# 1. INTRODUCTION

This report documents the results of the Phase II Remedial Investigation (RI) of Load Line (LL) 1 at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figures 1-1 and 1-2). The Phase II RI was conducted under the U.S. Department of Defense (DoD) Installation Restoration Program (IRP) by Science Applications International Corporation (SAIC) and their subcontractors, under contract number DACA62-00-D-0001, Delivery Order No. CY09, with the U.S. Army Corps of Engineers (USACE), Louisville District. The Phase II RI was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA following work plans reviewed and commented on by the Ohio Environmental Protection Agency (Ohio EPA).

Phase II RI field activities were conducted in September 1999 and September and October 2000 at LL 1. The field program, environmental setting, and nature and extent of contamination are discussed. Human health and ecological screening assessments were performed as part of the Phase II RI. Results of the data analysis and risk assessments are used to develop a conceptual model for LL 1 to support the investigation summary and conclusions that are the framework for future decisions regarding remedial actions at LL 1.

#### 1.1 PURPOSE AND SCOPE

Figure 1-3 presents the approach to implementing the CERCLA process under the guidance of the IRP. Priorities for environmental restoration at areas of concern (AOCs) at RVAAP are based on their relative potential threat to human health and the environment, derived from Relative Risk Site Evaluations (RRSEs). Thirty-eight AOCs were identified in *The Facility-wide Preliminary Assessment (PA) for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). Thirteen additional AOCs were identified in 1998 in records searches and site walkovers. These were ranked by the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) and entered into the OSC's database. AOCs ranked as high-priority sites (i.e., those with high RRSE scores) are targeted for Phase I RIs. Medium-and low-priority sites will be characterized in Phase I RIs following completion of the RIs for high-priority AOCs. Not all AOCs are CERCLA sites, but those that are will follow the CERCLA process in order of priority as funding becomes available.

The objective of a Phase II RI for any AOC at RVAAP is to determine the nature and horizontal and vertical extent of contaminants, and to obtain data that are sufficient to support quantitative human health and ecological risk assessments. The results of the risk assessments will be used to make recommendations for further action, if warranted. Depending upon the outcome of the risk assessments, an AOC will either require no further action or will be the subject of a Feasibility Study (FS) to evaluate potential remedies and future actions.

The specific objectives of the Phase II RI of LL 1 are as follows:

- Characterize the physical environment of LL 1 and its surroundings to define potential transport pathways and receptor populations.
- Characterize sources, types, chemical properties, and quantities of contaminants; identify potential contaminant release mechanisms, and contaminant fate and transport; obtain sufficient engineering data to develop a conceptual site model (CSM) suitable for use in a baseline risk assessment and to evaluate remedial action alternatives.



Figure 1-1. General Location and Orientation of RVAAP



Figure 1-2. RVAAP Installation Map



Figure 1-3. CERCLA Approach at RVAAP

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- Conduct baseline human health and ecological risk assessments using characterization data and the CSM to evaluate the potential threats and to develop preliminary remediation goals (PRGs) for use in determining areas that may require remediation and in evaluating remedial alternatives.
- Assess the suitability of field-portable X-ray fluorescence (XRF) spectrometry for performing in-situ and ex-situ analyses of metals in soil and sediment samples. Results of these tests will determine the suitability of metals field determinations for future environmental investigations and remedial activities at RVAAP.

To meet the primary project objectives, investigation-specific data quality objectives (DQOs) were developed using the approach presented in the Facility-Wide Sampling and Analysis Plan (SAP) (USACE 2000a). The DQOs specific to the LL 1 Phase II RI are discussed in Section 1.4.

The approach to the Phase II RI at LL 1 involved a combination of field and laboratory activities to characterize the AOC. Field investigation techniques included soil boring and sampling, as well as sampling of surface water, groundwater, and sediment. Colorimetric analyses of soils and sediments for 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) were conducted in the field to support the assessment of extent of explosives contamination. XRF spectrometry for metals in soils and sediment was performed in the field (in situ) and in laboratory specimens (ex situ). The field program was conducted in accordance with the Facility-Wide SAP for Ravenna Army Ammunition Plant (USACE 2000a) and the SAP Addendum Nos. 1 and 2 for the Phase II Remedial Investigation at Load Line 1 (USACE 1999a and 2000b).

## **1.2 GENERAL FACILITY DESCRIPTION**

## **1.2.1** Historical Mission and Current Status

RVAAP is a government-owned, contractor-operated (GOCO) facility. It is jointly operated by the U. S. Army Operations Support Command (OSC) and the National Guard Bureau. The OSC controls environmental AOCs and bulk explosives storage areas. The Ohio Army National Guard (OHARNG) controls non-AOC areas for training purposes.

RVAAP is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 km (3 miles) east-northeast of the city of Ravenna and approximately 1.6 km (1 mile) northwest of the town of Newton Falls. The installation consists of 8,668.3 hectares (21,419 acres) contained in a 17.7 km (11 mile) long, 5.6 km (3.5 mile)-wide tract bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garretsville and Berry roads on the west; and the CONRAIL Railroad on the north (see Figures 1-1 and 1-2). Additional communities surrounding the installation include: Windham on the north, Garretsville 9.6 km (6 miles) to the northwest, Charlestown to the southwest, and Wayland 4.8 km (3 miles) southeast.

Industrial operations at RVAAP primarily consisted of 12 munitions assembly facilities referred to as "load lines." Load Lines 1 through 4 were used to melt and load TNT and Composition B into large-caliber shells. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. LL 12 was used to produce ammonium nitrate for explosives and fertilizers prior to its use as a weapons demilitarization facility.

The operations of the primary load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically the floors and walls would be cleaned with water and

steam. The liquid, containing TNT and Composition B, was known as "pink water" for its characteristic color. A description of LL 1 operations is provided in Section 1.3.

RVAAP used several areas for burning, demolition, and testing of ordnance and explosives. These burning grounds and demolition areas consist of large parcels of open space or abandoned quarries. Potential contaminants at these AOCs include, but are not necessarily limited to, explosives, propellants, metals, waste oils, and sanitary waste.

RVAAP has been inactive since 1992. The only activities still being carried out from the wartime era are the storage of bulk explosives and the infrequent demolition of unexploded ordnance found at the installation. The Army is also overseeing the reclamation of railroad tracks, telephone lines, and steel for reuse or recycling. The Army has completed the demolition of buildings at LLs 1 and 12 and has begun the demolition of excess buildings at LL 2, which includes the removal of friable asbestos.

#### **1.2.2** Demography and Land Use

RVAAP consists of 8,998.3 hectares (21,419 acres) and is located in northeastern Ohio, approximately 37 km (23 miles) east-northeast of Akron and 48.3 km (30 miles) west-northwest of Youngstown. RVAAP occupies east-central Portage County and southwestern Trumbull County. The 2000 Census lists the total populations of Portage and Trumbull counties as 152,061 and 225,116, respectively. Population centers closest to RVAAP are Ravenna, with a population of 11,771, and Newton Falls, with a population of 5,002.

The RVAAP facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of RVAAP is located, consists of either woodland or farm acreage. The Michael J. Kirwan Reservoir (also known as West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of RVAAP south of State Route 5.

Until May 1999, about 1,010 hectares (2,497 acres) of land and some existing facilities at RVAAP were used by the National Guard Bureau for training purposes and were administered by the OHARNG. Training and related activities that took place included field operations and bivouac training, convoy training, equipment maintenance, and storage of heavy equipment. In a Memorandum of Agreement (MOA) dated December 1998, 6,544 hectares (16,164 acres) of land at RVAAP was transferred from the Army OSC to the National Guard Bureau, effective May 1999, for expanded training missions. On May 13, 2002, an additional 3,774 acres of land was transferred from RVAAP to the National Guard Bureau via an amendment to the MOA. Approximately, 1,481 acres of property remain under the control of OSC; this acreage includes AOCs and active mission areas. As AOCs are remediated, transfer of remaining acreage from OSC to the National Guard Bureau will be conducted. The OHARNG has prepared a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan, which will address future uses of the property. These uses include two live-fire rifle ranges, hand grenade practice and qualification ranges, a light demolition range, and two armored vehicle maneuver areas. Additional field support and cantonment facilities will be constructed to support future training. The Ohio Air National Guard and the U.S. Air Force Reserve plan to partner with the OHARNG in construction of a 1,219-m (4,000-ft) unpaved tactical runway. Additional information on land use is presented in Section 6.3.

#### **1.3 LOAD LINE 1 SITE DESCRIPTION**

A detailed history of process operations and waste processes for each AOC at RVAAP is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). The following is a summary of the history and related contaminants at LL 1.

#### **1.3.1** Operational History

LL 1 (RVAAP-08) is located in the southeastern portion of RVAAP (Figure 1-2). It began operation in 1941 and was used until 1971. A detailed site map of LL 1 is presented in Figure 1-4. During World War II (1941 through 1945) and the Korean War (1951 through 1957), LL 1 was used to melt and load TNT and Composition B explosives into large-caliber shells. Composition B is a mixture of TNT and RDX. Cadmium was applied to various components of the shells to deter rust. The operation on the load line produced explosive dust, spills, and vapors that collected on the floors and walls of several buildings. These residues were periodically washed from walls and floors with water and steam. During building wash down, pink water or loose explosive flakes, chips, or dust were occasionally swept out of doorways onto the ground. The majority of the wastewater, known as pink water, was collected in concrete sumps located throughout the load line area. The pink water was then pumped to a sawdust filtration unit for clarification and removal of nitro-compounds prior to discharge. Sawdust filtration units consisted of a set of three parallel  $3 - \times 9.1 - \times 0.9$ -m ( $10 - \times 30 - \times 3$ -ft) concrete settling tanks and a set of three  $1.5 - \times 4.6 - \times 0.9$ -m ( $5 - \times 15 - \times 3$ -ft) filter blocks in the bottom of the filtration tanks. Sawdust from the filtration unit near Building CA-6A was disposed of at Winklepeck Burning Grounds (WBG).

Various industrial operations associated with the munitions loading process were also conducted during the operation of LL 1. These operations included painting, drilling and boostering; munitions truck and equipment maintenance; and paint, oil, solvent, and equipment storage. The load lines were rehabilitated in 1951 to remove and replace soils contaminated with accumulated explosives and to remove and replace waste water lines, particularly at Buildings CB-4 and CB-4A. However, many contaminated storm drain lines remained in each load line after 1951 (USATHAMA 1978).

During 1961–1967, LL 1 was the site of munitions rehabilitation activities. These activities primarily involved the dismantling, replacing of components, and repainting of mines. Much of this work was conducted in Buildings CB-13 and CB-14. Additionally, demilitarization of primers occurred in the southeastern area of Building CB-13, which may have contributed to propellant contamination.

LL 1 was the subject of a Phase I RI in 1996 (USACE 1998). The purpose of the investigation was to confirm whether contamination was present at the site and to determine the nature of the chemicals of potential concern (COPCs). The results of this investigation are summarized in Section 1.3.2.

Most LL 1 buildings were demolished and removed between 1999 and 2000. All buildings with residual explosive dust were washed down, and the freestanding equipment was removed from the buildings before the load line was declared inactive in 1971. Salvaging contractors removed telephone lines and major rail spurs across the site from 1996 to 1998. Similarly, the overhead steam lines have been removed for metal recycling following the removal of friable asbestos. Inside the buildings, removal of friable asbestos shielding began in 1997, as did removal of the steel piping, trim, overhead lighting [with polychlorinated biphenyl (PCB) ballasts], and some structural steel. All salvage/scrap operations have been overseen by the U. S. Army OSC. Transite (asbestos and concrete) siding and roofing, and any remaining recyclable steel, were removed as part of the demolition work. There was concern that



Figure 1-4. Topography and Cultural Features at Load Line 1

removing the transite panels would introduce new contamination to the soil around the buildings. To minimize the spread of potential contaminants, the following measures were taken during the demolition work:

- vacuuming and sweeping all dust and debris before transite removal/demolition, during removal activities as significant quantities of dust and debris accumulated, and at the completion of demolition activities;
- disposing of dust and debris according to all applicable state, federal, and local laws, rules, and regulations;
- removing loose paint on all surfaces; and
- removing structural steel members with high levels of paint-related contamination by mechanical cutting where feasible, with minimal use of cutting torches.

Salvage and demolition activities at LL 1 were complete as of June 2000. All buildings (except for CB-13 and CB-801) have been demolished, and the debris either has been removed from the site or, if inert, placed in "clean, hard fill" areas at the locations of the former change houses (CB-12, CB-8, CB-22, and CB-23). Metal piping that is suspected to be contaminated with PCB-laden paint is staged on the ground near CB-801 for removal. Floor slabs of the demolished buildings and all below-grade infrastructure remain in place. Several manholes or other storm/sanitary sewer access points were filled in or obstructed during the demolition process. Figure 1-5 depicts current site conditions.



Figure 1-5. Current Conditions at Load Line 1. View to East from Northwest Corner of Former Building CB-4

Based on the site operational history, waste constituents and potential contaminants at LL 1 include TNT, RDX, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), Composition B, propellants, lead, cadmium, chromium, mercury, and arsenic from the handling and processing of materials used to assemble ammunition. Contaminants associated with support activities include petroleum products, solvents, pesticides, PCBs, and metals. Primary sources of contamination at LL 1 are residues from the melting and loading of explosives such as TNT, RDX, dinitrotoluene (DNT), and associated metals (e.g., cadmium, chromium, lead, and mercury). In addition, the widespread use of aluminum-rich slag throughout RVAAP may account for some elevated concentrations of metals (especially aluminum, barium, beryllium, and manganese). Additional information regarding site-related contamination identified in environmental investigations is presented in Section 1.4.

## **1.3.2** Previous Investigations at Load Line 1

Four previous investigations have been conducted at LL 1. These are (1) the Water Quality Surveillance Program (USATHAMA 1980-92); (2) the residential well sampling effort conducted by Ohio EPA in 1997 (Ohio EPA 1998a and 1998b); (3) the Cold Regions Research and Engineering Laboratory (CRREL) study of explosives contamination in surface soils (USACE 1997b); and (4) the *Phase I RI of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant* (USACE 1998). Other studies were conducted, but are missing some or all of the documentation, and are not discussed in this section. Previous groundwater and surface water data relevant to LL 1 are summarized in Table 1-1.

#### Water Quality Surveillance Program

The Water Quality Surveillance Program included monitoring nine surface water locations throughout RVAAP between 1980 and 1992. In addition, groundwater samples were collected from former site production wells located in the Pottsville Formation. Of the surface water locations, the one of interest to this study is a Parshall flume located near the eastern boundary of the installation, adjacent to Route 534 (station PF534; see Figure 3-1). Surface water from LL 1, in part, discharged off the installation though this point. However, the station receives drainage from a large area in addition to LL 1. Copper, chromium, hexavalent chromium, lead, zinc, TNT, and RDX were monitored annually in surface water during the entire program. Cadmium was added to the annual list of metal analytes between 1988 and 1992. Due to the lack of available quality assurance/quality control documentation and use of older analytical methods, these data are of limited value for characterization purposes.

Indicator parameters, such as pH, temperature, specific conductance, dissolved oxygen, oil and grease, total suspended solids, fecal coliform, and biochemical oxygen demand, were monitored quarterly. Total organic carbon, total Kjehldal nitrogen, nitrate, and phosphorus were evaluated semiannually. Samples collected and analyzed from station PF534 between 1980 and 1992 had no detectable quantities of explosives, with the exception of a November 6, 1987, sample (RDX at 64  $\mu$ g/L) that was subsequently reanalyzed with a result of <0.25  $\mu$ g/L. Low concentrations of zinc and copper were occasionally detected. Hexavalent chromium was detected on one occasion in 1985. Groundwater samples collected from site production wells had no detectable quantities of chromium, arsenic, or cadmium. Low concentrations of TNT were detected in samples from site production wells in 1977. Detectable quantities of lead were also present in several wells during 1977 and 1980 sampling events (Table 1-1).

## Ohio U. S. Environmental Protection Agency Residential Well Sampling

Ohio EPA's 1997 residential groundwater survey included analysis for explosives, Target Analyte List (TAL) metals, and anions/water quality parameters (alkalinity, chloride, total dissolved solids, nitrate/nitrite, and sulfate). No explosives were detected in domestic water supplies. One arsenic result exceeded its maximum contaminant limit (MCL) of 50  $\mu$ g/L.

Sample ID <sup>a</sup>	Date	TNT	RDX	DNT	Pb	Cr	As	Cd
	1	RVAAP Wa	ter Qualit	y Surveill	ance Progr	am 🔤		
Water P	roduction	Wells (mee	asurement	s in mg/L,	; analytical	methods u	<u>nknown)<sup>b</sup></u>	-
Well 25	9/77	0.002	ND	ND	0.023	< 0.025	< 0.01	< 0.005
Well 27	9/77	0.001	ND	ND	0.006	< 0.025	< 0.01	< 0.005
	9/85	ND	ND	ND	< 0.05	< 0.02		< 0.01
	12/89	ND	ND	ND	< 0.02	< 0.03		< 0.01
	11/90	ND	ND	ND	< 0.02	< 0.03		< 0.01
	8/91	ND	ND	ND	< 0.015	< 0.03		< 0.01
Well 86	9/77	0.001	ND	ND	0.008	< 0.025	< 0.01	< 0.005
Well 88	9/77	0.001			0.008	< 0.025	< 0.01	< 0.005
	12/80	0	0		0.034	< 0.01		
	12/89	< 0.001	< 0.001	< 0.001	< 0.02	< 0.03		< 0.01
	11/90	< 0.001	< 0.001	< 0.001	< 0.02	< 0.03		< 0.01
	8/91	< 0.001	< 0.001	< 0.001	< 0.015	< 0.03		< 0.01
		Surface	Water (me	easuremen	nts in µg/L)			
Parshall flume	1980-	ND	ND	ND	ND	ND	ND	ND
$(PF534)^{a}$	1992	ND	ND	ND	ND	ND	ND	ND
CRREI	. Soil Sam	ple Analys	is (measur	rements in	n mg/kg; SV	V-846 meth	od 8330)	
LL1-1 (0-6")	7/97	0.6	0.1	0.5				
LL1-1 (6-12")	7/97	ND	ND	ND				
LL1-2 (0-6")	7/97	0.1	ND	ND				
LL1-2 (6-12")	7/97	0.2	ND	ND				
LL1-2 (12-18")	7/97	0.3	ND	ND				
LL1-3 (0-6")	7/97	0.5	ND	0.3				
LL1-3 (6-12")	7/97	ND	ND	ND				
Phase I RI G	roundwate	er (measur	ements in	μg/L; SW	-846 metho	ds 6010A/7	7000 and 8	330)
LL1mw-063	8/96	ND	ND	ND	ND	ND	ND	ND
LL1mw-064	8/96	ND	ND	ND	ND	ND	ND	ND
LL1mw-065	8/96	ND	ND	ND	ND	ND	ND	ND
LL1mw-067	8/96	ND	ND	ND	ND	ND	ND	ND
Phase I RI S	ediments	(measurem	ents in m	g/kg; SW-	846 method	ls 6010A/7	000 and 8.	<b>330</b> )
LL1sd-024	7/96	770	ND	ND	356	54.8	12.5	8.7
LL1sd-028	7/96	16	ND	ND	2,220	345	43.3	26.9
LL1sd-048	7/96	ND	ND	ND	30.7	12.1	10.7	1.5
LL1sd-049	7/96	0.43	16	ND	2,160	218	12.9	2.5
LL1sd-050	7/96	ND	ND	ND	75.5	19.4	20.3	1.5
LL1sd-051	7/96	ND	ND	ND	16.2	13.3	14.4	0.04
LL1sd-052	7/96	ND	ND	ND	18.1	13.4	15.5	0.4
LL1sd-056	7/96	ND	0.43	ND	13	11.4	18.8	0.45

**Table 1-1. Summary of Results from Previous Investigations** 

<sup>a</sup>Sample locations of data used in this Phase II report are shown on Plate 3-1 and/or Figure 3-1.

<sup>b</sup>Detection limits for the Water Quality Surveillance Program varied over time.

CRREL = Cold Regions Research and Engineering Laboratory.

DNT = dinitrotoluene.

ND = not detected.

RDX = hexahydro-1,2,5-trinitro-1,3,5-triazine.

RI = remedial investigation.

TNT = trinitrotoluene.

#### **CRREL** Surface Soil Sampling

The 1997 CRREL study evaluated explosives only in soils; TNT, DNT, and RDX were detected in site soil samples.

#### Phase I Remedial Investigation

The Phase I RI performed in 1996 included sampling and analysis of groundwater, surface soils, ditch sediment, and sediment from Criggy's and Charlie's ponds. The Phase I RI indicated that elevated concentrations of explosives, inorganics, and organics occur in soils in the central portion of the complex. Contaminants were prevalent around the doorways, drains, and vacuum pumps associated with the melt/pour buildings (Buildings CB-4 and CB-4A) and near the main concrete settling tank adjacent to monitoring well LL1mw-063. During Phase I RI field activities, residual propellant pellets were found on the ground beside Buildings CB-13, CB-13B, and CB-14.

Aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, magnesium, mercury, selenium, and zinc were all found in soils at concentrations above their respective background criteria. Maximum concentrations of inorganics in soils were higher at LL 1 than at any of the remaining high-priority AOCs investigated, but occurrences of high concentrations of metals did not coincide with high concentrations of explosives. Pond sediment samples did not contain explosives. Explosives were not detected in groundwater samples. Trace levels of heptachlor and two semivolatile organic compounds (SVOCs) (2,4-dimethylphenol and diethyl phthalate) were detected on one occasion. Inorganic constituents included cyanide, arsenic, barium, beryllium, cobalt, copper, manganese, mercury, nickel, and zinc, in addition to major geochemical elements (aluminum, calcium, iron, magnesium, potassium, and sodium).

Four sediment samples in drainage ditches contained detectable concentrations of explosives. The ponds were found to contain no explosives. Samples from a concrete settling tank near Building CB-13 contained the highest concentrations of explosives. Metals were concentrated near Building CB-3A and the ditch along Outlet D just upstream at former Track 23 (see Figure 1-6). PCBs were identified in the southern third of the load line and were associated with Building CB-3A and the drainage ditch along Outlet D.

Six monitoring wells were installed and sampled as part of the Phase I RI (LL2mw-059 and LL2mw-060, LL1mw-063, LL1mw-064, LL1mw-065, and LL1mw-067). Appendix D contains Phase I RI monitoring well boring logs and construction data. No explosives were detected during the Phase I sampling event. Eight Phase II RI monitoring wells were installed in 1999. The eight Phase II wells and the six Phase I wells were sampled in September of 1999 for explosives, propellants, TAL metals, and cyanide. Two samples were also analyzed for volatile organic compounds (VOCs), SVOCs, and PCB/pesticides. The explosives TNT and 1,3,5-trinitrobenzene (TNB) were detected in five of the wells during this sampling round (LL1mw-078, LL1mw-079, LL1mw-080, LL1mw-081, and LL1mw-083). The maximum concentration of any explosive in groundwater was  $15 \,\mu$ g/L for 2,4,6-TNT in LL1mw-084. This concentration exceeds the U. S. Environmental Protection Agency (EPA) Region 9 tap-water PRG of 2.2  $\mu$ g/L. Given that the Phase II wells were installed at the sites of Phase I maximum soil contamination with explosives, these results suggest a very low vertical mobility of explosives from soils to groundwater.

Inorganics, such as arsenic, cyanide, lead, barium, and selenium, were all detected in the Phase II monitoring wells, but none were present at concentrations above MCLs. Comparisons to the facility-wide background criteria were conducted as part of the Phase II investigation (see Chapter 4.0).

VOCs and SVOCs were analyzed in samples from LL1mw-079 and LL1mw-085. There were low levels (< 0.01 mg/L) of bis(2-ethylhexyl)phthalate, chloroform, and methylene chloride detected in LL1mw-079 and methylene chloride in LL1mw-085. PCBs and pesticides were not detected.



Figure 1-6. Existing Phase I RI Sampling Locations and Phase II RI Monitoring Wells at Load Line 1

#### **1.3.3** Chemicals of Potential Concern

Available process knowledge and previous investigation results suggest that the primary COPCs are those shown in Table 1-2. These COPCs represent constituents associated with the melting and loading of explosives and the maintenance of equipment in the load line. From the COPCs identified in this Phase II RI, a subset of COCs will be developed based on the human health and ecological risk assessments.

<b>Chemical Group</b>	Chemical	Rationale
Explosives	TNT	Primary munitions explosive
	DNT	Primary munitions explosive
	RDX	Primary munitions explosive
	HMX	Primary munitions explosive
	Trinitrobenzene	Associated with primary explosives
	Dinitrobenzene	Associated with primary explosives
	Nitrobenzene	Associated with primary explosives
	Nitrotoluene	Associated with primary explosives
Propellants	Nitroglycerine	Associated with primary explosives
	Nitroguanidine	Associated with primary explosives
	Nitrocellulose	Associated with primary explosives
Metals	Arsenic	Previously detected
	Aluminum	Munitions booster cups, slag
	Barium	Previously detected
	Cadmium	Previously detected
	Chromium	Common to munitions processing, previously detected
	Lead	Common to munitions processing, previously detected
	Manganese	Previously detected
	Mercury	Previously detected
	Selenium	Previously detected
	Silver	Common to munitions processing
	Zinc	Previously detected
		Other COPCs
VOCs	—	Associated with industrial processes
SVOCs	—	Associated with industrial processes
PCBs	_	Associated with industrial processes
Pesticides		Associated with industrial processes, previously
		detected

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COPC = chemical of potential concern.

DNT = dinitrotoluene.

HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine. PCB = polychlorinated biphenyl. RDX = hexahydro-1,2,5-trinitro-1,3,5-triazine. SVOC = semivolatile organic compound. TNT = trinitrotoluene. VOC = volatile organic compound.

## 1.4 LOAD LINE 1 PHASE II REMEDIAL INVESTIGATION DATA QUALITY OBJECTIVES

Process knowledge and archived records were used to develop the Phase II RI sampling design based on the data quality objective (DQO) approach presented in the Facility-Wide SAP (USACE 2000a). The DQOs for the Phase II RI at LL 1 are presented in the Phase II RI SAP Addendum No. 2 for Load Line 1 (USACE 2000b). A summary of DQOs is presented below for reference purposes.

• Source Area Soils. Potential source areas and accumulation points were the specific focus of the Phase II sampling effort. Biased sampling of surface and subsurface soils in the production area

(Buildings CB-4, CB-4A, CA-6, and CA-6A) and in Buildings CB-2, CB-3, CB-10, CB-13, CB-14, and CB-17 was planned to define extent in the areas where soil contamination had been identified in Phase I. In addition, soils were collected beneath the floor slabs at six buildings.

- **Perimeter Soils**. Thirty random-grid samples were collected to characterize areas not targeted for biased sampling both within and outside the operational area of the load line. The objective of this sampling was to employ statistical sampling methods to characterize non-production areas and to confirm the absence of contamination at levels presenting a risk to human or ecological receptors.
- Sediment. Eight surface water drainage features were identified as requiring additional sampling in order to fully characterize nature and extent of contamination. These included six stream sediment samples collected at locations outside and downstream of LL 1 to characterize the primary surface water exit pathway from the AOC. Sediment may function as a transport mechanism because contaminants adsorbed to particles can be mobilized by surface water flow.
- **Surface Water**. Surface water was not sampled in the Phase I RI. The primary exit pathway for surface water from LL 1 off of RVAAP is the unnamed tributary that passes beneath State Route 534 (PF534) to the east. The North Area Channel discharges to tributaries to Sand Creek. These locations and Outlets A, C, D, and E were targeted for sampling.
- **Groundwater**. Eight new groundwater wells were installed during the Phase II RI at locations identified during the Phase I RI as areas of known soil contamination. These areas are directly downgradient of former operational facilities, and the locations maximize the potential to identify contaminated groundwater resulting from leaching and infiltration from soil at known and suspected source areas (i.e., the melt-pour buildings, settling basins, and high-explosives prep areas). The six wells installed during the Phase I RI were also resampled, and all of the results were compared to the facility-wide background criteria for groundwater.
- Sewer Lines. The storm and sanitary sewer lines still in place beneath LL 1 were suspected to be pathways, as well as a significant source of explosives contamination with a potential to migrate to groundwater and surface water. These lines were also sampled during the Phase II RI. Manholes, outlets, and catch basins were inspected and sampled to determine volume estimates for the potential removal and disposal of contaminated pipes.
- **Railroad Track CB and Former Change House Soils**. Soils were collected from beneath the ballast remaining on Track CB and from the area surrounding Buildings CB-8, CB-12, CB-22, and CB-23 in order to determine the suitability of these sites for future use as disposal areas for clean, hard fill from demolition activities.

Facility-wide background criteria for inorganics in environmental media were not determined until after the Phase I RI was completed. Phase II RI groundwater data collected in 1999 were not previously compared to background values. Therefore, an objective of this report is to compile previous data and conduct screening against background values and other criteria defined in Section 4.1 and Chapters 6.0 and 7.0.

# **1.5 REPORT ORGANIZATION**

This Phase II RI Report is organized to meet Ohio EPA requirements in accordance with EPA CERCLA Superfund and USACE guidance. The report consists of an Executive Summary, Chapters 1.0 through 9.0, and supporting appendices. Chapter 1.0 describes the purpose and organization of this report

and provides a description and history of LL 1. Chapter 2.0 describes the environmental setting at RVAAP and LL 1, including the geology, hydrogeology, climate, population, and ecological resources. Chapter 3.0 describes the specific Phase II RI objectives and methodologies used for data collection and explains the approach to analytical data management and laboratory programs. Chapter 4.0 presents the data generated during the Phase II RI and discusses the nature and extent of contamination at LL 1. Chapter 5.0 discusses the likely environmental fate and transport of COPCs at LL 1. Chapters 6.0 and 7.0 include the methodology and results of the human health and ecological risk assessments, respectively. Chapter 8.0 summarizes the results and conclusions of this study, and Chapter 9.0 provides recommendations for future actions. Chapter 10.0 provides a list of referenced documents used to support this Phase II RI.

Appendices (A through S) contain supporting data collected in the Phase II RI. These appendices consist of sampling logs, analytical data tables, a data quality assessment (DQA), survey data, risk data tables, and other detailed information used to make the interpretations presented herein.