1. INTRODUCTION

This report documents the results of the Phase I Remedial Investigation (RI) for High Priority Areas of Concern (AOCs) at the Industrial Operations Command (IOC) Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. This RI was conducted for the RVAAP under the U.S. Department of Defense (DoD) Installation Restoration Program (IRP) by Science Applications International Corporation (SAIC) and their subcontractors under contract DACA62-94-D-0029, Delivery Order Nos. 0010 and 0022, with the U. S. Army Corps of Engineers (USACE), Nashville District. The Phase I RI was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 following work plans reviewed and commented on by the Ohio Environmental Protection Agency (OEPA).

A *Facility-Wide Preliminary Assessment (PA) for RVAAP* (USACE 1996a) was performed by the USACE in 1996 and identified 38 areas at RVAAP with known or suspected environmental concerns. Twenty-six of the 38 currently identified areas at RVAAP known or suspected to be environmental sites are currently regulated under CERCLA as AOCs. Two of these, Demolition Area #2 and Winklepeck Burning Grounds, also have permitted areas regulated under the Resource Conservation and Recovery Act (RCRA). The RVAAP is not currently on the National Priorities List (NPL) of high-priority CERCLA sites. The *Action Plan for RVAAP* (USACE 1996b) prioritized these AOCs for CERCLA actions based on a relative risk ranking methodology that considers potential threat to human health and the environment. The Load Line 12 Pink Wastewater Treatment Plant (RVAAP-18), although not in itself a high-priority AOC, is included in the scope of high-priority AOCs as it is contained completely within the boundaries of Load Line 12 (RVAAP-12). **Table 1.1** lists the relative priority ranking of high- and medium-priority AOCs at RVAAP. The *Action Plan* identified the following eleven AOCs as having the highest risk rankings and, therefore, the highest priority for IRP-funded CERCLA actions:

- Demolition Area #2 (RVAAP-04),
- Winklepeck Burning Grounds (RVAAP-05),
- Load Line 1 and Dilution/Settling Pond (RVAAP-08),
- Load Line 2 and Dilution/Settling Pond (RVAAP-09),
- Load Line 3 and Dilution/Settling Pond (RVAAP-10),
- Load Line 4 and Dilution/Settling Pond (RVAAP-11),
- Load Line 12 and Dilution/Settling Pond (RVAAP-12),
- Building 1200 and Dilution/Settling Pond (RVAAP-13),
- Load Line 12 Pink Wastewater Treatment Plant (RVAAP-18),
- Landfill North of Winklepeck Burning Grounds (RVAAP-19), and
- Upper and Lower Cobbs Ponds (RVAAP-29).

These eleven AOCs are the subject of this Phase I RI Report. Future actions under CERCLA for 15 lower priority AOCs are planned as funding becomes available under the IRP for RVAAP. Environmental restoration activities for non-CERCLA sites at RVAAP [4 RVAAP sites regulated under RCRA and 10 sites regulated under other regulations (e.g., OEPA Division of Solid and Infectious Waste)] are not subject of this report; however, some data collected for RCRA studies (e.g., in Demolition Area #2 and Winklepeck Burning Grounds) are used to support the Phase I RI.

Table 1.1. Relative Priority Ranking of AOCs at RVAAP

Area of Concern		
Number	Name	AHP Score[a]
High Priority Sites		
RVAAP-04	Demolition Area #2	23
RVAAP-05	Winklepeck Burning Grounds	27
RVAAP-08	Load Line 1 Dilution Settling Pond	27
RVAAP-09	Load Line 2 Dilution Settling Pond	27
RVAAP-10	Load Line 3 Dilution Settling Pond	27
RVAAP-11	Load Line 4 Dilution Settling Pond	27
RVAAP-12	Load Line 12 Dilution Settling Pond	27
RVAAP-13	Building 1200 Dilution Settling Pond	27
RVAAP-19	Landfill North of Winklepeck Burning Ground	27
RVAAP-29	Upper and Lower Cobbs Pond	27
Medium Priority Sites		
RVAAP-2	Erie Burning Grounds	3
RVAAP-3	Demolition Area #1	19
RVAAP-6	C Block Quarry	11
RVAAP-14	Load Line 6 Evaporation Unit	15
RVAAP-16	Quarry Landfill/Former Fuse and Booster Burning Pits	19
RVAAP-23	Unit Training Equipment Site Waste Oil Tank	7
RVAAP-24	Waste Oil Tank	7
RVAAP-26	Fuse and Booster Area Settling Tanks	7
RVAAP-28	Mustard Agent Burial Site	3
RVAAP-32	40 & 60 MM Firing Range	3
RVAAP-33	Firestone Test Facility	15
RVAAP-34	Sand Creek Disposal Road Landfill	7
RVAAP-35	Building 1037—Laundry Waste Water Tank	11
RVAAP-36	Pistol Range	7
RVAAP-37	Pesticide Building 5-4452	7
RVAAP-38	NACA Test Area	7

[a] Analytical Hierarchy Process Score, *Action Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996b).

Figure 1.1 presents the approach to implementing the CERCLA process at RVAAP under the guidance of the DoD IRP. Priorities for environmental restoration of CERCLA AOCs at RVAAP will be based on their relative potential threat to human health and the environment.

High-priority AOCs will be addressed first followed by medium- and low-priority AOCs as funding resources are available. The list of high- and medium-priority AOCs at RVAAP currently being addressed under CERCLA is presented in Table 1.1.

The IRP investigative approach at RVAAP is consistent with the CERCLA process as presented in the *RVAAP Facility-Wide Sampling and Analysis Plan (SAP)* (USACE 1996c). However, DoD terminology is used in reference to the CERCLA investigative steps for consistency with the IRP. Phase I RIs will be conducted at AOCs as the initial investigative phase following the PA. The primary objective of the Phase I RI is to collect environmental samples to confirm if contamination is present and is being released to the environment, and to determine the nature of potential chemicals of concern. The Phase I RI is consistent with the CERCLA requirements for a Site Investigation. Based on the results of the Phase I RI, AOCs will either be investigated further during a Phase II RI, or No Further Action (NFA) will be required and documented with a No Future Remedial Action Plan (NFRAP). The primary objective of the Phase II RI is to characterize the extent of contamination at an AOC and assess the risk posed to human health and the environment. The Phase II RI is consistent with the CERCLA requirements for an RI. Based on the results of the Phase II RI, AOCs will either be evaluated for remedial options during a Feasibility Study (FS), or NFA will be required and documented with an NFRAP. The Phase II RI and FS may be completed separately in an iterative manner, or, if AOC conditions warrant, they may be performed contemporaneously as a Phase II RI/FS. After an FS is completed for an AOC, a Proposed Remedial Plan will be developed followed by a Record of Decision prior to Remedial Design/Remedial Action and a post-remedial report documenting cleanup. At any point during this process if conditions (i.e., a release or threat of release or unacceptable risk to human health and the environment) are encountered that warrant an early remedial action, an Interim Removal Action or Removal Action may be necessary.

This document summarizes the results of the Phase I RI field activities conducted in July and August 1996 at each of the 11 high-priority AOCs. The field program, environmental setting, and nature of contamination at each of the AOCs are discussed. A preliminary risk evaluation, using published methods and action levels with background screening levels, was performed as part of the Phase I RI. Results of the data analysis and risk evaluation are used to develop a revised conceptual model for the facility and to re-prioritize the AOCs studied for future IRP actions.

1.1 PURPOSE AND SCOPE

The purpose of this RI Report is to describe the investigations conducted at the 11 high-priority AOCs at RVAAP and to document the current environmental conditions therein. The specific objectives of the Phase I RI are as follows:

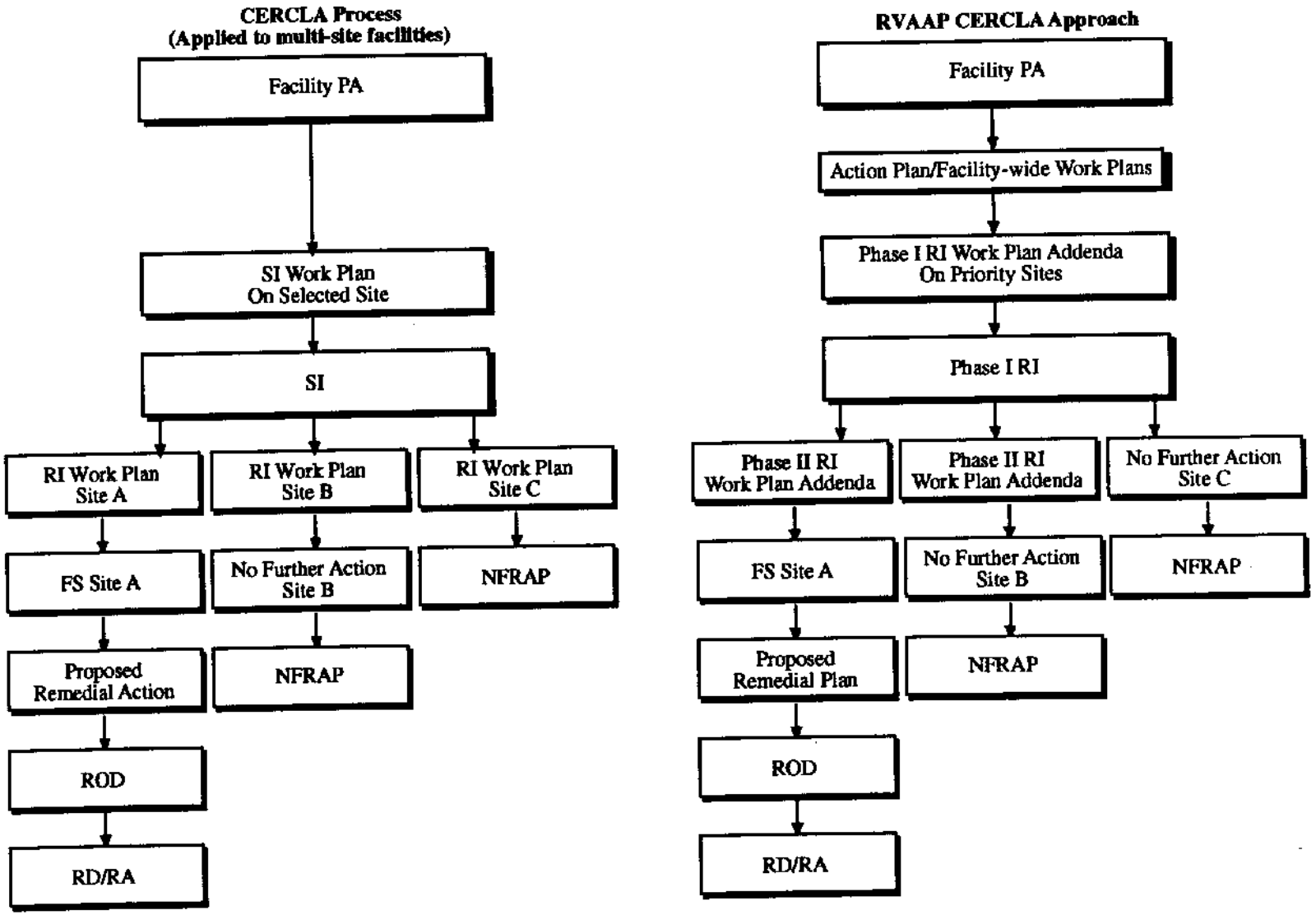


Figure 1.1. CERCLA Approach at RVAAP

- collect environmental samples from potentially impacted media to confirm if contamination is present and is being released to the environment; and

- determine the nature of the chemicals of potential concern (COPCs).

Process knowledge (munitions assembly and demilitarization), historical information, and the results of previous investigations were used to determine the Phase I RI Data Quality Objectives (DQOs) and to develop the Phase I RI investigative strategy for each AOC. The DQO process followed the *Data Quality Objectives Process for Superfund, Interim Final Guidance Document* (EPA 1993), and is explained in detail in the *RVAAP Phase I SAP Addendum for High Priority AOCs* (USACE 1996d). The investigative approach to the Phase I RI involved a combination of field and laboratory activities to characterize the 11 AOCs. The field investigation techniques included soil borings and soil sampling; geophysical surveys; landfill trenching sampling; installation of temporary well points and groundwater sampling; monitoring well installation and groundwater sampling; aquifer testing; and sediment sampling from ditches, streams, and ponds. The field program was conducted in accordance with the *RVAAP Facility-Wide SAP* (USACE 1996c) and the *RVAAP Phase I RI SAP Addendum for High Priority AOCs* (USACE 1996d).

Primary sources of potential contamination at RVAAP are wastewater effluent from munitions assembly and demilitarization, open burning and detonation of explosives, and landfill operations. Known releases of contaminants to surface water and soils have occurred from the load lines and from open burning and detonation. The COPCs at RVAAP are explosives [trinitrotoluene (TNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), Composition B (mixture of TNT, RDX, and HMX), and lead azide] and metals (e.g., chromium, lead, and mercury).

1.2 AOC DESCRIPTIONS, HISTORY, AND PREVIOUS INVESTIGATIONS

1.2.1 General Site Description

RVAAP is a government-owned, contractor-operated (GOCO) IOC facility. RVAAP is located in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 km (3 miles) east/northeast of the Town of Ravenna and approximately 1.6 km (1 mile) northwest of the Town of Newton Falls (**Figure 1.2**). The installation consists of 8668.3 ha (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; State Route 534 on the east; Garrettsville and Berry Roads on the west; and the CONRAIL Railroad on the north. The land use surrounding the installation is primarily farmland with sparse private residences. The installation is surrounded by several more populus communities: Windham, which borders the installation to the north; Garrettsville, located 9.6 km (6 miles) to the northwest; Newton Falls, 1.6 km (1 mile) to the east; Charleston, bordering the southwest; and Wayland, 4.8 km (3 miles) to the southeast.

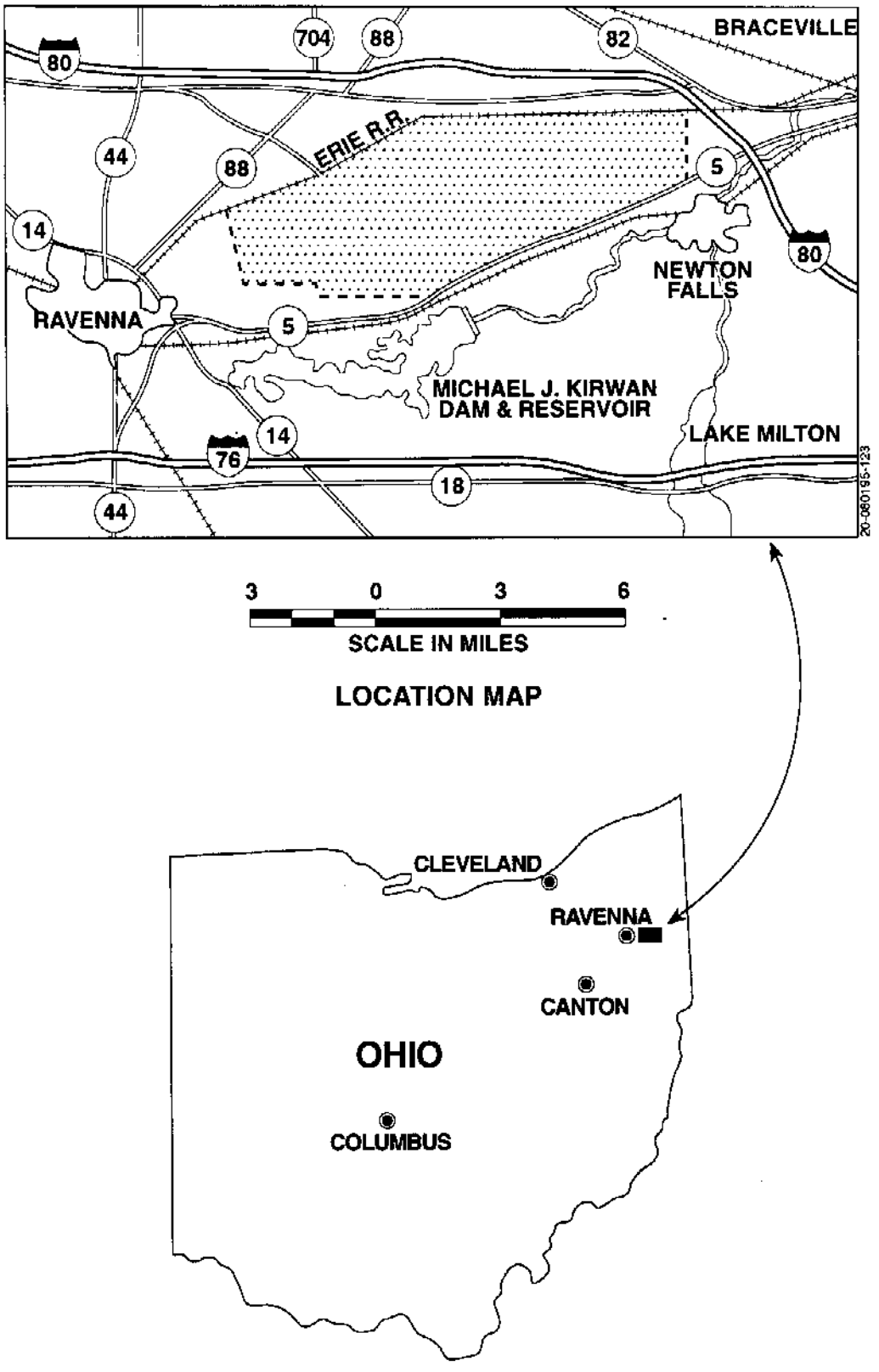


Figure 1.2. General Location and Orientation of RVAAP

The industrial operations at RVAAP 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 and tanks. The operations on these 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," and was collected in concrete holding tanks, filtered, and pumped to unlined ditches for transport to earthen settling ponds. Potential contaminants associated with the settling ponds include explosives, aluminum chloride, and metals. Load Lines 5 through 11 were used to manufacture fuses, primers, and boosters; potential contaminants in these load lines include lead azide, lead styphnate, black powder, TNT, and Composition B. Load Line 12 was also used to produce ammonium nitrate for explosives and fertilizers prior to use as a demilitarization facility.

RVAAP also had several areas used for the burning, demolition, and testing of munitions. These burning grounds and demolition areas consisted of large parcels of open space or abandoned quarries. Potential contaminants at these AOCs include explosives (RDX, HMX, Composition B, TNT, and black powder), white phosphorus, antimony sulfide, lead azide, propellant, waste oils, metals, (arsenic, chromium, mercury, and lead), explosives sludge from load lines, various laboratory chemicals, and sanitary waste. RVAAP has historically handled hazardous wastes and operated several waste management units in support of their operations. Potentially hazardous materials were stored, treated, deposited in landfills, or burned at the facility.

RVAAP has various industrial operations indirectly linked to munitions processes that have been identified as potential sources of contaminants. These operations include sewage treatment, waste water treatment, vehicle maintenance, storage tanks, waste storage areas, equipment storage areas, furnaces, and evaporation units. Contaminants associated with these operations include explosives, lead azide, lead styphnate, metals (arsenic, chromium, mercury, and lead), polychlorinated biphenyls (PCBs), waste oil, and petroleum.

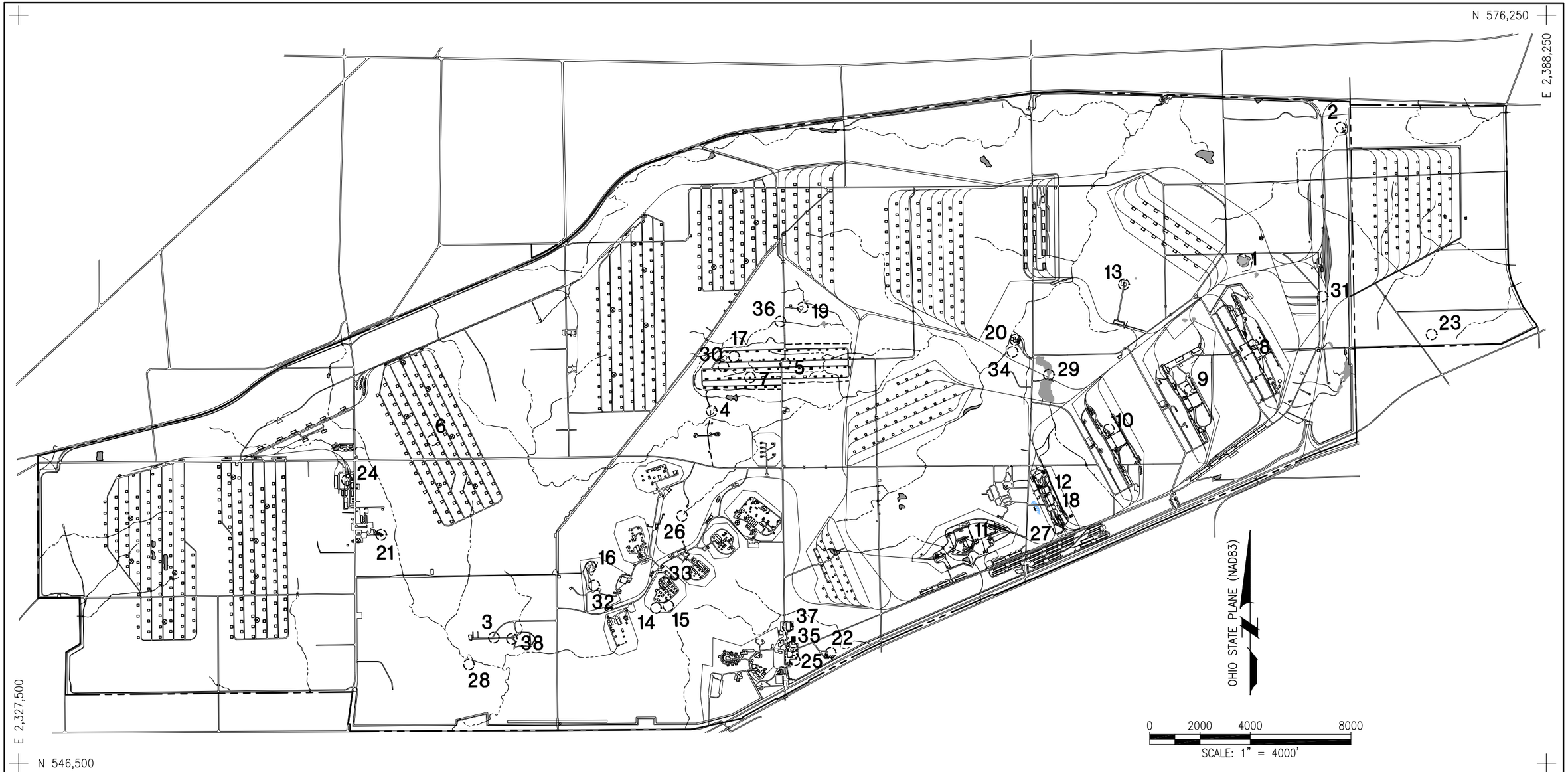
The *RVAAP PA* (USACE 1996a) contains a description of the facility history and process operations along with a description of activities conducted at each of the AOCs at RVAAP. **Figure 1.3** shows the locations of the 38 AOCs at RVAAP.

1.2.2 High Priority Areas of Concern

The following is a brief description of the history and operations of each of the 11 high-priority AOCs included in the Phase I RI.

Demolition Area #2 (RVAAP-04)

Demolition Area #2 is an elongate, horseshoe-shaped, cleared area approximately 8 ha (20 acres) in size. This area was used from 1948 to detonate large-caliber munitions and "off spec" bulk explosives that could not be deactivated or demilitarized by any other means (Halliburton NUS 1992). Within the boundaries of this AOC, there are five distinct areas.



LEGEND OF SITES:

1 . . . . . RAMSDELL QUARRY LANDFILL
2 . . . . . ERIE BURNING GROUNDS
3 . . . . . DEMOLITIONS AREA #1
4 . . . . . DEMOLITIONS AREA #2
5 . . . . . WINKLEPECK BURNING GROUNDS
6 . . . . . C BLOCK QUARRY
7 . . . . . BLDG 1601 HAZARDOUS WASTE STORAGE
8 . . . . . LOAD LINE 1 AND DILUTION/SETTLING POND
9 . . . . . LOAD LINE 2 AND DILUTION/SETTLING POND
10 . . . . . LOAD LINE 3 AND DILUTION/SETTLING POND
11 . . . . . LOAD LINE 4 AND DILUTION/SETTLING POND
12 . . . . . LOAD LINE 12 AND DILUTION/SETTLING POND
13 . . . . . BLDG 1200 AND DILUTION/SETTLING POND
14 . . . . . LOAD LINE 6, EVAPORATION UNIT
15 . . . . . LOAD LINE 6, TREATMENT PLANT
QUARRY LANDFILL/FORMER
16 . . . . . FUZE & BOOSTER BURNING PITS
17 . . . . . DEACTIVATION FURNACE
18 . . . . . LOAD LINE 12 PINK WASTE WATER TREATMENT
19 . LANDFILL NORTH OF WINKLEPECK BURNING GROUND
20 . . . . . SAND CREEK SEWAGE TREATMENT PLANT
21 . . . . . DEPOT SEWAGE TREATMENT PLANT
22 . . . . . GEORGE ROAD SEWAGE TREATMENT PLANT
23 . . . . . UNIT TRAINING SITE WASTE OIL TANK
24 RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25 . . . . . BLDG 1034 MOTOR POOL WASTE OIL TANK
26 . . . . . FUZE BOOSTER AREA SETTLING TANKS
27 . . . . . BLDG 854–PCB STORAGE
28 . . . . . MUSTARD AGENT BURIAL SITE
29 . . . . . UPPER AND LOWER COBBS POND COMPLEX
31 . . . . . ORE PILE RETENTION POND
32 . . . . . 40 AND 60 MM FIRING RANGE
33 . . . . . FIRESTONE TEST FACILITY
34 . . . . . SAND CREEK DISPOSAL ROAD LANDFILL
35 . . . 1037 BUILDING–LAUNDRY WASTEWATER SUMP
36 . . . . . PISTOL RANGE
37 . . . . . PESTICIDE BUILDING S–44S2
38 . . . . . NACA TEST AREA

US Army Corps of Engineers Nashville District

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
FACILITY MAP

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	REV. E/03–26–98	95021/DWGS/19111X17

Fig. 1-3. RVAAP Facility Map

- Open Detonation Area—an area in which detonation was accomplished in backhoe-dug pits with a minimum depth of 1.2 m (4 feet). After detonation, metal parts were typically removed from the site, and the pits were backfilled, mulched, and seeded.

- Open Burning Area [approximately 0.1 ha (0.25 acre) horseshoe-shaped bermed area]—from 1981 to 1986, the sludge from Load Line 6 Evaporation Unit was thermally destroyed in this area.

- Prototype Testing Range—an area where projectiles were fired into targets.

- Burial Site—an area where possible scrap bombs have been buried. This site is approximately 3 m (10 feet) wide, 61 m (200 feet) long, and 1.2 m (4 feet) deep. The area lies along a swale in the northwest corner of the Demolition Area.

- Past Disposal Area—an area that is posted, "Off Limits, Dangerous Material" and is located along a 21.3-m (70-feet) embankment overlooking Sand Creek.

Wastes known to be disposed of at this AOC include unexploded ordnance, shrapnel, white phosphorus, explosive residues, and heavy metals. Recent burning and detonation activities occurred until 1994 in a 0.6-ha (1.5-acre) area covered under a RCRA permit application. In 1983, an investigation revealed high concentrations of explosives and metals in surface soils collected from the horseshoe-shaped open burning area. In 1992, an investigation revealed low concentrations of explosives and metals in the surface soils in the RCRA area outside of the horseshoe-shaped open burning area (Jacobs Engineering 1989).

Winklepeck Burning Grounds (RVAAP-05)

The burning grounds have been in operation since 1941, and occupy approximately 80.9 ha (200 acres). Prior to 1980, ordnance waste burning was carried out in four pits, burning pads, and occasionally along roads. Seventy burning pads were identified from historical drawings and aerial photographs; the actual number of pads is unknown. The pads consisted of 6 × 12.2 m (20 × 40 feet) areas without berms. The pits consisted of areas bermed on three sides, approximately 15.2 × 22.9 m (50 × 75 feet) in size. Burns were conducted using scrap wood, straw, and No. 2 fuel oil. The fire would cause the explosives to melt and flow out of the projectiles and burn. Occasionally, projectiles would explode and be ejected from the burning pads into the surrounding area within the AOC. Many of the further flung projectiles are still in the field where they landed. In some instances, high energy material such as black powder and explosives were laid out in a string along a road and burned.

Prior to 1980, wastes burned at Winklepeck Burning Grounds included RDX, antimony sulfide, Composition B, lead oxide, TNT, propellant, black powder, explosives sludge from load lines, and domestic wastes. Small amounts of laboratory chemicals were also routinely disposed of by burning during production periods. Shrapnel and other metallic fragments were allowed to remain on the site after burning, as were possible residual explosives. Waste oil was disposed in the northeast corner of the burning grounds until 1973.

Since 1980, burns have been conducted at Burning Pad #37 using metal, refractory-lined trays set on top of a bed of slag. Ash residues are drummed and stored in Building 1601 until testing for waste characterization. In 1994, four RCRA groundwater monitoring wells were installed at the active portion of the site (Jacobs Engineering 1989). A closure plan is currently being prepared for the RCRA part of this AOC.

Load Line 1 and Dilution/Settling Pond (RVAAP-08)

Load Line 1 was in operation from 1941 to 1971. Pink water generated from the munitions assembly operations was collected in concrete sumps located throughout the load line. The wastewater was then pumped to a sawdust filtration unit for removal of explosive compounds prior to discharge. The sawdust filtration unit consisted of a set of three parallel 3 × 9.1 × 0.9 m (10 × 30 × 3 feet) concrete settling tanks and a set of three 1.5 × 4.6 × 0.9 m (5 × 15 × 3 feet) filter blocks in the bottom of the filtration tanks. Plant effluent was introduced into the top of one end of the filtration unit and discharged to an earthen settling pond (Griggy's Pond) via an unlined ditch. The discharge from the settling pond impoundment immediately exits the installation. Sawdust from the filtration unit was disposed by open burning at Winklepeck Burning Grounds (Halliburton NUS 1992).

In 1981, monitoring wells were installed around the perimeter of Load Line 1. The locations of these wells are unknown; frost heaving is reported to have destroyed these wells. Arsenic was detected in one well. Explosive compounds were detected in sediments from the ditch receiving the discharge from the sawdust filtration unit (Jacobs Engineering 1989).

Load Line 2 and Dilution/Settling Pond (RVAAP-09)

As with Load Line 1, Load Line 2 was also used to melt and load TNT and Composition B into large caliber shells and bombs. It operated from 1941 to 1971. Pink wastewater was similarly collected in concrete sumps connected to settling tanks. After settling, the water was pumped by low-pressure steam ejectors to two tanks, approximately 26,200 L (6,900 gallons) in volume for cooling. When the water cooled to 80°F, it was pumped through an overhead pipe to a sawdust filtration unit, configured identically to that in Load Line 1. The effluent from the sawdust filtration units was discharged to Kelly's Pond, a triangular, unlined earthen settling impoundment, approximately 0.8 ha (2 acres) in size and 1.8 to 2.4 m (6 to 8 feet) deep. The discharge from the impoundment was channeled to a surface stream that immediately exits the installation south of the load line and ultimately empties into the West Branch of the Mahoning River.

When the facility was at full capacity, Load Line 2 generated approximately 9,211 kg (20,310 pounds) of Composition B and 3,192,000 L (842,688 gallons) of pink water per month (Jacobs Engineering 1989). In addition, chromic acid waste was discharged from Building 802 into a ditch that ultimately discharges to Kelly's Ponds (APCO Ohio 1951).

Load Line 3 and Dilution/Settling Pond (RVAAP-10)

Load Line 3 operated from 1941 to 1971. Pink water generated from the assembly of munitions was also collected in concrete sumps located throughout the Load Line 3 area, and pumped into settling tanks via steam ejectors. Sawdust used in filtration tanks and the settled

sludge were periodically removed and destroyed at Winklepeck Burning Grounds. The effluent was discharged via an unlined drainage ditch that emptied into Upper Cobbs Pond and ultimately Lower Cobbs Pond for settling. Approximately 9,173 kg (20,226 pounds) of explosives scrap and sludge, and 304,800 L (80,467 gallons) of pink water were generated per month when the facility was at full capacity.

Load Line 4 and Dilution/Settling Pond (RVAAP-11)

Load Line 4 operated from 1941 to 1971. Pink water from munitions assembly operations was again collected in concrete sumps, pumped to a sawdust filtration system, and discharged to a surface ditch. Effluent from the filtration unit was conveyed to a 0.8 ha (2 acre) settling pond within the Load Line 4 area. This pond discharges to a surface stream that exits the RVAAP facility south of the Load Line 4. Sludge and spent sawdust from the filtration unit were periodically removed and destroyed at Winklepeck Burning Grounds. Approximately 11,930 kg (26,305 pounds) of explosives scrap and sludge; 14,900,000 m^3 (421,917 cubic feet) of explosives dust; and 3,390,000 L (894,960 gallons) of pink water were generated per month when the load line was at full capacity.

Load Line 12 (RVAAP-12) and Load Line 12 Pink Wastewater Treatment Plant (RVAAP-18)

From 1946 to 1950, Load Line 12 was used to produce 470,080 metric tons (518,264 tons) of fertilizer grade ammonium nitrate. After serving as a fertilizer production facility, Load Line 12 was primarily used for the demilitarization of munitions. Explosives were melted out of bomb casings in Building FJ-904 and shipped off site. Building FJ-904 was washed down weekly and the water flowed into two stainless-steel tanks, one tank was used for settling and one for filtration. Prior to 1981, the tank effluent was flowed through an unlined ditch from Building FJ-904 to the Load Line 12 Settling Pond, where ultimately the water drained into Upper and then Lower Cobbs Ponds. Approximately 324,000 L (85,536 gallons) of pink water were generated per month when the plant was fully operational in the 1950s.

Load Line 12 Pink Wastewater Treatment Plant was installed in 1981 to process pink water from demilitarization operations at Building FJ-904. The treatment plant consists of a dual-mode activated-carbon filtration system. Twin 907.2-kg (2000-pound) carbon units are enclosed in a 6 × 13.2 m (20 × 40 feet) metal-sided building on a concrete slab. The plant was built in 1981, within the confines of Load Line 12, and was operational for two years. The plant was designed to treat 76 liters (20 gallons) of wastewater per minute and averaged 19,000 L (5000 gallons) per day. The treatment plant currently has an active National Pollution Discharge and Elimination System (NPDES) permit for the disposal of stormwater from Load Line 12.

The demilitarization effluent contained TNT, HMX, RDX, Composition B, Ammatol (a mixture of ammonium nitrate and TNT), lead, chromium, and mercury.

Landfill North of Winklepeck Burning Grounds (RVAAP-19)

The Landfill North of Winklepeck Burning Grounds is an unlined 4-ha (10-acre) landfill site used for general refuse disposal from 1969 to 1976. An unknown quantity of material was

landfilled at the site, including munitions components (booster cups, aluminum liners), sanitary waste, and possibly explosive and munitions waste and ash from Winklepeck Burning Grounds.

Building 1200 and Dilution Settling Pond (RVAAP-13)

Building 1200, the Ammunition Sectioning Area, is a half concrete, half transite-sided building approximately 9.1 m × 6.1 m (30 × 20 feet) with a 3.7 m (12-foot) peak. Building 1200 was used from 1941 to 1971 for ammunition demilitarization. Munition rounds were checked for flaws, steam cleaned, and the wastewater drained, via a pipe, through a crushed slag gravel bed and into a ditch and finally into a 0.2 ha (0.5-acre) sedimentation pond.

Effluent from the facility contained explosive-contaminated wastewater. The water may have contained TNT, HMX, Composition B, or other explosives as well as metals such as lead, chromium, and mercury.

Upper and Lower Cobbs Ponds (RVAAP-29)

The Upper and Lower Cobbs Pond complex was active from 1941 to 1971 as sedimentation basins for explosive pink wastewater. The Upper and Lower Cobbs Ponds complex consisted of two unlined ponds that received the effluent from RVAAP-10 (Load Line 3) and RVAAP-12 (Load Line 12) sawdust filtration units and storm and surface water runoff. Overflow from Upper Cobbs Pond discharged to Lower Cobbs Pond and from there to a receiving stream prior to exiting the facility. Upper Cobbs Pond is approximately 2 ha (5 acres) in size and Lower Cobbs Pond is approximately 1.2 to 1.6 ha (3 to 4 acres) in size. Both ponds have been used for recreational purposes and support abundant fish and wildlife.

A ponded area known as the "backwater area," created by beavers [about 0.4 ha (1 acre) in size], presently exists south of Upper Cobbs Pond. This area did not exist during plant operations; it also contains abundant fish and wildlife.

In 1966, a large fish kill occurred at Cobbs Pond. The fish kill was attributed to the improper handling of aluminum chloride during the manufacturing operations at RVAAP-12 (Load Line 12). The bulk of the aluminum chloride was collected and disposed of at the RVAAP-01 (Ramsdell Quarry Landfill).

Contaminants of concern include TNT, HMX, Composition B, lead, chromium, mercury, and aluminum chloride. RDX was detected (1.16 μg/mL) in the sediment samples collected from Upper Cobbs Pond during the investigation conducted by The Mogul Corporation in 1982. TNT and RDX were not detected in the sediments from Lower Cobbs Pond.

1.2.3 Site History

RVAAP began operation on August 26, 1940 for the primary purpose of loading medium- and major-caliber artillery ammunition, bombs, mines, fuses and boosters, primers and percussion elements, and the storage of finished ammunition components. Originally, the installation was divided into two separate units: one was designated the Portage Ordnance Depot with the primary

mission of the depot's storage activity, and the other was designated as the Ravenna Ordnance Plant with the primary mission of ammunition-loading activities.

RVAAP handled and stored strategic and critical materials for various government agencies and received, stored, maintained, transported, and demilitarized military ammunition and explosive items. RVAAP maintained the capabilities to load, assemble, and pack military ammunition, but these operations have been inactive since 1992. As part of the RVAAP mission, inactive facilities were maintained in standby status by keeping equipment in a condition to allow speedy resumption of production.

The Atlas Powder Company was the original GOCO manager of the Ravenna Ordnance Depot, and operated the plant from 1940 to 1945. The government operated the Portage Ordnance Depot. Final production for World War II ended in August 1945. The government assumed operation of both areas from 1945 to 1951 when Ravenna Arsenal Inc. (RAI), a subsidiary of the Firestone Tire and Rubber Co., of Akron, Ohio, was contracted to operate the entire facility. In 1982, Physics International Co., a subsidiary of Rockcor Inc., purchased RAI from Firestone. Rockcor Inc. was purchased by Olin Corporation in June 1985 and operated RVAAP until 1993 when the U.S. Army contracted Mason and Hanger-Silas Co., Inc. as caretaker.

1.2.4 Previous Investigations at RVAAP

In 1978, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an Installation Assessment of RVAAP and concluded that no migration of contamination to groundwater had occurred at the installation (USATHAMA 1978). In 1982, a reassessment by USATHAMA (USATHAMA 1982) also concluded that no migration of contamination to groundwater had occurred.

An investigation was conducted in 1982 by Heidi W. Kammer in support of her thesis "A Hydrogeologic Study of the Ravenna Arsenal, Eastern Portage and Western Trumbull Counties, Ohio" (Kammer 1982).

The U.S. Army Environmental Hygiene Agency (USAEHA) conducted a groundwater contamination survey and evaluation of Solid Waste Management Units (SWMUs) in 1988. Twenty-nine potentially contaminated SWMUs were identified. Further investigation was recommended for 15 of the 29 SWMUs to determine if contaminants had migrated from these units.

In 1989, Jacobs Engineering performed a RCRA Facility Assessment (RFA) – Preliminary Review and Visual Site Inspection (USEPA 1989). The report identified 31 SWMUs, 13 of which were recommended for NFA. These 31 SWMUs are listed as sites in the Restoration Management Information System.

In 1992, USAEHA conducted a hydrogeologic study of the Open Burning/Open Detonation areas as part of a response to a Notice of Deficiency issued by OEPA regarding the installation's RCRA Part B permit application.

USAEHA also performed a Preliminary Assessment Screening (PAS) of the Boundary Load Line areas and provided a Statement of Findings to support a Record of Environmental Considerations along with recommendations for additional work at these sites (USAEHA 1994).

In 1996, the USACE performed a facility-wide preliminary assessment (USACE 1996a) covering all known environmental sites at RVAAP.

Results of previous environmental investigations at the 11 high-priority AOCs are summarized in Section 2 of this RI Report.

1.2.5 Chemicals of Potential Concern

Based on available process knowledge and the results of previous investigations, the anticipated primary COPCs at the RVAAP High Priority AOCs are summarized in **Table 1.2**. The mission at RVAAP focused on assembly and demilitarization of munitions and generally did include the manufacturing of explosives or munitions components. For a time, Load Line 12 activities included the production of the explosive compound ammonium nitrate. The anticipated COPCs at RVAAP are constituents associated with process wastes (e.g., pink water effluent, explosives sludge and dust, spent filtration saw dust, etc.), waste disposal practices (e.g., open burning, open detonation, and landfill of explosives and explosives waste), and industrial operations (e.g., mechanized processes, facility maintenance, etc.) associated with assembling and demilitarization of munitions. From the preliminary COPCs identified in the Phase I RI, a subset of chemicals of concern will be developed during subsequent phases of investigation based on screening against human health and ecological risk-based criteria.

1.2.6 Data Quality Objectives

Process knowledge and past waste practices at each AOC were used to develop the Phase I RI sampling design using the DQOs approach presented in the *Facility-wide SAP* (USACE 1996c). The DQOs for the Phase I RI are presented in the *Phase I RI SAP Addendum* (USACE 1996d). The problems to be addressed for each high-priority AOC identified in the DQO process are the basic drivers for the Phase I RI sampling design. The sampling design focused on achieving the Phase I RI objectives to confirm if contamination is present and determine the nature of COPCs. The problems to be addressed during the Phase I RI for each AOC are restated as follows:

Demolition Area #2 (RVAAP-04)

Soils are potentially contaminated from open detonation of munitions and bulk explosives in unlined earthen pits, and buried white phosphorous, bombs, and potentially hazardous materials. There is a potential for surface water runoff to adjacent Sand Creek. A 1983 USAEHA investigation of this RCRA area detected high concentrations of explosives and metals in surface soils in the horseshoe-bermed area. A 1992 USAEHA investigation detected low concentrations of explosives and metals in surface soils in the RCRA area outside the horseshoe-bermed area. The 1995 RCRA groundwater monitoring detected indicator parameters above statistical triggers in groundwater. In addition, 1,2-DCA was detected, and HMX and RDX were detected in one duplicate groundwater sample.

Table 1.2. Chemicals of Potential Concern at RVAAP High-Priority AOCs

Chemical Group	Chemical	Rationale
	Primary COPCs	
Explosives	DNT	Primary munitions explosive
	TNT	Primary munitions explosive
	RDX	Primary munitions explosive
	HMX	Primary munitions explosive
	Trinitrobenzene	Commonly associated with primary explosives
	Dinitrobenzene	Commonly associated with primary explosives
	Nitrobenzene	Commonly associated with primary explosives
	Nitrotoluene	Commonly associated with primary explosives
Metals	Arsenic	Previously detected
	Aluminum	Munitions booster cups and aluminum chloride
	Barium	Previously detected
	Cadmium	Previously detected
	Chromium	Process related and previously detected
	Lead	Process related and previously detected
	Manganese	Ore stockpiles at RVAAP
	Mercury	Previously detected
	Selenium	Previously detected
	Silver	Common munitions process-related
	Zinc	Common munitions process-related
	Other COPCs	
VOCs	—	Commonly associated with industrial processes
SVOCs (including PAHs)	—	Industrial waste oils, open burning waste disposal
TAL Metals	—	Commonly associated with industrial processes
PCB	—	Commonly associated with industrial processes
Pesticides	—	Commonly associated with industrial processes

Winklepeck Burning Grounds (RVAAP-05)

Open burning of explosive wastes and munitions on earthen "burning pads" has potentially contaminated surface soils. There is potential for surface water runoff to drainage ditches and migration to groundwater. A 1983 USAEHA investigation of 11 active burning pads found significant concentrations of explosives and metals in surface soils and in one drainage ditch. The 1995 RCRA groundwater monitoring detected indicator parameters above statistical triggers. In addition, 1,2-DCA was detected.

Load Line 1 and Dilution/Settling Pond (RVAAP-08)

There is potential for surface soil contamination adjacent to process buildings from washout of explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. There is potential for sediment, surface water, and shallow groundwater contamination from earthen settling ponds receiving process effluent. Previous sediment samples detected low concentrations of explosives. The settling pond is located in close proximity to the facility boundary. Previous groundwater monitoring detected low concentrations of arsenic.

Load Line 2 and Dilution/Settling Pond (RVAAP-09)

There is potential for surface soil contamination adjacent to process buildings from washout of explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. There is potential for sediment, surface water, and shallow groundwater contamination from earthen settling pond receiving process effluent. Previous sediment samples detected low concentrations of explosives. The settling pond is located in close proximity to the facility boundary.

Load Line 3 and Dilution/Settling Pond (RVAAP-10)

There is potential for surface soil contamination adjacent to process buildings from washout of explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. There is potential for sediment, surface water, and shallow groundwater contamination from earthen settling pond receiving process effluent. Sediment samples detected low concentrations of explosives in settling ponds (Cobbs Ponds).

Load Line 4 and Dilution/Settling Pond (RVAAP-11)

There is potential for surface soil contamination adjacent to process buildings from washout of explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. There is potential for sediment, surface water, and shallow groundwater contamination from earthen settling pond receiving

process effluent. Previous sediment samples detected low concentrations explosives. The settling pond is located in close proximity to the facility boundary.

Load Line 12 and Dilution/Settling Pond (RVAAP-12)

There is potential for surface soil contamination adjacent to process buildings from washout of explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. There is potential for sediment, surface water, and shallow groundwater contamination from earthen settling pond receiving process effluent. Red surface soil stains indicate explosives adjacent to Building FJ-905. Sediment samples detected low concentrations of explosives in settling ponds (Cobbs Ponds).

Building 1200 and Dilution Settling Pond (RVAAP-13)

There is potential for surface soil, sediment, surface water, and groundwater contamination from process effluent (pink water) containing explosive and metal constituents from ammunition sectionalizing operations released to earthen ditch and settling pond.

Load Line 12 Pink Wastewater Treatment Plant (RVAAP-18)

There is potential for surface soil, sediment, surface water, and groundwater contamination from the processing of effluent (pink water) containing explosive and metal constituents. Red surface soil stains have been observed adjacent to Load Line 12 Building FJ-905.

Landfill North of Winklepeck Burning Grounds (RVAAP-19)

There is potential for soil and groundwater contamination from leaching of wastes buried in unlined trenches. Explosive waste residue from Winklepeck Burning Grounds are reported to be buried here. There is potential impact to adjacent surface water via groundwater migration and surface runoff. Location of burial trenches and waste inventory are undocumented.

Upper and Lower Cobbs Ponds (RVAAP-29)

There is potential for sediment, surface water, and groundwater contamination from process effluent containing explosive and metal constituents from Load Lines 3 and 12. Low concentration of explosives were detected in sediment and a fish kill was reported in 1966.

The rationale and sampling design for each high-priority AOC is presented in Section 2 of the Phase I RI Report.

1.3 REPORT ORGANIZATION

This Phase I RI Report is organized to meet OEPA requirements in accordance with U.S. Environmental Protection Agency (EPA) and USACE guidance. The report consists of an Executive Summary, Sections 1 through 7, and supporting appendices. Section 1 describes the

purpose and organization of this RI Report, and provides descriptions and a history of the 11 high-priority AOCs investigated. The objective of this section is to provide a historical perspective to be used in evaluating the RI results relative to potential human health and environmental impacts associated with the 11 high-priority AOCs. Section 2 presents the specific Phase I RI objectives and methodologies used for data collection and describes the approach relative to analytical data management and the laboratory program. Section 3 describes the physical characteristics of the study area, including the geology, hydrology, climate, and ecological resources. Section 4 presents the results of the data generated during the RI and discusses the nature of contamination relative to each of the AOCs evaluated. Section 5 presents a risk evaluation of each AOC using the RI results in comparison to published risk-based action levels. Section 6 summarizes the Phase I RI results and conclusions, and Section 7 provides a list of referenced materials used to support the Phase I RI Report.

Appendices to the Phase I RI Report contain supporting data collected during the RI. The appendices contain boring logs, well construction diagrams, analytical data tables, a data quality assessment, geophysical data, a project quality assurance report, and other documents necessary to support interpretations made in the Phase I RI Report.