Final Investigation of the **Under Slab Surface Soils Post Slab and Foundation Removal** at **RVAAP-39 Load Line 5, RVAAP-40 Load Line 7, RVAAP-41 Load Line -LL 8, and RVAAP-43 Load Line 10**

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Ravenna Army Ammunition Plant,
Ravenna, Ohio

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LIST OF ACRONYMS / ABBREVIATIONS

AOC	Area of concern
BG	Background
BGS	Below ground surface
BRACD	Base Realignment and Closure Division
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Chemical of potential concern
CRREL	Cold Regions Research and Engineering Laboratory
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
FWHHRAM	Facility-wide Human Health Risk Assessor Manual
FWSAP	Facility-wide Sampling and Analysis Plan
Ha	Hectares
HE	High explosive
HMX	Cyclotetramethylene-tetranitramine
LL	Load Line
mg/kg	Milligrams per kilogram
µg/kg	Micrograms per kilogram
MI	Multi-increment
NAD	North American Datum 1983
NC	Nitrocellulose
NG	Nitroglycerin
OE	Ordnance and explosives
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OVA	Organic vapor analyzer
PCB	Polychlorinated biphenyl
PETN	Pentaerythritol tetra nitrate
PID	Photo ionization detector
PPE	Personal protective equipment
PRG	US EPA Region 9 Residential Preliminary Remediation Goal

QA	Quality assurance
QB	Quality assurance laboratory for the Ohio EPA
QAPP	Quality Assurance Project Plan
QC	Quality control
RDX	Cyclotrimethylenetrinitramine
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Application International Corporation
SAP	Sampling and Analysis Plan
SOP	Standard operating procedure
sq. ft.	Square feet
SRC	Site-related contaminant
SSHP	Site Safety and Health Plan
SVOC	Semi volatile organic compound
TAL	Target Analyte List
TNT	Trinitrotoluene
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
USCS	Unified Soil Classification System
VOC	Volatile organic compound
WBG	Winklepeck Burning Ground
WWII	World War

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), Louisville District completed surface soil sampling at four Areas of Concern (AOCs) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio (Figure 1). The four AOCs that were sampled include:

- RVAAP-39 – LL 5
- RVAAP-40 – LL 7
- RVAAP-41 – LL 8
- RVAAP-43 – LL 10

This report summarizes the objectives, methods and results from this sampling event at these four AOCs (Figure 2). In addition, this report presents recommendations for future activities at each AOC based upon the sampling results. Where appropriate, the report contains references to the Final Facility-wide Sampling (SAIC 2001a) and Analysis Plan (FWSAP) for the Ravenna Army Ammunition Plant, March 2001, (SAIC) for standard procedures and protocols.

1.1 BACKGROUND AND SIGNIFICANCE

This report was prepared to document and delineate any contamination that was left in the surface soil after the buildings and their foundations were removed and demolished at four Load Lines (LL). Demolition and removal of buildings, including slabs and foundations, was completed at LLs 5, 7, 8, and 10 under a contract to the Base Realignment and Closure Division (BRACD) during 2006. To facilitate future environmental work, the BRACD contractor surveyed the corners of the buildings in Ohio State Plane coordinates. These coordinates are provided in Appendix B and can be correlated with schematic figures of building in the four load lines, also in Appendix B. Figures 3, 4, 5, and 6 were developed from these coordinates for each building at each of the LLs. Once the floor slabs and foundations were removed, the BRACD contractor graded the surface of the earth below the slabs so the areas could be drained and seeded. There was no fill dirt or materials placed over the areas where the floor slabs had been. This report summarizes the results of the investigation completed to determine if any contamination was in the remaining surface soil.

1.2 HISTORICAL PERSPECTIVE

The Ravenna Army Ammunition Plant (RVAAP) is located in northeastern Ohio in Portage and Trumbull counties and is approximately 4.8 km (3 miles) east-northeast of the Ravenna, Ohio

(Figure 1). Operations at the facility began in September 1941 and included the storage, handling, and packing of military ammunition and explosives. The facility encompasses 8,775 hectares (21,683 acres) and is currently operated by the Base Realignment and Closure Division (BRACD) of the U.S. Army, National Guard Bureau and the Ohio Army National Guard (OHARNG). The BRACD controls environmental areas of concern (AOCs) and active mission areas. A detailed history of process operations and waste disposal processes for each AOC at RVAAP (Figure 1) is presented in the Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1996).

A description of the prior activities at each of the four AOCs is presented in Section 2.0 of this document.

1.3 PREVIOUS INVESTIGATIONS

- Installation Assessment of Ravenna Army Ammunition Plant. 1978. U.S. Army Toxic and Hazardous Materials Agency (USATHAMA 1978);

- Preliminary Review and Visual Site Inspection conducted as a part of Resource Conservation and Recovery Act (RCRA) Facility Assessment conducted by USEPA. 1989. Jacobs Engineering Group, Inc, (Jacobs 1989);

- Preliminary Assessment Screening of the Boundary Load Line Areas. 1994. U.S. Army Environmental Hygiene Agency (USAEHA 1994);

- Preliminary Assessment for the Ravenna Army Ammunition Plant. 1996. (USACE 1996);

- Relative Risk Site Evaluation (RRSE), Ravenna Army Ammunition Plant. 1996. U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM 1996);

- Relative Risk Site Evaluation for Newly Added Sites at the Ravenna Army Ammunition Plant. 1998. (USACHPPM 1998);

- Phase 1 Remedial Investigation (RI) for High-Priority Areas of Concern at the Ravenna Army Ammunition Plant. 1998. (SAIC 1998); and

- Final Report for the Characterization of 14 RVAAP AOCs, March 2007. (MKM Engineers, Inc. 2007).

1.4 OBJECTIVES

The main objective of this investigation was to identify areas of potential contamination from past military activities at LLs 5, 7, 8, and 10 in the surface soil directly below the former floor slabs where military operations were conducted. This information will be used to assist decision makers with evaluating what future actions are required. These decisions may range from no further action to soil removal. The specific goals of the collection of surface soil samples for these four LLs were as follows:

- identify any contaminants remaining in the under slab surface soils at each of the four AOCs;
- quantify any contaminants identified;
- determine if the concentrations at which the contaminants were identified pose any unacceptable risk to future receptors (end users) by comparing their concentrations to selected criteria;
- assess results and identify AOCs where additional characterization may be needed; and
- recommend future activities at these four AOCs.

The second objective associated with this investigation was to complete a comparative analysis of the multi-increment (MI) soil samples using different sample preparation techniques and different laboratories. First, the raw MI samples were sent to the primary lab (Test America, North Canton, OH) where they were ground into fine samples. Test America, GPL Lab (Corps QA), and Kemron Environmental Services (OH EPA QB) then performed analyses on splits of the ground samples for TAL metals, SVOCS, PCBs, and pesticides/herbicides. A representative portion of the ground sample was also forwarded to the Corps Cold Regions Research and Engineering Lab (CRREL), where it was pulverized, per US EPA Method 8330B. Representative splits of the pulverized samples were sent to the Test America-Sacramento (Primary Lab), GPL Lab (Corps QA), and Kemron Environmental Services (OH EPA QB), where analyses for explosives and propellants were performed.

Discrete 4-oz size jar samples were collected for VOCs analyses within the MI sampling locations specified in the SAP. To determine where the VOC sample was to be collected, a photo ionization detector was placed at the ground surface at each of the either 15 or 30 aliquot locations within a given MI sample area, and the discrete sample taken adjacent to the aliquot location that had the highest PID reading.

2.0 DESCRIPTIONS OF LL 5, 7, 8, AND 10

The investigation sites for LLs 5, 7, 8, and 10 are presented in Figures 3, 4, 5, and 6. These investigation sites were established by the USACE team during previous scoping activities and discussions. Load Lines 5, 7, 8, and 10 are located in an area known as Fuze and Booster Hill, which is in the south central part of RVAAP (Figure 2). Representative photographs were taken during the investigation and are presented in Appendix A.

2.1 LOAD LINE 5

Load Line 5, also designated as Fuze Line # 1 (Figure 3), was a finished product assembly line, which was operated from 1941 to 1945 to produce fuzes for artillery projectiles. Load Line 5 is a 39-acre (15.3 ha) AOC that consists of 18 process buildings ranging in size from 120 ft^2 (11 m^2) to 32,910 ft^2 (3060 m^2). Only 14 of the 18 buildings at LL 5 were deemed necessary to sample.

Operations were discontinued at the end of World War II (WWII) and the process equipment was removed in 1945. This AOC has been inactive for more than 50 years and is overgrown with vegetation consisting of young trees, bushes and weeds. With the exception of the mercury fulminate primer which was loaded and assembled within the line, all other primary explosive products were delivered as sealed, finished sub-assemblies. There is no evidence that the booster component was included in the assembly processes conducted at this line. Table 1 summarizes the former building names, historic utilizations, and the buildings at LL5 that were sampled for this investigation.

2.2 LOAD LINE 7

Load Line 7 also designated as Booster Line No. 1 (Figure 4), was a booster loading and assembly line for artillery projectiles and is a 15 ha (37 acre) AOC that is located on Fuze and Booster Spur Road.

Operations began in 1941 and were discontinued at the end of WWII. The booster process equipment was removed in 1945. In 1968, the line was modified for the production of M-406 High Explosive (HE) and M-407A1 practice 40 mm rounds. Sixteen million 40-mm projectiles were assembled at LL7 between 1969 and 1970, after which the line was deactivated and the equipment removed. The line was reactivated for the Research and Development of HE shape charges until 1993. Load Line 7, which has been inactive for more than a decade, is not maintained, and is overgrown with young trees, bushes and weeds. Table 2 summarizes the former building names, historic utilizations, and the buildings at LL7 that were sampled for this investigation.

Table 1. Description of the buildings and their former use; slab and sample area; and sample information for the MI samples collected at Load Line 5.

Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	No. of Aliquots per Sample	Depth (ft)
1F-WP-1	1941-45 - Fulminate Dry House	160	160	LL5ss-031M-SO	15	0 to 1
1F-WP-3	1941-45 - Fulminate Mix House	1250	1250	LL5ss-032M-SO	30	0 to 1
1F-WP-4	1941-45 - Primer Loading Bldg.	3750	3750	LL5ss-033M-SO	30	0 to 1
1F-WP-6	1941-45 - Black Powder Dry House	160	160	LL5ss-034M-SO	15	0 to 1
1F-WP-7	1941-45 - Black Powder Pelleting House	780	780	LL5ss-035M-SO	30	0 to 1
1F-WP-8	1941-45 - Delay Loading House	3875	3875	LL5ss-036M-SO	30	0 to 1
1F-WP-9	1941-45 - Primer Dry House	710	710	LL5ss-037M-SO	30	0 to 1
1F-WP-10	1941-45 - Detonator Service Magazine	160	160	LL5ss-038M-SO	15	0 to 1
1F-WP-11	1941-45 - Fuze Assembly Bldg.	30000	10000	LL5ss-039M-SO	30 each at 3 grids	0 to 1
1F-WP-12	1941-45 - Fuze Testing Bldg.	1250	1250	LL5ss-042M-SO	30	0 to 1
1F-WP-18	1941-45 - Primer House	160	160	LL5ss-044M-SO	15	0 to 1
1F-WP-19	1941-45 - Pellet Storage Bldg.	160	160	LL5ss-045M-SO	30	0 to 1
1F-WP-20	1941-45 - Delay Storage Bldg.	160	160	LL5ss-046M-SO	15	0 to 1
1F-WP-15	1941-45 - Paint Storage Bldg.	160	160	LL5ss-047D-SO	15	0 to 1

Table 2. Description of the buildings and their former use; slab and sample area; and sample information for the MI samples collected at Load Line 7.

Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	No. of Aliquots per Sample	Depth (ft)
1B-WP-1	1941-45 - Tetryl Magazine; 1968-70 - Booster Storage (A-5), Pellet Magazine	160	160	LL7ss-042M-SO	15	0 to 1
1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	470	470	LL7ss-043M-SO	15	0 to 1
1B-WP-3	1941-45 - Tetryl Rest House; 1969-70 - Not in Use	160	160	LL7ss-044M-SO	15	0 to 1
1B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	5625	5625	LL7ss-045M-SO	30	0 to 1
1B-WP-5	1941-45 - Detonator Magazine; 1969-70 - Detonator Magazine	160	160	LL7ss-046M-SO	15	0 to 1
1B-WP-6	1941-45 - Booster Assembly and Shipping; 1969-70 - Assembly and Shipping	13125	6563	LL7ss-047M-SO	30 each at 2 grids	0 to 1
1B-WP-7	1941-45 - Testing Bldg.; 1969-70 - Testing Bldg.	940	940	LL7ss-049M-SO	30	0 to 1
1B-WP-12	1941-45 - Tetryl Pellet Storage Bldg.; 1969-70 - M42 Primer Storage & Case Assembly	160	160	LL7ss-050M-SO	30	0 to 1
1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	3125	3125	LL7ss-051M-SO	30	0 to 1
1B-WP-17	1941-45 - Cupped Pellet Rest House; 1969-70 - M551 Fuze Storage	160	160	LL7ss-052M-SO	15	0 to 1
1B-WP-18	1941-45 - Primer House; 1969-70 - Not In Use	160	160	LL7ss-053M-SO	15	0 to 1
1B-WP-22	1941-45 - Solvent Storage Bldg.; 1969-70 - M9 Propellant Storage	160	160	LL7ss-054M-SO	15	0 to 1

2.3 LOAD LINE 8

Load Line 8, also designated as Booster Line No. 2 (Figure 5), is a 17.8 ha (44 acre) AOC that operated as a booster loading and assembly line from 1941 to 1945. Load Line 8 is located on Fuze and Booster Road. Load Line 8 consists of 15 process buildings ranging in size between 120 sq. ft. and 13,104 sq. ft. Only 13 of the 15 buildings at LL8 were deemed necessary to sample.

Operations were discontinued at the end of WWII and the process equipment removed in 1945. Load Line 8 has not been used since 1945 and is overgrown by trees, bushes, and weeds. Table 3 summarizes the former building names, historic utilizations, and the buildings at LL8 that were sampled for this investigation.

2.4 LOAD LINE 10

Load Line l0, also known as the Percussion Element Manufacturing Line (Figure 6), is a 17.4 ha (43 acre) AOC located on Fuze and Booster Road. Load Line 10 consists of 29 process buildings ranging in size between 36 sq. ft. and 13, 413 sq. ft. Load Line 10 was an initiator blending and loading line that was operated from 1941 to 1945. Only 20 of the 29 buildings at LL10 were deemed necessary to sample.

Operations at LL 10 were discontinued at the end of WWII and the process equipment and production line was placed on standby status. The line was activated in 1951 and operated until 1956, when it was again placed on standby. The 1951 to 1956 production mimicked the 1941 to 1945 production. The line was activated a third time in 1969 and operated until 1971, when the line was finally deactivated permanently, and the production equipment removed. Load Line 10 is overgrown by trees, bushes and weeds. Table 4 summarizes the former building names, historic utilizations, and the buildings at LL 10 that were sampled for this investigation.

Table 3. Description of the buildings and their former use; slab and sample area; and sample information for the MI samples collected at Load Line 8.

Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	No. of Aliquots per Sample	Depth (ft)
2B-WP-1	1941-45 - Tetryl Magazine; 1970 Era - Not In Use	160	160	LL8ss-042M-SO	15	0 to 1
2B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1970 Era - Octol Storage Magazine	470	470	LL8ss-043M-SO	15	0 to 1
2B-WP-3	1941-45 - Tetryl Rest House; 1970 Era - Not in Use	160	160	LL8ss-044M-SO	15	0 to 1
2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	5625	5625	LL8ss-045M-SO	30	0 to 1
2B-WP-5	1941-45 - Detonator Magazine; 1970 Era - Not In Use	160	160	LL8ss-046M-SO	15	0 to 1
2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	13125	6563	LL8ss-047M-SO	30 each at 2 grids	0 to 1
2B-WP-7	1941-45 - Testing Bldg.; 1970 Era - Curing	940	940	LL8ss-049M-SO	30	0 to 1
2B-WP-12	1941-45 - Tetryl Pellet Storage Bldg.; 1970 Era - S & A Device With Detonator Storage	160	160	LL8ss-050M-SO	15	0 to 1
2B-WP-13	1941-45 - Tetryl Cupping Bldg. 1970 Era - Not In Use	3125	3125	LL8ss-051M-SO	30	0 to 1
2B-WP-17	1941-45 - Cupped Pellet Rest House; 1970 Era - Not In Use	160	160	LL8ss-052M-SO	15	0 to 1
2B-WP-21	1941-45 - Booster Assembly and Shipping; 1970 Era - Not In Use	7247	7247	LL8ss-053M-SO	30	0 to 1
2B-WP-22	1941-45 - Solvent Storage Bldg.; 1970 Era - Not In Use	160	160	LL8ss-054M-SO	15	0 to 1

Table 4. Description of the buildings and their former use; slab and sample area; and sample information for the MI samples collected at Load Line 10.

Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	No. of Aliquots per Sample	Depth (ft)
PE-1	1941 - 1945; 1951 - 1956; 1969-70 - PE Manufacturing Bldg	13125	6563	L10ss-040M-SO	30 each at 2 grids	0 to 1
PE-4	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-042M-SO	15	0 to 1
PE-5	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-043M-SO	15	0 to 1
PE-6	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-044M-SO	15	0 to 1
PE-7	1941 - 1945; 1951 - 1956 - Canned Primer Storage Bldg; 1969-70 - Not In Use	625	625	L10ss-045M-SO	15	0 to 1
PE-8	1941 - 1945; 1951 - 1956 - Canned Primer Storage Bldg; 1969-70 - Not In Use	625	625	L10ss-046M-SO	15	0 to 1
PE-9	1941 - 1945; 1951 - 1956; 1969-70 - Final Dry House	625	625	L10ss-047M-SO	15	0 to 1
PE-10	1941 - 1945; 1951 - 1956; 1969-70 - Testing, Packaging and Shipping	2500	2500	L10ss-048M-SO	30	0 to 1
PE-12 & 13	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Bldg.	470	470	L10ss-049M-SO	15	0 to 1
PE-14	1941 - 1945; 1951 - 1956; 1969-70 - Fuel Mixing Bldg.	470	470	L10ss-050M-SO	15	0 to 1
PE-15	1941 - 1945; 1951 - 1956; 1969-70 - Wet Mix B	315	315	L10ss-051M-SO	15	0 to 1
PE-16	1941 - 1945; 1951 - 1956; 1969-70 - Dry House	240	240	L10ss-060M-SO	15	0 to 1
PE-18	1941 - 1945; 1951 - 1956; 1969-70 - Mixture Inspection Bldg.	625	625	L10ss-052M-SO	30	0 to 1

Table 4. Description of the buildings and their former use; slab and sample area; and sample information for the MI samples collected at Load Line 10.

Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	No. of Aliquots per Sample	Depth (ft)
PE-19	1941 - 1945; 1951 - 1956;19 69-70 - Gum Solution Bldg.	470	470	L10ss-053M-SO	15	0 to 1
PE-20	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Magazine	160	160	L10ss-054M-SO	15	0 to 1
PE-21	1941 - 1945; 1951 - 1956; 1969-70 - TNT Magazine	160	160	L10ss-055M-SO	15	0 to 1
PE-22	1941 - 1945; 1951 - 1956; 1969-70 - Solvent Storage Bldg	39	39	L10ss-056M-SO	15	0 to 1
PE-28	1941 - 1945; 1951 - 1956 - Primer Canning Bldg.; 1969-70 - Not In Use	117	117	L10ss-057M-SO	15	0 to 1
PE-29	1941 - 1945; 1951 - 1956 - Primer Canning Bldg.; 1969-70 - Not In Use	117	117	L10ss-058M-SO	15	0 to 1
PE-30	1941 - 1945; 1951 - 1956; 1969-70 - PETN Screen House	240	240	L10ss-059M-SO	15	0 to 1

3.0 METHODS

Prior to initiation of any study conducted at Ravenna, a detailed Sampling and Analysis Plan (SAP) and Site Safety and Health Plan (SSHP) are completed that are compliant with the FWSAP. These documents also incorporate information from the Facility-Wide SAP. Rather than repeat all the details of these documents herein, please refer to the following documents for full description of the methods:

- Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio, DACA62-00-D-0001, D.O. CY02, Final (FWSAP). March 2001. SAIC. (SAIC 2001a).

- Final Sampling and Analysis Plan RVAAP-39, 40, 41, and 43 for the Exposed Soil Sampling and Characterization After Slab and Foundation Removals at LLs 5, 7, 8, and 10, Ravenna, Ohio (SAP). August, 2007. USACE. (USACE 2007a).

- Final Site Safety and Health Plan for Field Activities Associated with Soil Sampling and Characterization of Soils Exposed Following Slab and Foundation Removals at Load Lines 5, 7, 8 and 10 at the Ravenna Army Ammunition Plant, Ravenna, Ohio (SSHP). August 2007. USACE. (USACE 2007b).

3.1 OVERALL APPROACH

Surface soil sampling employed MI field sampling to provide characterization of the exposed soils after the removal of the slabs of the razed buildings at LLs 5, 7, 8, and 10. Samples were collected from the surface soils at 0.0 m to 0.3 m (0 to 1 ft) depths. Multiple subsamples (aliquots) were collected from either 15 or 30 stratified random locations within each grid. These subsamples or aliquots were combined to produce one MI sample from each grid. The MI sample grid was used to assess contamination and distribution, if any, in surface soil at the LLs. All samples were analyzed for explosives and Target Analyte List (TAL) metals. Approximately 15% of the MI field samples were also analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyl (PCBs), pesticides, and propellants.

This work was completed in accordance with the methods described in the approved FWSAP, SAP, and the SSHP. Any deviation from the methods described in these documents is noted herein.

3.2 FIELD SAMPLING

The field sampling was completed by USACE at LLs 5, 7, 8, and 10 from 7 August to 14 August 2007. This section describes the associated field activities for this sampling event. Specific details for the methods are provided in the SSHP, FWSAP and SAP and are not repeated in this document.

3.2.1 Sample Location Selection and Grid Development

In 2006, a contractor surveyed the corners of the razed buildings. The purpose of the survey was to record the perimeter of the buildings so sampling locations could be established in the future. The coordinates of X, Y and Z were recorded using the NAD83 (North American Datum of 1983) Ohio State Plane (detailed on the National Geodetic Survey website, http://www.ngs.noaa.gov/PUBS_LIB/ManualNOSNGS5.pdf). A contract surveyor located building corners (using the 2006 survey data) prior (within 1 week) to the 2007 MI field sampling. The surveyor placed pink colored pin flags at all building corners, except the southeast one. At the southeast corner, he placed a white pin flag with the building number noted on it, see the photograph for LL-5, Building 1F-WP-9 and the photograph for LL-5 2/2 of Building 1F-WP-3. After the first day, the Corps team placed green flagging on the pink and white (corner) pin flags to make the photographs more illustrative. The survey coordinates are provided in Appendix B and correlated to the buildings shown on the schematic plans of the load lines. The surveyor prepared a report of his activities that is provided in Appendix F. Of note is that the surveyor reported that, "the current ground elevation at the former building corner is anywhere from 3 inches up to 15 inches lower that it was back in 2006 when I originally surveyed it." Thus it appears that little on no fill has been placed above the locations where the former floor slabs were removed.

USACE personnel reviewed the sizes of each of the buildings to determine how many grids were needed to assess each building. The size of the grid is dependent upon many factors but usually is relative to a standardized exposure unit. For this study, the exposure unit was based upon the end use of the property. The accepted value for an exposure unit used in RVAAP-specific risk assessments for human health is 0.25-acre (~10,000 sq. ft.) area. For this investigation, the size of each grid was the same as the building footprint except for one building at each LL. Each of these four buildings was greater than the standard exposure unit (0.25 acre) area. The Building 1F-W-11 at LL 5 was divided into three grids. Buildings 1B-WP-6 at LL 7, 2B-WP-6 at LL 8, and PE-1 at LL 10 were divided into two grids each. See Tables 1, 2, 3, and 4 for building utilization and corresponding grid sizes for each of LLs 5, 7, 8, and 10, respectively.

For this study and in general, the premise of MI samples is to cover a large area of a site, collect numerous aliquots (n = 15 or 30), and then mix the aliquots together forming a single sample. This allows a better determination of the arithmetical average of each chemical constituent over a larger area. The MI sample method has been demonstrated to provide a better estimate of the mean (arithmetic average) for a given area than obtained from a single discrete sample for the same area.

3.2.2 Soil Sampling and Collection Methods

The appropriate number of aliquots was taken from stratified random locations (noted with red pin flags) throughout each grid based upon the size of the grid. The bulk MI samples were collected in plastic bags, placed on ice in a cooler in the field, and kept refrigerated until shipment, again on ice, to the primary analytical lab. The sample aliquots were collected using a small-diameter (7/8" inside diameter) step probe. The individual aliquots were obtained by pushing the step probe sampler from 0 – 1 ft. (0.0 – 0.3 m) in depth. In order to achieve a better estimate of the mean concentrations of chemicals, 30 aliquots from each area greater than 700 sq. ft were collected. Most of the grids included in this study, however, had areas less than 700 sq. ft. and only 15 aliquots were collected from them. See Tables 1, 2, 3, and 4 for grid sizes and the corresponding number of aliquots for each MI sample for LLs 5, 7, 8, and 10, respectively. Occasionally, 30 aliquots were taken from grids with areas less than 700 sq. ft. There were three grids with areas less than 700 sq. ft. that had 30 aliquots collected for the MI sample: Building 1F-WP-19 from LL5 (Table 1); Building 1B-WP-12 from LL 7 (Table 2); and PE-18 from LL 10 (Table 4). See the Field Performance Summary Tables in Appendix B pages 1-4 for the sample weights.

The MI surface soil samples were collected within the sampling boundaries of each of the established grids. Figures 3, 4, 5, and 6 depict the locations of the grids at LLs 5, 7, 8, and 10, respectively. Ohio State Plane coordinates of the subject buildings are provided in Appendix B. In order to achieve an estimate of mean concentrations of chemicals in substantially smaller areas, only 15 aliquots were collected from most grids with an area of 700 sq. ft or less. In order to assure that 15 samples would produce good estimates of the means of chemical concentrations in these smaller areas, we took duplicate samples of some of the smaller grids.

Depending upon the grid size, either 15 or 30 sampling points were located in a stratified random pattern across the grid. This technique is described in detail in Appendix C as well as in the FWSAP and SAP. All samples were analyzed for explosives and Target Analyte List (TAL) metals. Approximately 15% of the MI field samples were also analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyl (PCBs), pesticides, and propellants.

Discrete 4-0z size jar samples were collected for VOCs analyses within the MI sampling locations specified in the SAP. To determine where the VOC sample was to be collected, a photo ionization detector was placed at ground surface of each of the 15 or 30 aliquot locations within a given MI sample area. The discrete sample was taken adjacent to the aliquot location that had the highest PID reading. The discrete samples were analyzed for VOCs only, except for sample LL5ss-047D-SO taken at the Paint Storage Building at LL5 on which analyses for metals were also performed. Details of the discrete sampling method employed in this study can be found in the FWSAP and SAP. These VOC discrete samples were not processed and were shipped directly to the appropriate labs. The buildings where discrete samples were collected for VOC analyses were selected based on knowledge of the past production procedures at each building.

Field logs were completed in the field and are provided in Appendix B. Photographs of each site and sampling events can be found in Appendix A.

3.2.3 Quality Control of the Soil Samples for Field Work

One MI -duplicate bulk sample was collected for every 10 MI primary samples to meet the 10% QA requirement. The bulk MI and duplicate samples were sent to the primary lab, Test America- North Canton, OH, where they were processed via air-drying, sieving through a #10 size sieve, and grinding in a coffee grinder for less than 10 seconds. Evaluation of the field quality control was performed by comparing the analytical results of the MI primary sample to those of the MI duplicate sample, see Table 11. Tables 5, 6, 7, and 8 present the numbers of planned and actual primary, field duplicate, QA/QB, and QC samples collected at LLs 5, 7, 8, and 10, respectively. The minor differences between the numbers of planned and actual analyses were no doubt due in large part to the laboratory sample preparation for explosives and propellant analyses having to be performed at a laboratory different from the primary laboratory. Because it was expected that contamination of explosives and propellants would be somewhat limited, it was decided to prepare the field samples for those analyses with the most comprehensive laboratory sample preparation methods, pulverization via Method 8330B currently available. Hopefully in the future more laboratories will be proficient in sample preparation via Method 8330B, and also laboratory sample preparation for other analyses will be more similar to that of Method 8330B.

Quantitative comparisons of the primary to duplicate MI samples, comparisons of primary to QC analytical data, primary to QA analytical data, and primary to QB analytical data are shown on the analytical data sheets in Appendix D. These results are summarized on Table 11. Based on the very few numbers of non metals detections, the quantitative comparisons are based on metals data only.

The average relative percent difference for metals between the primary and duplicate field samples was 13.9%, with a standard deviation of 12.8%.

The average relative percent difference for metals between the primary and QC samples (both done at the primary lab) was 11.5%, with a standard deviation of 20.9%.

Thus it appears that the duplicate field MI samples are of similarity approximately equal to that of the primary to QC samples.

The average relative percent differences for metals between the primary and QA samples (analyses at different laboratories); and primary and QB samples (analyses at different laboratories) were 28.1% and 19.7%, respectively. Although these relative percent differences are somewhat higher than those for the primary and duplicate field samples and primary to QC samples, they are still much lower than what is typically found when the laboratory sample preparation is not as thorough as was done for this investigation.

Table 5. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 5.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/ Herbicides/PCBs
Multi-increment Surface Soil Locations	1F-WP-1	1941-45 - Fulminate Dry House	160	160	LL5ss-031M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-3	1941-45 - Fulminate Mix House	1250	1250*	LL5ss-032M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-4	1941-45 - Primer Loading Bldg.	3750	3750*	LL5ss-033M-SO	0 to 1	1	1	1	1	-	1 -
QA/QB	1F-WP-4	"	"	"	LL5ss-033M-QA	0 to 1	1	1	1	1	-	1 -
Field MI Duplicate to LL5ss-033SO MI-QA	1F-WP-4	"	"	"	LL5ss-048M-SO	0 to 1	1	1	1	1	-	1 -
QC Duplicate to LL5ss-033-SO	1F-WP-4	"	"	"	LL5ss-050M-SO	0 to 1	1	1	0	0	-	0 -
	1F-WP-6	1941-45 - Black Powder Dry House	160	160	LL5ss-034M-SO	0 to 1	1	-	1+QC	-	-	-
	1F-WP-7	1941-45 - Black Powder Pelleting House	780	780*	LL5ss-035M-SO	0 to 1	1	-	1+QC	-	-	-
	1F-WP-8	1941-45 - Delay Loading House	3875	3875*	LL5ss-036M-SO	0 to 1	1	1	1	1	-	1
QA/QB	1F-WP-8	"	"	"	LL5ss-036M-QA	0 to 1	1	1	1	1	-	1
Field MI Duplicate to LL5ss-036-SO MI-QA	1F-WP-8	"	"	"	LL5ss-049M-SO	0 to 1	1	0	1	1	-	1
QC Duplicate to LL5ss-036-SO	1F-WP-8	"	"	"	LL5ss-051M-SO	0 to 1	1	1	0	0	-	0
	1F-WP-9	1941-45 - Primer Dry House	710	710*	LL5ss-037M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-10	1941-45 - Detonator Service Magazine	160	160	LL5ss-038M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-11	1941-45 - Fuze Assembly Bldg.	30000	10000*	LL5ss-039M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-11	"	30000	10000*	LL5ss-040M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-11	"	30000	10000*	LL5ss-041M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-12	1941-45 - Fuze Testing Bldg.	1250	1250*	LL5ss-042M-SO	0 to 1	1	-	1	0	-	1
	1F-WP-12	"	"	"	LL5ss-042M-MS	0 to 1	1	-	1	1	-	1
	1F-WP-12	"	"	"	LL5ss-042M-MSD	0 to 1	1	-	1	1	-	1
	1F-WP-18	1941-45 - Primer House	160	160	LL5ss-044M-SO	0 to 1	1	-	1	-	-	-

Table 5. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 5.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/ Herbicides/PCBs
	1F-WP-19	1941-45 - Pellet Storage Bldg.	160	160*	LL5ss-045M-SO	0 to 1	1	-	1	-	-	- -
	1F-WP-20	1941-45 - Delay Storage Bldg.	160	160	LL5ss-046M-SO	0 to 1	1	-	1	-	-	- -
Discrete Surface Soil Locations	1F-WP-15	1941-45 - Paint Storage Bldg.	160	160	LL5ss-047D-SO	0 to 1		-	-	-	1	- -
QA	1F-WP-15	"	160	160	LL5ss-047D-QA	0 to 1			1		1	
	1F-WP-15	"	160	160	LL5ss-047D-MS	0 to 1					1	
	1F-WP-15	"	160	160	LL5ss-047D-MSD	0 to 1					1	
QC Duplicate to LL5ss-047D-SO	1F-WP-15	"	160	160	LL5ss-052D-SO	0 to 1			1		1	
	1F-WP-4	1941-45 - Primer Loading Bldg.	3750	3750	LL5ss-033D-SO	0 to 1	-	-	-	-	1	- -
	1F-WP-8	1941-45 - Delay Loading House	3875	3875	LL5ss-036D-SO	0 to 1	-	-	-	-	1	- -

Color Key		Primary Sample
		Quality Assurance
		Field MI Duplicate
		Blind Duplicate
		MS/MSD Pair
		Discrete

*** MI Sample from this Grid consisted of 30 aliquots or increments. All other Grids (MI samples) consisted of 15 aliquots.**

Total number of samples (minus lab QA samples) sent to the Primary, QA, and QB Laboratory for each analysis (planned/actual).

Lab	Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/ Herbicides/PCBs
Test America Primary Laboratory	21/21	6/5	22/23	9/6	6/6	9/7
GPL QA Laboratory	2/2	2/2	3/2	2/2	1/1	2/1
Kemron QB Laboratory	2/2	2/2	3/2	2/2	1/1	2/1

Results for MS/MSD not shown in data tables
0 - Sample was planned to be, but was not actually tested for
(1) - Sample was not planned to be, but was tested for
- Sample was not planned to be, nor was it tested for

Table 6. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 7.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides/PCBs
Multi-increment Surface Soil Locations	1B-WP-1	1941-45 - Tetryl Magazine; 1968-70 - Booster Storage (A-5), Pellet Magazine	160	160	LL7ss-042M-SO	0 to 1	1	-	1+QC	-	-	-
	1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	470	470	LL7ss-043M-SO	0 to 1	1+QB	0	1	1	-	1
QA/QB	1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	"	"	LL7ss-043M-QA	0 to 1	1	1	1	1	-	1
Field MI Duplicate to LL7ss-043-SO MI-QA	1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	"	"	LL5ss-056M-SO	0 to 1	1	0	1	1	-	1
QC Duplicate to LL7ss-043-SO	1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	"	"	LL5ss-058M-SO	0 to 1	1	1	0	0	-	0
	1B-WP-3	1941-45 - Tetryl Rest House; 1969-70 - Not in Use	160	160	LL7ss-044M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	5625	5625*	LL7ss-045M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-4	"	"	"	LL7ss-045M-MS	0 to 1	1	-	1	-	-	-
	1B-WP-4	"	"	"	LL7ss-045M-MSD	0 to 1	1	-	1	-	-	-
	1B-WP-5	1941-45 - Detonator Magazine; 1969-70 - Detonator Magazine	160	160	LL7ss-046M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-6	1941-45 - Booster Assembly and Shipping; 1969-70 - Assembly and Shipping	13125	6563*	LL7ss-047M-SO	0 to 1	1	-	1		-	
	1B-WP-6	"	13125	6563*	LL7ss-048M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-7	1941-45 - Testing Bldg.; 1969-70 - Testing Bldg.	940	940*	LL7ss-049M-SO	0 to 1	1	1	1	-	-	-
	1B-WP-12	1941-45 - Tetryl Pellet Storage Bldg.; 1969-70 - M42 Primer Storage & Case Assembly	160	160*	LL7ss-050M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	3125	3125*	LL7ss-051M-SO	0 to 1	1	-	1	-	-	-
QA/QB	1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	"	"	LL7ss-051M-QA	0 to 1	1	-	1	-	-	-
Field MI Duplicate to LL7ss-051-SO MI-QA	1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	"	"	LL5ss-057M-SO	0 to 1	1	-	1	-	-	-

Table 6. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 7.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides/PCBs
QC Duplicate to LL7ss-051-SO	1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	"	"	LL5ss-059M-SO	0 to 1	1	-	0	-	-	-
	1B-WP-17	1941-45 - Cupped Pellet Rest House; 1969-70 - M551 Fuze Storage	160	160	LL7ss-052M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-18	1941-45 - Primer House; 1969-70 - Not In Use	160	160	LL7ss-053M-SO	0 to 1	1	-	1	-	-	-
	1B-WP-22	1941-45 - Solvent Storage Bldg.; 1969-70 - M9 Propellant Storage	160	160	LL7ss-054M-SO	0 to 1	1	1	1	1	-	1
Discrete Surface Soil Locations	1B-WP-22	1941-45 - Solvent Storage Bldg.; 1969-70 - M9 Propellant Storage	160	160	LL7ss-055D-SO	0 to 1	-	-	-	-	1	-
QA	1B-WP-22	"	"	"	LL7ss-055D-QA	0 to 1					1	
QC Duplicate to LL7ss-055D-SO	1B-WP-22	"	"	"	LL7ss-060D-SO	0 to 1					1	
	1B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1969-70 - Main Charge Storage, Melt Pour and Curing	470	470	LL7ss-043D-SO	0 to 1	-	-	-	-	1	-
	1B-WP-13	1941-45 - Tetryl Cupping Bldg. 1969-70 - M42 Primer Storage and Case Assembly	3125	3125	LL7ss-051D-SO	0 to 1	-	-	-	-	1	-

Color Key		Primary Sample
		Quality Assurance
		Field MI Duplicate
		Blind Duplicate
		MS/MSD Pair
		Discrete

*** MI Sample from this Grid consisted of 30 aliquots or increments.**
All other Grids (MI samples) consisted of 15 aliquots.

Total number of samples (minus lab QA samples) sent to the Primary, QA, and QB Laboratory for each analysis (planned/actual).

Lab	Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/ Herbicides/PCBs
Test America Primary Laboratory	19/17	5/2	19/18	4/3	4/4	4/3
GPL QA Laboratory	2/2	1/1	2/2	1/1	1/1	1/1
Kemron QB Laboratory	2/2	1/0	2/2	1/1	1/1	1/1

Results for MS/MSD not shown in data tables
0 - Sample was planned to be, but was not actually tested for
(1) - Sample was not planned to be, but was tested for
- Sample was not planned to be, nor was it tested for

Table 7. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 8.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides /PCBs
Multi-increment Surface Soil Locations	2B-WP-1	1941-45 - Tetryl Magazine; 1970 Era - Not In Use	160	160	LL8ss-042M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-2	1941-45 - Tetryl Screening & Blending Bldg.; 1970 Era - Octol Storage Magazine	470	470	LL8ss-043M-SO	0 to 1	1	1	1	-	-	-
	2B-WP-3	1941-45 - Tetryl Rest House; 1970 Era - Not in Use	160	160	LL8ss-044M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	5625	5625*	LL8ss-045M-SO	0 to 1	1	1	1	1	-	1
QA	2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	"	"	LL8ss-045M-QA	0 to 1	1	1	1	0	-	0
Field MI Duplicate to LL8ss-045-SO MI-QA	2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	"	"	LL5ss-056M-SO	0 to 1	1	1	1	1	-	1
QC Duplicate to LL8ss-045-SO	2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	"	"	LL5ss-058M-SO	0 to 1	1	1	0	0	-	0
	2B-WP-5	1941-45 - Detonator Magazine; 1970 Era - Not In Use	160	160	LL8ss-046M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	13125	6563*	LL8ss-047M-SO	0 to 1	1		1	-	-	-
QA	2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	13125	6563*	LL8ss-047M-QA	0 to 1	1		1	(1)	-	(1)
Field MI Duplicate to LL8ss-047-SO MI-QA	2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	"	"	LL5ss-057M-SO	0 to 1	1		1	-	-	-
QC Duplicate to LL8ss-047-SO	2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	"	"	LL5ss-059M-SO	0 to 1	1		0	-	-	-
	2B-WP-6	"	"	"	LL8ss-048M-SO	0 to 1	1	-	1		-	
	2B-WP-7	1941-45 - Testing Bldg.; 1970 Era - Curing	940	940*	LL8ss-049M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-12	1941-45 - Tetryl Pellet Storage Bldg.; 1970 Era - S & A Device With Detonator Storage	160	160	LL8ss-050M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-13	1941-45 - Tetryl Cupping Bldg. 1970 Era - Not In Use	3125	3125*	LL8ss-051M-SO	0 to 1	1	-	1	-	-	-
	2B-WP-13	"	"	"	LL8ss-051M-MS	0 to 1	1*	-	1*	-	-	-
	2B-WP-13	"	"	"	LL8ss-051M-MSD	0 to 1	1*	-	1*	-	-	-
	2B-WP-17	1941-45 - Cupped Pellet Rest House; 1970 Era - Not In Use	160	160	LL8ss-052M-SO	0 to 1	1	-	1	-	-	-

Table 7. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 8.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides /PCBs
	2B-WP-21	1941-45 - Booster Assembly and Shipping; 1970 Era - Not In Use	7247	7247*	LL8ss-053M-SO	0 to 1	1	-	1	1	-	1
	2B-WP-22	1941-45 - Solvent Storage Bldg.; 1970 Era - Not In Use	160	160	LL8ss-054M-SO	0 to 1	1	-	1	1	-	1
Discrete Surface Soil Locations	2B-WP-22	1941-45 - Solvent Storage Bldg.; 1970 Era - Not In Use	160	160	LL8ss-055D-SO	0 to 1	-	-	-	-	1	-
QA	2B-WP-22	"	"	"	LL8ss-055D-QA	0 to 1					1	
QC Duplicate to LL8ss-055M-SO	2B-WP-22	"	"	"	LL8ss-060D-SO	0 to 1					1	
	2B-WP-4	1941-45 - Tetryl Pelleting Bldg.; 1970 Era - Melt Pour Operation	5625	5625	LL8ss-045D-SO	0 to 1	-	-	-	-	1	-
	2B-WP-6	1941-45 - Booster Assembly and Shipping; 1970 Era - Assembly and Shipping	13125	6263	LL8ss-047D-SO	0 to 1	-	-	-	-	1	-

Color Key		Primary Sample
		Quality Assurance
		Field MI Duplicate
		Blind Duplicate
		MS/MSD Pair
		Discrete

*** MI Sample from this Grid consisted of 30 aliquots or increments.**
All other Grids (MI samples) consisted of 15 aliquots.

Total number of samples (minus lab QA samples) sent to the Primary, QA, and QB Laboratory for each analysis (planned/actual).

Lab	Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/ Herbicides/PCBs
Test America Primary Laboratory	19/19	4/4	19/18	5/4	4/4	5/4
GPL QA Laboratory	2/2	1/1	2/2	1/1	1/1	1/1
Kemron QB Laboratory	2/2	1/1	2/2	1/2	1/1	1/1

Results for MS/MSD not shown in data tables
0 - Sample was planned to be, but was not actually tested for
(1) - Sample was not planned to be, but was tested for
- Sample was not planned to be, nor was it tested for

Table 8. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 10.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides/PCBs
Multi-increment Surface Soil Locations	PE-1	1941 - 1945; 1951 - 1956; 1969-70 - PE Manufacturing Bldg	13125	6563*	L10ss-040M-SO	0 to 1	1+QB	-	1	-	-	
	PE-1	"	13125	6563*	L10ss-041M-SO	0 to 1	1	-	1+QA +QB	-	-	-
	PE-1	"	"	"	L10ss-041M-MS	0 to 1	1	-	1	-	-	-
	PE-1	"	"	"	L10ss-041M-MSD	0 to 1	1	-	1	-	-	-
	PE-4	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-042M-SO	0 to 1	1	-	1	-	-	-
	PE-5	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-043M-SO	0 to 1	1	-	1	-	-	-
	PE-6	1941 - 1945; 1951 - 1956; 1969-70 - Preliminary Dry House	625	625	L10ss-044M-SO	0 to 1	1	-	1+QC	-	-	-
	PE-7	1941 - 1945; 1951 - 1956 - Canned Primer Storage Bldg; 1969-70 - Not In Use	625	625	L10ss-045M-SO	0 to 1	1	-	1	-	-	-
	PE-8	1941 - 1945; 1951 - 1956 - Canned Primer Storage Bldg; 1969-70 - Not In Use	625	625	L10ss-046M-SO	0 to 1	1	-	1	-	-	-
	PE-9	1941 - 1945; 1951 - 1956; 1969-70 - Final Dry House	625	625	L10ss-047M-SO	0 to 1	1	-	1	-	-	-
QA	PE-9	1941 - 1945; 1951 - 1956; 1969-70 - Final Dry House	"	"	L10ss-047M-QA	0 to 1	1	-	0	-	-	-
Field MI Duplicate to LL10ss-047-SO MI-QA	PE-9	1941 - 1945; 1951 - 1956; 1969-70 - Final Dry House	"	"	LL5ss-063M-SO	0 to 1	1	-	1	-	-	-
QC Duplicate to LL10ss-047-SO	PE-9	1941 - 1945; 1951 - 1956; 1969-70 - Final Dry House	"	"	LL5ss-065M-SO	0 to 1	1		0	-	-	-
	PE-10	1941 - 1945; 1951 - 1956; 1969-70 - Testing, Packaging and Shipping	2500	2500*	L10ss-048M-SO	0 to 1	1	-	1	-	-	-
	PE-12 & 13	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Bldg.	470	470	L10ss-049M-SO	0 to 1	1	-	1+QC	-	-	-
	PE-12 & 13	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Bldg.	470	470	L10ss-049M-MS	0 to 1	-	-	-	-	-	-
	PE-12 & 13	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Bldg.	"	"	L10ss-049M-MSD	0 to 1	-	-	-	-	-	-
	PE-14	1941 - 1945; 1951 - 1956; 1969-70 - Fuel Mixing Bldg.	470	470	L10ss-050M-SO	0 to 1	1 + PETN	-	1	-	-	-
	PE-15	1941 - 1945; 1951 - 1956; 1969-70 - Wet Mix B	315	315	L10ss-051M-SO	0 to 1	1 + PETN	0	1	1	-	1
QA	PE-15	1941 - 1945; 1951 - 1956; 1969-70 - Wet Mix B	"	"	L10ss-051M-QA	0 to 1	1 + PETN	0	1	1	-	1 -
Field MI Duplicate to LL10ss-051-SO MI-QA	PE-15	1941 - 1945; 1951 - 1956; 1969-70 - Wet Mix B	"	"	LL5ss-062M-SO	0 to 1	1 + PETN	1	1	0		1 -

Table 8. Sample and Building information and laboratory QA samples for soil samples collected at Load Line 10.

Facility/Area	Building	Building Utilization	Slab Area sq. ft.	MI Area sq. ft.	Sample ID	Depth (ft)	Number of Samples					
							Explosives	Propellants	Metals	SVOCs	VOCs	Pesticides/Herbicides/PCBs
QC Duplicate to LL10ss-051-SO	PE-15	1941 - 1945; 1951 - 1956; 1969-70 - Wet Mix B	"	"	LL5ss-064M-SO	0 to 1	1 + PETN	1	0	0		0 -
	PE-16	1941 - 1945; 1951 - 1956; 1969-70 - Dry House	240	240	L10ss-060M-SO	0 to 1	1	-	1	-	-	- -
	PE-18	1941 - 1945; 1951 - 1956; 1969-70 - Mixture Inspection Bldg.	625	625*	L10ss-052M-SO	0 to 1	1+QB	1	1	-	-	-
	PE-19	1941 - 1945; 1951 - 1956;19 69-70 - Gum Solution Bldg.	470	470	L10ss-053M-SO	0 to 1	1	-	1	1	-	1
	PE-20	1941 - 1945; 1951 - 1956; 1969-70 - Potassium Chlorate Magazine	160	160	L10ss-054M-SO	0 to 1	1	-	1	-	-	-
	PE-21	1941 - 1945; 1951 - 1956; 1969-70 - TNT Magazine	160	160	L10ss-055M-SO	0 to 1	1	-	1	-	-	-
	PE-22	1941 - 1945; 1951 - 1956; 1969-70 - Solvent Storage Bldg	39	39	L10ss-056M-SO	0 to 1	1	-	1	1	-	1
	PE-28	1941 - 1945; 1951 - 1956 - Primer Canning Bldg.; 1969-70 - Not In Use	117	117	L10ss-057M-SO	0 to 1	1	-	1	-	-	-
	PE-29	1941 - 1945; 1951 - 1956 - Primer Canning Bldg.; 1969-70 - Not In Use	117	117	L10ss-058M-SO	0 to 1	1	-	1	-	-	-
	PE-30	1941 - 1945; 1951 - 1956; 1969-70 - PETN Screen House	240	240	L10ss-059M-SO	0 to 1	1 + PETN	-	1	-	-	-
Discrete Surface Soil Locations	PE-19	1941 - 1945; 1951 - 1956;19 69-70 - Gum Solution Bldg.	470	470	L10ss-060D-SO	0 to 1		-	-	-	1	-
QA	PE-19	1941 - 1945; 1951 - 1956;19 69-70 - Gum Solution Bldg.	"	"	L10ss-060D-QA	0 to 1					1	
QC Duplicate to LL10ss-060D-SO	PE-19	1941 - 1945; 1951 - 1956;19 69-70 - Gum Solution Bldg.	"	"	L10ss-066D-SO	0 to 1					1	
"	PE-22	1941 - 1945; 1951 - 1956; 1969-70 - Solvent Storage Bldg	39	39	L10ss-061D-SO	0 to 1		-	-	-	1	-

Total number of samples (minus lab QA samples) sent to the Primary, QA, and QB Laboratory for each analysis (planned/actual).

Lab	Explosives	Propellants	Metals	SVOCs	VOCs	Pest/ Herb/PCBs
Test America Primary Laboratory	27*/27	4/3	27/27	5/3	3/3	5/4
GPL - QA Laboratory	2**/1	1/0	2/2	1/1	1/1	1/1
	*22 + 5 W/PETN					
	** 1 + 1W/PETN					
Kemron QB Laboratory	2/3	1/0	2/2	1/1	1/1	1/1

Color Key		Primary Sample
		Quality Assurance
		Field MI Duplicate
		Blind Duplicate
		MS/MSD Pair
		Discrete

*** MI Sample from this Grid consisted of 30 aliquots or increments. All other Grids (MI samples) consisted of 15 aliquots.**

Results for MS/MSD not shown in data tables
0 - Sample was planned to be, but was not actually tested for
(1) - Sample was not planned to be, but was tested for
- Sample was not planned to be, nor was it tested for

3.2.4 Specific Sample Information for each Load Line

3.2.4.1 Load Line 5 Sampling

Table 5 presents the sample information for the soil samples collected from LL 5. Fifteen grids (12 buildings each with one grid and one building {1F-WP-11} which was divided into 3 grids = 15 grids) were established for LL 5 to assess the potential impact of operations on the soils within the AOC and determine the nature of contamination found within grids.

One MI surface soil (0-l ft.) sample was collected at each of the 15 grids as described in Appendix C. Two MI sample duplicates were collected from LL5 (Table 5). The sample and any duplicate were submitted to Test America – North Canton, OH for processing and analyses. Once the samples were processed, Test America prepared three split samples and sent one each to GPL, CRREL, and Kemron Environmental Services.

Three discrete VOC samples were collected from different grids within LL 5 (Table 5). The samples were taken in accordance with the FWSAP. One discrete VOC sample (LL5ss-030M-SO) was collected, independent of any MI sampling grids, outside Building 1F-WP-15 (formerly used for paint storage). These samples were sent to Test America – North Canton, OH. One split sample associated with this location was collected and submitted for analysis to GPL Labs (QA sample) and another split sample to Kemron Environmental Services (QB sample). Samples were prepared, packaged and shipped per guidance in the FWSAP and the SAP. A field sampling form documenting this sampling activity is presented in Appendix B of this report.

3.2.4.2 Load Line 7 Sampling

Table 6 presents the sample information for the soil samples collected from LL 7. Thirteen grids (11 buildings each with one grid and one building {Building 1-B-6} with two grids = 13 grids) were established for LL 7 to assess the potential impact of operations on the soils within the AOC and determine the nature of contamination found within grids.

One MI surface soil (0-l ft) sample was collected from each grid. In addition, two duplicate MI samples were collected from LL 7. All MI samples were collected as described in Appendix C. Samples were submitted to Test America – North Canton, OH for processing and analyses. Once the samples were processed, Test America prepared three split samples and sent one each to GPL, CRREL, and Kemron Environmental Services.

Three sets of discrete VOC samples were collected within grids within LL 7 (Table 6). One discrete VOC sample (LL7ss-055D-SO) was collected, independent of any MI sampling grids, outside Building 1B-WP-22 (formerly used for solvent storage). The discrete surface soil (0-l ft) samples were collected as specified in the FWSAP and the SAP. The discrete VOC samples

were not subjected to MI sample drying or processing. The primary samples were sent to Test America – North Canton, OH. One split sample associated with this location was collected and submitted for analysis GPL Labs (QA sample) and another split sample to Kemron Environmental Services (QB sample). Samples were prepared, packaged and shipped per guidance in the FWSAP and the SAP. A field sampling form documenting this sampling activity is presented in Appendix B of this report.

3.2.4.3 Load Line 8 Sampling

Table 7 presents the sample information for the soil samples collected from LL 8. Thirteen grids (11 buildings each with one grid and one building {Building 2B-6} with two grids = 13 grids) were established for LL 8 to assess the potential impact of operations on the soils within the AOC and determine the nature of contamination found within grids.

One MI surface soil (0-l ft) sample was collected from each grid as described in Appendix C. Two MI duplicate samples were collected from LL 8. Samples were submitted to Test America for processing and analyses. Once the samples were processed, Test America prepared three split samples and sent one each to GPL, CRREL, and Kemron Environmental Services.

Three discrete VOC samples were collected within grids at LL 8 (Table 7). One discrete VOC sample (LL8ss-055D-SO) was collected, independent of any MI sampling grids, outside the Building 2B-WP-22 (formerly used for solvent storage). The discrete surface soil (0-l ft) samples were collected as specified in FWSAP and SAP and were not subjected to sample drying or processing. One split sample associated with this location was collected and submitted for analysis GPL Lab (QA sample) and another split sample to Kemron Environmental Services (QB sample). Samples were prepared, packaged and shipped per the FWSAP and SAP. A field sampling form documenting this sampling activity is presented in Appendix B of this report.

3.2.4.4 Load Line 10 Sampling

Table 8 presents the sample information for the soil samples collected from LL 10. Twenty one grids (19 buildings each with one grid and one building {Building PE-1} with two grids = 21 grids) were established for LL 10 to assess the potential impact of operations on the soils within the AOC and determine the nature of contamination found within grids.

One MI surface soil (0-l ft) sample was collected from each grid as described in Appendix C. Two MI duplicate samples were collected from LL 10. Samples were submitted to Test America for processing and analyses. Once the samples were processed, Test America prepared three split samples and sent one each to GPL, CRREL, and Kemron Environmental Services.

Three discrete VOC samples were collected within grids at LL 10 (Table 8). One discrete VOC sample (LL10ss-061D-SO) was collected, independent of any MI sampling grids, outside the

Building PE-19 (formerly used for solvent storage). The discrete surface soil (0-l ft) sample was collected as specified in the FWSAP and SAP. The discrete VOC samples were not subjected to MI sample drying or processing. One split sample associated with this location was collected and submitted for analysis to GPL Labs (QA sample) and another split sample collected and sent to Kemron Environmental Services (QB sample). Samples were prepared, packaged and shipped per guidance in the FWSAP and SAP. A field sampling form documenting this sampling activity is presented in Appendix B of this report.

3.2.5 Sample Handling and Documentation

The aliquots (increments) were placed into a plastic-lined bucket and combined to make one bulk MI sample for each grid in this investigation. The bulk sample was tied, labeled and delivered to Building 1036 for storage in a refrigerator until shipped to the laboratories where the samples were processed. A set of typical sample labels is shown on Figure 8. The green labels were from the field to the primary lab, Test American – North Canton, OH. One green label was placed on the bulk sample, another on a cardboard tag tied to the plastic liner, and a third on a larger clear plastic bag wrapped around the bulk sample with rubber bands to secure the outer bag to the inner bag. The white labels were used for interlab shipping of samples. The entire bulk sample was then forwarded to the primary fixed-base laboratory, Test America – North Canton, OH, where laboratory sample preparation, consisting of air-drying, sieving (size #10), and grinding was done to provide a small representative sample suitable for chemical analysis. Chain-of-Custody forms were completed for each sample and sent with each sample to the appropriate laboratories. All samples were labeled according to procedures in the SAP (USACE) 2007 and FWSAP. Completed chain-of-custody forms are provided in Appendix D.

Soil samples that were analyzed for explosive analytes were prepared by drying, sieving and grinding at Test America – North Canton, OH, and then sent to CRREL where they performed Method 8330B Ring and Puck Mill grinding (SW-846 Manual, USEPA 2007) on each sample. The standard operating procedure (SOP) for laboratory drying and particle size reduction is provided in Appendix D of this document. Figure 7, Flow Chart of Field Samples to Analytical Labs shows the types of analyses each of the project laboratory performed.

Tables 5, 6, 7, and 8 summarize the number of samples collected, type of analyses for each sample, receiving laboratory, date of sample collection and sample depth at which the samples were collected for LLs 5, 7, 8, and 10 respectively.

3.2.6 Sample Numbering System

The sample numbering system that was used to identify samples collected during the investigation is explained in Section 5.3 of the FWSAP. Samples were previously collected at each LL; therefore, sample numbering continued the sequence established in the previous investigation. Tables 5 through 8 define the sample identification listing for the soil samples collected for this investigation. Example sample labels are shown on Figure 8.

3.2.7 Sample Shipping, Packaging and Preservation

Packaging and shipping of primary samples followed procedures specified in Chapter 6.0 of the FWSAP. Coolers containing QA samples that were shipped to the USACE contract laboratory for independent analysis were prepared and shipped in accordance with the FWSAP. The addresses and points-of-contact for laboratories used for chemical analyses for this field effort are listed in SAP. MI samples and discrete samples were prepared similarly for shipping. These samples were labeled, triple-layered with plastic, packed and sealed in an ice-filled cooler. The Chain-of-Custody forms were attached to the cooler and these samples were sent to the required laboratories.

3.3 LABORATORY ANALYSES AND PROCEDURES

3.3.1 Designated Laboratories and Roles

There were several laboratories involved in this investigation. Figure 7 and Table 9 show the laboratories and the appropriate designations. Test America was designated as the Primary Lab. Test America (formerly known as STL) is located in North Canton, Ohio. As the Primary Lab, Test America processed all bulk samples and completed all primary analyses on the samples except explosives and propellants. MI samples were processed according to MI SOP (Appendix C). Test America then split the samples, and sent a portion to (CRREL). CRREL pulverized the samples, as per Method 8330B, and sent portions back to Test America – Sacramento, CA. CRREL also sent portions of the pulverized samples to GPL Laboratory (QA) and Kemron Environmental Services (QB). GPL Laboratory and Kemron Environmental Services also received some samples directly from the field for VOC analyses.

3.3.2 Laboratory Methods for Analytes

Table 10 provides the laboratory methods from USEPA's methods described in the Solid Waste – 846 (USEPA 2007). Sampling handling and preparation were conducted following the techniques in the SAP, FWSAP, and the MI sampling guide (Appendix C).

3.3.3 Laboratory Quality Control Procedures

The bulk MI soil samples were brought to Building 1036, and stored in a refrigerator until they were shipped on ice to the primary laboratory, Test America. At the primary laboratory, the entire sample was refrigerated until it was air-dried, sieved, and ground. The primary lab conducted its QC, and the secondary lab (GPL), conducted its QA on a representative split of the processed sample.

Table 9. Information and the role of each laboratory that analyzed samples for this study.

Laboratory	Address	Title	Sample Processing	Samples Analyzed
Test America (formerly Severn Trent Laboratories - STL)	4101 Shuffel Drive North Canton, OH	Primary	Air Dry, Sieve, Grind	Metals, SVOCs, PCBs, Pesticides.
Test America (formerly Severn Trent Laboratories – STNS)	880 Riverside Parkway West Sacramento, CA	Primary	Performed at Test America at North Canton	Explosives and Propellants.
GPL	7210A Corporate Court Frederick, MD	QA USACE's QA Lab	Performed at Test America at North Canton	Metals, SVOCs, PCBs, Pesticides, Explosives, Propellants, VOCs.
Kemron Environmental Services	156 Starlite Drive Marietta, OH	QB (Ohio EPA's QA Lab)	Performed at Test America at North Canton	Metals, SVOCs, PCBs, Pesticides, Explosives and Propellants, VOCs.
CRREL (Cold Regions Research and Engineering Laboratory)	72 Lyme Road Hanover, NH	Secondary	Pulverize with Puck Mill	Explosives and Propellants.

Table 10. Laboratory methods used for each of the analyses completed for this study.

Parameter	Method
VOCs	SW-846, 8260B/5030
SVOCs	SW-846, 8270C/3540C/3520C
Pesticides	SW-846, 8081A/3540
PCBs	SW-846, 8082/3540
Explosives – (for example) HMX - cyclotetramethylene-tetranitramine PETN - pentaerythritol tetra nitrate RDX - cyclotrimethylenetrinitramine	SW-846, 8330/3540C/3520C
Explosive - Nitroglycerine (NG)	SW-846, 8332
Propellant - Nitrocellulose (NC)	SW-846, 9056 Mod
Metals (TAL)	SW-846, 3050B (according to 6010B and 6020A) SW-846, Cold Vapor Analysis for Mercury 7470A and 7471A

Matrix spike/matrix spike duplicate samples were collected at a rate of 5% of total samples per media. Duplicate and split samples were derived from the same sampling station, selected on a random basis, and submitted for the same analyses with the other samples. Two rinsate blanks were collected for surface soil equipment per field cycle. Trip blanks accompanied all shipments containing VOCs, and temperature blanks were added to all coolers. The SAP and FWSAP summarize laboratory requirements. Quantitative comparisons of the primary to duplicate MI samples, comparisons of primary to QC analytical data, primary to QA analytical data, and primary to QB analytical data are shown for on the analytical data sheets in Appendix D. Table 11 provides summary comparisons of this data. Discussion of laboratory quality control is provided in Paragraph 3.2.3 above.

3.4 DATA REDUCTION, VALIDATION, AND REPORTING

3.4.1 Data Reduction

Sample collection and field measurements followed the established protocols defined in the FWSAP. Laboratory data reduction followed the laboratory specific QAPP guidance and conformed to general guidance provided by the FWSAP, and the Louisville Chemistry Guideline, Rev. 5, (USACE 2002).

3.4.2 Data Verification / Validation

Project data verification and validation followed guidance provided in the FWQAPP Section 9.2. A minimum of 10% of the data acquired during this investigation was validated in accordance with the guidance provided in the FWSAP and the Louisville Chemistry Guideline, Rev. 5, (USACE 2002).

3.4.3 Comparison of the Quality Assurance and the Laboratory Performance

Table 11 presents the comparison of the field and laboratory quality control metrics evaluated in this study.

Table 11. Comparison of the field and laboratory Quality Control metrics evaluated in this study.

		Field and Analytical Quality Control					Analytical Quality Control Metrics															
		Primary MI vs Duplicate MI					Primary vs QC							Primary vs QA					Primary vs QB				
AOC	Type Analyses	Number Samples	Number Detects	Avg RPD (%)	Number Detects	Avg RPD (%)	Number Samples	Number Detects	Avg RPD (%)	Number Detects	Avg RPD (%)	Number Detects	Avg RPD (%)	Number Samples	Number Detects	Avg RPD (%)	Number Detects	Avg RPD (%)	Number Samples	Number Detects	Avg RPD (%)	Number Detects	Avg RPD (%)
LL-5	Metals	2	15	23.58	15	14.28	1D,2	15	30.51	15	12.67	16	13.24	2	16	26.13	15	27.59	2	16	22.27	15	19.72
	SVOC	2	0		0		0							2	0		0		2	0		0	
	PCBs	2	0		0		0							2	0		0		2	0		0	
	VOCs	NA					1D	0						1D	0				1D	0			
LL-7	Metals	2	15	17.41	16	8.81	1	15	3.06					2	16	23.67	16	23.9	2	16	18.13	16	20.52
	SVOC	1	6	17.67			0							1	7	30.83			1	7	9.8		
	PCBs	1	0				1	0						1	0				1	0			
	VOCs	NA					1D	0						1D	0				1D	0			
LL-8	Metals	2	15	9.79	15	15.31	1	15	25.9					2	16	33.13	15	38.84	2	16	18.08	15	18.29
	SVOC	1	3	98.7			0							0					1	3	15.23		
	PCBs	1	0				0							0					1	1	68.46		
	VOCs	NA					1D	0						1D	0				1D	0			
LL-10	Metals	2	15	12.85	15	9.35	2	15	6.62	15	7.23			2	15	28.13	16	24.02	2	15	17.61	16	22.82
	SVOC	0					0							1	7	15.63			1	7	16.87		
	PCBs	1	0				0							1	0				1	0			
	VOCs	NA					1D	1	23.46					1D	0				1D	0			

Primary MI vs Duplicate MI		Primary vs QC		Primary vs QA		Primary vs QB	
		*Avg of 30.51% not used in Metals since it's a discrete sample					
Avg Metals RPD (%) =	13.88	Avg Metals RPD (%) =	11.47	Avg Metals RPD (%) =	28.10	Avg Metals RPD (%) =	19.71
Std Dev Metals RPD (%) =	12.84	Std Dev Metals RPD (%) =	20.85	Std Dev Metals RPD (%) =	16.49	Std Dev Metals RPD (%) =	15.54

NOTES:
Avg - Average Value
Duplicate MI sample is a second, independently collected field MI sample in the same sampling area as the Primary MI sample; analytical lab for both the Primary MI and Duplicate MI was Test America- North Canton, OH and Sacramento, CA
The Primary lab is Test America – North Canton, OH; except that analyses for explosives and propellants were conducted at Test America – Sacramento, CA
The Quality Assurance (Corps QA) Lab is GPL Laboratory
The Quality Assurance (OH EPA QB) is Kemron Laboratory
The "D" following the number of samples indicates a discrete sample

3.5 DATA EVALUATION METHODS

The concentrations of the chemicals detected in the samples for this study were evaluated to determine which of the chemicals site-related compounds (SRCs) were and Chemicals of Potential Concern (COPCs). The determination of which chemicals were SRCs and COPCs was based upon results of several screening processes. The screening processes are described in the following sections in the order they were performed.

3.5.1 Essential Nutrient Screen

Chemicals considered as essential nutrients (i.e., calcium, iron, magnesium and potassium) are an integral part of the food supply and are often added to foods as supplements. Thus, these constituents are not generally addressed as contaminants as directed by the Facility Wide Human Health Risk Assessor Manual (FWHHRAM) (USACE 2005) unless they are grossly elevated relative to background values. During this under slab sampling investigation, analyses were conducted for calcium, iron, magnesium, potassium and sodium. If the detected concentration of these five chemicals was similar to background, they were eliminated as SRCs and COPCs in this investigation. Once the chemicals deemed to be an essential nutrient were eliminated from additional evaluation, a screen to compare to the concentrations of the remaining chemicals to the US Region 9 Residential Preliminary Remediation Goals (PRGs).

3.5.2 PRG Screen

All positive detections not considered to be an essential nutrient were compared to PRGs. The most updated PRG values can be found at the following website: http://www.epa.gov/region09/waste/sfund/prg/index.htm. Per the FWHHRAM, the PRG value for non-cancer effects for each chemical was adjusted by $1/10^{th}$ the value. Screening values listed for residential receptors will be used. All chemicals (excluding the essential nutrients) that exceeded the PRGs were retained as SRCs and COPCs. Chemicals with concentrations less than the PRG were eliminated as SRCs and COPCs.

3.5.3 Background Screen

Analytical results of the chemicals with an established facility-wide surface soil background values for RVAAP developed as part of the RI for the Winklepeck Burning Grounds (WBG) April, 2001 (SAIC 2001b) were further assessed. These facility-wide background criteria and the processes used to generate them have been reviewed and accepted by USACE and Ohio EPA. This screening step was used to determine if the concentrations of the remaining chemicals were such that they were SRCs and COPCs or if they are naturally occurring. Discussion of this process is contained in Paragraphs 3.4 and 3.5 of FWHHRAM.

4.0 NATURE OF CONTAMINATION

This section summarizes the analytical results from surface soil (0 – l ft) sampling.

4.1 DETERMINATION OF SRCS AND CHEMICALS OF POTENTIAL CONCERN

A summary of all surface soil (0 – l ft) analytical results with detection values in bold is presented in Appendix D. The Laboratory Data Verification Report s associated with these data is provided in Appendix E. Several detected chemicals were removed from consideration as a SRC or COPC because they were eliminated as essential nutrients. These chemicals were: calcium, potassium, iron, and magnesium. Because discrete samples were analyzed only for VOCs, no screening of nutrients or background was completed for these sample results.

Concentrations of the remaining chemicals were compared to PRGs. The surface soil (0 – l ft) analytical results that exceeded PRGs are summarized in Tables 12, 13, 14, and 15 for LLs 5, 7, 8, and 10 respectively.

Following this screen, the chemicals with an established RVAAP background were subjected to another screening process. This screen served to remove the analytes with concentrations that were less than RVAAP background criteria. The surface soil (0 – l ft) analytical results that exceeded chemicals for which there was an established background values are summarized in Tables 12, 13, 14, and 15 for LLs 5, 7, 8, and 10 respectively.

A summary of all surface soil (0 – l ft) analytical results with detected values as well as the determination of whether or not the chemical exceeded the PRG or background value is presented in Tables 12, 13, 14, and 15 for LLs 5, 7, 8, and 10 respectively. In addition, the chemical is identified as whether or not it is an SRC or a COPC.

4.2 MULTI-INCREMENT SAMPLES

MI samples were collected and analyzed for TAL metals; explosives, pesticides; PCBs; and SVOCs. Some of the samples were analyzed for propellants. Analytical results are discussed in the following LL sections and are assessed by chemical group (e.g., metals, VOCs, etc) for each LL. Explosives and propellants are discussed together.

Table 12. Surface soil samples from LL 5 with detected concentrations (mg/kg)of metals that were greater than background and/or Region 9 PRGs (mg/kg).

Analyte	PRG	*Classification (see below)	Background	LL5SS-037	LL5SS-031	LL5SS-032	LL5SS-033	LL5SS-035	LL5SS-036	LL5SS-038	LL5SS-039	LL5SS-040	LL5SS-041	LL5SS-045	LL5SS-034	LL5SS-044	LL5SS-046
Building				1F-WP-9	1F-WP-1	1F-WP-3	1F-WP-4	1F-WP-7	1F-WP-8	1F-WP-10	1F-WP-11	1F-WP-11	1F-WP-11	1F-WP-19	1F-WP-6	1F-WP-18	1F-WP-20
Aluminum	7614	nc	17700	9690		9110	9420	8780		8850	8070	8800	7820		8500	8110	8380
Arsenic	0.39	ca	15.4	8.1	7.8	10.2	11.2	10.3	11.7	10.6	9.5	8.8	8.4	9.2	9.5	8.4	9.8
Barium	538	nc	88.4														
Chromium	30	ca	17.4	22.8		23.4	25.2	20.4		86.7		20.3			17.5	20.4	23.9
Copper	313	nc	17.7			19.7	19.1	19.4		21.2				17.8	23		
Iron	2346	nc/n	23100	15500	15000	17800	19000	17400	14200	19900	16600	15900	15500	14500	17900	15400	16800
Lead	400	pbk	26.1	108	32.8	41.9	30.3	37.7		48.3				28.2	35.2 E	50	72.7
Manganese	176	nc	1450	424	450	481	284	471	333	359	482	373	276	524	617	717	497
Mercury	2.3	nc	0.04	0.094 B	0.041 B	0.14	0.4		0.055 B		0.083 B					0.048 B	0.099 B
Nickel	156	nc	21.1		22.6	29.6	27.2	25.4		29.6	21.2		22.2	24.8	25.6	25.9	
Vanadium	7.8	nc	31.1	16.3	12.1	14.1	15.2	14.3	11.1	16.1	13.4	13.4	12.8	11	13.5	12.9	14.6
Zinc	2346	nc	61.8		70	84		78.8		99.4				102	79.6	95.2	115

* ca – carcinogen
nc – non-carcinogen
n – nutrient
pbk – Pharmacokinetic Lead Model
B – estimated result due to concentration detected was less than the Reporting Limit
E – matrix interference

Tables 13. Surface soil samples from LL 7 with detected concentrations (mg/kg) of metals that were greater than background and/or Region 9 PRGs (mg/kg).

Analyte	PRG	Classification (see below)	Background	LL7SS-043	LL7SS-049	LL7SS-051	LL7SS-053	LL7SS-045	LL7SS-042	LL7SS-044	LL7SS-045	LL7SS-046	LL7SS-047	LL7SS-048	LL7SS-050	LL7SS-052
Building				1B-WP-2	1B-WP-7	1B-WP-13	1B-WP-18	1B-WP-4	1B-WP-1	1B-WP-3	1B-WP-4	1B-WP-5	1B-WP-6	1B-WP-6	1B-WP-12	1B-WP-17
Aluminum	7614	nc	17700	8230		9750			9010			8170			8280	8950
Arsenic	0.39	ca	15.4	10.2	9	10	10.4	15.1	9.5	9	9	10.3	9.2	11.4	12.9	13
Barium	538	nc	88.4													
Chromium	30	ca	17.4	29.6	24.8	17.9	19.1	17.4	91.6	29	21.5				30.6	97.5
Cobalt	30	ca	10.4						6.6 E							
Copper	313	nc	17.7				26.7	23.4						19.6		20.7
Iron	2346	nc/n	23100	15800	13800	17700	16300	15700	18300	17800	15400	16500	14200	16100	19400	22400
Lead	400	pbk	26.1	36.2			50.7		44.9	45.7		58.5			29.9	61.2
Manganese	176	nc	1450	412	313	386	425	426	473	406	358	527	450	355	707	617
Mercury	2.3	nc	0.04						0.04 B	0.046 B	0.047 B					
Nickel	156	nc	21.1	31.1	28.1	25.5		27.5	23.1	28.5	28.3	25.5	21.7	24.7	27.9	25.2
Vanadium	7.8	nc	31.1	12.6		14.4	9.8	10.7	15.4	13.3	11.9	14.6	10.9	10.9	15.9	17.8
Zinc	2346	nc	61.8	65.2			96.5	79.6	74.5	102	53.4	63.3			74.4	96.4

* ca – carcinogen
nc – non-carcinogen
n – nutrient
pbk – Pharmacokinetic Lead Model

B – estimated result due to concentration detected was less than the Reporting Limit
E – matrix interference

Table 14. Surface soil samples from LL 8 with detected concentrations (mg/kg) of metals that were greater than background and/or Region 9 PRGs (mg/kg).

Analyte	**PRG**	***Classification (see below)**	**Background**	**LL8SS-045**	**LL8SS-047**	**LL8SS-054**	**LL8SS-043**	**LL8SS-044**	**LL8SS-046**	**LL8SS-048**	**LL8SS-049**	**LL8SS-050**	**LL8SS-051**	**LL8SS-052**	**LL8SS-053**	**LL8SS-042**
Building				2B-WP-4	2B-WP-6	2B-WP-22	2B-WP-2	2B-WP-3	2B-WP-5	2B-WP-6	2B-WP-7	2B-WP-12	2B-WP-13	2B-WP-17	2B-WP-21	2B-WP-1
Aluminum	7614	nc	17700	8880	9020	8930		9110	9810	7790		8030		8490	11300	8580
Arsenic	0.39	ca	15.4	8.1	7.1	8.8	9.9	11.6	8.8	8.7	10.5	9.5	9	10.5	13.3	11.8
Barium	538	nc	88.4						93							
Chromium	30	ca	17.4	20	18.4		21.8	19	27.9	23.1	20	30.5	24.7	19.5	28.2	18.9
Copper	313	nc	17.7			18	17.7	18.2			19.5	18.2		19	20.7	20.8
Iron	2346	nc/n	23100	15500	14000	15100	16100	18800	17200	14700	16100	19300	16700	18000	23700	19300
Lead	400	pbk	26.1	51.5			40	52.3	60.1	37	39.7	42.3	53.9	66.5		73.4
Manganese	176	nc	1450	427	414	790	377	552	906	517	476	473	588	496	455	451
Mercury	2.3	nc	0.04						0.041 B			0.045 B				
Nickel	156	nc	21.1	0.066 B	22.2	23.6	28	24	162	35.9	30.6	28.3	26.5	36.9	31	26.2
Vanadium	7.8	nc	31.1	13.9	12.7	13.2	11.6	13.6	13.3	12.1	11.8	14.6	12.5	13.4	18.3	14.2
Zinc	2346	nc	61.8	89.4			79.3	98.6	105		77.3	94.5	83.7	119	76.9	73.2

* ca – carcinogen
nc – non-carcinogen
n – nutrient
pbk – Pharmacokinetic Lead Model

B – estimated result due to concentration detected was less than the Reporting Limit

Table 15. Surface soil samples from LL 10 with detected concentrations (mg/kg) of metals that were greater than background and/or Region 9 PRGs (mg/kg).

Analyte	PRG	*Classification (see below)	Background	LL10SS-042	LL10SS-043	LL10SS-044	LL10SS-045	LL10SS-046	LL10SS-048	LL10SS-049	LL10SS-059	LL10SS-040	LL10SS-041	LL10SS-047	LL10SS-050
Building				PE-4	PE-5	PE-6	PE-7	PE-8	PE-10	PE-12 & 13	PE-30	PE-1	PE-1	PE-9	PE-14
Aluminum	7614	nc	17700	8990	10100	8860	8150	8470	10600	8130	9120	9490	10100		8780
Arsenic	0.39	ca	15.4	12.1	12.7	13.9	12.4	13.7	11.5	13.8	11.6	12.5	12.1	13.3	11.2
Barium	538	nc	88.4					90.9							
Chromium	30	ca	17.4	28.8	18.6	18.7	19.6	19.1	21.6	22.1	21.5	21		18.3	21
Copper	313	nc	17.7	18.9	18.9		20.6	21.1	19.2	22.9	18.3	21.1	21.6	20.3	22.1
Iron	2346	nc/n	23100	17700	19300	18200	18600	19300	22600	19600	20300	21000	19900	17100	19100
Lead	400	pbk	26.1	76.6	49	42.5	91.6	62.7	34.6	102	124		27.7	58.4	77.6
Manganese	176	nc	1450	737	842	659	676	589	483	681	464	449	463	417	551
Mercury	2.3	nc	0.04		0.045 B	0.04 B	0.043 B	0.04 B		0.045 B	0.1 B				0.042 B
Nickel	156	nc	21.1	30.1	26.6	22.4	29.9	26.2	24.4	28.1	37.4	32	30.4	25.5	28.9
Vanadium	7.8	nc	31.1	14.2	14.3	14.8	14.2	14.3	18.5	13.7	16.7	14.7	15.3	13.3	
Zinc	2346	nc	61.8	86.3	94.7	71.5	116	114	68.5	124	146	67.3	72.7	80.5	108

				LL10SS-051	LL10SS-052	LL10SS-053	LL10SS-054	LL10SS-055	LL10SS-056	LL10SS-058M	L10SS-057M-SO
Building				PE-15	PE-18	PE-19	PE-20	PE-21	PE-22	8/9/2007	8/9/2007
Aluminum	7614	nc	17700	8080	9020	9910	9720	8890	8460	7940	9300
Arsenic	0.39	ca	15.4	10.1	10.1	20	9.9	11	12.1	11.4	12
Barium	538	nc	88.4								
Chromium	30	ca	17.4	17.4		17.7	26.4	24.3		18.2	19.1
Copper	313	nc	17.7	18.7		19.6	18.4	22.1	22.4		21.5
Iron	2346	nc/n	23100	16400	14900	19700	15800		19000	19200	21200
Lead	400	pbk	26.1	48.4	80	41.9	28.1	64	45.7	63.4	114
Manganese	176	nc	1450	482	574	616	598	604	418	647	490
Mercury	2.3	nc	0.04			0.045 B				0.049	0.041
Nickel	156	nc	21.1	24.8		29.1	29	29.3	22.4	30.5	25.4
Vanadium	7.8	nc	31.1	13.2	11.9	16.4	12.5	13.8	13.7	15.2	17.4
Zinc	2346	nc	61.8	88.5	135	84.1	68.8	105	94.4	125	136

* ca – carcinogen
nc – non-carcinogen
n – nutrient
pbk – Pharmacokinetic Lead Model

B – estimated result due to concentration detected was less than the Reporting Limit

4.2.1 TAL Metals

A total of 15 inorganic compounds were detected at least once in surface soil samples collected during the investigation. Three of the detected constituents were eliminated as potential SRCs because they were considered as essential nutrients (calcium, potassium and magnesium). Although iron is considered an essential nutrient, we retained it for further evaluation. Five of the metals (barium, copper, lead, mercury and zinc) did not exceed the PRG but did exceed their BG criteria and are therefore deemed SRCs/COPCs. Two of the metals (chromium and nickel) exceeded both their PRG and BG criteria and are therefore deemed SRCs/COPCs. Four metals (aluminum, arsenic, manganese and vanadium) exceeded their PRG criteria only and therefore are not considered SRCs or COPCs.

Table 12 presents the results of the concentrations of metals for soil samples from LL 5 that exceeded either PRG or BG. At LL5, the concentrations of lead, nickel and zinc exceeded their background criteria in more than 50% of the samples and are considered as prevalent inorganic SRCs. Lead exceeded BG 67% of the time, nickel exceeded BG 73% of the time and zinc exceeded BG 60% of the time. In addition two other inorganics (chromium and copper) exceeded BG at LL5. Chromium exceeded BG 47% of the time, copper exceeded BG 40% of the time.

Table 13 presents the results of the concentrations of metals for soil samples from LL 7 that exceeded either background or Region 9 PRGs. At LL 7 chromium, nickel and zinc exceeded their background criteria in more than 50% of the samples and are considered as prevalent inorganic SRCs. Chromium exceeded BG 54% of the time, nickel exceeded BG 92% of the time and zinc exceeded BG 66% of the time. In addition two other inorganics (copper and lead) exceeded BG at LL 7. Copper exceeded BG 31% of the time, lead exceeded BG 46% of the time.

Table 14 presents the results of the concentrations of metals for soil samples from LL 8 that exceeded either background or Region 9 PRGs. At LL8 chromium, copper, lead, nickel and zinc exceeded their background criteria in more than 50% of the samples and are considered as prevalent inorganic SRCs. Chromium exceeded BG 92% of the time, copper exceeded BG 62% of the time, lead exceeded BG 77% of the time, nickel exceeded BG 85% of the time and zinc exceeded BG 77% of the time. In addition one other inorganic (barium) exceeded BG at LL 8. Barium exceeded BG 8% of the time.

Table 15 presents the results of the concentrations of metals for soil samples from LL 10 that exceeded either background or Region 9 PRGs. At LL 10 chromium, copper, lead, nickel and zinc exceeded their background criteria in more than 50% of the samples and are considered as prevalent inorganic SRCs. Chromium exceeded BG 84% of the time, copper exceeded BG 84% of the time, lead exceeded BG 95% of the time, nickel exceeded BG 94% of the time and zinc exceeded BG 100% of the time. In addition two other inorganic (arsenic and barium) exceeded BG at LL 10. Arsenic and barium exceeded BG 5% of the time.

4.2.2 Pesticides/Herbicides and PCBs

There were twelve locations overall at the four AOCs that were sampled for pesticides/herbicides and PCBs. At LLs 5, 7 & 10 all samples for pesticides/herbicides and PCBs were non - detectable. At LL8, one PCB (Arochlor-1254) was detected in one sample from Building 2B-WP-4 (tetryl pelleting, melt pour operation) at a concentration of 100 µg/kg, which was an order of magnitude less than its PRG criteria. No other samples, QA or QB laboratory data, had detectable concentrations of any other PCBs.

4.2.3 Semi-Volatiles

Three SVOCs above the PRGs were detected at least once in the under slab surface soil sample investigation. Benzo (a) anthracene was detected above the PRG at three LLs; Benzo (b) fluoranthene was detected above the PRG at two LLs, and benzo (a) pyrene was detected above the PRG at two LLs. All of these SVOCs were retained as SRCs or COPCs.

Table 16 presents the results of the concentrations of SVOCs for soil samples from LLs 5, 7, 8 and 10 that exceeded the PRGs.

At LL5, Building 1F-WP-12 (fuze testing building) had one SVOCs (benzo (a) anthracene) retained as a SRC or COPC.

At LL7, Building 1B-WP-2 (tetryl screening & blending, main charge storage & melt pour and curing) had one SVOCs (benzo (a) pyrene) that was retained as a SRC or COPC.

At LL8, one sample had two SVOCs (benzo (a) anthracene, benzo (b) fluoranthene) that were retained as SRCs or COPCs. This sample was collected from Building 2B-WP-21 (booster assembly and shipping).

At LL10, three buildings had samples with at least one detectable SVOCs above the appropriate PRG. At Building PE-15 (wet mix building) one sample had three SVOCs (benzo (a) anthracene, benzo (b) fluoranthene, benzo (a) pyrene) that were retained as SRCs or COPCs. At Building PE-19 (gum solution), one sample had two SVOCs (benzo (a) anthracene, benzo (b) fluoranthene) that were retained as SRCs or COPCs. At Building PE-22 (solvent storage) one sample had one SVOC (benzo(b)fluoranthene) that was retained as a SRC or COPC.

Table 16. Surface soil samples (by sample number) from LLs 5, 7, 8 and 10 with detected concentrations (mg/kg) of SVOCs that were greater than Region 9 PRGs (mg/kg).

LL 5				**LL 8**				
Analyte	**PRG**	*****	**LL5SS-042M-SO from Building 1F-WP-12-**	**Analyte**	**PRG**	*****		**LL8SS-053M-SO from Building 2B-WP-21**
Benzo(a)anthracene	0.62	ca	1.400	Benzo(a)anthracene	0.62	ca		1.500
				Benzo(b)fluoranthene	0.62	ca		1.600
LL 7				**LL 10**				
Analyte	**PRG**	*****	**LL7-043M-SO from Building 1B-WP-2**	**Analyte**	**PRG**	*****	**LL10SS-051-SO from Building PE-15**	**LL10SS-053-SO from Building PE-19**	**LL10SS-056-SO from Building PE-22**
				Benzo(a)anthracene	0.62	ca	2.400	1.600	
Benzo(a)pyrene	0.062	ca	.390	Benzo(a)pyrene	0.062	ca	2.000		
				Benzo(b)fluoranthene	0.62	ca	2.600	1.800	2.300

Classification
* ca – carcinogen
-- Value not available

4.2.4 Explosives and Propellants

Three explosives and one propellant were detected at least once in the under slab surface soil sample investigation. Of the detected propellant compounds, NC was found at each LL. Three explosive compounds were detected; NG, HMX and RDX all had one detected sample each. The greatest value for NG was 0.6 and was collected at LL10. The greatest value for HMX and RDX were 0.89 and 0.27 respectively.

At LL 5, one propellant compound NC was detected at a concentration of 1.9 mg/kg in the sample collected from building 1F-WP-8 (delay loading house). No explosives were detected in the samples from LL 5.

At LL 7, one propellant and two explosives were detected. The propellant compound NC was detected in the samples collected from building 1B-WP-7 (testing) and 1B-WP-22 (M9 propellant storage) at concentrations of 3.0 mg/kg and 3.2 mg/kg respectively. The explosive compounds HMX and RDX were detected in a single sample collected from building 1B-WP-4 (pelleting and main charge storage) at concentrations of 0.89 mg/kg and 0.27 mg/kg respectively.

At LL 8, one propellant compound NC was detected at a concentration of 1.7 mg/kg in the sample collected from building 2B-WP-2 (tetryl screening storage). No explosives were detected in the samples from LL 8.

At LL 10, one propellant compound NC was detected in two samples. The samples collected from building PE-15 (wet mixture B) and building PE-18 (mixture inspection) at concentrations of 4.0 and 2.2 mg/kg respectively.

4.3 DISCRETE SAMPLE RESULTS

At each LL three discrete samples were taken. These samples were analyzed only for VOCs. None of the samples had detectable concentrations of the VOCs assessed in this investigation. Therefore no further characterization was completed to evaluate concentrations of VOCs.

5.0 SUMMARY

Sixty two MI samples were analyzed for TAL metals; explosives; pesticides; PCBs; and SVOCs. Nine MI samples were analyzed for propellants. Eleven discrete samples were analyzed for VOCs.

A total of 17 TAL metals were detected at least once in surface soil samples collected during the investigation. Ten of the detected metals were eliminated as potential SRCs or COPCs during the background screening process. These were aluminum, arsenic, calcium, cobalt, iron, magnesium, manganese, mercury, potassium and vanadium. The seven remaining TAL metals; (barium, chromium, copper, lead, mercury, nickel and zinc) were retained as SRCs or COPCs because of the concentrations at which they were detected was greater than that of background.

Three explosives were detected at least once in the under slab surface soil samples. All three explosives had one sample with detectable concentrations. The greatest value for NG (0.6 mg/kg) is less than the corresponding PRG of 35 mg/kg. The greatest concentrations for HMX and RDX were 0.89 mg/kg and 0.27 mg/kg and are both less than their corresponding PRG of 306 mg/kg and 4.4 mg/kg, respectively.

No pesticides were detected in the surface soil samples collected for this investigation.

At LL8, one PCB (Arochlor-1254) was detected at a concentration of 100 µg/kg in the sample collected from Building 2B-WP-4 (tetryl pelleting, melt pour operation). No QA or QB laboratory data could be found to support this result. The detectable PCB from LL8 was not retained as a SRC and COPC because of its concentration was less than the PRG 0.22 mg/kg.

Three SVOCs above PRG were detected at least once in a sample. Of the detected SVOCs; Benzo (a) anthracene above PRG was detected at LLs 5, 8, and 10; Benzo (b) fluoranthene above PRG was detected at LLs 8 and 10; and Benzo (a) pyrene above PRG was detected at LLs 7 and 10. These three SVOCs (benzo (a) anthracene, benzo (b) fluoranthene, benzo (a) pyrene) were retained as SRCs and COPCs because of their concentrations greater than PRGs.

One propellant was detected at least once in the under slab surface soil samples. Only NC was found at each LL. The greatest value for NC is (4.0 mg/kg). There is no evidence that NC has any detrimental effect on the environment. The only evaluation criterion (characteristic) that describes the potential for effects from NC is reactivity. If concentrations of the NC are such that it is reactive, then safety is the focus of the concern and not health effects. Specifically, NC must be at a concentration of 10% in order to fail characteristic reactivity. The average levels of NC at LL5, 7, 8 and 10 are orders of magnitude below its characteristic reactivity. Three explosive compounds were detected: NG, HMX and RDX.

No VOCs were detected in the surface soil samples collected for this investigation.

6.0 RECOMMENDATIONS

6.1 LOAD LINE 5

Of the 13 Buildings investigated at LL 5 for surface soil contamination, only two require additional evaluation. The buildings that have SRCs or COPCs include:

- Building 1F-WP-10 (detonator service magazine) because of (chromium).
- Building 1F-WP-12 (fuze testing) because of the following SVOC (benzo (a) anthracene).

6.2 LOAD LINE 7

Of the 12 buildings investigated at LL 7 for surface soil contamination only five require additional evaluation. The buildings that have SRCs or COPC include:

- Building 1B-WP-1 (tetryl and pellet magazine and booster storage), 1B-WP-12 (tetryl pellet storage) & 1B-WP-17 (cupped pellet rest house) because of the following metal (chromium).
- Building 1B-WP-2 (tetryl screening & blending, main charge storage & melt pour and curing) because of the following SVOC (benzo (a) pyrene).
- Building 1B-WP-4 (pelleting and main charge storage) because of the following explosives (HMX and RDX).

6.3 LOAD LINE 8

Of the 12 buildings investigated at LL 8 for surface soil contamination only four require additional evaluation. The buildings that have SRCs or COPCs include:

- Building 2B-WP-12 (tetryl pellet storage and detonator storage) because of the following metal (chromium).
- Building 2B-WP-5 (detonator magazine) because of the following metal (nickel).
- Building 2B-WP-4 (tetryl pelleting, melt pour operation) because of (PCB 1254).

- Building 2B-WP-21 (booster assembly and shipping) because of the following SVOCs (benzo(a) anthracene and benzo(b) fluoranthene).

6.4 LOAD LINE 10

Of the 20 buildings investigated at LL 10 for surface soil contamination only three require additional evaluation. The buildings that have SRCs or COPCs include:

- Building PE-15 (wet mix "B") because of the following SVOCs (benzo (a) anthracene, benzo (b) fluoranthene, benzo (a) pyrene).

- Building PE-19 (gum solution) because of the following SVOCs (benzo (a) anthracene, benzo (b) fluoranthene).

- Building PE-22 (solvent storage) because of the following SVOC (benzo (b) fluoranthene).

In summary, the SRCs or COPCs identified in the surface soils at LLs 5, 7, 8, and 10 and require additional evaluation were distributed as follows:

- Chromium at LLs 5, 7 and 8,

- Nickel at LL 8,

- SVOCs at LLs 5, 7, 8 and 10,

- PCB-Arochlor 1254 at LL 8,

- HMX and RDX at LL 7.

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FIGURES

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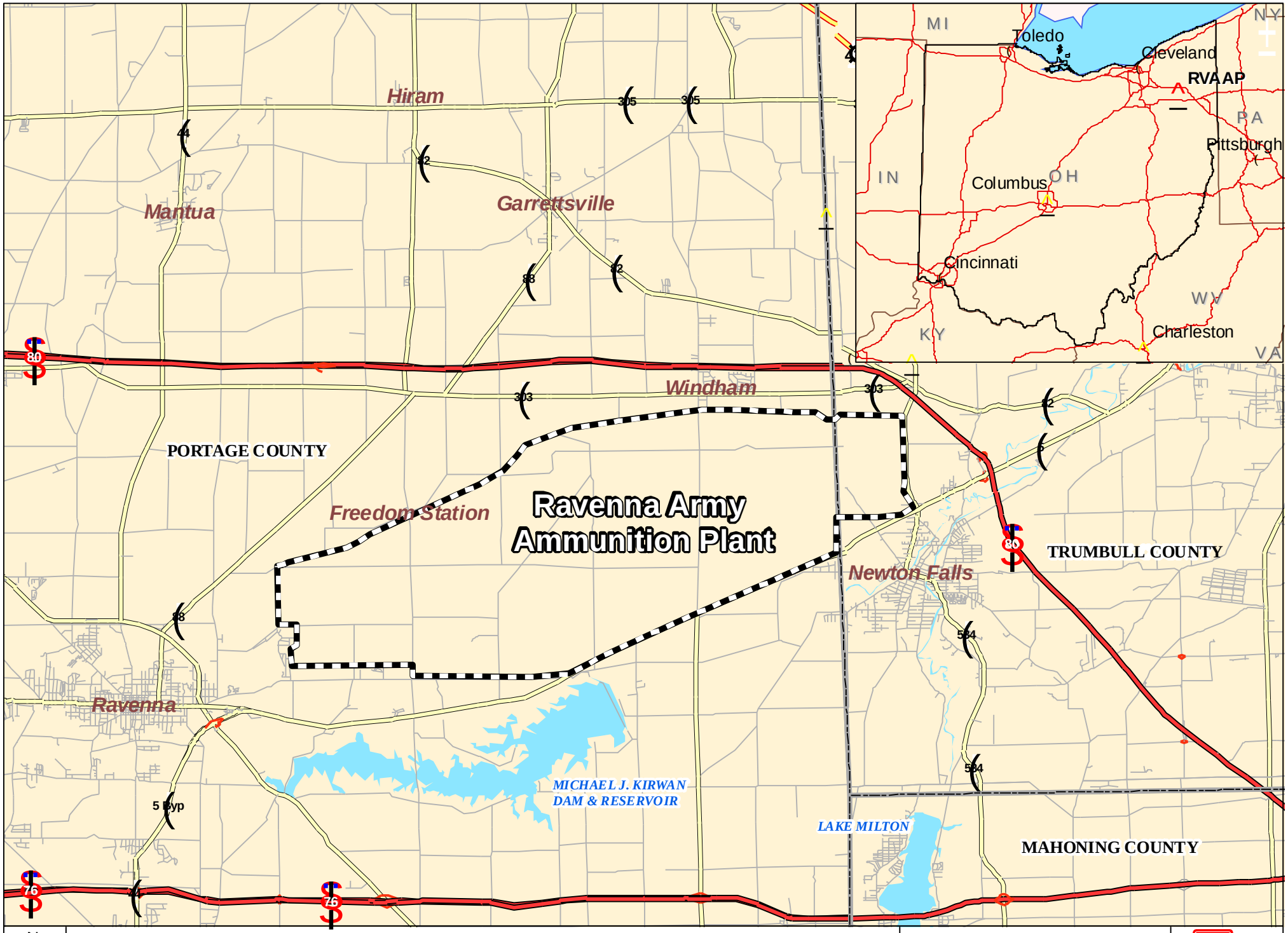
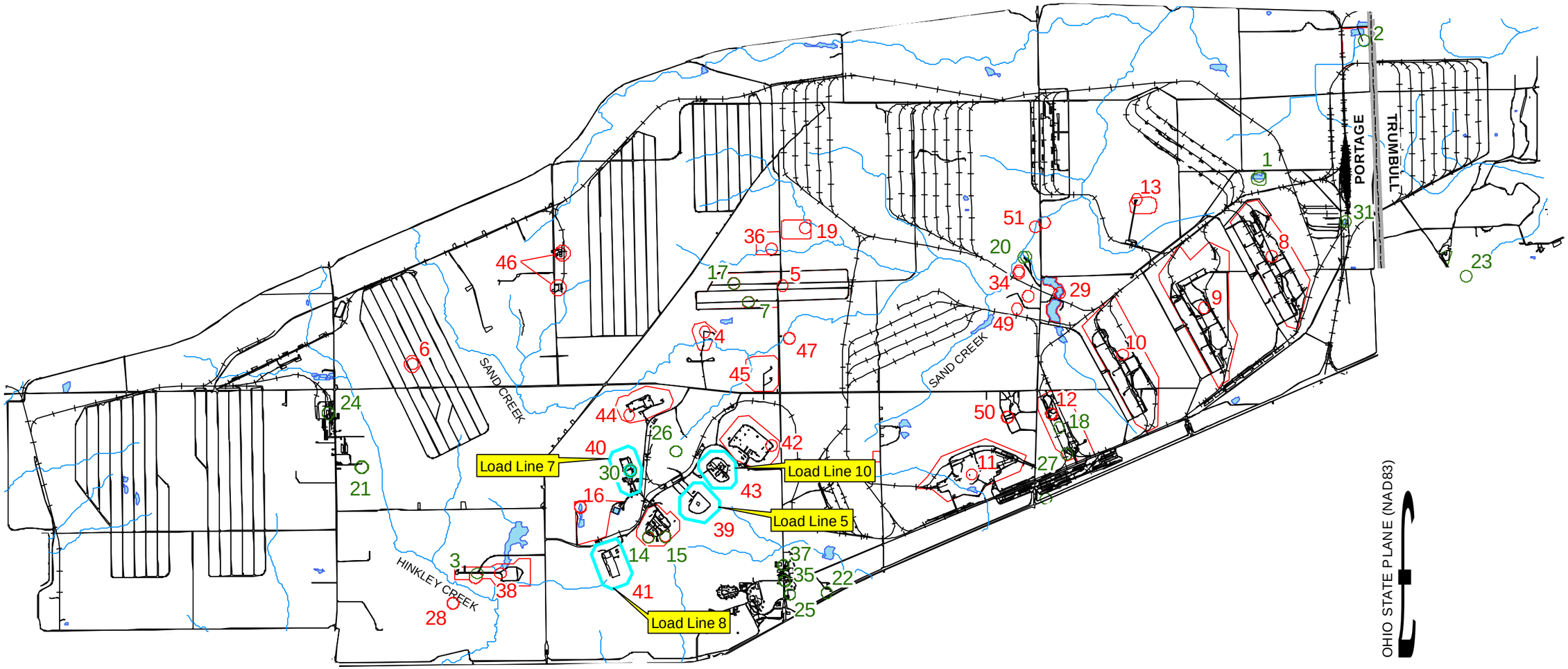


Figure 1. General location and orientation of Ravenna Army Ammunition Plant (RVAAP)



LEGEND OF SITES

1 RAMSDELL QUARRY LANDFILL	13 BLDG 1200 AND DILLUTION/SETTLING POND	25 BLDG 1034 MOTOR POOL WASTE OIL TANK	37 PESTICIDE STORAGE BUILDING T-4452	49 CENTRAL BURN PITS
2 ERIE BURNING GROUNDS	14 LOAD LINE 6 EVAPORATION UNIT	26 FUZE BOOSTER AREA WASTE OIL TANK	38 NACA TEST AREA	50 ATLAS SCRAP YARD
3 DEMOLITION AREA 1	15 LOAD LINE 6 TREATMENT PLANT	27 BLDG 854-PCB STORAGE	39 LOAD LINE 5 / FUZE LINE 1	51 DUMP ALONG PARIS-WINDHAM ROAD
4 DEMOLITION AREA 2	16 QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS	28 MUSTARD AGENT BURIAL SITE	40 LOAD LINE 7 / BOOSTER LINE 1	CERCLA
5 WINKLEPECK BURNING GROUNDS	17 DEACTIVATION FURNACE	29 UPPER AND LOWER COBBS POND COMPLEX	41 LOAD LINE 8 / BOOSTER LINE 2	RCRA
6 C BLOCK QUARRY	18 LOAD LINE 12 PINK WASTE WATER TREATMENT	30 LOAD LINE 7 PINK WASTEWATER TREATMENT PLANT	42 LOAD LINE 9 / DETONATOR LINE	OTHER REGULATORY
7 BLDG 1601 HAZARDOUS WASTE STORAGE	19 LANDFILL NORTH OF WINKLEPECK BURNING GROUND	31 ORE PILE RETENTION POND	43 LOAD LINE 10 / PERCUSSION ELEMENT	
8 LOAD LINE 1 AND DILLUTION/SETTLING POND	20 SAND CREEK SEWAGE TREAMENT PLANT	32 40 AND 60-MM FIRING RANGE	44 LOAD LINE 11 / ARTILLERY PRIMER	
9 LOAD LINE 2 AND DILLUTION/SETTLING POND	21 DEPOT SEWAGE TREAMENT PLANT	33 FIRESTONE TEST FACILITY	45 WET STORAGE AREA	
10 LOAD LINE 3 AND DILLUTION/SETTLING POND	22 GEORGE ROAD SEWAGE TREATMENT PLANT	34 SAND CREEK DISPOSAL ROAD LANDFILL	46 BUILDINGS F-15 AND F-16	
11 LOAD LINE 4 AND DILLUTION/SETTLING POND	23 UNIT TRAINING SITE WASTE OIL TANK	35 1037 BUILDING-LAUNDRY WASTEWATER SUMP	47 BUILDING T-5301 DECONTAMINATION	
12 LOAD LINE 12 AND DILLUTION/SETTLING POND	24 RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK	36 PISTOL RANGE	48 ANCHOR TEST AREA	

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Figure 2
RVAAP
Facility Map

US Army Corps of Engineers
Louisville District

Figure 3. Grid and sampling locations for surface soil samples collected from Load Line 5

Figure 4. Grid and sampling locations for surface soil samples collected from Load Line 7

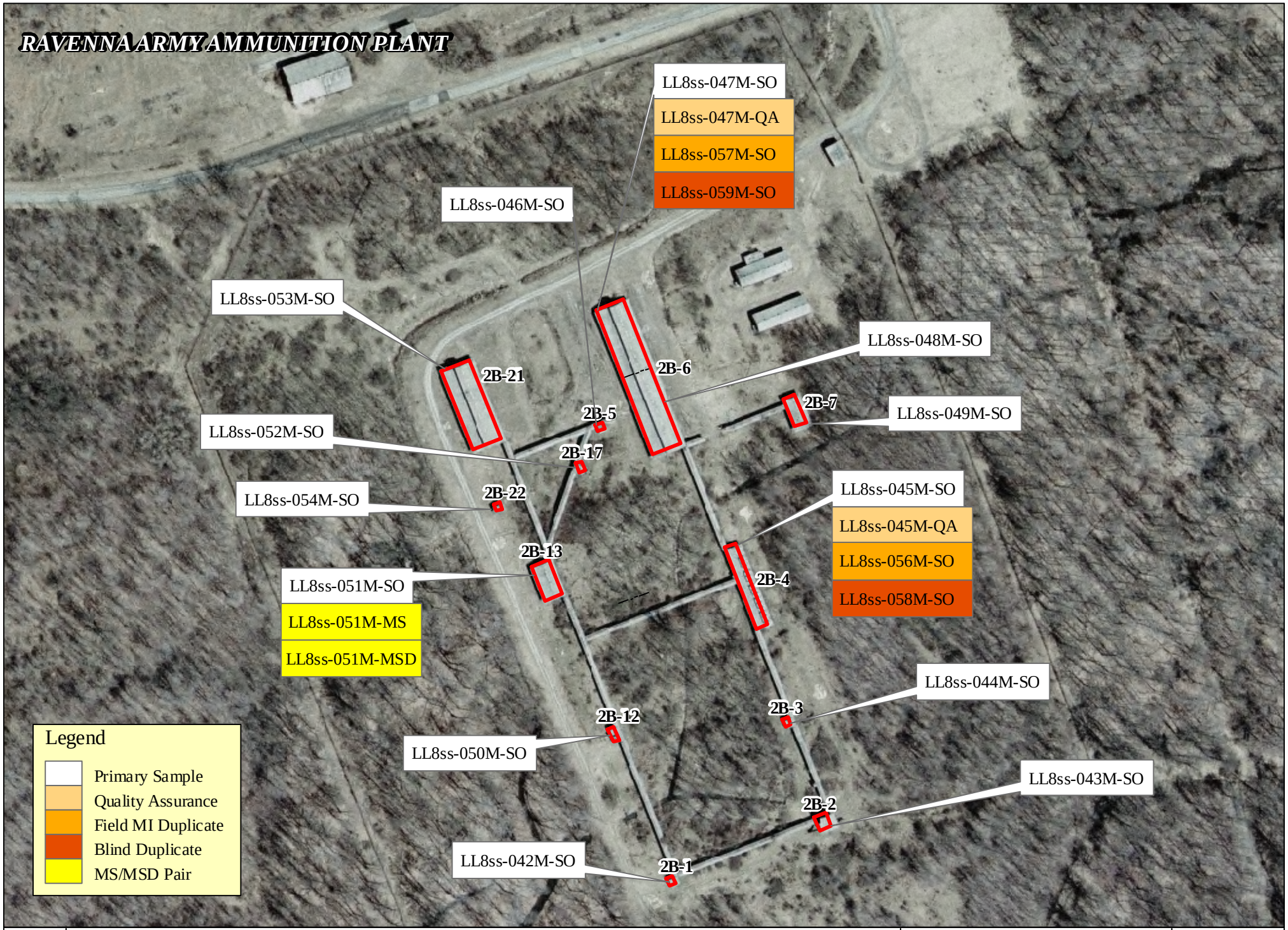


Figure 5. Grid and sampling locations for surface soil samples collected from Load Line 8

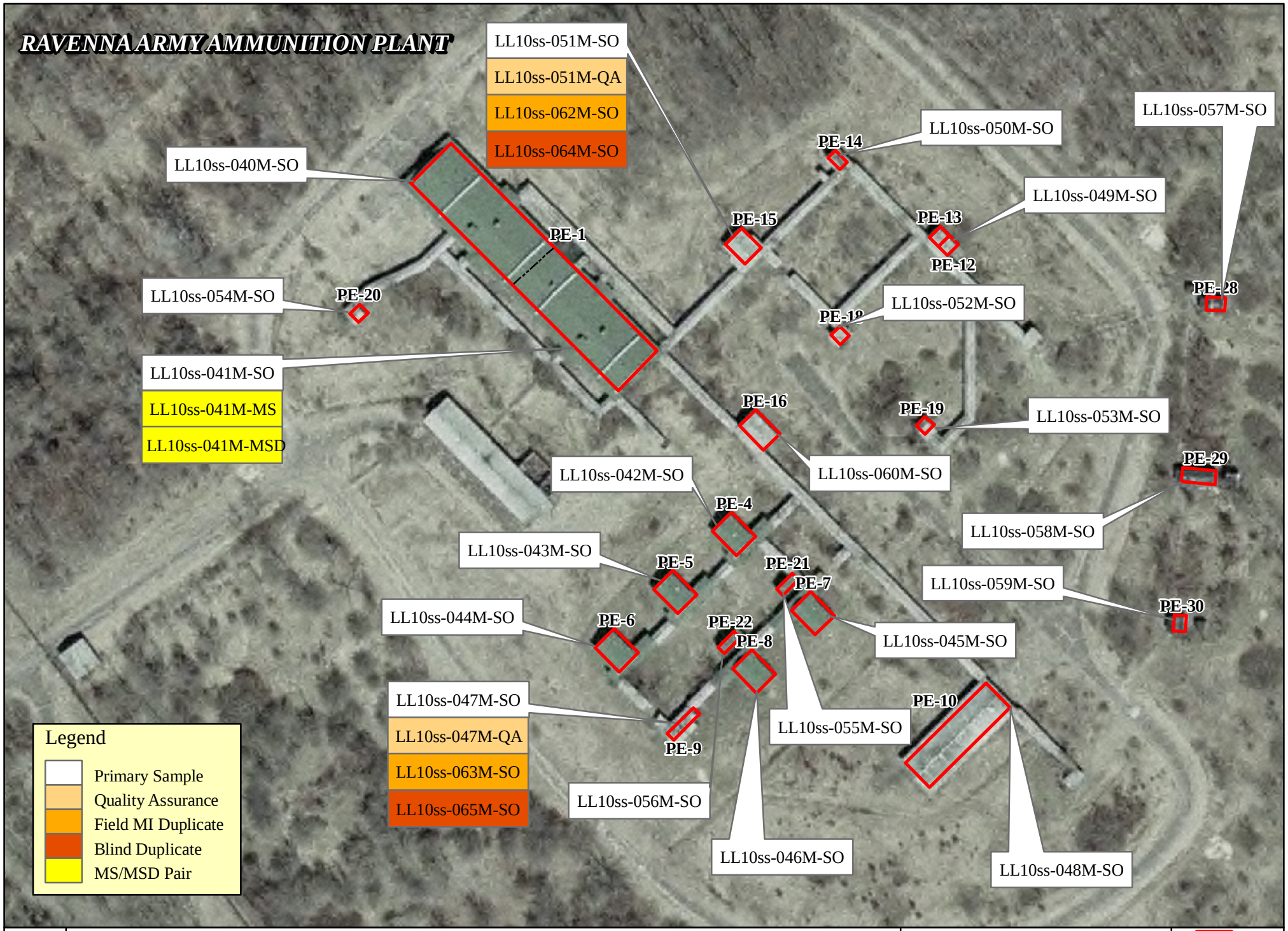
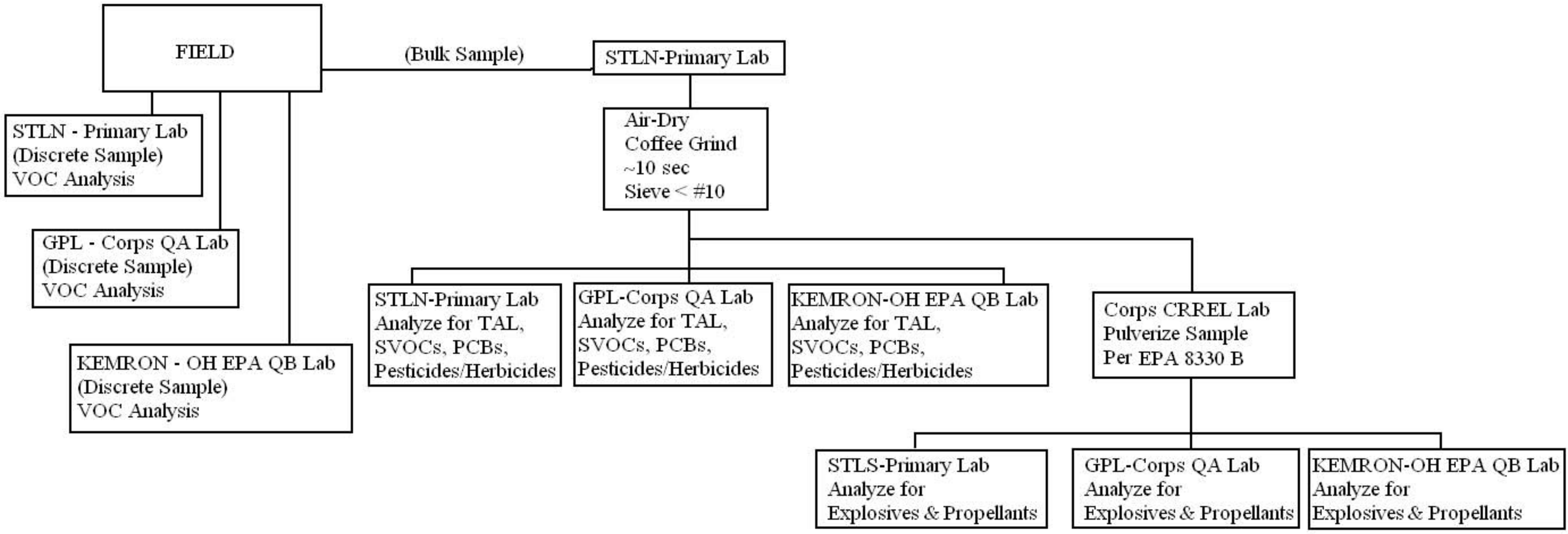


Figure 6. Grid and sampling locations for surface soil samples collected from Load Line 10

Figure 7

Flow Chart of Field Samples to Analytical Labs



STLN = Test America, North Canton, Ohio (Primary Lab)
Processed bulk samples (air-dry, coffee grind, sieve)
Analyzed air-dried, coffee ground, sieved samples for TAL, SVOCs, PCBs, Pesticide/Herbicides
Analyzed discrete samples for VOC

CRREL – USACE Cold Regions Research & Engineering Lab
(Pulverized Portion of the air-dried # 10 Ground Sample for analyses of explosives & propellants)

STLS = Test America, Sacramento, CA
Analyzed pulverized samples for explosives & propellants

GPL = Corps QA Lab
Analyzed air-dried, coffee ground, sieved samples for TAL, SVOCs, PCBs, Pesticide/Herbicides
Analyzed discrete samples for VOC
Analyzed pulverized samples for explosives & propellants

KEMRON – OH EPA QA Lab
Analyzed air-dried, coffee ground, sieved samples for TAL, SVOCs, PCBs, Pesticide/Herbicides
Analyzed discrete samples for VOC
Analyzed pulverized samples for explosives & propellants

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: Metals, Explos, Propel, SVOCs, Pest/Herb/PCBs

Sample Collection Date/Time:_____

Sample Collected By: _____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-QB LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: TAL metals, SVOCs, PCBs, Pesticide

Sample Collection Date/Time:_____

Interlab Samp Ship: **STLN - KEMRON**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: Metals, Explos, Propel, SVOCs, Pest/Herb/PCBs

Sample Collection Date/Time:_____

Sample Collected By: _____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: 8 oz Jar
Analyses: Explosives, Propellants

Sample Collection Date/Time:_____

Interlab Samp Ship: **CRREL - STLS**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: Metals, Explos, Propel, SVOCs, Pest/Herb/PCBs

Sample Collection Date/Time:_____

Sample Collected By: _____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-QA LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: 8 oz Jar
Analyses: Explosives, Propellants

Sample Collection Date/Time:_____

Interlab Samp Ship: **CRREL - GPL**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: Explosives, Propellants

Sample Collection Date/Time:_____

Interlab Samp Ship: **STLN - CRREL**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-050M-SO LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: 8 oz Jar
Analyses: Explosives, Propellants

Sample Collection Date/Time:_____

Interlab Samp Ship: **CRREL - STLS**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-QA LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: Plastic Bag
Analyses: TAL metals, SVOCs, PCBs, Pesticide, Herbicide

Sample Collection Date/Time:_____

Interlab Samp Ship: **STLN - GPL**, date_____

RVAAP – UNDER SLAB SAMPLING

SAMPLE ID: LL5-033M-QB LL5 BLDG 1F-WP-4

Sample Type: Soil Sample Depth: 0- 12 inches
Sample Container: 8 oz Jar
Analyses: Explosives, Propellants

Sample Collection Date/Time:_____

Interlab Samp Ship: **CRREL - KEMRON**, date_____

Figure 8 Example Sample Labels (Green: Field to Test America – North Canton, OH)
(One green label on bulk sample liner bag, 2nd label on tag on inner bag, 3rd on outer bag wrapped around inner bag)