APPENDIX I

PBA08 Remedial Investigation Summary

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ACRONYMS AND ABBREVIATIONS

ADR	Automated Data Review
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
FCR	Field Change Request
FWCUG	Facility-wide Cleanup Goal
FWSAP	*Facility-Wide Sampling And Analysis Plan*
HQ	Hazard Quotient
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
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) of surface water and wet sediment at Load Line 12. The PBA08 RI was implemented in accordance with the Performance-based Acquisition 2008 Supplemental Investigation Sampling and Analysis Plan Addendum No. 1 (PBA08 SAP) to supplement historical data and complete the remedial investigation (RI) phase of the Comprehensive Environmental Response, Compensation, and Liability Act process. The results of the PBA08 RI sampling completed in 2010 and 2011 are combined with the results of the Phase I Remedial Investigation Report for High-Priority Areas of Concern (USACE 1998) and Phase II Remedial Investigation Report for Load Line 12 (USACE 2004) 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 12 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. Table I-1 lists the chemicals with detected concentrations that exceed screening criteria in historical wet sediment and surface water samples.

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 and in October 2010 that included collecting four co-located surface water and wet sediment sample locations. In addition, four co-located surface water and wet sediment sample locations (L12swsd-310, L12swsd-311, L12swsd-312, and L12swsd-313) were sampled for both surface water and wet sediment at Load Line 12 in April 2011 to further refine extent of potential contamination.

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.

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

Wet Sediment	Surface Water
Aluminum	Arsenic
Antimony	Lead
Arsenic	Manganese
Chromium	Silver
Copper	TNT
Silver	2,4-Dinitrotoluene
Thallium	2,6-Dinitrotoluene
PCB-1016	Bis(2-ethylhexyl)phthalate
PCB-1254	
Benz(a)anthracene	
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Dibenz(a,h)anthracene	
Indeno(1,2,3-cd)pyrene	

Source: Phase I Remedial Investigation Report for High-Priority Areas of Concern (USACE 1998), and Phase II Remedial Investigation Report for Load Line 12 (USACE 2004).
PCB = Polychlorinated biphenyl.
TNT = 2,4,6-Trinitrotoluene.

I.1 SURFACE WATER AND WET 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 below ground surface (bgs)] in terms of contaminant nature and extent, fate and transport, and risk exposure models. The term "wet 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 wet sediment samples were collected to characterize current conditions and assess potential entrance and exit pathways from the AOC (Figure I-1). Four co-located surface water and wet sediment samples were collected during the PBA08 RI in 2010. Four additional co-located surface water and wet sediment samples were collected in 2011.

I.1.1 Surface Water and Wet 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 the RVAAP full-suite analytes [i.e., target analyte list (TAL) metals, explosives, propellants (nitrocellulose and nitroguanidine), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and pesticides]. 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 wet 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.1.2 Load Line 12 Surface Water and Wet Sediment Sampling Rationale

During previous investigations, surface water or wet sediment samples were collected for characterization purposes at Load Line 12. Four co-located surface water and wet sediment samples were collected during the PBA08 RI from the Load Line 12 in 2010. Additionally, four more co-located surface water and wet sediment samples were collected from Load Line 12 in 2011. The samples were collected in accordance with the following decision rules approved in the PBA08 SAP:

- At areas 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 (Upper and Lower Cobbs Ponds and Atlas Scrap Yard).
- 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-2 presents the specific rationale for the surface water and wet sediment samples collected for the PBA08 RI.

Table I-2. PBA08 RI Surface Water and Wet Sediment Samples and Rationales

PBA08 RI Location	Targeted Area	Comments/Rationale	Sample Type	Depth (ft bgs)
L12sd-306	Egress of Active Area Channel north of Newton Falls Road.	Confirmatory documentation is needed of the off-AOC migration towards Upper and Lower Cobbs Ponds.	Discrete	0–0.5
L12sw-306			Grab	NA
L12sd-307	Former settling pond in the middle of Load Line 12.	No surface water samples have previously been collected within the settling pond. Sediment from unlined settling pond receiving pink water effluent from former process operations at Building 904.	Discrete	0–0.5
L12sw-307			Grab	NA
		QA/QC.	Grab	NA
			Grab	NA

Table I-2. PBA08 RI Surface Water and Wet Sediment Samples and Rationales (continued)

PBA08 RI Location	Targeted Area	Comments/Rationale	Sample Type	Depth (ft bgs)
L12sd-308	Ingress waterway from Atlas Scrap Yard	Confirm chemical concentrations in drainage from Atlas Scrap Yard just outside the western boundary of Load Line 12, near Phase II RI sample L12-228.	Discrete	0–0.5
L12sw-308			Grab	NA
L12sd-309	Tributary to Upper and Lower Cobbs Ponds	Confirm chemical concentrations in Tributary to Upper and Lower Cobbs Ponds (off-AOC migration). Analyzed for RVAAP full-suite analytes.	Discrete	0–0.5
		QA/QC. Analyzed for RVAAP full-suite analytes.	Discrete	0–0.5
			Discrete	0–0.5
L12sw-309		Confirm chemical concentrations in Tributary to Upper and Lower Cobbs Ponds (off-AOC migration).	Grab	NA
L12sd-310	Active Area Channel, North of Main Ditch	Confirm chemical concentrations in Active Area Channel north of confluence with Main Ditch, near Phase II RI sample L12-213 and the former Ejector Station #3 sanitary overflow outfall. Collected in April 2011.	Discrete	0–0.5
L12sw-310			Grab	NA
L12sd-311	Active Area Channel, North of Main Ditch	Confirm chemical concentrations in Active Area Channel north of confluence with Main Ditch. Collected in April 2011.	Discrete	0–0.5
L12sw-311			Grab	NA
L12sd-312	Active Area Channel, North of Main Ditch	Confirm chemical concentrations in Active Area Channel north of confluence with Main Ditch, at northern fence boundary. Collected in April 2011.	Discrete	0–0.5
L12sw-312			Grab	NA
L12sd-313	Active Area Channel at Western AOC Boundary	Confirm chemical concentrations in drainage from Atlas Scrap Yard inside the western boundary of AOC. Collected in April 2011.	Discrete	0–0.5
L12sw-313			Grab	NA

Note: Sediment samples were collected as a multi-point composite from discrete sample locations.
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.
RI = Remedial investigation.
RVAAP = Ravenna Army Ammunition Plant.
SVOC= Semi-volatile organic compound.
VOC = Volatile organic compound.

I.2 CHANGES FROM THE WORK PLAN

Changes to the PBA08 SAP are documented in the field change requests (FCRs) provided in Appendix B. Changes made in the field based on AOC-specific conditions are not documented on FCRs but on the field sampling logs (Appendix A). No changes based on site conditions were made in the field at Load Line 12.

I.3 ANALYTICAL PROGRAM OVERVIEW

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

I.3.1 Data Quality Objectives

Samples were collected and analyzed according to the Facility-wide Sampling and Analysis Plan (FWSAP) and the PBA08 SAP that were prepared in accordance with U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (USEPA) guidance. The FWSAP and PBA08 SAP outline the organization, objectives, intended data uses, and quality assurance (QA)/quality control (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.3.2 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-3 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.

I.3.3 Field Analyses

No field laboratory analyses (i.e., field explosives testing) were conducted for the PBA08 RI. Additionally, field screening for organic vapors was not used to guide sampling or analytical efforts. However, water quality parameters were recorded using water quality meters (Hanna Instrument Models 9828 and 98703) that were calibrated daily.

Table I-3. 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.3.4 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 SVOC and pesticide compounds. With the exception of aldrin in one

surface water sample and 11 SVOCs in another surface water sample, the non-detectable concentration results for samples analyzed at dilution remained below FWCUGs. These goals and exceptions are further discussed in Appendix C, Data Quality Control Summary Report. While some quantitation levels were elevated above FWCUGs, all method detection limits for undetected analytes remained below these levels with the exception of six SVOCs. Preparation and analyses for chemical parameters were performed according to the methods listed in Table I-4.

Table I-4. Summary of PBA08 RI Sample Preparation and Analytical Procedures

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

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

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

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

I.3.5 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, seven non-detectable concentration PCB results in surface water sample L12SW-308-5005-SW were rejected due to surrogate recoveries; in addition, one non-detectable concentration of heptachlor epoxide in sediment sample L12sd-309-5006-SD and one non-detectable concentration of antimony in sediment sample L12sd-313-5826-SD were rejected due to matrix spike recoveries. Rejected data constituted 0.3% of the Load Line 12 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 99.67% 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.

ID	Former Building Use and Description
Production Buildings:	
Building 900	1941-1943: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: Disassembly & Flashing Furnace (Demil)
Building 901	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: TNT storage (Demil)
Building 902	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit
Building 903	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit Post-1943 Receiving Building
Building 904 Building 905	1941-1943: Ammonium Nitrate Evaporation and Crystallization Unit; Post-1949: Melt Out Operations (Demil)
Building 904VP1	904 Vacuum Pump Building
Building 906	1941-1943, 1946-1950: Ammonium Nitrate Evaporation and Crystallization Unit
Building FF-19	1941-1943, 1946-1950: Neutral Liquor Building 1965-1967: Aluminum chloride production
Building FN-54	1941-1943, 1946-1950: Neutral Liquor Storage and Shipping; 1951-1954: Cartridge Case Renovation
Non-production Buildings:	
Building 4-51	Time Clock/Gate House
Building FA-20	Air Compressor Building
Building FE-17	Power House No. 3 (and associated Coal silos and Fuel Oil Storage tanks)
Building FE-17A	Pump House
Building FE-22	Change House
Building FE-52	Lunch Room and QA Laboratory
Building FE-53	Office Building
Building FJ-55	Rest Room/First Aid Building
Building FJ-56	Storage
Building SD-4	Sewer Ejector Station
WH-29	Well House No. 29
WW-2	Water Works No. 2
WW-2A	Filtered Water Reservoir
WW-22	Elevated Water Tank
Building T-2501	Boiler House
Building T-4513	Sump Building (Sedimentation Tank)
Building T-5201	Gate House
Building PS-5	Regulator House

Figure I-1. Load Line 12 Map Showing Historical and PBA08 RI Sampling Locations – Former RVAAP/Camp Ravenna

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REFERENCES

U.S. Army Corps of Engineers (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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