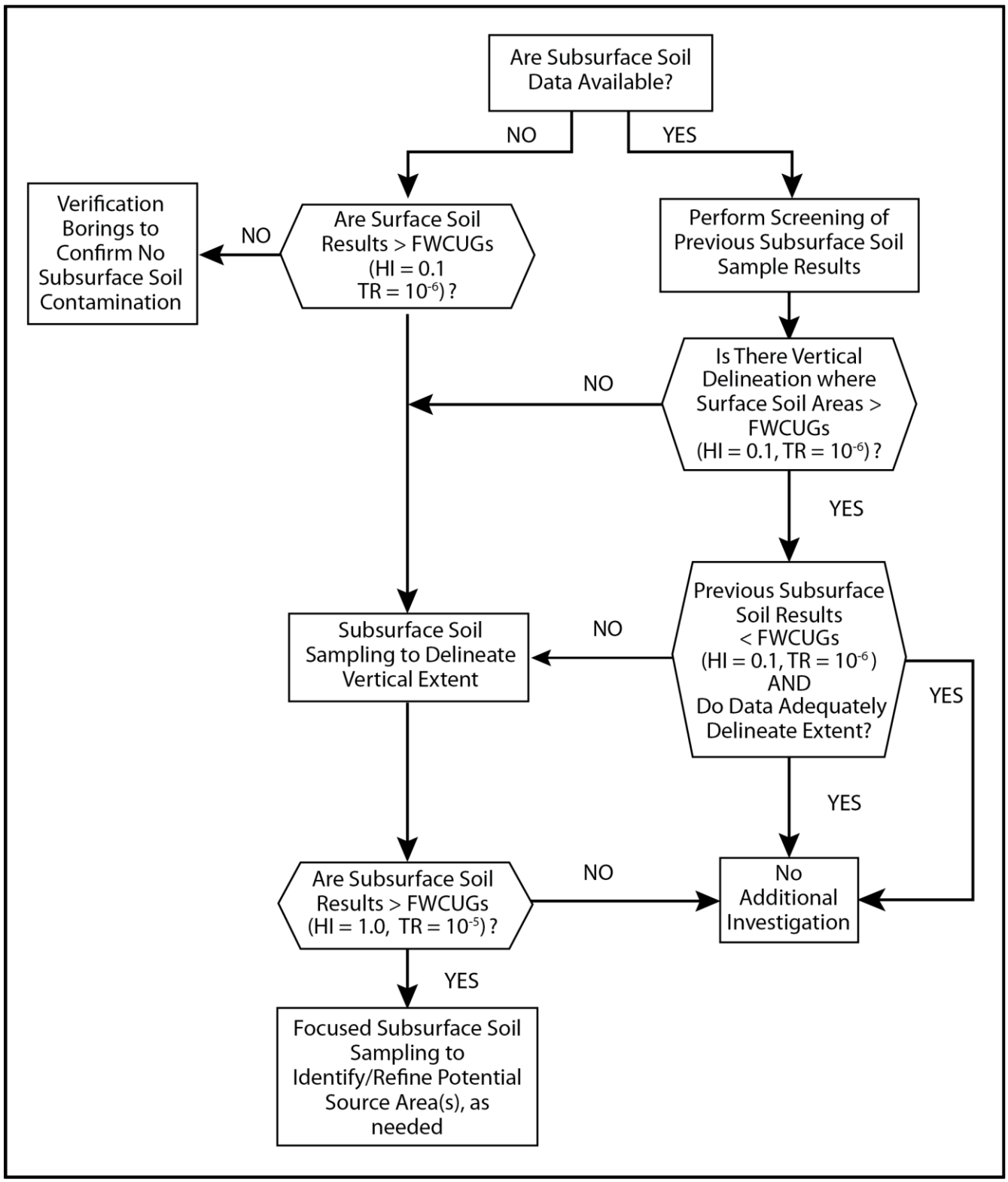

Figure I-2. PBA08 RI Subsurface Soil Sampling Decision Flowchart

Representatives of the Army, Ohio Environmental Protection Agency (Ohio EPA), U.S. Army Corps of Engineers (USACE) Louisville District, and Camp Ravenna reviewed and approved the PBA08 RI sample locations and rationale as part of the approval process for the PBA08 SAP in January 2010.

The PBA08 RI was conducted from February through April 2010 and included collecting surface water, sediment, surface soil, and subsurface soil using discrete sampling techniques. One additional sediment sample (LL11sd-096-5874-SD) was collected from Load Line 11 in August 2012.

No groundwater samples were collected during the PBA08 RI, as the current condition of groundwater will be evaluated as an individual area of concern (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 and subsurface soil sampling plans are presented in Figures I-1 and I-2, respectively.

I.1.1 Surface Soil Sampling Rationale and Methods

A total of 12 surface soil (discrete) samples were collected at Load Line 11 during the PBA08 RI in 2010. Nine surface soil samples were collected in ditches not previously investigated, downgradient of former operational areas and former buildings, and at locations where historical screening criteria exceedances were observed to vertically delineate contamination (Figure I-3). Three discrete samples were collected to evaluate chromium speciation. All surface soil samples were collected from 0-1 ft below ground surface (bgs) in accordance with the bucket hand auger method described in Section 4.5.2.1.1 of the Facility-Wide Sampling and Analysis Plan (USACE 2001a) (herein referred to as the FWSAP). An updated version of the FWSAP was developed in February 2011 and approved by the Ohio EPA; however, the PBA08 RI was implemented prior to approval of this updated version. Samples were analyzed for target analyte list (TAL) metals, explosives, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs); chromium speciation samples were analyzed for total and hexavalent chromium. One sample (10% of the total number of discrete surface soil samples collected) was analyzed for RVAAP full-suite analytes [i.e., TAL metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compound (SVOCs), volatile organic compounds (VOCs), PCBs, and pesticides]. Table I-2 presents the specific rationale for each surface soil sample collected.

A quality control (QC) field duplicate and quality assurance (QA) split sample were collected at 10% frequency (one sample). The QC field duplicate sample was submitted to the laboratory as “blind” and was used to determine whether the field sampling technique was reproducible and as an indicator of sample heterogeneity. The QA split sample was sent to a USACE QA laboratory for independent analysis and evaluation of analytical results obtained by the primary laboratory.

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

PBA08 RI Station	Targeted Area	Purpose	Analyses Performed				
			Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL11ss-070	Adjacent to Earthen Barricade associated with Building AP-18 (Percussion Elements Storage)	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-071	Building AP-9 (Shipping Building)	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-074	Building AP-14 (Change House)	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
LL11ss-076	LL11ss-022; Drainage ditch near Buildings AP-1 and AP-3.	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
		QA/QC	Y	Y	N	PCBs	PAH
			Y	Y	N	PCBs	PAH
LL11ss-077	Drainage ditch exiting AOC in north-west portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-078	Drainage ditch in north-central portion of NPA across road from Building AP-10 (downgradient of LL11sb-006)	Delineate previously identified contamination.	Y	Y	N	PCBs	PAH
LL11ss-079	Northern portion of NPA, upgradient of FPA	Characterize an area not previously sampled. Analyzed for RVAAP full-suite analytes.	Y	Y	Y	Y	Y
LL11ss-080	Downgradient of IRA excavation area in north-east portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH
LL11ss-081	Confluence of drainage ditches in northeastern portion of NPA	Characterize an area not previously sampled.	Y	Y	N	PCBs	PAH

FPA = Former production area.
IRA = Interim removal action.
NPA = Non-production area.
PAH = Polycyclic aromatic hydrocarbon.
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.

Three discrete chromium speciation samples were collected to evaluate the potential contribution of hexavalent chromium to the total chromium concentrations in soil. 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. 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 the project-approved potable water.

I.1.2 Subsurface Soil Sampling Rationale and Methods

The PBA08 RI used discrete samples from 10 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:

- Where previous surface soil sampling results exceeded screening criteria and vertical delineation was warranted.
- Where previous surface soil sampling results only slightly exceeded screening criteria to confirm that contaminant concentrations did not increase with depth.
- Locations not previously sampled to provide full characterization of 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, subsurface borings were biased toward areas where contamination from historical uses or site drainage was most likely. Soil samples from 10 soil borings were collected to further delineate the vertical extent of contamination in subsurface soil at the AOC (Figure I-3). Table I-3 presents the specific rationale for each subsurface soil sample collected for the PBA08 RI.

Table I-3. Subsurface Soil Rationale and Analyses

PBA08 RI Location	Comments/Rationale	Sample Type	Depth (ft bgs)	Analyses Performed				
				Metals	Explosives	VOCs	Pesticides/ PCBs	SVOC
LL11sb-060	Confirm presence of contamination in previously sampled area (LL11sb-001)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	Y	Y	N	N	N
LL11sb-061	Further investigation of previously identified contamination (LL11ss-003 and LL11ss-005, Building AP-8)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
LL11sb-062	Delineate vertical and lateral extent of previously identified contamination (LL11sb-004 and LL11sb-017	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
	QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
LL11sb-085	Geotechnical. Water encountered at 6.5 ft bgs. South of Building AP-11	Discrete	2-3.9	N	N	N	N	N
		Discrete	4-5.5	N	N	N	N	N
LL11sb-063	Confirm presence of contamination in previously sampled area (LL11ss-024; LL11cs-018, LL11cs-019); Geoprobe could not access location safely over steep ditch slopes; hand auger refusal at 5 ft bgs	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-5	Y	Y	N	PCBs	PAH
		NS	7-13	N	N	N	N	N
LL11sb-064	Confirm presence of contamination in previously sampled area (LL11ss-012 and LL11ss-013; Building AP-11 QA/QC	Discrete	0-1	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	4-7	Y	Y	N	PCBs	PAH
		Discrete[b]	7-13	Y	Y	N	PCBs	PAH
		Discrete	7-13	Y	Y	N	PCBs	PAH
		Discrete	7-13	Y	Y	N	PCBs	PAH
LL11sb-065	Confirm presence of contamination in previously sampled area (LL11ss-029)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		Discrete[a]	7-13	Y	Y	N	PCBs	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
LL11sb-066	Delineate vertical extent of previously identified contamination (LL11ss-028)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
LL11sb-067	Confirm presence of contamination in previously sampled area (LL11cs-045)	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-7	Y	Y	N	PCBs	PAH
		NA	7-13	N	N	N	N	N
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
	QA/QC	Discrete	1-4	Y	Y	N	PCBs	PAH
LL11sb-068	Delineate previously identified contamination (LL11cs-050, LL11sb-040, and LL11sb-039). Analyzed for RVAAP full-suite analytes	Discrete	0-1	Y	Y	Y	Y	Y
		Discrete	1-4	Y	Y	Y	Y	Y
		Discrete	4-7	Y	Y	Y	Y	Y
		NA	7-13	N	N	N	N	N
	QA/QC. Analyzed for RVAAP full-suite analytes	Discrete	4-7	Y	Y	Y	Y	Y
		Discrete	4-7	Y	Y	Y	Y	Y
LL11sb-069	Confirm presence of contamination in previously sampled area (LL11ss-031, drainage ditch); Geoprobe could not access location safely over steep ditch slopes; hand auger refusal at 5 ft bgs	Discrete	0-1	Y	Y	N	PCBs	PAH
		Discrete	1-4	Y	Y	N	PCBs	PAH
		Discrete	4-5	Y	Y	N	PCBs	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 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 results of the 4-7 ft 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.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RVAAP = Ravenna Army and Ammunition Plant.
SVOC = Semi-volatile Organic Compound.
VOC = Volatile Organic Compound.

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

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

Two samples collected from the 7-13 ft bgs sample interval were submitted for laboratory analysis for Load Line 11. One 7-13 ft bgs sample (LL11SB-065-5576-SO) was analyzed due to preliminary screening criteria exceedances for arsenic (24.7 mg/kg) within the 4-7 ft bgs sample interval (LL11SB-065-5575-SO). Sample LL11SB-064-5572-SO was analyzed to ensure the 7-13 ft bgs interval was adequately characterized.

All subsurface soil samples were analyzed for TAL metals, explosives, and PAHs. A minimum of 10% of samples (three) were analyzed for the 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 at L11sb-085to provide soil data for fate and transport modeling. A pilot boring was installed with a Geoprobe® to a depth of 13 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 then collected beneath the hollow stem augers directly into the Shelby tubes. The undisturbed Shelby tube samples were collected from 2-3.9 ft bgs and 4-5.5 ft bgs.

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 hydrating with the project-approved potable water.

I.2 SURFACE WATER AND SEDIMENT CHARACTERIZATION

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

Surface water and sediment samples were collected to characterize current conditions and assess potential entrance and exit pathways from the AOC (Figure I-3). Three co-located surface water and sediment samples were collected from drainage ditches within and exiting from the AOC during the PBA08 RI.

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.

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. 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 Load Line 11 Surface Water and Sediment Sampling Rationale

During previous investigations, surface water or sediment samples were collected for characterization purposes at Load Line 11. Three co-located surface water and sediment samples were collected during the PBA08 RI from the Load Line 11. 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
LL11sd-082	Sand Creek near Newton Falls Road	Assess potential off-AOC migration of contamination; sample collected in Sand Creek north of the AOC.	Composite	0–0.5	Y	Y	N	PCBs	PAH
LL11sw-082			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-083	LL11sd-017 (drainage ditch within FPA)	Confirm presence of contamination in previously sampled area; sediment sample analyzed for RVAAP full-suite analytes.	Composite	0–0.5	Y	Y	Y	Y	Y
LL11sw-083			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-084	LL11sd-030 (drainage ditch west of FPA)	Delineate lateral extent of previously identified contamination.	Composite	0–0.5	Y	Y	N	PCBs	PAH
LL11sw-084			Discrete	N/A	Y	Y	Y	Y	Y
LL11sd-096	LL11sd-030 and LL11sd-084 (drainage ditch west of FPA)	Recollect sediment near LLsd-084 for RVAAP full-suite analytes in August 2012. No surface water present.	Composite	0–0.5	Y	Y	Y	Y	Y

AOC = Area of concern.
bgs = Below ground surface.
ft = Feet.
N/A = Not applicable.
PAH = Polycyclic aromatic hydrocarbon.
PBA08 RI = Performance-based Acquisition 2008 Remedial Investigation.
PCB = Polychlorinated biphenyl.
RVAAP = Ravenna Army Ammunition Plant.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.

I.3 CHANGES TO THE WORK PLAN

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

Table I-5. Changes from the PBA08 SAP

Location	Affected Sample	Date Sampled	Change/Rationale
LL11sb-060	LL11SB-060-5551-SO	3/18/2010	Relocated to the southwest to the bottom of the ditch
	LL11SB-060-5552-SO	3/18/2010	
	LL11SB-060-5553-SO	3/18/2010	
	LL11SB-060-5554-SO	3/18/2010	
LL11sb-064	LL11SB-063-5563-SO	3/22/2010	Sample could not be hand augered because location was in asphalt, so the 0-1 ft bgs sample was collected by the Geoprobe®
LL11sb-067	LL11SB-067-6186-FD	3/18/2010	A twin boring had to be drilled to collect volume for QA/QC samples
	LL11SB-067-6190-QA	3/18/2010	
LL11sb-068	LL11SB-068-5586-SO	3/18/2010	A twin boring had to be drilled to collect adequate volume for samples collected from the 1-4 ft bgs and 4-7 ft bgs
	LL11SB-068-5587-SO	3/18/2010	
	LL11SB-068-6187-FD	3/18/2010	
	LL11SB-068-6191-QA	3/18/2010	
LL11sb-069	LL11SB-069-5589-SO	3/22/2010	Relocated to the southwest to the bottom of a ditch
	LL11SB-069-5590-SO	3/22/2010	
	LL11SB-069-5591-SO	3/22/2010	
LL11ss-076	LL11SS-076-5602-SO	4/12/2010	Relocated to the southwest to the bottom of a ditch
	LL11SS-076-6183-FD	4/12/2010	
	LL11SS-076-6182-QA	4/12/2010	
LL11ss-078	LL11SS-078-5604-SO	4/12/2010	Relocated to the northwest to the bottom of a ditch
LL11ss-080	LL11SS-080-5606-SO	4/12/2010	Relocated to the north to the bottom of a ditch
LL11ss-081	LL11SS-081-5607-SO	4/12/2010	Relocated to the east to the bottom of a ditch
LL11sd-082	LL11SD-082-5593-SD	2/24/2010	Relocated downstream so samples could be collected safely
LL11sw-082	LL11SW-082-5608-SW	2/24/2010	
LL11sd-083	LL11SD-083-5594-SD	2/25/2010	Relocated to the east to the bottom of a ditch
LL11sw-083	LL11SW-083-5609-SW	2/25/2010	

bgs = Below ground surface.
ft = Feet.N/A = Not applicable.
PBA08 SAP = Performance-Based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1.
QA/QC = Quality assurance/quality control.

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 U.S. Environmental Protection Agency (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 summarizes 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.

I.4.3 Field Analyses

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

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.4.4 Laboratory Analyses

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

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

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

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

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

Leidos is the custodian of project files and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, photographs, subcontractor reports, correspondence, and sample custody forms. These files will remain in a secure area under the custody of the Leidos project manager until they are transferred to USACE Louisville District and the Army at the end of the PBA08 project.

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

I.4.5 Data Review, Verification, and Quality Assessment

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

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

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

Leidos performed a systematic process utilizing automated data review (ADR) software for data verification to ensure the precision and accuracy of the analytical data were adequate for their intended use. The ADR outlier reports are included as Attachment 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 (SAP). These definitive data were then verified through the review process outlined in the project SAP and presented in Appendix C. During the review process, two sediment data points and one soil data point were rejected "R" due to very low matrix spike/matrix spike duplicate recoveries. Rejected data constituted less than 0.1% of the Load Line 11 data. Additional results were qualified as estimated, indicating accuracy, precision, or sensitivity was less than desired but adequate for their intended use. The completeness goal for analytical data is 90% as defined in Tables 3-1 and 3-2 of the Facility-wide Quality Assurance Project Plan. The project achieved this goal by collecting all samples presented in the PBA08 SAP and producing usable results for 99.9% of all sample analyses performed. In addition to the Leidos data review, a 10% validation of all data was performed by USACE to evaluate data usability.

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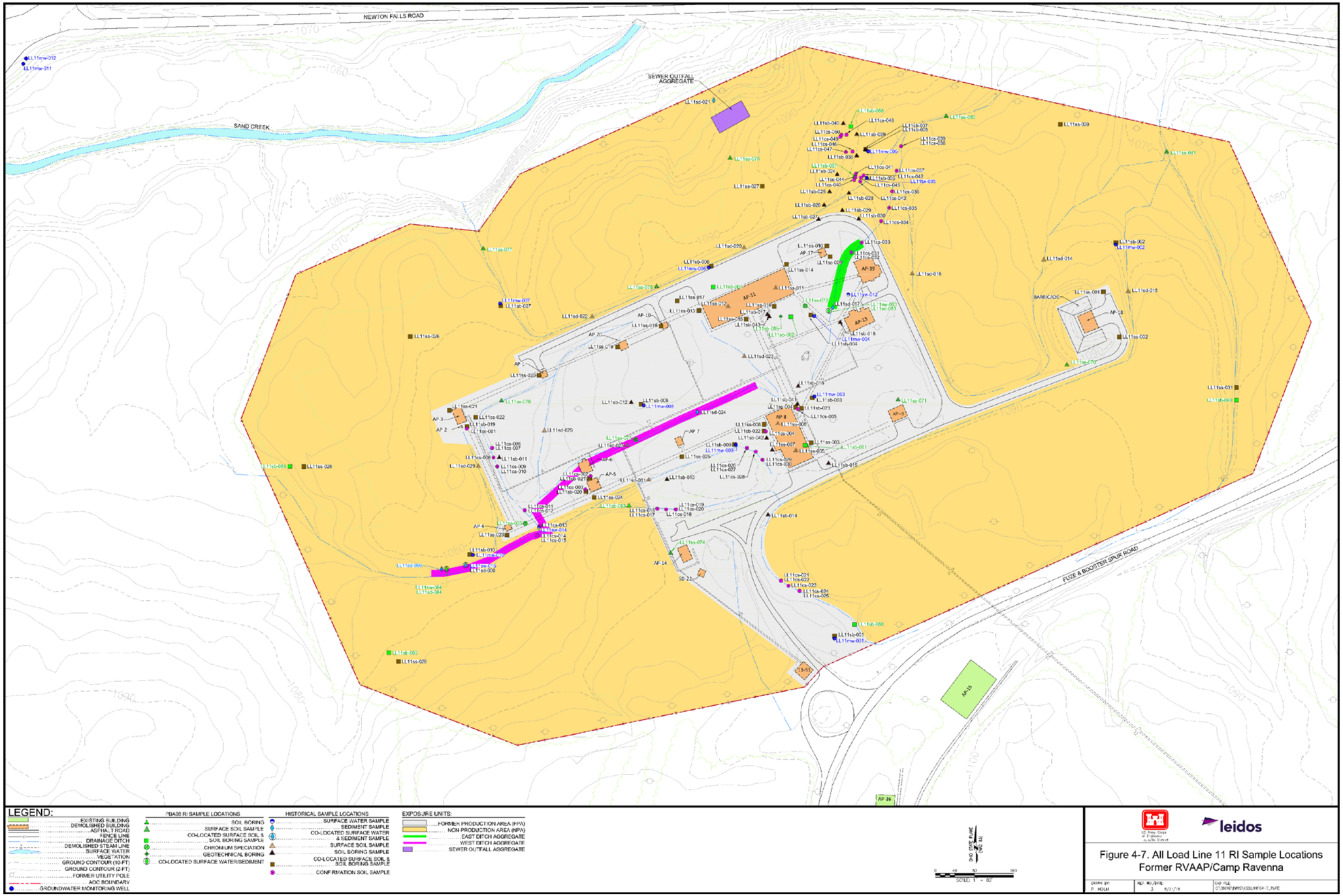

Figure I-3. Load Line 11 Map Showing Historical and PBA08 RI Sampling Locations – Former RVAAP/Camp Ravenna

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REFERENCES

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

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

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