APPENDIX A

Previous Investigations at Load Lines 1 Through 4 and 12

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
bgs	Below Ground Surface
BHHRA	Baseline Human Health Risk Assessment
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CUG	Cleanup Goal
DLA	Defense Logistics Agency
DNT	Dinitrotoluene
DQO	Data Quality Objective
FFS	Focused Feasibility Study
FS	Feasibility Study
FWBWQS	Facility-wide Biological and Water Quality Study
FWCUG	Facility-wide Cleanup Goal
HMX	Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocane
ISM	Incremental Sampling Methodology
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MI	Multi-Increment
MRS	Munitions Response Site
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
RD	Remedial Design
RDX	Hexahydro-1,3,5-Trinitro-1,3,5-Triazine
RGO	Remedial Goal Option
RI	Remedial Investigation
RM	River Mile
ROD	Record of Decision
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SRV	Screening Reference Value
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
VOC	Volatile Organic Compound

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A.0 PREVIOUS INVESTIGATIONS AT LOAD LINES 1 THROUGH 4 AND 12

Since 1978, Load Lines 1 through 4 and 12 have been the subject of multiple investigations and/or assessments leading to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) decisions and/or remedial actions at the area of concerns (AOCs). This appendix summarizes the results of the numerous investigations that have been conducted at Load Lines 1 through 4 and 12.

A.1 LOAD LINE 1

CERCLA activities completed at Load Line 1 are presented in the following report summaries. These 18 reports present extensive evaluations and remedial activities performed to address contaminated media, including assessments at each of the former buildings.

A.1.1 Installation Assessment of Ravenna Army Ammunition Plant

In 1978, the *Installation Assessment of Ravenna Army Ammunition Plan* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. The installation assessment presented quantities of munitions produced, amounts of chemicals utilized, and waste produced at each load line. No sampling, investigation, or actions were performed at Load Line 1 as part of the assessment. The assessment concluded that no sampling was presently required for AOC exit pathways or surface water bodies and additional action may be warranted.

A.1.2 Preliminary Assessment for the Characterization of Areas of Contamination

In 1996, the *Preliminary Assessment for the Characterization of Areas of Contamination* (herein referred to as the Preliminary Assessment [PA]) (USACE 1996) was developed following the requirements of CERCLA and provided information concerning conditions at CERCLA AOCs at the Ravenna Army Ammunition Plant (RVAAP) to assess potential contamination risks posed to human health and the environment. The assessment provided a narrative of the facility history and process operations and a description of activities conducted at each of the AOCs. As discussed in the PA, waste constituents at Load Line 1 included 2,4,6-trinitrotoluene (TNT); octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocane (HMX); Composition B; lead; chromium; mercury; and arsenic. Primary contaminant release mechanisms were process effluent discharges to surface water and process building wastewater washout to surface soils. Characterization data from previously completed sampling for groundwater and sediment were included as part of the PA; no additional sampling or investigative actions were completed. The waste constituents TNT and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) were detected in sediments from the ditch receiving discharge from the pinkwater sawdust filtration units, and heavy metals were detected in groundwater.

The report provided a PA scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model. Load Line 1 was ranked as a high-priority AOC

for future environmental investigations due to the primary contaminant release mechanism from process effluent discharges to surface water and surface soil.

A.1.3 Phase I Remedial Investigation

A *Phase I Remedial Investigation Report for the Phase I Remedial Investigation of High Priority Areas of Concern* (herein referred to as the Phase I Remedial Investigation [RI]) (USACE 1998) was conducted at Load Line 1 from July through August 1996. During this investigation, surface soil and ditch sediment sampling was completed. A total of 51 surface soil samples were collected as part of the Phase I RI. Forty-eight surface soil samples were collected and analyzed for explosives. Fifty surface soil samples were analyzed for metals. Twelve of the surface soil samples were analyzed for RVAAP full-suite analysis, including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). Twenty-two sediment samples were collected at Load Line 1 and analyzed for explosives and metals. A total of 3 of the 22 sediment samples also were analyzed for VOCs, SVOCs, pesticides, and PCBs. The conclusions of the Phase I RI categorized Load Line 1 as a "high-priority" AOC due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout soil and sediment at the AOC, and a Phase II RI was recommended (USACE 1998).

A.1.4 Sampling of Potential Disposal Areas at Load Lines 1 and 2

Surface soil sampling was conducted in November 1999 to characterize potential demolition debris disposal areas and to evaluate their suitability for use as fill areas for clean, solid demolition debris from the load line (USACE 2000). Samples were collected at the four change-out buildings (CB-8, CB-12, CB-22, and CB-23) and analyzed for Target Analyte List (TAL) metals and explosives. A total of 3 of the 17 samples collected also were analyzed for propellants, VOCs, SVOCs, pesticides, and PCBs. Depth to bedrock at Load Line 1 was very shallow, and most samples did not exceed 0.5 ft below ground surface (bgs) due to bedrock refusal. Results from sampling indicated 14 metals were detected above background at Load Line 1. In addition to inorganic chemicals, 11 SVOCs, 2 VOCs, 2 pesticides, and PBC-1254 were detected from the change-out buildings at Load Line 1.

A.1.5 Phase II Remedial Investigation

The *Phase II Remedial Investigation Report for the Load Line 1* (herein referred to as the Phase II RI) (USACE 2003) evaluated the nature and extent of process-related contaminants in surface and subsurface soil, sediment, surface water, and groundwater, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 1.

A total of 324 environmental samples were collected to determine the nature and extent of surface soil contamination at Load Line 1. A total of 37 discrete subsurface soil samples were collected across the AOC to assess vertical migration. No explosives or propellants were detected in samples collected from the perimeter area of the AOC, indicating that there are no additional source areas exterior to the main production area and no significant migration of contamination from the major production areas to soil within the outlying areas of the load line. A total of 36 sediment samples were

collected from 6 drainage channels that exit the AOC, Charlie's Pond, Criggy's Pond, the North Area Channel, and off-AOC locations. Metals, polycyclic aromatic hydrocarbons (PAHs), PCBs, and explosives were detected in sediment samples collected as part of the Phase II RI. Seven surface water samples within the AOC were collected as part of the investigation. Explosives and metals were detected in surface water samples at the AOC. No SVOCs, VOCs, PCBs, or pesticides were detected in surface water (USACE 2003). A baseline human health risk assessment (BHHRA) and screening ecological risk assessment were completed as part of the Phase II RI. Recommendations of the Phase II RI included completing a Feasibility Study (FS) to evaluate possible remedial actions at Load Line 1.

Data from eight sediment samples and three surface water samples from the Phase II RI Report (USACE 2003) were incorporated into the FS Addendum dataset. Samples collected in the off-AOC channel were not included in this evaluation since the off-AOC channel was further evaluated in the *Facility-wide Biological and Water Quality Study 2003 Ravenna Army Ammunition Plant* (FWBWQS) (USACE 2005c).

A.1.6 Supplemental Baseline Human Health Risk Assessment for Load Line 1 Alternative Receptors

The supplemental BHHRA (USACE 2004a) was conducted to evaluate and document risks and health hazards to humans associated with contaminated media at Load Line 1 for future use scenarios. The supplemental BHHRA was completed to supplement the BHHRA presented in the Phase II RI (USACE 2003) and reflects land use changes made by the Ohio Army National Guard (OHARNG) in 2004. No samples were collected as part of the assessment. The report identifies chemicals of potential concern (COPCs), calculates risks and hazards, identifies chemicals of concern (COCs), and calculates remedial goal options (RGOs) to generate conclusions regarding human health risks and hazards associated with contaminated media at Load Line 1 for National Guard receptors, recreational receptors, and residential receptors (USACE 2004a).

A.1.7 Facility-wide Biological and Water Quality Study

In 2003, the U.S. Army Corps of Engineers (USACE) collected surface water and incremental sampling methodology (ISM) sediment samples from four locations in the off-AOC channel for the FWBWQS (USACE 2005c), evaluated as the Tributary to West Branch Mahoning River (at river mile [RM] 0.01). Sampling locations were identified as NN#3-1 through NN#3-4 and flow direction is from NN3#-1 located downstream from the Erie Burning Grounds Pond through NN3#-4 located at State Route 534. As noted in the FWBWQS, besides the Erie Burning Grounds and Load Line 1, there are no other AOCs from the main production at RVAAP that could affect the Tributary to West Branch Mahoning River off-AOC channel aggregate. The off-AOC channel is downstream from many of the channels draining Load Line 1that are evaluated in this FS (including Outlet A and B Channels; Outlet C Channel and Charlie's Pond; and Outlets D/E/F Channels and Criggy's Pond), where impacts from Load Line 1 process operations would be expected. In addition to chemical data, the FWBWQS sampling also included the collection of biological (i.e., fish and macroinvertebrates) and habitat quality data.

Surface water and sediment quality were both rated "good" at all four locations in the off-AOC channel. In surface water, only pH exceeded Ohio criteria. Only two organics were detected and metals were at low levels. In sediment, the farthest upstream location contained slightly elevated concentrations of PAHs, while organic compounds were not detected in the three downstream locations, reflecting a lack of contamination. Metals were below Ohio sediment reference values (SRVs).

For all four locations in the off-AOC channel, the fish community was rated "poor" or fair"; the benthic community was rated "fair" or "good"; and the habitat was rated "very poor," "fair," or "good." Thus, the study found some biological impairment, but attributed it to habitat limitations such as lack of riffles or shallow pool depths, ephemeral nature of stream segment, and soft bottom substrates rather than chemical contamination (as surface water and sediment quality were both rated "good"). This suggests that chemical contamination from the Erie Burning Grounds and Load Line 1 is not a concern in the off-AOC channel. Based on these results, chemical data from the off-AOC channel were not evaluated further in this FS.

A.1.8 Remedial Goal Options for Soil at Load Lines 1 Through 4

The *Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4* Report (USACE 2004b) documented the proposed land use and corresponding risk-based RGOs to support the remedial alternative selection process in the *Focused Feasibility Study for the Remediation of Soils at Load Lines 1 through 4* (herein referred to as the Focused Feasibility Study [FFS]) (USACE 2005a). Environmental sample collection or remedial actions were not completed under this task.

A.1.9 Final November 2004 Sampling Completion Report

Sampling was completed in November and December 2004 for delineating the horizontal and vertical extents of contamination at the AOC. Some identified data gaps were not fully addressed as part of the additional data gap sampling due to manganese concentrations continuing to exceed the established RGO. As part of this data gap sampling event, sampling ceased following three step-outs of 10 ft per step-out, confirming that a COC was not a random detection or when manganese was detected at concentrations less than 2,000 mg/kg (USACE 2005b). Data from this report were incorporated into the FFS and are presented as Appendix B of the FFS.

A.1.10 Focused Feasibility Study for Soils at Load Lines 1 Through 4

The FFS presented the remedial alternatives for surface soil, subsurface soil, and dry sediment at Load Lines 1 through 4. Additional data from the 2004 perceived data gap investigation (USACE 2005b) also were incorporated into the FFS. The recommended interim remedy, based on a detailed analysis of the feasible remedial alternatives to address surface soil, subsurface soil, and dry sediment contamination at Load Line 1, was excavation with off-site disposal. This alternative was recommended due to expediency, permanency, consistency with future land use, moderate relative cost, feasibility, and implementability (USACE 2005a). Environmental sampling and remedial actions were not completed as part of the FFS.

A.1.11 Interim Record of Decision for Soil at Load Lines 1 Through 4

In 2007, USACE developed the *Interim Record of Decision for the Remediation of Soils at Load Lines 1 through 4* (USACE 2007) to address chemical exposure in soil and dry sediment. The selected remedy was chosen in accordance with the requirements of CERCLA. The selected remedy for surface soil, subsurface soil, and dry sediment that were currently accessible at Load Lines 1 through 4 with concentrations of chemicals exceeding RGOs was excavation and off-site disposal. The selected remedy was recommended as part of the FFS, documented in the Proposed Plan (PP), received public acceptance during the public comment period, and received state acceptance from the Ohio Environmental Protection Agency (Ohio EPA). The Interim Record of Decision (IROD) and selected remedy was jointly signed by the U.S. Army Division of Base Realignment and Closure (BRAC) and Ohio EPA in the summer of 2007.

A.1.12 Remedial Action Completion Report for Soils and Dry Sediments

Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 539 tons of hazardous (PCB-contaminated) soils and 3,126 tons of non-hazardous soils were removed from Load Line 1. The maximum depth of the excavation was to 3 ft bgs; however, most excavations were typically to 2 ft bgs. A total of 51 discrete areas were excavated within Load Line 1. After the excavation was completed, 57 multi-increment (MI) samples, including quality assurance/quality control (QA/QC) samples, were collected and analyzed for Load Line 1 COCs: PCB-1254, benzo(a)pyrene, TNT, RDX, propellants, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese.

As part of the planned remedial action, concrete slabs were to remain in place and periodic monitoring of the concrete slab integrity was to be completed. A post-Record of Decision (ROD) change to the concrete slab maintenance task for Load Lines 1 through 4 was initiated by USACE and BRAC in late 2007. BRAC commenced slab and foundation removal in March 2008 at Load Lines 1 through 4, eliminating the need for routine maintenance directed in the selected remedy.

After remedial activities were complete, Ohio EPA also indicated that "the physical remedial action of soil and dry sediment removal has been completed in accordance with the intents and provisions of the Interim ROD for Load Lines 1 through 4" (Ohio EPA 2008).

A.1.13 Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers

The *Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers* (herein referred to as the Facility-Wide Sewers RI/FS) (USACE 2012) evaluated the nature and extent of process-related contaminants in sewer sediment, surface water, and outfalls, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 1. As part of the RI, field investigative activities included conducting visual survey inspections of sanitary and storm sewer structures (i.e., manholes, drop inlets, catch basins, and outfalls); performing video camera surveys of select sewer lines; and collecting sewer sediment, sewer water, pipe bedding,

outfall sediment, and outfall water samples using discrete methods. No remedial actions were recommended for sewers and outfalls at Load Line 1.

Data collected during the Facility-Wide Sewers RI/FS activities are excluded from the FS Addendum dataset, as the sewers media data are currently being evaluated in an RI/FS under a separate contract.

A.1.14 Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations

Removal of buildings down to the floor slab at Load Line 1 was completed in 2007. Removal of the floor slab and associated foundation walls was completed in May 2009. Plastic covers were placed within 2 days of slab removal to minimize potential for contamination of infiltration water through exposed soil areas and the movement of potentially contaminated soil.

As part of this investigation, 486 field screening grab samples were collected beneath all building slabs at Load Line 1 and field-screened for the explosives TNT and RDX (USACE 2010a). The analytical data were compared to facility-wide cleanup goals (FWCUGs) utilized in the *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* Report (USACE 2010a), and no additional areas for remediation were identified based on the results of the ISM sampling.

A.1.15 Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 Through 4

The *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* Report (USACE 2010a) analyzed soils to a maximum depth of 3.5 ft bgs. This study was performed to sample and characterize deeper subsurface soils beneath the former building slabs via subsurface soil ISM techniques. Additional surface soil ISM samples in the former coal storage area at Load Line 1 were collected and analyzed to provide preliminary data for future RIs. The Power House No. 1, Facility-Wide Coal Storage (CC-RVAAP-73), is located at the northeastern corner of former Building CC-1 and is currently undergoing investigation; therefore, it is not included in the Sampling and Analysis Plan (SAP) Addendum.

Of the 30 total surface soil MI (or ISM) samples collected as part of the 2009 investigation at Load Line 1, 7 were analyzed for metals, 26 for explosives, 5 for SVOCs, 4 for pesticides and PCBs, and 3 for VOCs. Metals, explosives, propellants, pesticides, PCBs, and VOCs were not detected above the cleanup goals (CUGs) utilized in the *Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1, 2, 3, and 4* (herein referred to as the 2011 Sampling Report) (USACE 2011a) in any of the samples collected from the buildings at Load Line 1. Some SVOCs were detected.

Of the 53 subsurface soil ISM samples collected as part of the 2010 investigation at Load Line 1, 24 were analyzed for metals, 38 for explosives, 11 for SVOCs, 12 for VOCs, and 6 for PCBs and pesticides. Metals, pesticides, PCBs, and VOCs were not detected above CUGs from the 2011

Sampling Report in any of the samples collected from the buildings at Load Line 1. Some explosives, SVOCs, and propellants were detected.

A.1.16 Remediation Completion Report for Sub-Slab Soils at RVAAP-08 Load Line 1

Based on the conclusions and recommendations of the *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* Report (USACE 2010a), remedial activities consisting of excavation and off-site disposal of contaminated surface and subsurface soils were completed in 2010 at Buildings CB-4A/CB-4AWS and CB-4/CB-4WN. A removal area estimated to be 20 ft by 20 ft by 5 ft was removed at each building location. A total of 175 cubic yards of soil were removed at Building CB-4/CB-4WN and 184 cubic yards were removed at Building CB-4A/CB-4AWS.

Six ISM confirmation samples collected in 2010 at the buildings indicated that no further areas required remediation (USACE 2011b). All excavated areas were backfilled with clean fill and restored to OHARNG specifications.

A.1.17 Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 Through 4 and 12

Additional characterization sampling was completed at Load Line 1 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010b). A total of 15 subsurface soil horizontal ISM samples (five from each depth: 1–3, 3–5, and 5–7 ft bgs) were collected at Load Line 1 to further refine ISM sample areas that had levels of contamination above CUGs utilized as part of the *Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1, 2, 3, 4, and 12* (herein referred to as the Characterization Sampling Report [USACE 2013]), to conduct ISM sampling on soil where previous discrete samples exceeded these CUGs, and to provide approved analytical documentation for backfill sources.

Conclusions of this soil investigation indicated the area requiring remediation was reduced, several previous ISM areas exceeding CUGs identified in this report were further delineated, and one ISM area was not fully delineated for PCBs.

A.1.18 Final Construction Completion Report for Closure for Clean Hard-fill Sites RVAAP-08 Site CB-23 and Site CB-22 on Load Line 1 and George Road

Three sites located within Load Line 1 at three former change house buildings (CB-12, CB-22, and CB-23) were utilized to store clean hard-fill from Former RVAAP building demolition and removal operations at Load Lines 1 and 12. The scope of this project was to close the CB-22 and CB-23 clean hard-fill sites. CB-22 and CB-23 were constructed 15 to 20 ft below grade and were filled to surrounding grade with a mixture of brick and concrete clean hard-fill materials. Each site is approximately 0.5 acres.

Closure of the sites commenced in June 2013 and included concrete processing, installing geo-textile fabric, and installing soil cover consisting of verified clean fill dirt and topsoil. Site restoration activities concluded in October 2013 (USACE 2014a).

A.1.19 Remedial Investigation Report for RVAAP-008-R-01 Load Line 1 Munitions Response Site

Results for the RI Report indicated no munitions and explosives of concern (MEC) or munitions debris (MD) were found on the ground or within shallow soils at the Load Line 1 munitions response site (MRS) (USACE 2014b). No explosive hazard is anticipated to be present at the MRS. Munitions constituents, including lead and nitroguanidine, were identified as site-related contaminants in discrete and ISM samples collected from the MRS. These chemicals were not retained as COPCs and, therefore, are not retained as COCs. Resident Receptor Unrestricted Land Use was achieved for munitions constituents. The RI determined that the Load Line 1 MRS has been adequately characterized and data quality objectives (DQOs) have been achieved. A no further action ROD is recommended as the next course of action.

A.2 LOAD LINE 2

CERCLA activities completed at Load Line 2 are presented in the following report summaries. These 18 reports present extensive evaluations and remedial activities performed to address contaminated media, including assessments at each of the former buildings.

A.2.1 Installation Assessment of Ravenna Army Ammunition Plant

In 1978, the *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. The installation assessment presented quantities of munitions produced, amounts of chemicals utilized, and waste produced at each load line. No sampling, investigation, or actions were performed at Load Line 2 as part of the assessment. The assessment concluded that no sampling was presently required for AOC exit pathways or surface water bodies and additional action may be warranted.

A.2.2 Preliminary Assessment for the Characterization of Areas of Contamination

In 1996, the PA (USACE 1996) was developed following the requirements of CERCLA and provided information concerning conditions at CERCLA AOCs at RVAAP to assess potential contamination risks posed to human health and the environment. The assessment provided a narrative of the facility history and process operations and described activities conducted at each AOC. According to the PA, waste constituents at Load Line 2 included, but are not limited to, TNT, Composition B, smokeless powder, chromic acid, and lead. Primary contaminant release mechanisms were process effluent discharges to surface water and process building wastewater washout to surface soils and sediments.

Characterization data from previously completed sampling were included as part of the PA. No additional sampling or investigative actions were completed as part of the PA. Waste constituents TNT (0.6 µg/mL) and RDX (1.75 µg/mL) were detected in sediments from the drainage ditch receiving discharge from the pinkwater sawdust filtration units.

The report provided a PA scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model. Load Line 2 was ranked as a high-priority AOC for future environmental investigations due to the primary contaminant release mechanism from process effluent discharges to surface water and surface soil.

A.2.3 Phase I Remedial Investigation

A Phase I RI (USACE 1998) was conducted at Load Line 2 from July through August 1996. During this investigation, sampling activity at Load Line 2 included surface soil, ditch and pond sediment, and groundwater sample collection. Samples were analyzed for explosives, metals, cyanide, VOCs, SVOCs, pesticides, and/or PCBs. Most occurrences and highest concentrations of explosive compounds, PAHs, and inorganic chemicals in surface soils were associated with the melt and pour buildings (DB-4 and DB-4A), explosive offloading areas (DA-6 and DA-6A), or with Building DB-10. A total of 11 ditch and pond sediment samples were collected at Load Line 2 for inorganics and explosives. A total of 3 of the 11 samples also were analyzed for VOCs, SVOCs, PCBs, and pesticides. Chemicals, including explosives, inorganics, PAHs, PCBs, and the pesticide endrin, were observed in the drainages leading to Kelly's Pond and/or in pond sediments but did not appear to be exiting Kelly's Pond. Drainages on the north and west sides of the load line were not impacted with explosive or inorganic chemicals.

The conclusions of the Phase I RI categorized Load Line 2 as a "high-priority" AOC due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC, and a Phase II RI was recommended (USACE 1998).
Data from the Phase I RI are excluded from the FS Addendum dataset as these discrete samples were resampled as part of more recent investigations.

A.2.4 Sampling of Potential Disposal Areas at Load Lines 1 and 2

Surface soil sampling was conducted in November 1999 to characterize potential demolition debris disposal areas and to evaluate their suitability for use as fill areas for clean, solid demolition debris from the load line (SAIC 2000). Samples were collected from two change-out buildings (DB-8A and DB-22) and analyzed for TAL metals, explosives, propellants, VOCs, SVOCs, pesticides, PCBs, and/or cyanide. Depth to bedrock at Load Line 2 was very shallow, and samples did not exceed 1.0 ft bgs due to bedrock refusal. Results from sampling indicated eight metals were detected above background at Load Line 2. In addition to inorganic chemicals, two VOCs were detected at concentrations less than residential risk screening criteria at DB-22-03. SVOCs, pesticides, and PCBs were only analyzed at station DB-22-03 and were not detected in collected samples (SAIC 2000). All six samples from the 1999 sampling of potential disposal areas are included in the FS Addendum dataset.

A.2.5 Phase II Remedial Investigation

The Phase II RI (USACE 2004c) evaluated the nature and extent of process-related contaminants in surface and subsurface soil, sediment, surface water, and groundwater, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 2.

As part of the Phase II RI, the AOC was evaluated by dividing it into spatial aggregates based on former process operations and drainage areas. Surface and subsurface soil was separated into six aggregates (Explosive Handling Areas, Preparation and Receiving Areas, Packaging and Shipping Areas, Change House, Perimeter Area, and North Ditches). Sediment and surface water aggregates evaluated as part of the Phase II RI are Kelly's Pond and Exit Drainages (sediment and surface water), North Ponds (sediment), and Miscellaneous Water (surface water).

A total of 172 surface soil samples (including 17 sub-slab samples) were collected across the 6 aggregates to determine the nature and extent of surface soil contamination at Load Line 2. The Explosive Handling Areas aggregate contained the highest concentrations and frequency of detected chemicals in surface soil within Load Line 2. Explosives, propellants, and inorganic chemicals were commonly detected in surface soil, with the highest overall concentrations occurring near Buildings DB-4, DB-4A, DB-6, and DB-6A. SVOCs, PCBs, and pesticides were frequently detected within this aggregate, especially adjacent to former process buildings. Explosive and inorganic chemicals were detected at this aggregate. Explosives, inorganic chemicals, SVOCs (primarily PAHs), PCBs, and pesticides were detected in the Preparation and Receiving Areas aggregate and Packaging and Shipping Areas aggregate. VOCs were rarely detected within these aggregates. Explosives, propellants, inorganic chemicals, and PCBs were detected within the Perimeter Area aggregate, largely adjacent to buildings present within the aggregate (i.e., DA-21 and DB-3). SVOCs and pesticides were rarely detected within the Perimeter Area aggregate and VOCs were not detected. Explosives and inorganic chemicals were identified at the North Ditches aggregate. The Change House aggregate was relatively uncontaminated for surface soil.

A total of 29 discrete subsurface soil samples were collected across the AOC to assess vertical migration. Explosives and inorganic chemicals were detected at the Explosives Handling Areas, with the highest concentrations at process Buildings DB-4 and DA-6. Inorganic chemicals and a few, low estimated concentrations of SVOCs and VOCs were detected at the Preparation and Receiving Areas aggregate. Explosives were not detected in subsurface soils at this aggregate. Inorganic chemicals were the only chemicals identified in elevated concentrations at the Packaging and Shipping Areas aggregate. Explosives, SVOCs, PCBs, and pesticides were not detected in this aggregate. Explosives, two inorganic chemicals, and one PCB were detected in subsurface soil at the Perimeter Area aggregate.

A total of 23 sediment samples and 5 surface water samples were collected from streams, ponds, and drainage channels under the Load Line 2 Phase II RI. At the Kelly's Pond and Exit Drainage aggregate, explosives, inorganic chemicals, pesticides, and SVOCs were detected. PCBs and VOCs were not detected at this sediment aggregate. At the North Ponds aggregate, explosives and nitrocellulose and inorganic chemicals were detected in sediment. VOCs, SVOCs, PCBs, and

pesticides were not detected in the North Ponds sediment aggregate. Explosive and inorganic chemicals were detected at the Kelly's Pond and Exit Drainages surface water aggregate. Only 11 inorganic chemicals were detected at the miscellaneous water samples surface water aggregate.

Recommendations of the Phase II RI included completing an FS to evaluate possible remedial actions at Load Line 2 to reduce or eliminate potential risks to human and/or ecological receptors (USACE 2004c).

Data from 173 samples characterized as soil media, 7 sediment samples, and 4 surface water samples collected during the Phase II RI (USACE 2004c) are included in the FS Addendum dataset. Phase II samples collected from remediated areas; off-AOC areas; and from sewers or media, including floor sweep, ballast, test pit, and groundwater samples, are excluded from the FS Addendum dataset.

A.2.6 Facility-Wide Biological and Water Quality Study

In 2003, an assessment of 11 ponds at RVAAP was completed. As part of the assessment, analytical samples were collected and macroinvertebrate and fish assessments were completed at each pond. Kelly's Pond, which receives exit drainage from the Load Line 2 AOC, was assessed during the study. One MI (or ISM) sediment sample and two surface water samples were collected from Kelly's Pond. The exact footprint or extent of the MI sample is unknown but is assumed to have included the entire footprint of Kelly's Pond. The samples were analyzed for explosives, inorganic chemicals, SVOCs, PCBs, and pesticides. Explosives, PAHs, and metals were detected in sediment and/or surface water from the pond. As part of the biological assessment, the physical habitat conditions in Kelly's Pond were rated as very poor quality based on the Lake/Lacustrine Qualitative Habitat Evaluation Index. Kelly's Pond was the lowest score of the ponds (20.5) evaluated at RVAAP (USACE 2005c).

The MI sediment sample and two surface water samples collected from Kelly's Pond south of the Load Line 2 AOC during the 2003 investigation are included in the FS Addendum dataset.

A.2.7 Proposed Remedial Goal Options for Soil at Load Lines 1 Through 4

The 2004 *Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4* Report (USACE 2004b) documented the proposed land use and corresponding risk-based RGOs that were used to support the remedial alternative selection process in the FFS (USACE 2005a). Environmental samples or remedial actions were not completed under this task; therefore, no data are available for the FS Addendum dataset.

A.2.8 Final November 2004 Sampling Completion Report

Sampling was completed in November and December 2004 for delineating the horizontal and vertical extents of contamination at the AOC (USACE 2005b). The majority of samples collected at Load Line 2 fully delineated the extent of contamination below RGOs. Two identified data gaps were not fully addressed as part of the additional data gap sampling due to manganese concentrations

continuing to exceed the established RGO. As part of this data gap sampling event, sampling ceased following three step-outs of 10 ft per step-out, confirming that a COC was not a random detection or when manganese was detected in concentrations less than 2,000 mg/kg (USACE 2005b). Data from this report are incorporated into the FFS and are presented as Appendix B of the FFS.

Data from the data gap analysis and additional sampling are not included in the FS Addendum dataset because these areas were remediated as part of the 2007 remedial action.

A.2.9 Focused Feasibility Study for the Remediation of Soils at Load Lines 1 Through 4

The FFS presented remedial alternatives for surface soil, subsurface soil, and dry sediment at Load Lines 1 through 4. As part of the FFS, data acquired in the Phase I and II RIs were evaluated against RGOs and considered during the evaluation of remedial alternatives. Additional data from the 2004 perceived data gap investigation (USACE 2005b) also were incorporated into the FFS.

The recommended interim remedy, based on a detailed analysis of the feasible remedial alternatives to address surface soil, subsurface soil, and dry sediment contamination at Load Line 2, was excavation with off-site disposal. This alternative was recommended due to expediency, permanency, consistency with future land use, moderate relative cost, feasibility, and implementability (USACE 2005a). Environmental sampling and remedial actions were not implemented as part of the FFS. Data were not generated as part of this FFS; therefore, no data from the FFS are included in the FS Addendum.

A.2.10 Interim Record of Decision for the Remediation of Soils at Load Lines 1 Through 4

In 2007, USACE developed the *Interim Record of Decision for the Remediation of Soils at Load Lines 1 Through 4* to address chemical exposure in soil and dry sediment. The selected remedy was chosen in accordance with CERCLA requirements. The selected remedy for surface soil, subsurface soil, and dry sediment was excavation and off-site disposal for Load Lines 1 through 4 where concentrations of chemicals exceed RGOs. The selected remedy was recommended as part of the FFS, documented in the PP, received public acceptance during the public comment period, and received state acceptance from Ohio EPA. The IROD was jointly signed by the U.S. Army Division of BRAC and Ohio EPA in the summer of 2007.

A.2.11 Remedial Action Completion Report for the Remediation of Soils and Dry Sediments

Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007. A total of 320 tons of hazardous PCB-contaminated soils and 2,617 tons of non-hazardous soils were removed from Load Line 2. The maximum depth of the excavation was to 3 ft bgs; however, most excavations were typically to 2 ft bgs. A total of 24 discrete areas were excavated within Load Line 2. After completing the excavations, MI confirmation samples were collected and analyzed for Load Line 2 COCs: PCB-1254, TNT, RDX, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese. Laboratory results for the MI samples collected at Load

Line 2 indicate that COCs were removed to below CUGs at all Load Line 2 excavation areas (USACE 2008a).

As part of the planned remedial action, concrete slabs were to remain in place and periodic monitoring of the concrete slab integrity was to be completed. A post-ROD change to the concrete slab maintenance task for Load Lines 1 through 4 was initiated by USACE and the U.S. Army Division of BRAC in late 2007. BRAC commenced slab and foundation removal in March 2008 at Load Lines 1 through 4, eliminating the need for routine maintenance as directed in the selected remedy.

Ohio EPA indicated that "the physical remedial action of soil and dry sediment removal has been completed in accordance with the intents and provisions of the Interim ROD for Load Lines 1 through 4" (Ohio EPA 2008).

The 24 MI confirmation samples collected post-remedial activities are included as part of the FS Addendum dataset.

A.2.12 Preliminary Evaluation of Pre (Floor Slab Removal) Contamination for the Sampling of Soils Beneath Floor Slabs and Load Lines 2 Through 4 and Excavation and Transportation of Contaminated Soils to Load Line 4

Sampling was completed pre-removal below floor slabs of demolished buildings at Load Lines 2 through 4. Sampling was conducted prior to floor slab removal through holes in building slabs from building demolition activities that allowed access to soil below the floor slabs. Field screening of 17 soil samples was completed at Building DB-4 at Load Line 2. Field screening results indicated concentrations of TNT or RDX were detected below CUGs in all samples from Load Line 2. Based on the field screening results, no samples were submitted for laboratory analysis (USACE 2008b).

The field screening samples collected as part of this investigation were considered and reviewed as part of the data gap analysis included in the report but are not included in the FS Addendum dataset.

A.2.13 Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

Floor slab removal was completed between March and June 2008. As part of the scope of this investigation, the following sampling activities were completed at Load Lines 2 through 4: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. The objective of the sampling was to determine if any areas required excavation to remove contaminated soils beneath former building slabs. The focus for the majority of the sampling completed at Load Line 2 involved buildings with the highest probability of contamination, including DB-4, DB-4A, DA-6, DA-6A, and DB-10. Core samples were collected to a maximum depth of 4 ft bgs at these locations for explosives field screening. Analytical and field screening results from these building slabs at Load Line 2 indicated there were no concentrations of explosives beneath former building slabs that exceeded CUGs (USACE 2009a).

Additional field investigation activities completed at Load Line 2 outside of investigation of soils beneath floor slabs included collecting a field screening sample from a visually impacted zone at Building DB-4 and collecting samples from outside the DB-4A building footprint in an area that visually appeared to be impacted with explosives and sampling around an area where approximately 1 lb of explosive product was removed at Building DB-10. Field screening samples collected around Buildings DB-10 and DB-4 exceeded the TNT CUG (USACE 2009a). The report concluded that additional characterization and remediation were warranted at the following Load Line 2 locations:

- North elevator sump at Building DB-4 to a maximum depth of 4 ft bgs,
- The north sump area (DB-4-WN) to a maximum depth of 4 ft bgs, and
- An area adjacent to DB-10 and DB-10-VP-2 where bulk TNT was removed to a maximum depth of 2 ft bgs.

Field screening samples and samples from remediated areas collected as part of this investigation are not included in the FS Addendum dataset. Field screening samples were considered and reviewed as part of the data gap analysis included in the report but were not included in the FS Addendum dataset.

A.2.14 Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

MI (or ISM) sampling was completed in 2008 within building footprints following the removal of building slabs and any contaminated soils identified as part of the *Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, 10, and 11* (USACE 2009b). The purpose of MI confirmatory sampling was to determine if any additional excavation was required at building locations beyond those determined by field screening. Each sample was analyzed for metals and explosives, with select locations also being analyzed for RVAAP full-suite parameters (VOCs, SVOCs, PCBs, pesticides, and propellants). Areas selected for full-suite analysis were based on actual operations at an individual building and whether operations would indicate contamination other than explosives and metals based on the historical process knowledge. MI samples were collected from 0–ft bgs across 46 building footprints. Explosives, propellants, SVOCs (primarily PAHs), PCBs, and metals were detected in MI samples collected at Load Line 2. VOCs and pesticides were not detected in samples collected at Load Line 2. This investigation concluded that there were no additional areas outside of those areas identified during the screening effort requiring remediation at Load Line 2 (USACE 2009b).

Fifty building footprint samples collected as part of this investigation are included in the FS Addendum dataset.

A.2.15 Remediation Completion Report Sub-Slab Soils at Load Lines 2 Through 4

As part of the remedial actions completed for sub-slab soils at Load Line 2, two distinct areas were excavated in June 2010. A total of 791 cubic yards of soil were excavated from the sumps at DB-4/DB-4-WN and 94 cubic yards were excavated from the bulk TNT area at DB-10/DB-10-VP-2

(USACE 2010c). Excavated soils were stockpiled temporarily at Load Line 2 prior to off-site disposal.

Following excavations and collecting field screening samples, confirmation MI (or ISM) samples were collected. A minimum of one MI sample was collected from the floor of the excavation and the side walls. Samples were analyzed for explosives, metals, SVOCs, and PCBs. The confirmatory MI sampling conducted at Load Line 2 indicated that the excavated areas have been successfully remediated to CUGs identified in the IROD (USACE 2010c).

Six confirmation MI samples collected as part of this investigation are included in the FS Addendum dataset.

A.2.16 Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers

The Facility-Wide Sewers RI/FS (USACE 2012) evaluated the nature and extent of process-related contaminants in sewer sediment, surface water, and outfalls and assessed the potential risk to human health and the environment resulting from former operations at Load Line 2. RI field investigative activities included visual survey inspections of sanitary and storm sewer structures (i.e., manholes, drop inlets, catch basins, and outfalls); video camera surveys of select sewer lines; and collecting sewer sediment, sewer water, pipe bedding, outfall sediment, and outfall water samples using discrete methods. The RI recommended proceeding to the FS phase to evaluate remedial alternatives to address lead in sewer sediment from one storm sewer segment at Load Line 2 (USACE 2012).

The FS recommended the excavation and off-site disposal of segments of pipes, inlets, and manholes that contain contaminated sewer sediment at Load Line 2. There is one isolated location, LL2sd-615(st), that was recommended for excavation with off-site disposal at Load Line 2. Excavation with off-site disposal was recommended as it will achieve unrestricted land use, is protective of human health and the environment, and is an implementable remedy. No remedial action has been implemented based on these recommendations of the selected remedy. Prior to implementing a remedial action, these recommendations will be documented in a PP and solicit public input prior to the ROD to document the selected remedy (USACE 2012).

Data collected from the Facility-Wide Sewers RI activities are not included in the FS Addendum dataset because they are currently being evaluated in an RI under a separate contract.

A.2.17 Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 Through 4

The *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* Report (USACE 2010a) analyzed soils to a maximum depth of 3.5 ft bgs. This study was performed to sample and characterize deeper subsurface soils beneath the former building slabs via subsurface soil ISM techniques that were not previously characterized. Additional surface soil ISM samples in the former coal storage area at Load Line 2 were collected and analyzed to provide preliminary data for future RIs of these AOCs. The Power House No. 2 Facility-Wide Coal Storage

(CC-RVAAP-73) is located at the northern end of former Building DC-1 and is currently undergoing investigation; therefore, it is not included in the SAP Addendum.

In 2009, USACE collected 23 total surface soil MI (or ISM) samples at Load Line 2. Eight were analyzed for metals; 19 for explosives; 6 for SVOCs, pesticides, and PCBs; and 4 for VOCs. Metals, explosives, propellants, pesticides, and VOCs were not detected above the CUGs utilized in the 2011 Sampling Report (USACE 2011a) in any of the samples collected from the buildings at Load Line 2. PAHs and one PCB were detected in samples at Buildings DB-4/DB-4WS above the CUGs utilized in the 2011 Sampling Report.

Of the 37 subsurface soil ISM samples collected at Load Line 2, 23 were analyzed for metals; 28 for explosives; 9 for VOCs; and 6 for SVOCs, PCBs, and pesticides. Metals, SVOCs, pesticides, PCBs, and VOCs were not detected above CUGs identified in the 2011 Sampling Report in any of the samples collected from the buildings at Load Line 2. Explosives and propellants were detected in Building DA-6 above the CUGs utilized in the 2011 Sampling Report from 1–3 ft bgs. The TNT concentration from 1–3 ft bgs was 230 mg/kg. This sample was delineated horizontally and vertically (USACE 2011a).

All 23 surface soil samples collected in 2009 and the 37 subsurface samples collected in 2010 are included in the FS Addendum dataset.

A.2.18 Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 Through 4 and 12

Additional characterization sampling was completed at Load Line 2 to guide future remedial and administrative measures. The samples collected as part of this investigation were to help eliminate data gaps recognized in the *Land Use Controls Assessment Report* (USACE 2010b). Five surface soil ISM samples and 12 subsurface soil horizontal ISM samples (4 from each depth: 1–3, 3–5, and 5–7 ft bgs) were collected at Load Line 2 to further refine ISM sample areas that had levels of PAH contamination above RVAAP CUGs identified in the Characterization Sampling Report (USACE 2013).

Samples were collected at former Building DB-4, Building DB-4A, and discrete station LL2ss-165. Two PAHs (benzo[a]pyrene and dibenz[a,h]anthracene) were detected at concentrations exceeding CUGs utilized in the Characterization Sampling Report in surface and subsurface ISM samples. Conclusions of this investigation indicated that three of the six previous areas exceeding CUGs identified in the Characterization Sampling Report were further bound and delineated. The remaining three areas were not fully delineated for PAHs and RVAAP full-suite chemicals (USACE 2013).

The 17 surface and subsurface soil ISM samples collected during this investigation are included in the FS Addendum dataset.

A.3 LOAD LINE 3

CERCLA activities completed at Load Line 3 are presented in the following report summaries. These 16 reports present extensive evaluations and remedial activities performed to address contaminated media, including assessments at each of the former buildings.

A.3.1 Installation Assessment of Ravenna Army Ammunition Plant

In 1978, the *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. The installation assessment presented quantities of munitions produced, amounts of chemicals utilized, and waste produced at each load line. No sampling, investigation, or actions were performed at Load Line 3 as part of the assessment. The assessment concluded that no sampling was presently required for AOC exit pathways or surface water bodies and additional action may be warranted.

A.3.2 Preliminary Assessment for the Characterization of Areas of Contamination

In 1996, the PA (USACE 1996) was developed following CERCLA requirements and provided information concerning conditions at CERCLA AOCs at RVAAP to assess potential contamination risks posed to human health and the environment. The PA provided a narrative of the facility history and process operations and a description of activities conducted at each AOC. As noted in the PA, waste constituents at Load Line 3 included, but are not limited to, TNT, HMX, Composition B, lead, chromium, mercury, and arsenic. Primary contaminant release mechanisms were process effluent discharges to surface water and process building wastewater washout to surface soils and sediments.

The report provided a PA scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model. Load Line 3 was ranked as a high-priority AOC for future environmental investigations due to the primary contaminant release mechanism from process effluent discharges to surface water and surface soil.

A.3.3 Phase I Remedial Investigation

The Phase I RI (USACE 1998) was conducted at Load Line 3 from July through August 1996. During this investigation, sampling activity at Load Line 3 included surface soil and sediment sample collection across the AOC. Samples were analyzed for explosives, metals, cyanide, VOCs, SVOCs, and PCBs.

The explosive TNT was detected in samples at the highest concentration of any load line sample collected as part of the Phase I RI. Many of the occurrences and highest concentrations of TNT were located around melt pour Buildings EB-4 and EB-4A. The maximum concentration of TNT detected at Load Line 3 was 390,000 mg/kg at Building EB-10. Metals, SVOCs, pesticides, PCBs, and VOCs also were detected in surface soil samples collected at Load Line 3, primarily around Buildings EB-4, EB-4A, and EB-803.

Nine ditch sediment locations were sampled throughout the Load Line 3 AOC to characterize effluent that flows through ditches that exit the AOC to the west. Explosives were detected in sediment samples, although at lower concentrations (at least one order of magnitude) than observed in soil. The distribution and concentration of TNT in sediment was highest at Buildings EB-4 and EB-4A. Metals also were consistently detected in sediment at Load Line 3.

The conclusions of the Phase I RI categorized Load Line 3 as a "high-priority" AOC due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC, and a Phase II RI was recommended (USACE 1998).

A.3.4 Phase II Remedial Investigation

The Phase II RI (USACE 2004d) evaluated the nature and extent of process-related contaminants in surface and subsurface soil, sediment, surface water, and groundwater, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 3.

As part of the Phase II RI, the AOC was evaluated by dividing it into spatial aggregates based on former process operations and drainage areas. Surface and subsurface soil were separated into seven aggregates (Explosive Handling Areas, Preparation and Receiving Areas, Packaging and Shipping Areas, Change House, Perimeter Area, Defense Logistics Agency [DLA] Storage Tanks, and West Ditches). The two sediment and surface water aggregates evaluated as part of the Phase II RI are Cobbs Pond Tributary (sediment and surface water) and Miscellaneous Water (surface water).

A total of 159 surface soil samples were collected across the 7 aggregates to determine the nature and extent of surface soil contamination at Load Line 3. The distribution and occurrence of contaminants in surface soil differ within each aggregate; however, the constituents (i.e., explosives and inorganics) are consistent throughout the AOC. The Explosive Handling Areas aggregate contained the highest concentrations and frequency of detected chemicals in surface soil within Load Line 3. Explosives, inorganic chemicals, and SVOCs were common in surface soil with the highest overall concentrations occurring near Buildings EB-4, EA-6, and EB-10.

A total of 28 discrete subsurface soil samples were collected across the AOC to assess vertical migration. Explosives and inorganic chemicals were detected at the Explosives Handling Areas with the highest concentrations at process Buildings EA-6 and EB-4.

A total of 20 sediment samples and 10 surface water samples were collected from drainage channels under the Load Line 3 Phase II RI. Explosive and inorganic chemicals were the most frequent chemicals identified in sediment. Inorganic chemicals were frequently detected in surface water. Explosive and inorganic chemicals were detected at low concentrations in surface water.

Recommendations of the Phase II RI included completing an FS to evaluate possible remedial actions at Load Line 3 to reduce or eliminate potential risks to human and/or ecological receptors (USACE 2004d).

Data from four sediment samples and two surface water samples from the Phase II RI (USACE 2004d) were incorporated into the FS Addendum dataset.

A.3.5 Proposed Remedial Goal Options for Soil at Load Lines 1 Through 4

The *Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4* Report (USACE 2004b) documented the proposed land use and corresponding risk-based RGOs that were used to support the remedial alternative selection process in the FFS (USACE 2005a). Environmental samples or remedial actions were not completed under this task.

A.3.6 Final November 2004 Sampling Completion Report

Sampling was completed in November and December 2004 for delineating the horizontal and vertical extents of contamination at the AOC (USACE 2005b). Some identified data gaps were not fully addressed as part of the additional data gap sampling due to manganese concentrations continuing to exceed the established RGO. As part of this data gap sampling event, sampling ceased following three step-outs of 10 ft per step-out, confirming that a COC was not a random detection or when manganese was detected at concentrations less than 2,000 mg/kg (USACE 2005b). Data from this report were incorporated into the FFS and are presented as Appendix B of the FFS.

A.3.7 Final Focused Feasibility Study for the Remediation of Soils at Load Lines 1 Through 4

The FFS presented the remedial alternatives for surface soil, subsurface soil, and dry sediment at Load Lines 1 through 4. As part of the FFS, data acquired in the Phase I and II RIs were screened against RGOs and considered during the evaluation of remedial alternatives. Additional data from the 2004 perceived data gap investigation also were incorporated into the FFS (USACE 2005a).

The recommended interim remedy (excavation with off-site disposal) was based on a detailed analysis of the feasible remedial alternatives to address surface soil, subsurface soil, and dry sediment contamination at Load Line 3. This alternative was recommended due to expediency, permanency, consistency with future land use, moderate relative cost, feasibility, and implementability (USACE 2005a). Environmental sampling and remedial actions were not completed as part of the FFS.

A.3.8 Interim Record of Decision for the Remediation of Soils at Load Lines 1 Through 4

In 2007, USACE developed the *Interim Record of Decision for the Remediation of Soils at Load Lines 1 through 4* (USACE 2007) to address chemical exposure in soil and dry sediment. The selected remedy was chosen in accordance with CERCLA requirements. The selected remedy for surface soil, subsurface soil, and dry sediment that were currently accessible at Load Lines 1 through 4 with concentrations of chemicals exceeding RGOs was excavation and off-site disposal. The selected remedy was recommended as part of the FFS, documented in the PP, received public acceptance during the public comment period, and received state acceptance from Ohio EPA. The IROD and selected remedy received acceptance from the U.S. Army Division of BRAC in the summer of 2007.

A.3.9 Remedial Action Completion Report for the Remediation of Soils and Dry Sediments

Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007. A total of 893 tons of hazardous (PCB-contaminated) soils and 2,538 tons of non-hazardous soils were removed from Load Line 3. The maximum depth of the excavation was to 3 ft bgs; however, most excavations were typically to 2 ft bgs. A total of 35 discrete areas were excavated within Load Line 3. After the excavations were completed, 31 MI, or ISM, confirmation samples were collected and analyzed for Load Line 3 COCs: PCB-1254, benzo(a)pyrene, TNT, aluminum, antimony, arsenic, hexavalent chromium, lead, and manganese. Laboratory results for the MI samples collected at Load Line 3 indicate that the COCs were removed to below CUGs at all Load Line 3 final excavation areas (USACE 2008a).

As part of the planned remedial action, concrete slabs were to remain in place and periodic monitoring of the concrete slab integrity was to be completed. A post-ROD change to the concrete slab maintenance task for Load Lines 1 through 4 was initiated by USACE and BRAC in late 2007. BRAC commenced slab and foundation removal in March 2008 at Load Lines 1 through 4, eliminating the need for routine maintenance as directed in the selected remedy.

After remedial activities were complete, Ohio EPA also indicated that "the physical remedial action of soil and dry sediment removal has been completed in accordance with the intents and provisions of the Interim ROD for Load Lines 1 through 4" (Ohio EPA 2008).

A.3.10 Preliminary Evaluation of Pre (Floor Slab Removal) Contamination for the Sampling of Soils Beneath Floor Slabs and Load Lines 2 Through 4 and Excavation and Transportation of Contaminated Soils to Load Line 4

Sampling was completed pre-removal below floor slabs of demolished buildings at Load Lines 2 through 4. Sampling was conducted prior to floor slab removal through holes in building slabs from building demolition activities that allowed access to soil below the floor slabs. Field screening of seven soil samples was completed at Building EB-10 at Load Line 3. Field screening results indicated concentrations of TNT or RDX were detected below CUGs in all samples from Load Line 3. Based on the field screening results, no samples were submitted for laboratory analysis (USACE 2008b).

A.3.11 Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

Floor slab removal was completed between March and June 2008. As part of the scope of this investigation, the following sampling activities were completed at Load Lines 2 through 4: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. The objective of the sampling was to determine if any areas required excavation to remove contaminated soils beneath former building slabs. A total of 720 field screening samples were screened from Load Lines 2 through 4 in 2008. The focus for the majority of the sampling completed at Load Line 3 involved buildings with the highest probability of contamination, including Buildings EB-4, EB-4A, EA-6, EA-6A, and EB-10. Core samples were collected to a maximum depth of 4 ft bgs at these locations for explosives field screening. Analytical and field screening results from these building slabs at Load

Line 3 indicated there were concentrations of the explosive TNT beneath former building slabs that exceeded CUGs at Buildings EB-4, EA-6 and EA-6A (USACE 2009a). Additional field investigation activities completed at Load Line 3 outside of investigation of soils beneath floor slabs included collecting a field screening sample from soils at Building EB-4A.

A.3.12 Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

MI (or ISM) sampling was completed in 2008 within building footprints following the removal of building slabs and any contaminated soils identified as part of the Sampling and Screening Analysis Report (USACE 2009a). The purpose of MI confirmatory sampling was to determine if any additional excavation was required at building locations beyond those determined by field screening. A total of 102 primary MI samples were collected between Load Lines 2 through 4.

Each sample was analyzed for metals and explosives, with select locations also being analyzed for RVAAP full-suite parameters (VOCs, SVOCs, PCBs, pesticides, and propellants). Areas selected for full-suite analysis were based on actual operations at an individual building and whether operations would indicate contamination other than explosives and metals based on the historical process knowledge. MI samples were collected from 0–1 ft bgs across building footprints. Explosives, propellants, SVOCs (primarily PAHs), PCBs, and metals were detected in MI samples collected at Load Line 3. VOCs and pesticides were not detected in samples collected at Load Line 3.

A.3.13 Remediation Completion Report Sub-Slab Soils at Load Lines 2 Through 4

Based on the characterization and results provided as part of the Sampling and Screening Analysis Report (USACE 2009a) and *Multi-Increment Sampling and Analysis of Soils Below Floor Sabs at RVAAP-09, 10, and 11* Report (USACE 2009b), five distinct areas were identified for completing the remedial action at Load Line 3:

- Northeast corner of Building EB-4 and north sump area of Building EB-4-WN (40 ft by 80 ft by 4 ft),
- Northeast corner of Building EB-4A and sump area of Building EB-4A-WN (40 ft by 60 ft by 4 ft),
- Building EA-6 (20 ft by 20 ft by 5 ft),
- Building EA-6A (40 ft by 40 ft by 5 ft), and
- Building EB-25 (20 ft by 25 ft by 1 ft).

As part of the remedial actions completed for sub-slab soils at Load Line 3, the five areas were excavated in June 2010. A total of 1,602 cubic yards of soil were excavated from the five areas at Load Line 3. Excavated soils were stockpiled temporarily at Load Line 3 prior to off-site disposal (USACE 2010c). After the excavations were completed and the field screening samples were collected, confirmation MI (or ISM) samples were collected and analyzed for explosives, metals, SVOCs, and PCBs. The results of the MI samples indicated the excavated areas were successfully

remediated to CUGs identified in the IROD and no further remedial actions were needed for sub-slab soils (USACE 2010c).

A.3.14 Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers

The Facility-Wide Sewers RI/FS (USACE 2012) evaluated the nature and extent of process-related contaminants in sewer sediment, surface water, and outfalls, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 3. As part of this RI, field investigative activities included performing visual survey inspections of sanitary and storm sewer structures (i.e., manholes, drop inlets, catch basins, and outfalls); conducting video camera surveys of select sewer lines; and collecting sewer sediment, sewer water, pipe bedding, outfall sediment, and outfall water samples using discrete methods. The RI recommended no further action for Load Line 3.

Data collected from the Facility-Wide Sewers RI activities are not included in the FS Addendum dataset because they are currently being evaluated in an RI under a separate contract.

A.3.15 Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 Through 4

The *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* (USACE 2010a) was performed to sample and characterize deeper subsurface soils beneath the former building slabs via subsurface soil ISM techniques. Additional surface soil ISM samples in ore storage areas at Load Line 3 also were collected and analyzed to provide preliminary data for future RIs of these AOCs. The ore storage areas are currently being evaluated under the investigation associated with the DLA, and associated samples are not included in the FS Addendum dataset.

In 2009, USACE collected 19 total surface soil MI (or ISM) samples at Load Line 3 from 0.0–0.5 ft bgs: 6 were analyzed for metals; 17 for explosives; 4 for SVOCs, pesticides, and PCBs; and 2 for VOCs. Metals, explosives, propellants, SVOCs, and VOCs were not detected above the CUGs utilized in the 2011 Sampling Report (USACE 2001a) in any of the samples collected from the buildings at Load Line 3. PCB-1254 was detected above the CUGs identified in the 2011 Sampling Report in one sample.

A total of 66 subsurface soil ISM samples were collected at Load Line 3 to a maximum depth of 7 ft bgs. A total of 54 of the subsurface soil ISM samples were analyzed for metals, 21 for explosives and propellants, 37 for SVOCs, 12 for VOCs, and 9 for PCBs and pesticides. Explosives, propellants, pesticides, PCBs, and VOCs were not detected above the CUGs identified in the 2011 Sampling Report in any of the samples collected at Load Line 3 (USACE 2011a). Arsenic and SVOCs were detected above the CUG utilized in the 2011 Sampling Report at limited locations.

A.3.16 Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 Through 4 and 12

Additional characterization sampling was completed at Load Line 3 to guide future soil remedial and administrative measures. The samples collected as part of this investigation helped eliminate soil data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010b). Eight surface soil ISM samples and 13 subsurface soil horizontal ISM samples (2 from the 1–2 ft bgs interval, 4 from the 1–3 ft bgs interval, 4 from the 3–5 ft bgs interval, and 3 from the 5–7 ft bgs interval) were collected at Load Line 3 to further refine ISM sample areas that had concentrations of contaminants above the CUGs identified in the Characterization Sampling Report (USACE 2013).

This investigation concluded that 5 of the 11 previous areas exceeding the CUGs utilized in the Characterization Sampling Report were further bound and delineated. The remaining six areas were not fully delineated (USACE 2013).

A.4 LOAD LINE 4

CERCLA activities completed at Load Line 4 are presented in the following report summaries. These 17 reports present extensive evaluations and remedial activities performed to address contaminated media, including assessments at each of the former buildings.

A.4.1 Installation Assessment of Ravenna Army Ammunition Plant

In 1978, the *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. The installation assessment presented quantities of munitions produced, amounts of chemicals utilized, and waste produced at each load line. No sampling, investigation, or actions were performed at Load Line 4 as part of the assessment. The assessment concluded that no sampling was presently required for AOC exit pathways or surface water bodies and that additional action may be warranted.

A.4.2 Preliminary Assessment for the Characterization of Areas of Contamination

In 1996, the PA (USACE 1996) was developed following CERCLA requirements and provided information concerning conditions at CERCLA AOCs at RVAAP to assess potential contamination risks posed to human health and the environment. The PA provided a narrative of the facility history and process operations and described activities conducted at each AOC. According to the PA, waste constituents at Load Line 4 included, but are not limited to, TNT, RDX, Composition B, lead, chromium, mercury, and unknown constituents. Primary contaminant release mechanisms were process effluent discharges to surface water and process building wastewater washout to surface soils and sediments.

The report provided a PA scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model. Load Line 4 was ranked as a high-priority AOC

for future environmental investigations due to the primary contaminant release mechanism from process effluent discharges to surface water and surface soil.

A.4.3 Phase I Remedial Investigation

A Phase I RI (USACE 1998) was conducted at Load Line 4 from July through August 1996. During this investigation, sampling activities at Load Line 4 included collecting surface soil, sediment, and groundwater samples across the AOC. Samples were analyzed for explosives, metals, cyanide, VOCs, SVOCs, pesticides, and/or PCBs. Many of the occurrences and highest concentrations of chemicals detected were located and concentrated around the process buildings (G-12, G-12A, G-8, and G-13).

A total of 53 samples were collected from 50 surface soil locations across the AOC. Explosives were detected at nine locations, with the explosive TNT being detected at all locations with a maximum concentration of 2.2 mg/kg beside Building G-12A. TNT also was detected around Buildings G-8, G-12A, and G-13 and adjacent to the washout facility south of Building G-8. The highest concentrations of detected metals were observed around Buildings G-12 and G-12A. Metals were detected above background around Building G-8, its unnamed outbuilding, Building G-13, and Building G-17. SVOCs, pesticides, PCBs, and VOCs were detected in multiple samples analyzed at Load Line 4 primarily around process Buildings G-12, G-8, and G-17.

A total of 17 sediment samples were collected from 14 ditch, stream, or pond locations throughout the Load Line 4 AOC to characterize AOC drainage pathways. Explosives were detected in sediment samples, including in a ditch sample that contains influent that enters the load line from the east at 8.7 mg/kg for TNT. Explosives were not detected in the Load Line 4 settling pond sediment. Several metals were detected with their maximum concentration within the settling pond at Load Line 4. Ditch sediments also contained detected concentrations of metals but not in as high of concentrations compared to the pond. Low concentrations of three VOCs were measured in one sediment sample from the settling pond. SVOCs, pesticides, and PCBs were not detected in sediment.

The conclusions of the Phase I RI categorized Load Line 4 as a “high-priority” AOC due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC, and a Phase II RI was recommended (USACE 1998).

Data from the Phase I RI are excluded from the FS Addendum dataset, as these discrete samples were resampled as part of more recent investigations or removed as part of remedial actions.

A.4.4 Phase II Remedial Investigation

The Phase II RI (USACE 2004e) evaluated the nature and extent of process-related contaminants in surface and subsurface soil, sediment, surface water, groundwater, sewers, and selected buildings/structures. It also assessed the potential risk to human health and the environment resulting from former operations at Load Line 4.

As part of the Phase II RI, the AOC was evaluated by dividing it into spatial aggregates based on former process operations and drainage areas. Surface and subsurface soil were separated into six aggregates (Explosive Handling Areas, Preparation and Receiving Areas, Packaging and Shipping Areas, Change House, Perimeter Area, and Melt Pour Drainage Ditches). The four sediment and surface water aggregates evaluated as part of the Phase II RI are Main Stream Segment Upstream of Perimeter Road, Main Stream Segment and Settling Pong, Exit Drainage, and Miscellaneous Surface Water.

A total of 100 surface soil samples were collected across the 6 aggregates for the purpose of determining nature and extent of surface soil contamination at Load Line 4. The extent of explosives and propellant compounds in soil is relatively few, and extent is limited to the immediate proximity of source areas. The Explosive Handling Areas aggregate contained the highest concentrations and frequency of detected chemicals in surface soil within Load Line 4. Explosives, inorganic chemicals, and SVOCs were common in surface soil with the highest overall concentrations occurring near Buildings G-8 and G-12.

A total of 13 discrete subsurface soil samples were collected across the AOC to assess vertical migration. Contamination in subsurface soil was primarily limited to inorganic chemicals. Explosives and propellants were not detected in surface soil. Metals were detected in highest concentrations above background near Building G-1A in the Preparation and Receiving Area aggregate and near Building G-9 in the Explosives Handling Areas aggregate.

A total of 30 sediment samples and 18 surface water samples were collected from drainage channels and the settling pond at Load Line 4. Explosive and inorganic chemicals were the most frequent chemicals identified in sediment. Inorganic chemicals were frequently detected in surface water. Explosives, SVOCs, and PCBs were not detected in surface water.

Recommendations from the Phase II RI included completing an FS to evaluate possible remedial actions at Load Line 4 to reduce or eliminate potential risks to human and/or ecological receptors (USACE 2004e).

Data from the Phase II RI (USACE 2004e) were incorporated into the FS Addendum dataset. The report includes 108 samples characterized for soil, 10 sediment samples, and 10 surface water samples. Phase II samples collected from remediated areas; off-AOC areas; and from sewers or media, including floor sweep, buildings, and groundwater samples, were excluded from the FS Addendum dataset.

A.4.5 Remedial Goal Options for Soil at Load Lines 1 Through 4

The *Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4* Report (USACE 2004b) documented the proposed land use and corresponding risk-based RGOs that were used to support the remedial alternative selection process in the FFS (USACE 2005a). Environmental samples or remedial actions were not completed under this task; therefore, no data are available for the FS Addendum dataset.

A.4.6 Facility-Wide Biological and Water Quality Study

In 2003, an assessment of 11 ponds at RVAAP was completed (USACE 2005c). As part of the assessment, analytical samples were collected and macroinvertebrate and fish assessments were completed at each pond. The Load Line 4 settling pond, which receives drainage from the Load Line 4 AOC, was assessed during the study. Three MI (or ISM) sediment samples and six surface water samples were collected from Load Line 4 pond and exit drainages. The samples were analyzed for explosives, inorganic chemicals, SVOCs, PCBs, and pesticides. Explosives, PAHs, and metals were detected in sediment and/or surface water from the pond. Lead, zinc, and pH exhibited exceedances as part of this evaluation. As part of the biological assessment, the physical habitat conditions in Load Line 4 pond were rated as "fair" on the Lake/Lacustuary Qualitative Habitat Evaluation Index. The sufficient quality of the Load Line 4 pond does not adversely impact biological communities, and fauna did not differ from reference conditions.

The nine sediment and surface water samples collected from Load Line 4 settling pond and exit drainages as part of the 2003 investigation are included in the FS Addendum dataset.

A.4.7 Final November 2004 Sampling Completion Report

Sampling was completed in November and December 2004 for delineating the horizontal and vertical extents of contamination at the AOC (USACE 2005b). Five areas were sampled at Load Line 4 as part of the data gap analysis. Analytes of interest as part of the data gap sampling included manganese, aluminum, lead, RDX, and/or PCBs. All five areas fully delineated the extent of contamination below RGOs. Data from this report were incorporated into the FFS (USACE 2005a) and are presented as Appendix B of the FFS.

Data from the data gap analysis and additional sampling are not included in the FS Addendum dataset because these areas were remediated as part of the 2007 remedial action.

A.4.8 Focused Feasibility Study for Soils at Load Lines 1 Through 4

The FFS presented remedial alternatives for surface soil, subsurface soil, and dry sediment at Load Lines 1 through 4 (USACE 2005a). As part of the FFS, data acquired in the Phase I and II RIs were screened against RGOs presented and considered during the evaluation of remedial alternatives. Additional data from the *November 2004 Sampling Completion Report* (USACE 2005b) were incorporated into the FFS.

The recommended interim remedy based on a detailed analysis of the feasible remedial alternatives to address surface soil, subsurface soil, and dry sediment contamination at Load Line 4 was excavation with off-site disposal. This alternative was recommended due to expediency, permanency, consistency with future land use, moderate relative cost, feasibility, and implementability. Environmental sampling and remedial actions were not implemented as part of the FFS. Data were not generated in the FFS; therefore, no data are included FS Addendum dataset.

A.4.9 Interim Record of Decision for Soil at Load Lines 1 Through 4

In 2007, USACE developed the *Interim Record of Decision for the Remediation of Soils at Load Lines 1 Through 4* (USACE 2007) to address chemical exposure in soil and dry sediment. The selected remedy was chosen in accordance with CERCLA requirements. The selected remedy for surface soil, subsurface soil, and dry sediment was excavation and off-site disposal for Load Lines 1 through 4 where concentrations of chemicals exceeded RGOs. The selected remedy was recommended as part of the FFS (USACE 2005a), documented in the PP, received public acceptance during the public comment period, and received state acceptance from Ohio EPA. The IROD was jointly signed by the U.S. Army Division of BRAC and Ohio EPA in the summer of 2007.

A.4.10 Remedial Action Completion Report for Soils and Dry Sediments

Remedial action excavation activities occurred at Load Lines 1 through 4 from August to November 2007 (USACE 2008a). A total of 1,208 tons of non-hazardous soils were removed from Load Line 4. The maximum depth of the excavations was to 3 ft bgs; however, most excavations were typically to 2 ft bgs. Nine discrete areas were excavated within Load Line 4. After completing the excavations, 11 MI (or ISM) confirmation samples were collected and analyzed for Load Line 4 COCs: PCB-1254, aluminum, lead, and manganese. Laboratory results for the MI samples collected at Load Line 4 indicate that the COCs were removed to below CUGs at all Load Line 4 final excavation areas.

As part of the planned remedial action, concrete slabs were to remain in place and periodic monitoring of the concrete slab integrity was to be completed. A post-ROD change to the concrete slab maintenance task for Load Lines 1 through 4 was initiated by USACE and the U.S. Army Division of BRAC in late 2007. BRAC commenced slab and foundation removal in March 2008 at Load Lines 1 through 4, eliminating the need for routine maintenance as directed in the selected remedy.

Ohio EPA indicated that "the physical remedial action of soil and dry sediment removal has been completed in accordance with the intents and provisions of the Interim ROD for Load Lines 1 through 4" (Ohio EPA 2008).

A total of 10 MI (or ISM) confirmation samples collected post-remedial activities are included as part of the FS Addendum dataset.

A.4.11 Sampling and Screening Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

Floor slab removal was completed between March and June 2008 (USACE 2009a). As part of the scope of this investigation, the following sampling activities were completed at Load Lines 2 through 4: stockpile sampling, post-slab removal field screening, and final confirmatory sampling. The objective of the sampling was to determine if any areas required excavation to remove contaminated soils beneath former building slabs. A total of 720 field screening samples were screened from Load Lines 2 through 4 in 2008. The focus for the majority of the sampling completed at Load Line 4

involved buildings with the highest probability of contamination, including G-8, G-9, and G-15. Core samples were collected to a maximum depth of 4 ft bgs at these building locations for explosives field screening. Additional screening samples were collected from low- to medium-priority buildings at Load Line 4. Analytical and field screening results indicated there were no detections of either TNT or RDX at any of the low- or medium-potential buildings or at high-potential Building G-15 at Load Line 4. Concentrations of the explosives TNT and RDX were detected in five samples collected at Buildings G-8 and G-9; however, field screening results indicated that concentrations were at low levels (less than 2.6 mg/kg); below CUGs utilized in this report. Conclusions of the report indicated excavation was not required at Load Line 4 for TNT or RDX beneath building slabs.

Field screening samples collected as part of this investigation were considered and reviewed as part of the data gap assessment completed in this report but are not included as part of the FS Addendum dataset.

A.4.12 Multi-Increment Sampling and Analysis of Soils Below Floor Slabs at RVAAP-09, -10, and -11

MI (or ISM) sampling was completed in 2008 within building footprints following the removal of building slabs and any contaminated soils identified as part of the Sampling and Screening Analysis Report (USACE 2009a). The purpose of MI confirmatory sampling was to determine if any additional excavation was required at building locations beyond those determined by field screening. A total of 102 primary MI samples were collected between the 3 load lines.

Each sample was analyzed for metals and explosives, with select locations also being analyzed for RVAAP full-suite parameters (VOCs, SVOCs, PCBs, pesticides, and propellants). Areas selected for full-suite analysis were based on actual operations at an individual building and whether operations would be indicative of contamination other than explosives and metals based on the historical process knowledge. MI samples were collected from 0–1 ft bgs across building footprints. Propellants, SVOCs (primarily PAHs), PCBs, pesticides, and metals were detected in MI samples collected at Load Line 4. VOCs and explosives were not detected in MI samples collected at Load Line 4 (USACE 2009b).

Benzo(a)pyrene and arsenic exceeded the CUGs utilized in the MI Sampling and Analysis Report (USACE 2009b) in MI samples collected from Load Line 4. No building footprints at Load Line 4 were identified for remediation in the conclusions of this report.

The 32 building footprint samples collected as part of this investigation are included in the FS Addendum dataset. Field screening samples collected as part of this investigation were considered and reviewed as part of the data gap analysis completed in this report but are not included as part of the FS Addendum dataset. Samples collected from remediated areas were excluded from the FS Addendum dataset.

A.4.13 Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations

As part of this investigation, field screening and surface soil ISM sampling were completed at Buildings G-1, G-1A, and G-3 at Load Line 4. The three field screening samples collected at Load Line 4 were negative for explosives. The five ISM samples were collected for inorganic chemicals and explosives. Explosives were not detected in any of the ISM samples collected at Load Line 4 as part of this investigation (USACE 2010a). The analytical data were compared to CUGs identified in the IROD (USACE 2007), and no additional areas for remediation were identified based on ISM sampling.

Field screening data from the sampling and analysis investigation were considered and reviewed as part of the data gap analysis completed as part of this report but are not included in the FS Addendum dataset. Five ISM surface soil samples collected from this investigation are included in the FS Addendum dataset.

A.4.14 Remediation Completion Report Sub-Slab Soils at Load Lines 2 Through 4

Based on the characterization and results provided as part of the Sampling and Screening Analysis Report (USACE 2009a) and MI Sampling and Analysis Report (USACE 2009b), areas at Load Lines 2 and 3 were identified for remediation. As part of the remedial action, five soil stockpiles were removed from Load Line 4 for off-site disposal. The stockpiles included three piles of soil, one pile of concrete at Building G-1, and one pile of soil located at Building G-3.

One MI (or ISM) sample was collected at each of the five piles at Buildings G-1 and G-3. These samples were analyzed by the disposal facility for waste characterization. A total of 501 tons of materials were removed from the Load Line 4 stockpiles.

After completing the excavations and collecting field screening samples, confirmation MI samples and Global Positioning System coordinates of the excavations were collected. A minimum of one MI sample was collected from the floor of the excavation and a minimum of one MI sample was collected from the side walls. Samples were analyzed for explosives, metals, SVOCs, and PCBs. Buildings EB-4A and EB-4 required multiple MI samples due to the size of the excavations. Building EB-4 was excavated in two sections (a north and south section), and Building EB-4A was excavated in three sections (a north, south, and auxiliary section). The results of the MI samples collected indicated the excavated areas were successfully remediated to CUGs identified in the IROD (USACE 2007) and no further remedial actions were needed for sub-slab soils (USACE 2010c).

The characterization samples collected as part of the stockpile disposal characterization are not included in the FS Addendum dataset.

A.4.15 Remedial Investigation/Feasibility Study Report for RVAAP-67 Facility-Wide Sewers

The Facility-Wide Sewers RI/FS (USACE 2012) evaluated the nature and extent of process-related contaminants in sewer sediment, surface water, and outfalls and assessed the potential risk to human health and the environment resulting from former operations at Load Line 4. As part of the RI, field investigative activities included conducting visual survey inspections of sanitary and storm sewer structures (i.e., manholes, drop inlets, catch basins, and outfalls); conducting video camera surveys of select sewer lines; and collecting sewer sediment, sewer water, pipe bedding, outfall sediment, and outfall water samples using discrete methods. Based on the evaluation of nature and extent, fate and transport, and risk to human health and the environment, no further action was recommended for the Load Line 4 functional area.

Data collected from the Facility-Wide Sewers RI activities are not included in the FS Addendum dataset because they are currently being evaluated in a separate RI under a separate contract.

A.4.16 Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 Through 4

The *Sampling and Analysis of Soils Below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations* (USACE 2010a) was performed to sample and characterize deeper subsurface soils beneath the former building slabs via subsurface soil ISM techniques. Additional surface soil ISM samples in the former coal storage area at Load Line 4 were collected and analyzed to provide preliminary data for future RIs. Power House No. 7, Facility-Wide Coal Storage (CC-RVAAP-73), is located on the north end of former Building G-4 and is currently undergoing investigation; therefore, it is not included in the SAP Addendum.

In 2009, USACE collected 11 total surface soil MI (or ISM) samples at Load Line 4 from 0.0–0.5 ft bgs. Three samples were analyzed for metals, nine for explosives, three for SVOCs, two for pesticides and PCBs, and one for VOCs. None of the chemicals were detected above the CUGs utilized in the 2011 Sampling Report (USACE 2011a) in any of the samples collected from the buildings or coal storage areas at Load Line 4.

A total of 40 subsurface soil ISM samples were collected at Load Line 4 to a maximum depth of 7 ft bgs. The subsurface soil ISM samples were analyzed for metals, explosives, propellants, SVOCs, VOCs, PCBs, and/or pesticides. Metals, explosives, propellants, pesticides, PCBs, and VOCs were not detected above the CUGs identified in the 2011 Sampling Report in any of the samples collected at Load Line 4. PAHs (benzo[a]pyrene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene) were detected above CUGs at Building G-8 (USACE 2011a).

All 11 surface soil samples collected in 2009 and the 40 subsurface samples collected in 2010 are included in the FS Addendum dataset.

A.4.17 Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology Load Lines 1 Through 4 and 12

Additional characterization sampling was completed at Load Line 4 to guide future remedial and administrative measures (USACE 2013). The samples collected as part of this investigation helped eliminate data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010b). Eight surface soil ISM samples and 16 subsurface soil horizontal ISM samples (1 from 1–2, 5 from 1–3, 5 from 3–5, and 5 from 5–7 ft bgs) were collected at Load Line 4 to further refine ISM sample areas that had concentrations of contaminants above CUGs utilized in the Characterization Sampling Report (USACE 2013).

Samples were collected at former Building G-8 and several RI discrete stations. PAHs were detected in surface and subsurface ISM samples in 3 of 10 locations at concentrations exceeding CUGs identified in the Characterization Sampling Report. Conclusions of this investigation indicated that 7 of the 10 previous areas exceeding the CUGs utilized in the Characterization Sampling Report were further bound and delineated. The remaining three areas were not fully delineated.

The 24 surface and subsurface soil ISM samples collected during this investigation are included in the FS Addendum dataset.

A.5 LOAD LINE 12

CERCLA activities completed at Load Line 12 are presented in the following report summaries. These 10 reports present extensive evaluations and remedial activities performed to address contaminated media, including assessments at each of the former buildings.

A.5.1 Installation Assessment of Ravenna Army Ammunition Plant

In 1978, the *Installation Assessment of Ravenna Army Ammunition Plant* (USATHAMA 1978) incorporated a review of historical operational information and available environmental data to assess the potential for contaminant releases from operational facilities. No sampling was performed at Load Line 12 as part of the assessment. The assessment identified the following operational activities and records applicable to Load Line 12 surface water and sediment:

- Load Line 12 was used for ammonium nitrate production and demilitarization activities. No collection tanks existed at the AOC; therefore, pinkwater and washout of residue, dusts, and spills at Load Line 12 were discharged into the surface drainage channels, which ultimately drained to Upper Cobbs Pond.
- In August 1949, the ammonium nitrate fertilizer operations at Load Line 12 were investigated to determine whether high nitrate concentrations observed in Warren, Ohio, were related to Load Line 12 waste disposal procedures. Warren, Ohio, used the Mahoning River as a water supply source. Improvements in the operations and housekeeping at RVAAP in 1949 reduced nitrate concentrations to an acceptable concentration (<10 parts per million) in on-site surface waters and downstream in Warren, Ohio.

- The TNT washout plant was moved from Load Line 1 to Load Line 12 in 1949. In 1950, the washout plant was converted to a melt out process plant to recover and upgrade the quality of TNT and Composition B. Cartridge base reclamation also occurred from 1950–1952, where chemicals were used in an annealing process. Annealing process chemicals were disposed of in on-site quarries.
- From 1965–1967, Hercules Alcor, Inc. leased Building FF-19 in Load Line 12 for the production of aluminum chloride. A substantial fish kill occurred on November 15, 1966, at Upper and Lower Cobbs Ponds as a result of improper handling of aluminum chloride during manufacturing operations at Load Line 12. The bulk of the aluminum chloride at Load Line 12 was removed and disposed of in Ramsdell Quarry. The U.S. Army terminated the lease on December 3, 1967, due to environmental concerns related to air emissions and wastewater discharges from Load Line 12 to Upper and Lower Cobbs Ponds.
- Surface waters exiting the facility were not required to be monitored for nitrobodies and heavy metals.
- The assessment indicated that 154,600 lb of TNT; 250,900 lb of Composition B; 4,309,200 cubic meters of fumes; and 324,000 L of red water were generated each month during Load Line 12 operational periods.

A.5.2 Preliminary Assessment for the Characterization of Areas of Contamination

In 1996, the PA (USACE 1996) was developed following CERCLA requirements and provided information concerning conditions at CERCLA AOCs at RVAAP to assess potential contamination risks posed to human health and the environment. The PA provided a narrative of the facility history and process operations and described activities conducted at each of the AOCs. No sampling was completed as part of the PA.

According to the PA, waste constituents at Load Line 12 included, but are not limited to, TNT, HMX, Composition B, ammonium nitrate, lead, chromium, mercury, and other explosives. Primary contaminant release mechanisms were process effluent discharges to surface water via ditches and a holding pond and process building wastewater washout to surface soils and sediments. Sampling completed prior to the PA and included in the PA for Load Line 12 indicated dark, red-stained (explosive-contaminated) soil devoid of vegetative growth next to process buildings.

The report provided a PA scoring, subsequent prioritization of AOCs through evaluation of exposure pathways, and a relative risk site evaluation model. Load Line 12 was ranked as a high-priority AOC for future environmental investigations due to the primary contaminant release mechanism from process effluent discharges to surface water, sediment, and surface soil.

A.5.3 Phase I Remedial Investigation

A Phase I RI (USACE 1998) was conducted at Load Line 12 from July through August 1996. During this investigation, sampling activity at Load Line 12 included surface soil, sediment, and groundwater sampling across the AOC, including the dilution/settling pond and the wastewater treatment plant. Sampling was biased toward buildings used for demilitarization operations (900 and 904), the Nitrate

Settling Basin and Filter Bed, and the Pink Wastewater Treatment Plant. Samples were analyzed for explosives, metals, cyanide, VOCs, SVOCs, pesticides, and/or PCBs. Many of the occurrences and highest concentrations of chemicals detected were located and concentrated around the process buildings on the north side of the AOC. Chemicals were most widely detected at process areas, including Buildings 900, 904, and FF-19; the Pink Wastewater Treatment Plant; and the Nitrate Settling Basin and Filter Bed.

A total of 38 surface soil samples were collected across the AOC. The explosives trinitrobenzene, TNT, dinitrotoluene (DNT), HMX, and RDX were detected within the AOC, primarily at Buildings 900 and 904 and the Nitrate Settling Basin and Filter Bed. Metals and cyanide were detected above site background at the majority of the locations sampled. The highest concentrations of metals were present around Buildings 900, 904, and FF-19; the Pink Wastewater Treatment Plant; and the Nitrate Settling Basin and Filter Bed. SVOCs, pesticides, PCBs, and VOCs also were detected in multiple samples analyzed at Load Line 12. PAHs occurred mainly in the vicinity of Building 904, while pesticides and PCBs were most numerous at Building 900 and FF-19. A total of 12 individual pesticides, 2 PCBs, 20 SVOCs (including 16 PAHs), and 2 VOCs were detected at Load Line 12.

Twenty ditch and pond sediment samples were collected throughout the Load Line 12 AOC to characterize AOC drainage pathways. Explosives were detected in five of the samples, most of which were downgradient from the Nitrate Settling Basin and Filter Bed. Concentrations of explosives in sediment were several orders of magnitude lower than concentrations observed in soil. Metals were widespread in sediments across the AOC; however, the highest concentrations of metals in sediment were observed in the vicinity of Building FF-19 located in the main drainage leading from the AOC to the north. Low concentrations of VOCs, SVOCs (primarily PAHs), pesticides, and PCBs were measured in sediment samples collected at Load Line 12.

The conclusions of the Phase I RI categorized Load Line 12 as a “high-priority” AOC due to elevated concentrations of explosives, inorganic chemicals, and organic chemicals throughout surface soil and sediment at the AOC, and a Phase II RI was recommended (USACE 1998).

Data from the Phase I RI are not included in the FS Addendum dataset as these discrete samples were resampled during more recent investigations or removed as part of remedial actions.

A.5.4 Phase II Remedial Investigation

The Phase II RI (USACE 2004f) evaluated the nature and extent of process-related contaminants in surface and subsurface soil, wet sediment, surface water, and groundwater, and assessed the potential risk to human health and the environment resulting from former operations at Load Line 12. The AOC was evaluated by dividing it into spatial aggregates based on former process operations and drainage areas. Surface and subsurface soil were separated into two aggregates (the Eastern Soil aggregate and the Western Soil aggregate), which are bisected by the main drainage ditch across the AOC. The sediment and surface water aggregates evaluated as part of the Phase II RI are North of Active Area, Active Area Channel, Main Ditch, and West Ditch.

A total of 137 surface soil samples and 90 subsurface soil samples were collected during the Phase II RI. Samples were primarily analyzed for metals and field explosives, with select samples being analyzed by the laboratory for SVOCs, explosives, propellants, pesticides, PCBs, VOCs, and nitrate. Explosives were widespread in surface soil within the Western Soil aggregate, primarily in the vicinity of Buildings FF-19, 900, 904, and 905, but were not detected in the Eastern Soil aggregate. Metals and SVOCs, primarily PAHs, were detected across both soil aggregates, with the highest concentrations being observed in the Western Soil aggregate. Within the Eastern Soil aggregate, PAHs were limited to east of Building 900. The highest concentration of PAHs within the Western Soil aggregate occurred at Building FF-19, but were detected most frequently at Buildings 901, 902, and 906.

Explosives and propellants were detected in subsurface soil in the vicinity of Buildings FF-19, 900, 904, and 905. TNT was the most common occurring explosive detected in subsurface soil, with the highest concentrations detected in the footprints of Buildings 904 and 905. PAHs occurred in the Building FF-19 and FE-17 building areas. Isolated occurrences were detected around other building areas.

A total of 29 sediment and 16 surface water samples were collected during the Phase II RI. Across the four aggregates, metals and PAHs were the most common chemicals detected. Ditches downstream from former Buildings FF-19 and 905, considered wet sediment, were mostly contaminated with metals. Upgradient wet sediment samples contained elevated concentrations of SVOCs. Surface water downstream from major source areas was mostly contaminated with metals and explosives.

Explosives in sediment were less than 1 mg/kg and were limited to the West Ditch at Building 905. Sediment in the Main Ditch and West Ditch contained concentrations of metals greater than background. PCBs and VOCs were detected in sediment at the AOC. Explosives, metals, VOCs, and PAHs were detected in sediment at downstream locations sampled as part of the Phase II RI. Explosives were detected in all surface water aggregates at low concentrations but were not detected at the farthest downstream location. Surface waters in the West Ditch aggregate contained the greatest frequency and concentration of metals greater than background. Nitrate was detected in the West Ditch near Building 900. SVOCs and VOCs were not widespread and were primarily limited to the West Ditch near Building 900 and the northern AOC boundary. Pesticides and PCBs were absent from surface water.

Recommendations of the Phase II RI included completing an FS to evaluate possible remedial actions at Load Line 12 to reduce or eliminate potential risks to human and/or ecological receptors. Additional sampling for subsurface soil, sediment, surface water, and groundwater was recommended as part of the Phase II RI (USACE 2004f).

The 217 samples classified as soil are included as part of the FS Addendum dataset. Sediment and surface water samples collected as part of the Phase II RI were excluded from the FS Addendum dataset as they were evaluated within the Phase III RI. Groundwater and sewer samples were not included as part of the FS Addendum dataset.

A.5.5 Final Feasibility Study for Load Line 12 (RVAAP-12)

The *Feasibility Study for Load Line 12 (RVAAP-12)* (herein referred to as the FS) (USACE 2006) presented the remedial alternatives for soil and dry sediment at Load Line 12. The recommended alternative, based on a detailed analysis of the feasible remedial alternatives to address surface soil, subsurface soil, and dry sediment contamination at Load Line 12, was excavation with off-site disposal for the National Guard Trainee FWCUG identified in the FS. Implementing this recommended alternative would involve removing dry sediment in the Main Ditch at Load Line 12 that exceeded preliminary FWCUGs for arsenic identified in the FS.

This alternative was recommended due to expediency, permanency, consistency with future land use, moderate relative cost, feasibility, and implementability (USACE 2006). Environmental sampling and remedial actions were not implemented as part of the FS. Surface water and wet sediment were not included as part of the FS and will be addressed under future CERCLA investigations.

Data were not generated as part of the FS; therefore, no data from the FS are included as part of the FS Addendum dataset.

A.5.6 Final Record of Decision for Soil and Dry Sediment for Load Line 12

In 2009, USACE developed the *Record of Decision for Soil and Dry Sediment at the RVAAP-12 Load Line 12* (USACE 2009c) to address chemical exposure (arsenic) in soil and dry sediment. The Main Ditch and Western Ditch aggregates are considered dry sediment and were addressed under the ROD. All other ditch aggregates are considered wet sediment and are not further assessed under the SAP Addendum.

The selected remedy for soil and dry sediment was chosen in accordance with CERCLA requirements. The selected remedy for soil and dry sediment was excavation with off-site disposal for the arsenic FWCUG for protection of the National Guard Trainee identified in the ROD. The selected remedy was recommended as part of the FS, documented in the PP, received public acceptance during the public comment period, and received state acceptance from Ohio EPA. The ROD was jointly signed by the U.S. Army Division of BRAC and Ohio EPA in 2009.

A.5.7 Final Remedial Design for Load Line 12 (RVAAP-12)

The *Remedial Design for RVAAP-12 Load Line 12* (herein referred to as the remedial design [RD]) (USACE 2009d) detailed implementing the selected remedial action alternative specified in the ROD. Dry sediment at the Load Line 12 Main Ditch was the only area to be remediated for soil and dry sediment. The RD outlined remedial action objectives, CUGs, and implementation of the excavation mobilization and removal activities, and detailed confirmation sampling, waste disposal, and site restoration activities to be completed to achieve the remedial action specified in the ROD.

As part of the RD, five ISM samples were collected from the Main Ditch to confirm concentrations of arsenic present for the excavation design. One ISM characterization sample collected as part of the

RD was below FWCUGs specified within the ROD and was not required to be removed as part of the remedial action. This one dry sediment sample is incorporated into the FS Addendum dataset. The other ISM samples collected within areas excavated during the removal action are excluded from the FS Addendum dataset.

A.5.8 Final Remedial Action Report for Load Line 12

The *Remedial Action Report for the RVAAP-12 Load Line 12* (USACE 2010d) summarized excavation and disposal activities conducted to complete the selected remedial action alternative specified in the ROD (USACE 2009c). Remedial action excavation activities occurred at Load Line 12 in June 2010. A total of 1,212 tons of non-hazardous material were excavated and transported off-site for disposal. After completing excavation activities, confirmation ISM samples were collected from the excavation footprint. Laboratory results for all confirmation samples indicated that CUGs specified in the ROD had been achieved and no additional removal was required (USACE 2010d).

Four confirmation samples collected as part of the remedial action from the Main Ditch have been incorporated into the FS Addendum dataset.

A.5.9 Draft Phase III Remedial Investigation Report for Wet Sediment and Surface Water at Load Line 12 (RVAAP-12)

The Phase III RI (USACE 2012) addressed wet sediment and surface water at Load Line 12. The aggregates assessed as part of the Phase III RI included the North of Active Area, Active Area Channel, and Former Settling Pond aggregates. The Western Soil, Eastern Soil, Main Ditch, and West Ditch aggregates were considered to have a status of decision complete and remedy in place and were not evaluated. Field sampling activities were completed from February through March 2010 at the AOC. A total of 18 samples were collected from surface water and sediment media as part of this evaluation.

The Phase III RI concluded that investigations completed to date for surface water and wet sediment at Load Line 12 have adequately characterized wet sediment and surface water (USACE 2012). The assessment recommended no further action for wet sediment and surface water at the AOC.

Samples collected as part of the Phase III RI are not incorporated into the FS Addendum dataset because these media are not addressed.

A.5.10 Characterization Sampling Report of Surface and Subsurface Incremental Sampling Methodology at Load Lines 1 Through 4 and 12 (RVAAP-8, -09, -10, -11, and -12)

Additional characterization sampling was completed at Load Line 12 to guide future remedial and administrative measures. The samples collected as part of this investigation helped eliminate data gaps recognized in the *Land Use Control Assessment Report* (USACE 2010b). Two ISM samples were collected in 2009 and eight samples were collected in 2011 from 0–1 ft bgs at Load Line 12 to further refine previous discrete sample areas that had levels of PAHs above FWCUGs utilized in the

Land Use Control Assessment Report (USACE 2010b). This investigation concluded that all eight areas exceeding FWCUGs were not fully delineated for PAHs and RVAAP full-suite chemicals (USACE 2013).

All 10 samples collected as part of this investigation have been incorporated into the FS Addendum dataset.

A.6 REFERENCES

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