FINAL

FACILITY-WIDE GROUNDWATER MONITORING PROGRAM PLAN

FOR THE

RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO

Prepared for

US Army Corps of Engineers®

U.S. Army Corps of Engineers – Louisville District
Contract No. GS-10F-0350M
Delivery Order No. DACA27-03-F-0047

September 2004

FINAL

Part I – Sampling and Analysis Plan Addendum

For The

Facility-Wide
Groundwater Monitoring Program Plan

Ravenna Army Ammunition Plant,
Ravenna, Ohio

September 2004

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U.S. Army Corps of Engineers
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Prepared by

Portage
ENVIRONMENTAL

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PART 1 – SAMPLING & ANALYSIS PLAN ADDENDUM

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ACRONYMS

AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
CAR	Corrective Action Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemicals of potential concern
COC	chemicals of concern
CQC	Contractor Quality Control
DOT	U.S. Department of Transportation
DQOs	Data Quality Objectives
FCO	Field Change Order
FSA	Field Staging Area
FSAP	Facility-Wide Sampling and Analysis Plan
FSHP	Facility-Wide Safety and Health Plan
FWGWMP	Facility-Wide Groundwater Monitoring Plan
HQ	Hazard Quotient
HSO	Health & Safety Officer
IDW	investigation-derived waste
NCR	Nonconformance Report
OD#2	Open Detonation Area #2
Ohio EPA	Ohio Environmental Protection Agency
OVA	Organic Vapor Analyzer
PCB	polychlorinated biphenyl
PID	photo-ionization detector
PPE	personal protective equipment
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
REIMS	RVAAP Environmental Information Management System
RQL	Ramsdell Quarry Landfill
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SRC	site-related compound
SSHP	Site Safety and Health Plan
SVOC	semi-volatile organic compounds
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
USACE	U.S. Army Corps of Engineers
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
VOC	Volatile Organic Compound
WBG	Winklepeck Burning Grounds

INTRODUCTION

This Facility-Wide Groundwater Monitoring Program (FWGWMP) Plan for the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio, has been prepared by Portage Environmental, Inc., under contract GS-10F-0350M, Delivery Order DACA27-03-F-0047 with the U.S. Army Corps of Engineers (USACE) Louisville District. This Plan was developed in accordance with USACE and Ohio Environmental Protection Agency (Ohio EPA) guidance documents, to meet the requirements for the investigation of known or suspected Areas of Concern (AOCs) regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and other federal or state regulations that govern environmental restoration activities at RVAAP.

The decision to adopt a facility-wide approach to groundwater monitoring activities at RVAAP, rather than continue to monitor facility groundwater on an AOC by AOC basis, was based on the following considerations:

- Groundwater is an inherently mobile medium; it does not remain in place at each AOC but is expected to migrate beyond AOC boundaries;

- Assembling a network of wells representative of the overall facility groundwater regime will better accomplish the facility's overall objective of determining if AOC-related contaminants pose a risk to groundwater use, either on the RVAAP facility or off-post.

This FWGWMP Plan is intended to:

- Establish standards for the performance of facility-wide groundwater monitoring and reporting at RVAAP;

- Serve as Standard Operating Procedures (SOP) for groundwater sampling and analysis under the facility-wide program, with the realization that new information and new technologies may result in changes to these procedures; and

- Serve as a field-usable guide available to regulators, managers, and contracted firms involved in groundwater monitoring activities at RVAAP.

The standards of performance set forth in this plan are necessary to ensure consistency and defensibility of the large amounts of environmental data expected to be gathered as part of the FWGWMP, regardless of funding source, U.S. Army project manager, or contracted firm performing work. The requirements for consistency among investigation programs include not only detailed procedures for sample collection and handling, but also for documentation, data validation, quality assurance (QA)/quality control (QC), and reporting. All environmental data generated under this program will be archived in the proposed RVAAP Environmental Information Management System (REIMS).

This Sampling and Analysis Plan (SAP) addenda defines project-specific scope and objectives, sampling rationale and approach, and data quality needs to support decisions to be made using the data collected during implementation of the FWGWMP.

1.0 FACILITY WIDE GROUNDWATER MONITORING PROGRAM DESCRIPTION

1.1 PURPOSE OF THE FWGWMP

The overall purpose of developing and implementing a FWGWMP for RVAAP is to determine if hazardous contaminants from past activities may be posing a current or future risk via groundwater use on-site, or via groundwater contaminant migration to off-site receptors, and to ecological receptors. In addition, through implementation of this FWGWMP, groundwater monitoring obligations for the Ramsdell Quarry Landfill (RQL) and Open Detonation Area 2 (ODA #2) RCRA units will continue to be fulfilled.

1.2 HISTORY AND CONTAMINANTS

A comprehensive discussion of the RVAAP facility history and potential contaminants can be found in Section 1.1 of the current Facility-wide Sampling and Analysis Plan (FSAP).

1.3 ENVIRONMENTAL SETTING

A comprehensive discussion of the RVAAP environmental setting can be found in Section 1.2 of the FSAP.

1.4 SUMMARY OF EXISTING DATA

During the last 30 years, multiple environmental-related investigations were conducted at RVAAP. A brief summary of these investigations is provided in Section 1.3 of the FSAP. Investigations performed since the last publication of the FSAP are briefly summarized below.

Date	Description of Investigation
2001	USACE performed Phase II Remedial Investigations at Load Lines 2, 3 and 4.
2001	U.S. Army JMC performed a Phase II Remedial Investigation at Load Line 11.
2001	U.S. Army JMC performed a Phase I Remedial Investigation at the Central Burn Pits.
2002	U.S. Army JMC performed a Phase II Remedial Investigation at Upper and Lower Cobbs Pond.
2002	U.S. Army JMC performed a Phase II Remedial Investigation at Demolition Area 2.
2003	USACE Performed a Phase I Remedial Investigation at the Ramsdell Quarry Landfill.
2003	U.S. Army JMC performed a Phase I Remedial Investigation at Load Lines 6 and 9.

2003	U.S. Army JMC performed a Phase I/II Remedial Investigation at the Fuze & Booster Quarry Ponds
2003	USACE performed a Phase II Remedial Investigation at the Erie Burning Grounds
2003	U.S. Army JMC performed an assessment of potential contamination at the DLA outdoor storage areas

2.0 FACILITY WIDE GROUNDWATER PROGRAM ADMINISTRATION

2.1 ORGANIZATION AND RESPONSIBILITIES

This plan presents the organization and responsibility for implementation of the FWGWMP from a generic perspective because the identity of the firm that will be responsible for implementing this program has not yet been determined. The project organization and responsibilities identified here are based on the generic functional roles necessary to implement the field activities described in the FWGWMP and do not include specific names of organizations or individuals. It is the responsibility of the contractor selected to implement the FWGWMP to adhere to the procedures and standard operating procedures defined in this FWGWMP and those defined in the FSAP. It is expected that USACE Louisville District will continue to fulfill the role of laboratory data Quality Assurance Administrator for groundwater monitoring at RVAAP.

The organization chart shown in Figure 2-1 outlines the generic management structure that will be used to implement the FWGWMP at RVAAP. The functional responsibilities of key personnel are described in the following parts of this section.

2.1.1 Contractor Program Manager

The Contractor Program Manager ensures the overall management and quality of all projects performed at RVAAP under the general contract. This individual will ensure that all project goals and objectives are met in a high-quality and timely manner. Quality assurance and nonconformance issues will be addressed by this individual, in coordination with the Contractor Project Manager, for corrective action.

2.1.2 Contractor Project Manager

The Contractor Project Manager has direct responsibility for implementing a specific project, including all phases of work plan development, field activities, data management, and report preparation. This individual will also provide the overall management of the project, and serve as the technical lead and principal point of contact with the USACE Louisville District, RVAAP, or other U.S. Army Project Manager. These activities will involve coordinating all personnel working on the project, interfacing with U.S. Army project personnel, and tracking project budgets and schedules. The Contractor Project Manager will also develop, monitor, and fill project staffing needs, delegate specific responsibilities to project team members, and coordinate with administrative staff to maintain a coordinated and timely flow of all project activities. The Project Manager reports directly to the Program Manager.

2.1.3 Contractor QA/QC Officer

The Contractor Quality Assurance/Quality Control (QA/QC) Officer is responsible for the project QA/QC in accordance with the requirements of the Facility-wide Quality Assurance Project Plan (QAPP), the project-specific QAPP addendum, and appropriate management guidance. This individual will be responsible for participating in the project field activity readiness review; approving variances before work proceeds; approving, evaluating, and documenting the disposition of Nonconformance Reports (NCRs); overseeing and approving any required project training; and designing audit and surveillance plans followed by supervision of these activities. This individual and the field CQC officer report directly to the Program Manager, but they will inform the Project Manager of all information and decisions reported.

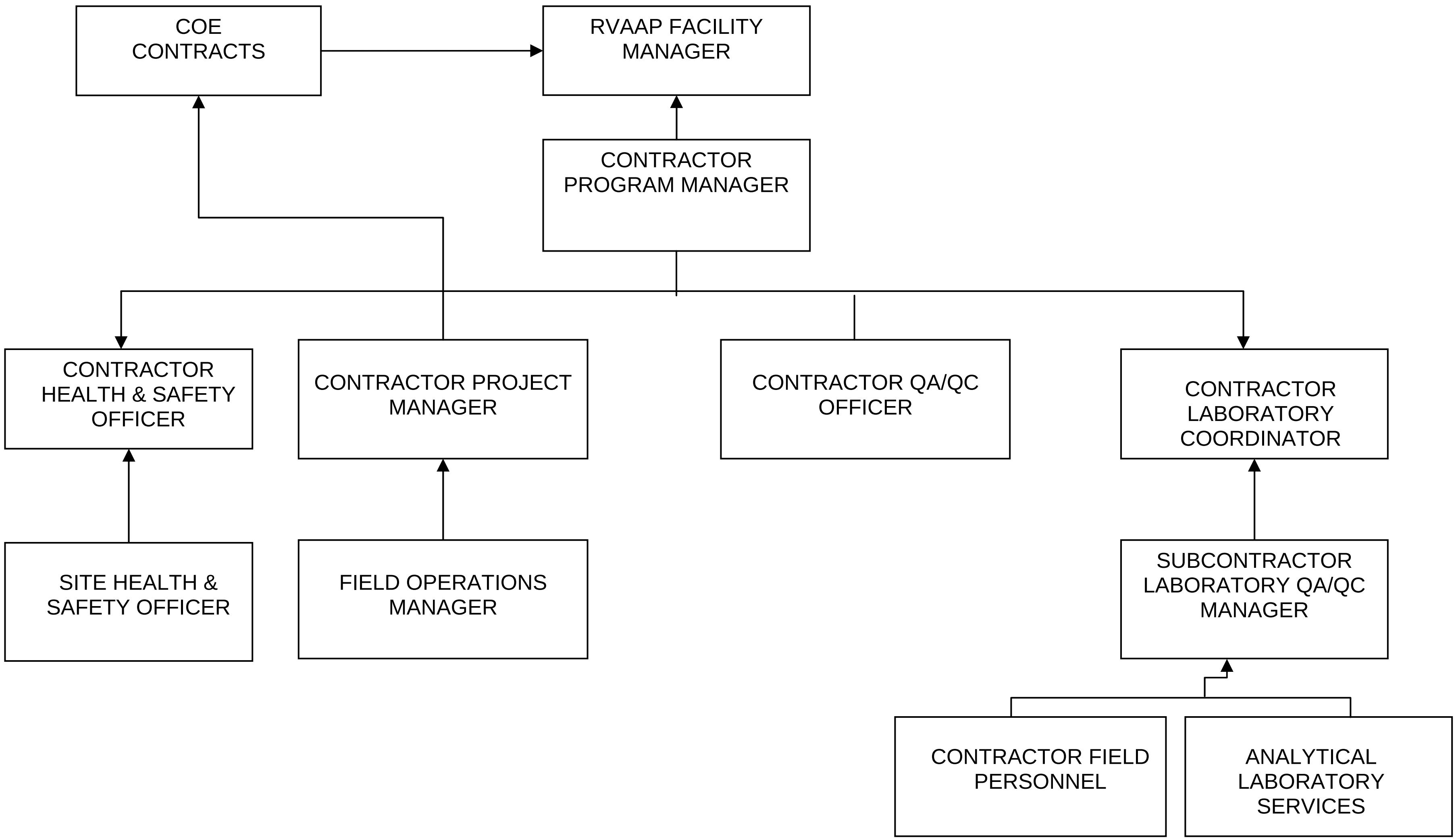

Figure 2-1 Generic Project Organization Chart for RVAAP FWGWMP

2.1.4 Contractor Health and Safety Officer

The Contractor Health and Safety Officer (HSO) will ensure that health and safety procedures designed to protect personnel are maintained throughout all field activities conducted at RVAAP. This will be accomplished by strict adherence to the Facility-wide Safety and Health Plan (FSHP), and the FWGWMP Site Safety and Health Plan (SSHP) Addendum. This individual, in coordination with the Site Health and Safety Officer (SHSO), will have the authority to halt field work if health and/or safety issues arise that are not immediately resolvable in accordance with the FSHP and the project-specific SSHP addendum. This individual and the SHSO report directly to the Contractor Program Manager, but they will inform the Contractor Project Manager of all information and decisions reported.

2.1.5 Subcontractor Laboratory QA/QC Manager

Analytical laboratories will be subcontracted to perform off-site chemical analysis for groundwater samples. All subcontract laboratory support shall be USACE Ohio River District validated. The subcontracted laboratory's QA/QC Manager is responsible for the laboratory QA/QC in accordance with the requirements of the Facility-wide QAPP and the project-specific QAPP addendum. In coordination with the Contractor Laboratory Coordinator, this individual will be responsible for handling and documenting samples received by the laboratory, ensuring that all samples are analyzed in accordance with required and approved methodologies, ensuring that instrument calibration is performed properly and documented, ensuring that field and internal laboratory QC samples are analyzed and documented, and ensuring that all analytical results for both field and QC samples are reported in the format required in the QAPP. The subcontracted laboratory QA/QC Manager is also responsible for ensuring that laboratory NCRs are processed in a timely manner and for making decisions regarding cost and schedule related to processing of NCRs and implementation of Corrective Action Report (CAR) recommendations and/or requirements. This individual reports directly to the Laboratory Coordinator, but he or she will inform the Project Manager of all information and decisions reported.

2.1.6 Contractor Laboratory Coordinator

The Contractor Laboratory Coordinator is responsible for coordination of sample collection and subsequent laboratory analysis in accordance with the requirements of the FSAP and Facility-wide QAPP and the FWGWMP specific addenda. This individual will be responsible for obtaining required sample containers from the laboratory for use during field sample collection, resolving questions the laboratory may have regarding QAPP requirements and deliverables, and preparing a quality assessment report for sample data package deliverables received from the laboratory. This individual reports directly to the Contactor Program Manager, but he or she will inform the Contractor Project Manager of all information and decisions reported.

2.1.7 Contractor Field Operations Manager

The Contractor Field Operations Manager is responsible for implementing all field activities for implementing the FWGWMP in accordance with the FSAP and Facility-wide QAPP and the FWGWMP-specific addenda. This individual will be responsible for ensuring technical performance of all field sampling activities; adherence to required sample custody and other related QA/QC field procedures; coordination of field subcontractor personnel activities; management of project investigation-derived wastes (IDW); QA checks of all field documentation; and preparation of Field Change Orders (FCOs), if required. This individual reports directly to the

Contractor Project Manager except with regard to QA/QC matters that are reported directly to the Contractor QA/QC Officer.

2.1.8 Contractor Field Personnel

In addition to the Field Operations Manager, other contractor field personnel participating in the implementation of field activities may include the Field Team Leader(s), Site Geologist(s), Sampling Technician(s), and Sample Manager. These individuals, in coordination with field subcontractor personnel, will be responsible for performing all field sampling activities in accordance with the FSAP and FSHP and the FWGWMP-specific addenda. These individuals report directly to the Field Operations Manager.

2.2 COORDINATION WITH ONGOING AND FUTURE PROJECTS

2.2.1 Ongoing and Future Environmental Restoration Projects

Efforts conducted as part of this FWGWMP will support and be coordinated with ongoing and future AOC Remedial Action (RA) processes and long term monitoring efforts. New wells installed as part of ongoing or future restoration projects will be considered for incorporation into the FWGWMP upon the completion of at least four quarterly sampling events at that particular AOC. Information generated as part of ongoing and future projects will be assessed annually to determine if changes to the FWGWMP or site-wide groundwater conceptual model are warranted.

2.2.2 Proposed RVAAP Environmental Information Management System (REIMS)

The large amount of available information, the large volumes of information that will be produced as work at RVAAP continues, and the number of stakeholders who need ready access to the information have necessitated the development of an integrated environmental information management system at RVAAP. The proposed REIMS that is currently being developed will consist of a system of computer hardware, software, procedures, and people to facilitate the rapid, secure, and reliable flow of information between users. The proposed integrated REIMS will provide a variety of users access to information of different types (such as maps, documents, and environmental characterization and monitoring data) from different sources (such as the OSC, Ohio ARNG, USACE, and contractors). REIMS will be designed to provide a systematic means of accessing existing (and future) information in an accessible format that will make data analysis and decision making more efficient.

All newly acquired information generated through the implementation of the FWGWMP will be provided to RVAAP in an electronic format compatible with the REIMS. The required format to be used will be provided to the FWGWMP contractor upon finalization of the REIMS and will be incorporated into the FWGWMP information collection process. Information collected as part of the FWGWMP will be submitted in the specified electronic format to the RVAAP Information Manager as part of the annual reporting requirements set forth in Section 5 of this program plan.

Three different electronic formats may be used depending on the type of information produced (maps, documents and drawings, or data). Information that that is best presented as maps (such as topographic features, sampling locations, contour plots, etc.) will be submitted in an ArcView compatible format. Map information will be placed in a geographic context that is acceptable for incorporation into the REIMS. Drawings, figures, diagrams, and photographs that are produced as part of the FWGWMP will be submitted as PDF files. These items may include such things as reports, boring logs, well construction diagrams, site photographs, etc. The PDF files for a document will contain all of the information in the hard copy document deliverable including text, graphics, maps and tables. All components of the document will be electronically hyperlinked to the document table of contents. Field and laboratory measurements made during the performance of the FWGWMP will be submitted to the RVAAP Information Manager in an electronic format compatible for use with the REIMS. All electronic information will be submitted on 3.5 inch diskettes or CDs to the RVAAP Information Manager.

3.0 FWGWMP SCOPE AND OBJECTIVES

3.1 APPROACH AND RATIONALE

The FWGWMP Plan is intended to serve as a description and schematic that outlines the components and standards of performance for a facility-wide groundwater monitoring program at RVAAP. The scope of the FWGWMP is to define methods and procedures for field sampling and reporting activities that are expected to be used during implementation of the FWGWMP at RVAAP. Based on the similarity of the former waste-generating operations, the chemicals of potential concern (COPCs), and the media of concern to be investigated, sampling activities as addressed in the FSAP will be applied in the implementation of the FWGWMP. The FSAP addresses sampling methods and procedures for groundwater sampling (Section 4.3); and also defines generic protocols for sample chain of custody/documentation; sample packaging and shipping; and IDW, which also will be applied to the RVAAP FWGWMP.

This FWGWMP SAP Addendum has been developed in accordance with requirements established in the USACE guidance documents *Requirements for the Preparation of Sampling Analysis Plans*, EM 200-1-3, September 1994, *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites*, EM 1110-1-4000, August 1994 (USACE 1994b; USACE 1994a), and Ohio EPA's *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (1995). It is meant to be tiered under the FSAP and addresses project-specific scope and objectives, sampling approach and rationale, data uses, project-specific sampling methods and procedures or deviations not covered in the FSAP, specific IDW requirements, and any other project-specific details not included in the FSAP.

The scope and objectives of the FWGWMP were developed based on EPA guidance for data quality objectives (DQOs) specified in *Data Quality Objectives Process For Superfund, Interim Final Guidance*, EPA/540/G-93/071, September, 1993 (USEPA 1993). Specific objectives for the FWGWMP are to:

- Characterize the nature and extent of facility-wide groundwater contamination at RVAAP;
- Assess the risk posed to human health and the environment from facility-wide groundwater contamination at RVAAP;
- Establish a system to monitor potential off-site migration of contaminants via groundwater; and
- Provide for continuing groundwater monitoring at the RQL and ODA#2 RCRA units.

3.1.1 Data Quality Objectives

As part of the Facility-wide approach to environmental investigation activities at RVAAP, Facility-wide DQOs have been developed. The DQO process is a tool to guide investigations at CERCLA sites. Although the FWGWMP does not focus solely on monitoring groundwater at CERCLA sites, this model still has relevance. The Facility-wide DQOs serve two major purposes: (1) to present the facility-wide approach to sampling at the installation, and (2) to present the process that has been used to develop the FWGWMP sampling and analysis plan. The stages of the DQO development process are:

- develop the conceptual site model,
- state the problem,
- identify decisions to be made,
- define the study boundaries,
- develop the decision rule (if/then),
- identify inputs to the decision (data uses and data needs),
- specify limits on uncertainty, and
- optimize the sample design.

The following FWGWMP-specific data quality objectives (DQOs) were developed jointly by the Ohio EPA and the USACE:

- Assess the hydrogeological conditions and groundwater quality in shallow and deep groundwater beneath the facility using selected previously-installed and newly-installed monitoring wells of known integrity suited to this purpose. Grouping of monitoring wells based on hydrogeology and AOC-specific characteristics will be considered.
- Provide a comparative assessment of hydrogeologic characteristics and groundwater quality in both unconsolidated and bedrock monitoring wells to evaluate potential hydraulic connection between the water-bearing units.
- Conduct monitoring of the facility-wide groundwater monitoring well network (hereafter; network) to provide characterization of groundwater chemical quality and to examine potential migration of contamination. Monitoring may be performed on a quarterly, semi-annual, or annual basis or other frequency as mutually agreed upon by Army and Ohio EPA.
- Conduct analysis of chemical data from the network to form a basis for remedial decision-making regarding groundwater at RVAAP.

3.1.2 Conceptual Site Model

A conceptual site model is the cornerstone for planning a field sampling effort. It reflects an understanding of the known or expected site conditions and serves as the basis for making decisions about sample locations, frequencies, and required analytes. A good conceptual model is inclusive of all available information, incorporating the hydrogeologic features and other characteristics of the site that combine to define the problem to be addressed (e.g., location of buried waste, primary contaminants and their properties, contaminant transport pathways, and potential human exposure scenarios, etc.). A preliminary conceptual model for RVAAP has been developed using available information and is presented in Section 3.2.1 of the FSAP.

A comprehensive review of existing RVAAP geologic and hydrogeologic information, including a review of all existing monitoring locations and well logs, was conducted during development of this FWGWMP. The information reviewed was used as a basis for refining and revising the preliminary RVAAP conceptual model, as described in the FSAP, with regard to groundwater occurrence and characteristics. The resulting refined groundwater conceptual model is described in the following section.

3.1.2.1 Description of Facility-Wide Hydrogeology

The site geology is characterized by sedimentary bedrock overlain by a thin veneer of glacial sediments consisting of tills and outwash deposits. Earlier reports by the U.S. Army Toxic and

Hazardous Materials Agency (USATHAMA,1978) and Kammer (1982) state that the bedrock at the RVAAP is predominantly covered by the Hiram and Kent till - both of Wisconsin age. A later report by the State of Ohio Department of Natural Resources (White, 1987) includes a geologic map indicating that the majority of the RVAAP is covered by the Lavery and Hiram tills, with glacial outwash deposits covering the northern corner of the site. Since the White (1987) report was published in a referenced publication that post-dates the earlier USATHAMA and Kammer reports, the following discussion regarding glacial deposits at RVAAP will be based on information provided in the White (1987) report. In addition, several of Remedial Investigation reports thus far generated for RVAAP AOCs (USACE, 2003a, 2003b, 2003c, 2003d, 2003e, 2003f) include a surface geology map that is consistent with the information provided in the White (1987) report.

Unconsolidated Deposits

The glacial till found at RVAAP was deposited as a more or less uniform sheet covering the bedrock surface as a ground moraine. Where the bedrock is reasonably level, the surface of the till cover is smooth to gently undulating. Where the bedrock surface has more relief, the till cover produces a masked erosional topography. There is some evidence that varved clays, indicative of lake deposits, exist in some of the deeper bedrock valleys (USACE 1970, 2003f). The Hiram till is the most extensive till in northeast Ohio and covers approximately the eastern two-thirds of RVAAP. It is the material from which is derived the silty-clay loam and clay-loam soils of much of the northern part of northeastern Ohio. The Hiram till is the most clay-rich till of northeastern Ohio and is only sparsely pebbly with boulders and cobbles rarely found. The Hiram is characteristically thin with a median thickness of 4 feet in the eastern and 6 feet in the western portion of RVAAP. The Lavery till is a surface till that is found in a large portion of central Portage County. It is comprised of a clayey-silt till that in general contains approximately 28 percent sand and 30 percent clay. The Lavery till contains few pebbles and only a few cobbles and boulders in marked contrast to earlier tills found in this area. In the subsurface, below the Hiram till, the Lavery is almost always present, although its median thickness is only 4 feet. The Lavery till can be found exposed across the western third of the RVAAP.

It is unclear whether the glacial outwash deposits located in the northeast corner of the RVAAP are of the Hiram, Lavery, or another glacial episode in origin. No gravel deposits of the Hiram age have been positively identified in Portage County. Likewise, Lavery outwash is scanty and inconspicuous. Only the most meager gravel deposits were formed in this age.

In addition to the glacial deposits, other unconsolidated deposits at the site include alluvium associated with the surface drainages at the site that may or may not be continuous with the surrounding glacial tills.

Bedrock Geology

The bedrock underlying the glacial deposits consists of sedimentary deposits, predominantly Pennsylvanian in age, with minor deposits of Mississippian Age rocks. The Preliminary Assessment (USACE, 1996) reports that the bedrock units at the site display a gentle southward dip of 5 to 10 feet per mile. In the subsurface bedrock below the glacial deposits, earlier erosion has exposed progressively older bedrock units in an eastern direction across the site. The initial Assessment report (USATHAMA, 1978) provides a map that illustrates the subsurface geology at the site. A geologic bedrock map of the site, along with stratigraphic description of the units, is presented in Figure 3-1, and a generalized stratigraphic section is presented in Figure 3-2. The youngest bedrock unit found on the RVAAP is the Homewood

Sandstone Member of the Pottsville Formation. The Homewood Sandstone consists of coarse to fine-grained clay-bonded micaceous sandstone with thin shale lenses. The Mercer Member of the Pottsville Formation directly underlies the Homewood Sandstone and is comprised of gray to black silty micaceous shale, thin sandstones, and coal. The Connoquenissing Sandstone Member, underlying the Mercer Member, consists of a coarse to fine-grained sandstone and silty to sandy shale. The Sharon Member Shale unit consisting of gray to black sand and micaceous shale with thin coal separates the Connoquenissing Sandstone Member from the underlying Sharon Sandstone/Conglomerate. Comprised of tan coarse to fine-grained orthoquartzite sandstone, the Sharon Sandstone/Conglomerate is loosely cemented and is the most important aquifer found at the site. The Mississippian bedrock units found in the eastern portion of the site consist of the Meadville Shale, a blue-gray shale, and the Berea Sandstone, a massive moderately hard medium to fine grain sandstone.

Groundwater Occurrence

Groundwater at the site is present in both the overlying unconsolidated glacial deposits and alluvium, and in selected bedrock units. Groundwater in the unconsolidated deposits is limited to sandy lenses in the glacial tills, saturated lake clays, and outwash material, and to the alluvium deposits associated with the numerous surface drainages at the site. Groundwater is also present at the glacial till-bedrock contact. Outside of the facility boundaries, unconsolidated deposits can be an important source of groundwater, as many of the domestic wells and small public water supplies located near the facility obtain reasonable quantities of water from wells completed in unconsolidated deposits. There is evidence that a buried valley tributary to the Mahoning River is present in the west-central portion of the RVAAP (USATHAMA, 1978). Although buried valleys can be important aquifers, there is no evidence to support the occurrence of significant water-bearing material in this buried-valley tributary. The main buried valley aquifer associated with the Mahoning River does not yield significant quantities of water (USATHAMA, 1978). Since the buried valley aquifer that may be found on the RVAAP site is a tributary, finer-grained sediments compared to the main buried valley aquifer would be expected, suggesting that lower water yields would be expected. Water production wells previously drilled in the area (Barnes, 1950) also support the insignificance of a buried valley aquifer at RVAAP.

The principle water-bearing aquifer at the RVAAP is the Sharon Sandstone/Conglomerate. Depending on the existence and depth of overburden, the Sharon ranges from an unconfined to a leaky artesian aquifer. USATHAMA (1978) reports water yields from area wells completed in the Sharon Sandstone/Conglomerate range from 30 to 400 gpm, and Kammer (1982) reports well yields of 5 to 200 gpm for bedrock wells completed in the Sharon Sandstone/Conglomerate. Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable with well yields less than 10 gpm, and the Connoquenessing Sandstone. The Connoquenessing is a good aquifer where it occurs, but is less productive than the Sharon Sandstone/Conglomerate (Kammer, 1982)

Figures 3-3 and 3-4 show the potentiometric surface maps for the unconsolidated aquifer and the bedrock aquifer flow systems, respectively. Groundwater potentiometric data on which these maps are based are taken from measured values reported as part of each particular AOC's Investigation Report or other recorded documentation, as provided by the USACE, or from logbook entries as provided either by USACE or directly by the contractor performing the investigation. Groundwater in both aquifers predominantly flows in an eastward direction. The unconsolidated aquifer, however, also shows numerous local flow variations that are influenced

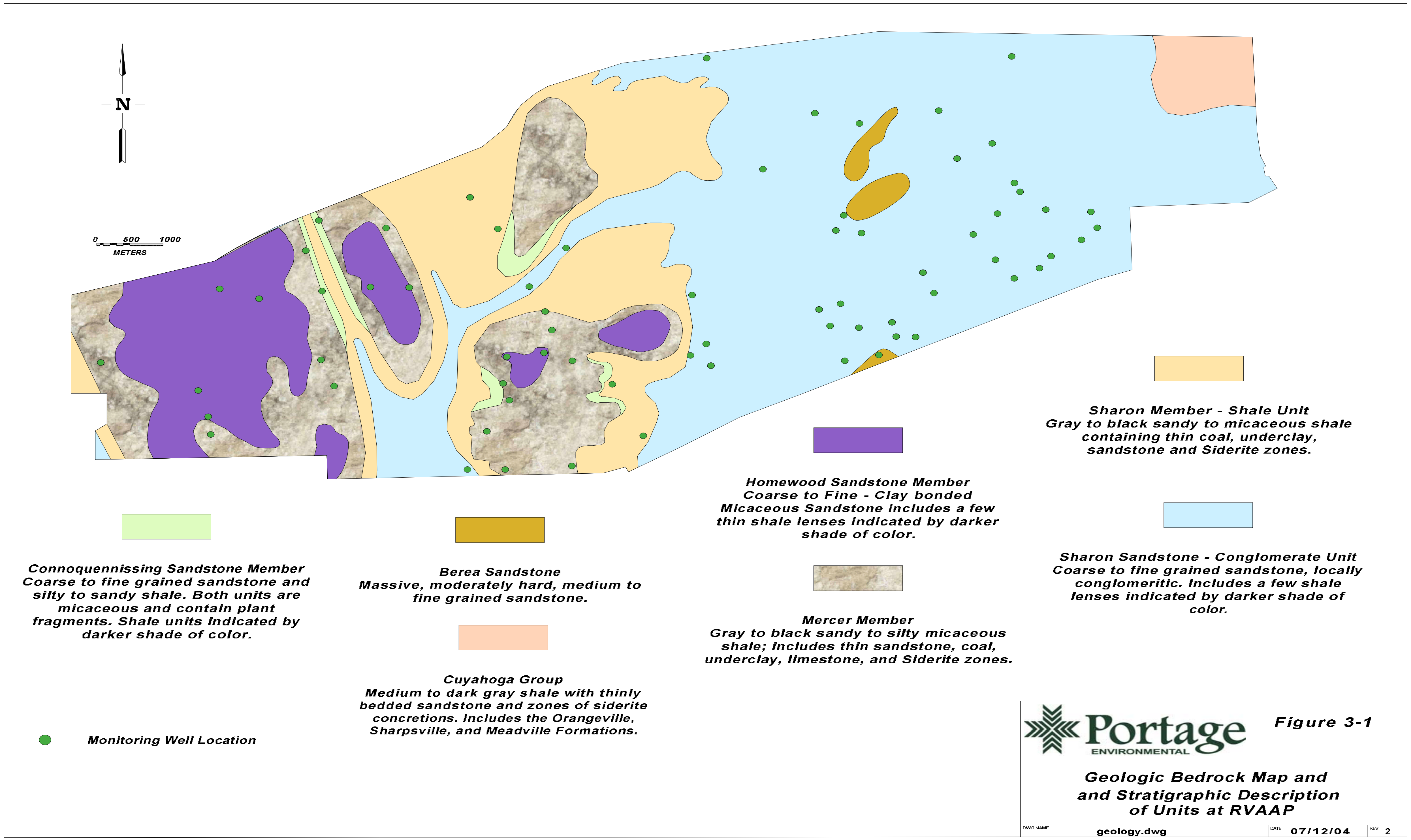

Figure 3-1

Geologic Bedrock Map and and Stratigraphic Description of Units at RVAAP

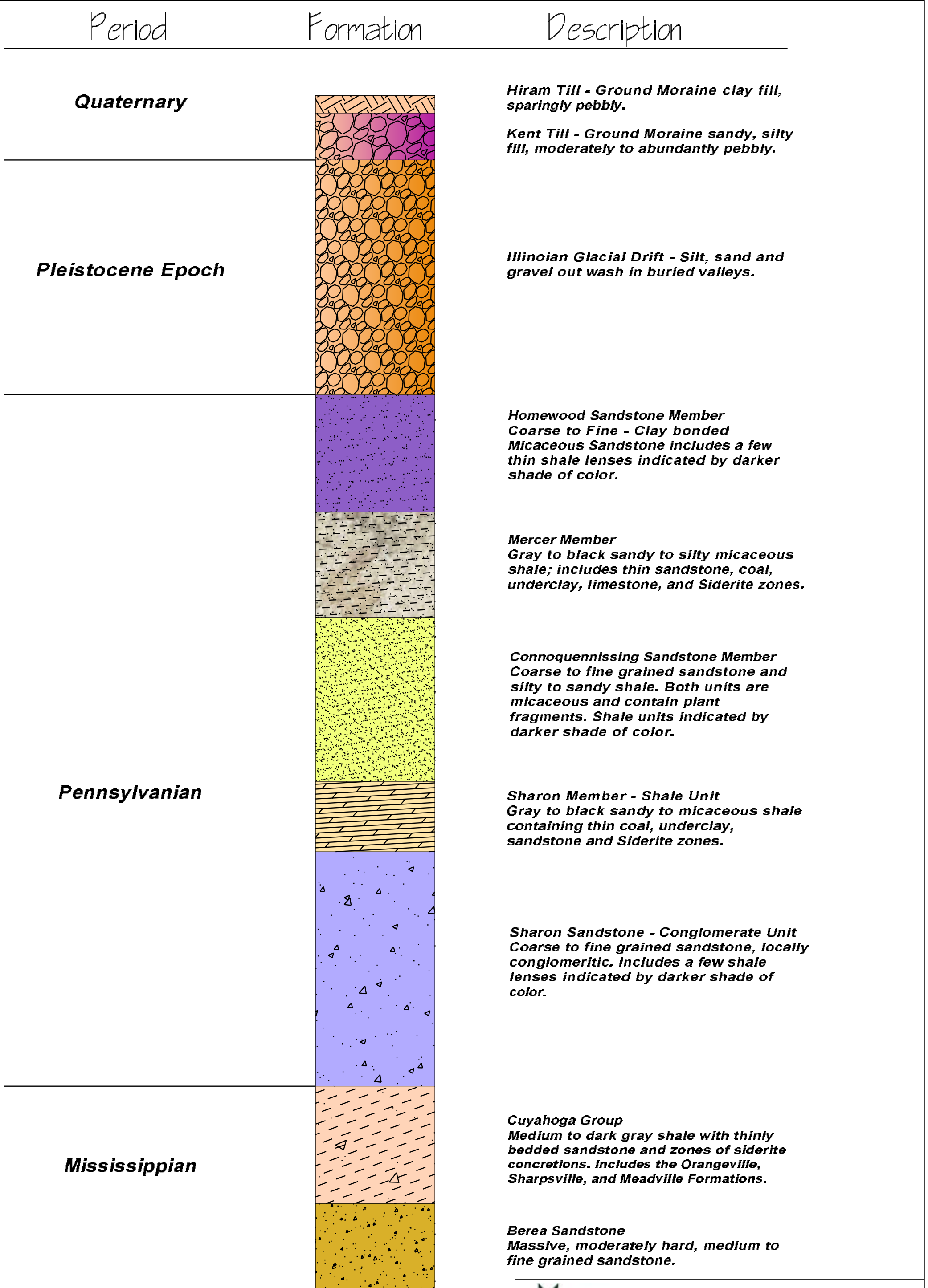

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Figure 3-2

Generalized Stratigraphic Section (after USATHMA, 1978)

DWG/NAME geology.dwg fig3-2 DATE 09/12/04 REV 0

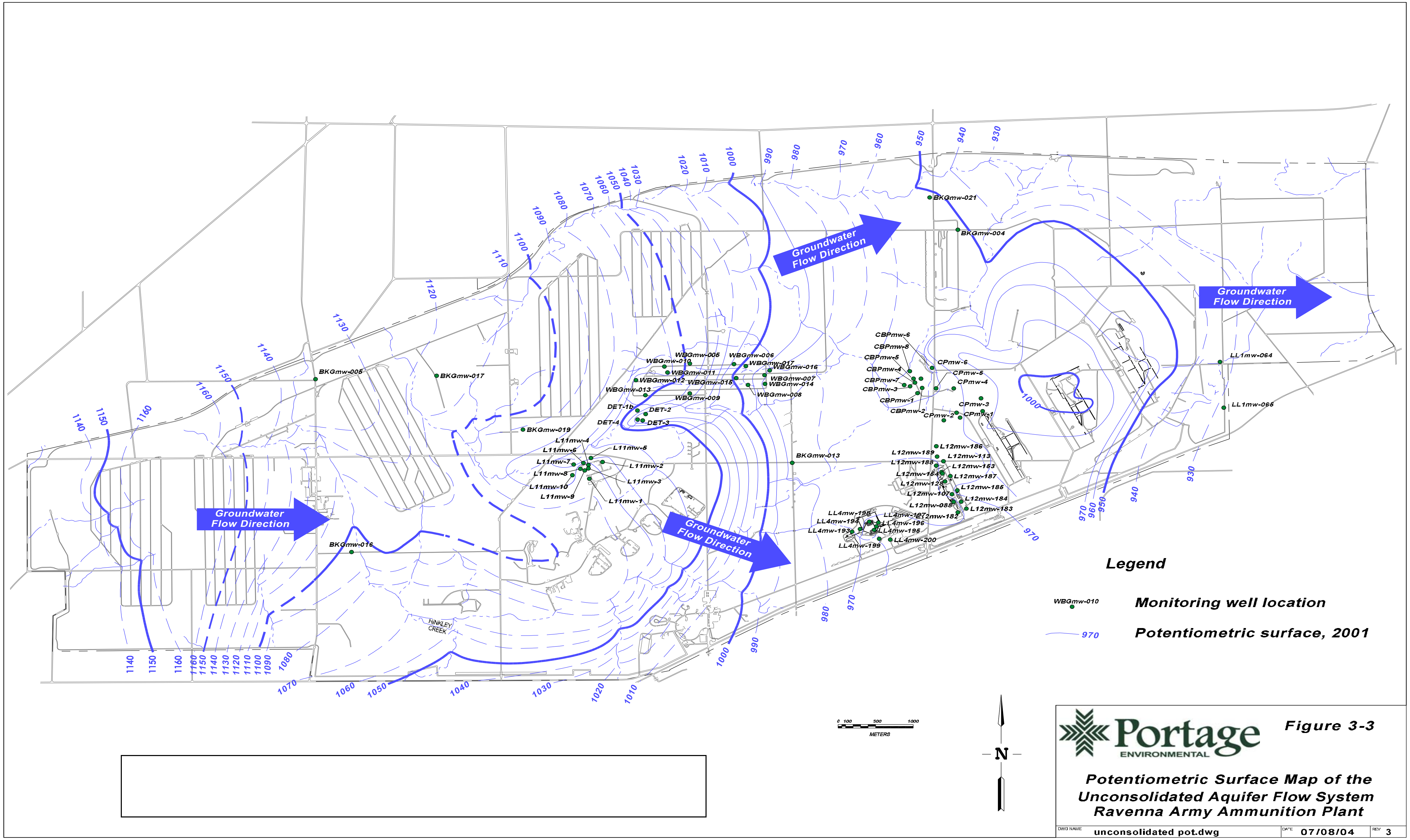
Groundwater Flow Direction
Groundwater Flow Direction
Groundwater Flow Direction
Groundwater Flow Direction
HINKLEY CREEK
METERS
N
Legend
WBGmw-010 Monitoring well location
970 Potentiometric surface, 2001
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Figure 3-3
Potentiometric Surface Map of the Unconsolidated Aquifer Flow System Ravenna Army Ammunition Plant
unconsolidated pot.dwg
07/08/04
3

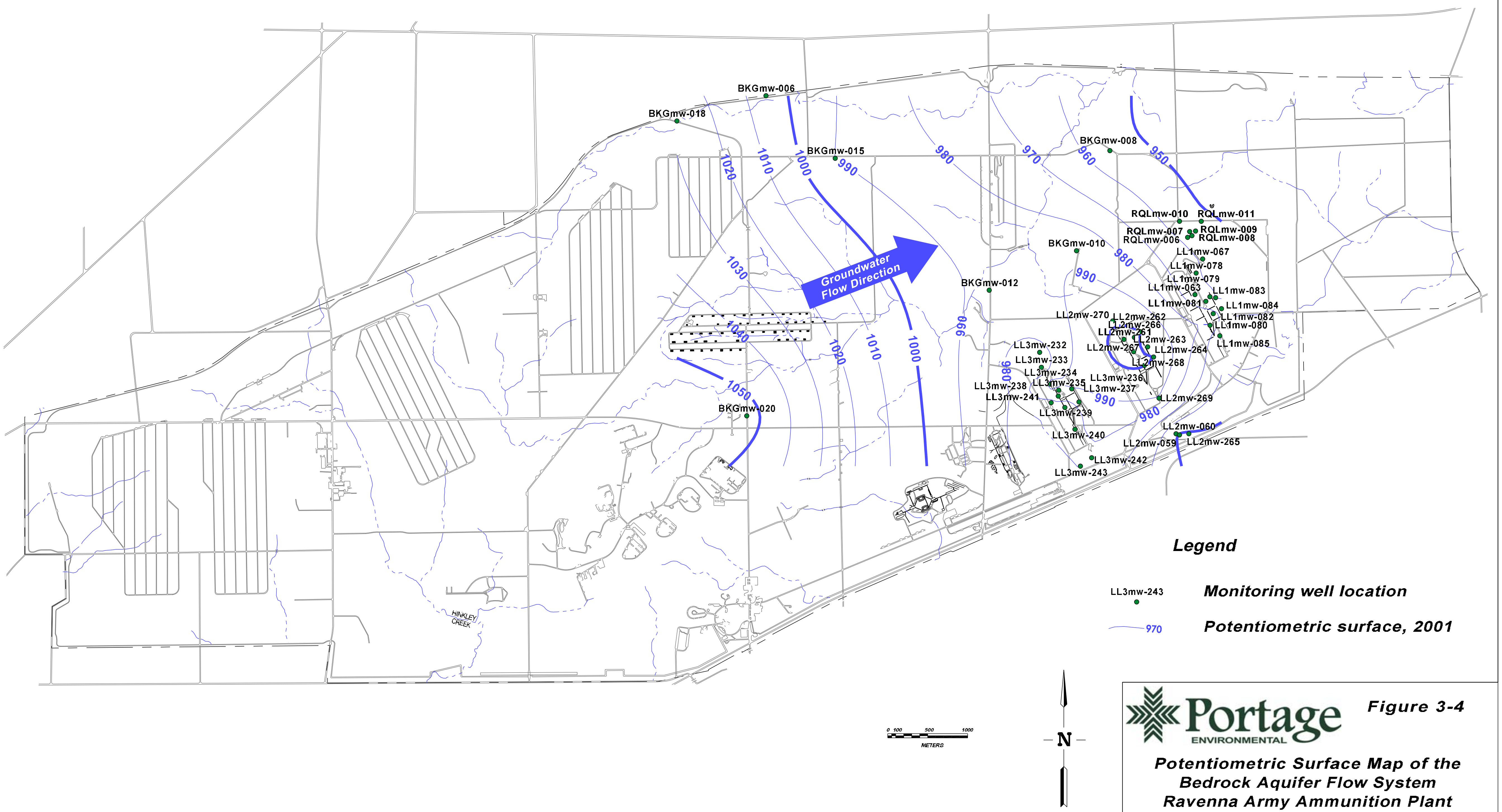

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Figure 3-4

Potentiometric Surface Map of the Bedrock Aquifer Flow System Ravenna Army Ammunition Plant

DWG NAME	DATE	REV
bedrock pot.dwg	07/08/04	3

by topography and site drainage patterns. The local variations in flow direction suggest that groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water, and that surface water drainageways may also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides for groundwater found in the unconsolidated deposits.

The bedrock potentiometric map shows a more uniform and regional eastward flow direction that is not as affected by local surface topography. Due to the lack of well data in the western portion of the site, the discussion below focuses on groundwater occurrence in the eastern portion of the site. For much of the eastern half of the site, the bedrock potentiometric surface is higher than the overlying unconsolidated potentiometric surface indicating an upward hydraulic potential. This evidence suggests that there is a confining layer that separates the two aquifers. In the far eastern site area, the two potentiometric surfaces are approximately at the same elevation, suggesting that hydraulic communication between the two aquifers is occurring.

Kammer (1982) also presents data from several hydraulic tests conducted in the Sharon Sandstone/Conglomerate, the Homewood Sandstone, and wells that combine both the Sharon Sandstone/Conglomerate and the Connoquenessing Sandstone. For wells solely completed in the Sharon Sandstone/Conglomerate, hydraulic conductivity values range from 8 to 14 ft/d (3×10^{-3} to 5×10^{-3} cm/sec) - approximately half of the values reported by Barnes (1950). For the sole Homewood Sandstone well test, the hydraulic conductivity was reported to be 8 ft/d (3×10^{-3} cm/sec) - at the lower range for wells in the Sharon Sandstone/Conglomerate. For wells completed in both the Sharon and Connoquenessing Sandstone, the range of hydraulic conductivity values were 3 to 11 ft/d (1×10^{-3} to 4×10^{-3} cm/sec). Results from these wells suggest either the Connoquenessing Sandstone does not supply significant quantities of water or the shale member of the Sharon is of substantial thickness within the screened interval to limit water to the wells.

The Preliminary Assessment Report (USACE, 1996) states that the Sharon Sandstone/Conglomerate is the primary source of groundwater for the RVAAP and produces the most significant well yields of the Pottsville Formation members with hydraulic conductivity values of 1 to 270 ft/d (4×10^{-4} to 9×10^{-2} cm/sec). The Connoquenessing Sandstone and the Homewood Sandstone are the remaining aquifers of the Pottsville Formation and exhibit hydraulic conductivities of 1 to 40 ft/d (4×10^{-4} to 1×10^{-2} cm/sec) and 1 to 27 ft/d (4×10^{-4} to 9×10^{-3} cm/sec), respectively. Slug tests conducted on bedrock wells in the LL2 area yielded a range of 0.01 to 7 ft/d (4×10^{-6} to 2×10^{-3} cm/sec) (USACE, 2003c).

Using the available site hydraulic information, an assumed effective porosity, and Darcy's Law, it is possible to estimate the rate of contaminant transport in the unconsolidated and bedrock aquifers. For groundwater flow estimates in the unconsolidated aquifer, a wide range of hydraulic conductivity values are reported in the available literature. Using the hydraulic conductivity range presented by SAIC (USACE 2003c) of1.31 $\times10^{2}$ ft/day (4 ×10-2 cm/sec) in sandy materials to as low as 2.83 $\times10^{-4}$ ft/day (1×10-7 cm/sec) for clays, an effective porosity of 0.2, and the average hydraulic gradient of 0.004, groundwater flow velocities (also referred to as the average linear velocity) in the unconsolidated deposits range from 0.002 ft/yr to 950 ft/yr (0.0006 to 290 m). This wide range in groundwater flow values is reflective of the heterogeneous nature of the unconsolidated deposits. Flow in the clayey glacial tills is basically insignificant while groundwater flow rates in the sandy lenses can be important. The lateral extent of these sandy unconsolidated deposits and the implications for significant transport pathways is not well understood. Because of the extreme variability of the localized sand deposits, including types of materials, horizontal and vertical extents, depths from surface, etc., full understanding of these sand layers is virtually impossible. The likelihood that sandy deposits are continuous over large areas is not likely, however, and transport of contamination in the unconsolidated aquifer is not considered to be significant on a facility-wide basis.

Using a range of hydraulic conductivity values reported by Barnes (1950) and Kammer (1982) of 8 to 34 ft/d (3×10^{-3} to 1×10^{-2} cm/sec), an effective porosity of 0.20, and the average hydraulic gradient of 0.005, groundwater-flow velocities in the bedrock aquifer (Sharon Sandstone/Conglomerate) are estimated to be 70 to 300 ft/yr (20 to 90 m). This range is expected to be more consistent over the site and indicates that the Sharon Sandstone/Conglomerate is capable being a regional groundwater transport pathway.

3.1.2.2 Selections of Wells for Inclusion in the FWGWMP

The refined conceptual model as described in the section above serves as the basis for the initial selection of wells for inclusion as part of the FWGWMP network. A discussion describing the specific wells to be initially included in the network, as agreed upon by the Army and Ohio EPA, along with the rationale for their selection, is presented below. After completion of the initial monitoring period, approximately 20% of the total number of groundwater wells at the time of the monitoring period under consideration will be included in the FWGWMP during any given monitoring event. If groundwater contamination is detected during any sampling and analysis activities, additional wells may be needed to define the extent of contamination and to determine the rate of contaminant migration. The selection of wells for monitoring as part of the network, including the need to incorporate additional wells, will be reevaluated on an annual basis.

Existing Wells

Existing wells can be defined either as RCRA/Solid Waste wells or CERCLA wells. In accordance with the RVAAP Final Findings and Orders, 10 June 2004 (hereafter; Orders), selected wells installed as part of the RCRA/Solid Waste programs (Ramsdell Quarry Landfill {RQL} and Open Detonation Area {OD#2}) will be included and monitored as part of the network. The remainder of the monitoring network is comprised of selected existing CERCLA wells, either AOC or background wells, meeting initial monitoring criteria.

Future Wells

Future wells installed as part of individual AOC investigations conducted under the ongoing CERCLA process at RVAAP will be evaluated for incorporation into the FWGWMP upon completion of at least four quarterly groundwater sampling events to be conducted as part of the Remedial Investigation (RI) phase at each AOC. The frequency of the initial sampling events may be other than quarterly if agreed upon by the Army and Ohio EPA.

Selection of Wells for the Initial FWGWMP Network

The purpose of the FWGWMP is to ensure the detection of groundwater contamination before it leaves the AOC by following a defined process designed to incorporate the specific data quality objectives as identified in Section 3.1.1. Because there are two aquifers that pose possible contaminant transport pathways, and because there are numerous AOCs on the facility, the program must monitor a sufficient number of wells to ensure detection of groundwater contamination on a facility-wide basis. The complexity of the site hydrogeology requires that both unconsolidated locally-controlled groundwater wells, as well as bedrock monitoring wells reflecting a more regional flow pattern, be included in the monitoring network. The initial selection of wells for the site wide groundwater monitoring network was made based on consideration of the following criteria:

- Detect/monitor groundwater contamination directly downgradient of areas of concern (AOCs)
- Detect/monitor groundwater contamination near the downgradient facility boundary
- Identify/quantify occurrence of COPCs in the unconsolidated aquifer
- Identify/quantify occurrence of COPCs in the regional bedrock aquifer
- Include all currently-monitored RCRA wells for the Ramsdell Landfill and Open Detonation Area #2

A listing of the COPCs for the RVAAP, as identified in the site's Preliminary Assessment (USACE, 1996), is presented in Table 3-1. Remedial Investigations that have been completed or that are currently underway, and for which groundwater monitoring information was available at the time this plan was being developed, are listed below:

- Load Line 1
- Load Line 2
- Load Line 3
- Load Line 4
- Load Line 11
- Load Line 12
- Central Burn Pits
- Cobbs Pond
- Winklepeck Burning Grounds

The location of monitoring wells installed as part of the foregoing RIs, as well as the level of contamination indicated in subsequent sampling of the wells, was considered when evaluating available wells in the initial network selection process. Areas that currently exhibit groundwater contamination need to continue to be monitored to ensure that the surrounding environment is not adversely impacted. Since there are numerous wells at the site, the approach used was to select wells that can detect contamination and eliminate wells that provide redundancy or provide minimal information on groundwater quality. Wells presently exhibiting COPCs were a priority in the monitoring well selection process since they indicate known contaminant transport pathways. Table 3-2 provides the water quality standards criteria for the COPCs listed in Table 3-1. Selection of wells exhibiting existing contaminant concentrations was made based on a comparison of reported COPC values to the USEPA Water Standards and Health Advisory (2002). Table 3-3 provides a list of wells where COPCs have been detected during the RI process. Most of the wells listed in Table 3-3 contain COPCs that exceed either the MCL or the health advisory listed in Table 3-3. The purpose of comparing groundwater quality to the standards and health advisories is solely for selection of facility-wide monitoring wells and not for any specific remedial action.

A listing of wells selected for monitoring under the FWGWMP, along with the rationale used for their selection, is presented in Table 3-4. Figure 3-5 depicts the locations for the wells selected for monitoring under the FWGWMP, and Figure 3-6 depicts a simplified decision diagram for the well selection process. As noted in Table 3-4, some of the wells were selected based on location and not on the presence of COPCs. Locations for which water quality data were not available at the time of well selection are identified with "N/A" with regard to COPCs.

Table 3-1 Chemicals of Potential Concern (COPCs) for the RVAAP (after USACE, 2001b)

Primary Chemicals of Potential Concern
Dinitrotoluene-2,4 (DNT)
Dinitrotoluene-2,6
Trinitrotoluene-2,4,6 (TNT)
RDX
Composition B (RDX + TNT)
HMX
Nitrocellulose
Nitroglycerine
Nitroguanidine
Aluminum
Arsenic
Barium
Cadmium
Chromium
Lead
Mercury
Selenium
Silver
Zinc
Other COPC's
1,3,5-Trinitrobenzene
1,3-Dinitrobenzene
Nitrobenzene
o-Nitrotoluene
n-Nitrotoluene
p-Nitrotoluene
Manganese
VOCs
SVOCs
PCBs

Table 3-2 Water Quality Standards for RVAAP CPOCs

COPCs	Standards MCL (mg/L)
TNT	N/A
HMX	N/A
Composition B	N/A
RDX	N/A
Polychlorinated biphenyls	.0005
Aluminum	0.05 - .2(1)
Antimony	0.006
Arsenic	0.01
Barium	2
Beryllium	.004
Cadmium	0.005
Chloride	250(1)
Chromium	0.1
Copper	1.3
Cyanide	0.2
Iron	0.3(1)
Lead	0.015
Manganese	0.05(1)
Mercury	0.002
Nitrate	10
Nitrite	1
Selenium	0.05
Silver	0.01(1)
Sulfate	250(1)
Thallium	.002
Zinc	5(1)

(1) Secondary Drinking Water Regulation
N/A – MCLs Not Established

Table 3-3 Monitoring Wells Exhibiting Contaminants of Potential Concern (COPCs).

Well	Monitoring Zone
Load Line 1	
LL1mw-067	Bedrock
LL1mw-078	Bedrock
LL1mw-079	Bedrock
LL1mw-080	Bedrock
LL1mw-081	Bedrock
LL1mw-083	Bedrock
LL1mw-084	Bedrock
LL1mw-085	Bedrock
Load Line 2	
LL2mw-059	Bedrock
LL2mw-060	Bedrock
LL2mw-261	Bedrock
LL2mw-262	Bedrock
LL2mw-263	Bedrock
LL2mw-264	Bedrock
LL2mw-265	Bedrock
Load Line 3	
LL3mw-238	Bedrock
LL3mw-241	Bedrock
Load Line 4	
LL4mw-198	Unconsolidated
LL4mw-199	Unconsolidated
Load Line 12	
LL12mw-113	Unconsolidated
LL12mw-128	Unconsolidated
LL12mw-153	Unconsolidated
LL12mw-186	Unconsolidated
LL12mw-189	Unconsolidated
Winklepeck Burning Grounds	
WBGmw-005	Unconsolidated
WBGmw-006	Unconsolidated
WBGmw-007	Unconsolidated
WBGmw-009	Unconsolidated

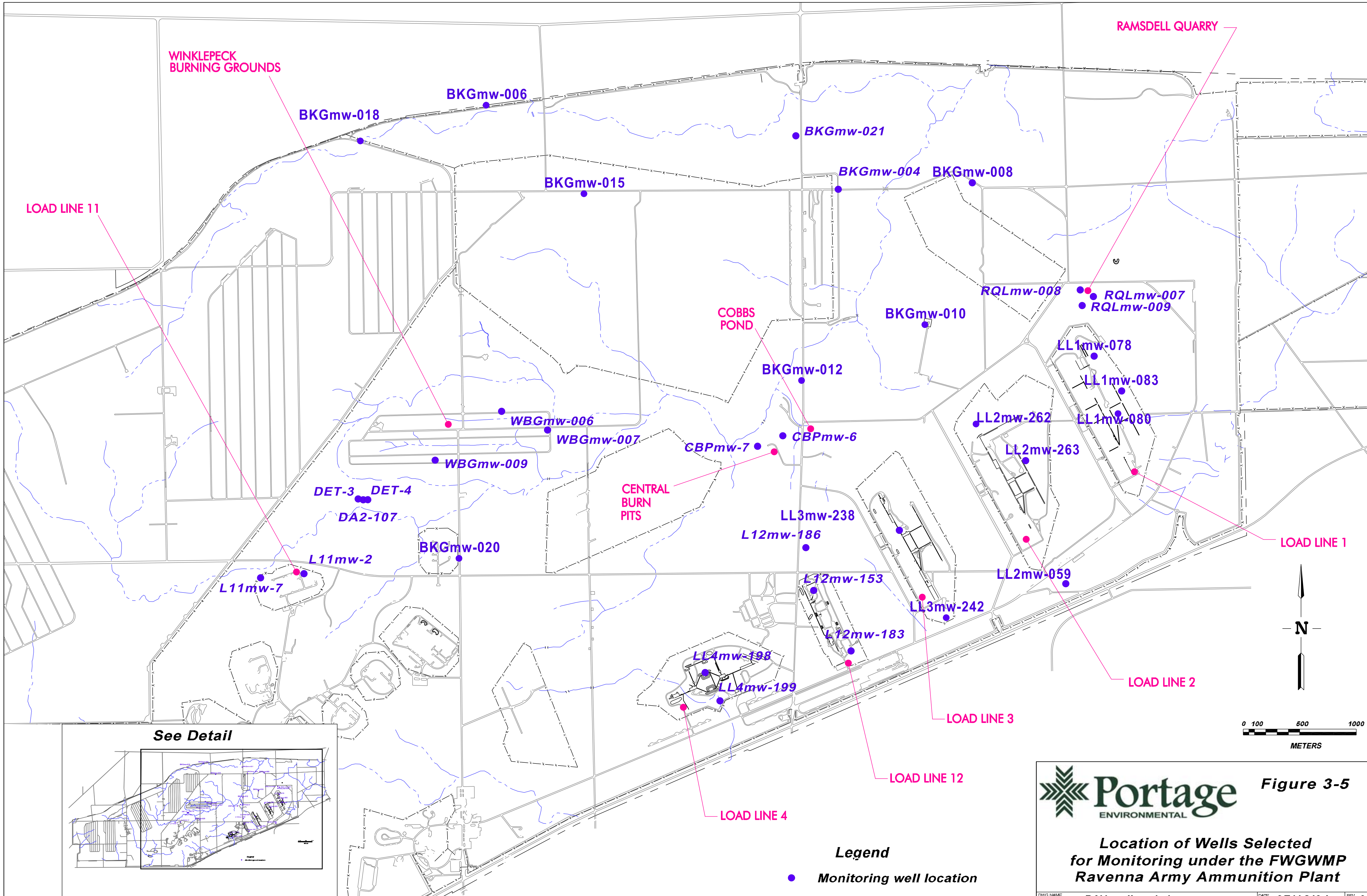
Table 3-4 Proposed Monitoring Wells for Inclusion in the Site-Wide Groundwater Monitoring Plan

Well	Monitoring Zone	Total Depth (ft below TOC)	Screen Length (ft)	COPCs Present	RCRA Well	Selection Rationale
Facility-Wide Monitoring Wells						
BKGmw-004	Unconsolidated	19.5	10	No	No	Downgradient of all AOCs
BKGmw-005*	Unconsolidated	19.0		No	No	Establish background conditions
BKGmw-006*	Bedrock	35.1		No	No	Establish background conditions
BKGmw-008	Bedrock	25.0	10	No	No	Downgradient of all AOCs
BKGmw-010*	Bedrock	22.0		No	No	Establish background conditions
BKGmw-012*	Bedrock	59.8		No	No	Establish background conditions
BKGmw-013*	Unconsolidated	25.5		No	No	Establish background conditions
BKGmw-015	Bedrock	51.0	20	No	No	Downgradient of all AOCs
BKGmw-016*	Unconsolidated	19.0		No	No	Establish background conditions
BKGmw-017*	Unconsolidated	34.0		No	No	Establish background conditions
BKGmw-018*	Bedrock	24.7		No	No	Establish background conditions
BKGmw-019*	Unconsolidated	34.0		No	No	Establish background conditions
BKGmw-020*	Bedrock	30.7		No	No	Establish background conditions
BKGmw-021	Unconsolidated	19.0	10	No	No	Downgradient of all AOCs
Load Line 1						
LL1mw-078	Bedrock	41.1	10	Yes	No	Site-wide/LL1 D.G. wells
LL1mw-080	Bedrock	22.0	10	Yes	No	Site-wide/LL1 D.G. wells
LL1mw-083	Bedrock	41.7	10	Yes	No	Site-wide/LL1 D.G. wells
Load Line 2						
LL2mw-059	Bedrock	21.8	10	Yes	No	Facility Boundary, Downgradient of LL2
LL2mw-262	Bedrock	22.6	10	Yes	No	Downgradient of LL2
LL2mw-263	Bedrock	22.2	10	Yes	No	Downgradient of LL2

Well	Monitoring Zone	Total Depth (ft below TOC)	Screen Length (ft)	COPCs Present	RCRA Well	Selection Rationale
Load Line 3						
LL3mw-238	Bedrock	23.4	10	Yes	No	Downgradient of LL3
LL3mw-242	Bedrock	22.5	10	No	No	Downgradient of LL3
Load Line 4						
LL4mw-198	Unconsolidated	22.0	10	Yes	No	Downgradient of LL4
LL4mw-199	Unconsolidated	23.2	10	Yes	No	Downgradient of LL4
Load Line 11						
LL11mw-002	Unconsolidated	16.0	10	N/A	No	Downgradient of LL11
LL11mw-007	Unconsolidated	22.0	10	N/A	No	Downgradient of LL11
Load Line 12						
LL12mw-153	Unconsolidated	26.0	10	Yes	No	Downgradient of LL12
LL12mw-182	Unconsolidated		10	Yes	No	Downgradient of LL12
LL12mw-183	Unconsolidated	36.0	10	No	No	Downgradient of LL12
LL12mw-186	Unconsolidated	23.0	10	Yes	No	Downgradient of LL12
Central Burn Area						
CBPmw-006	Unconsolidated	22.5	10	N/A	No	Monitors GW flow to Sand Creek
CBPmw-007	Unconsolidated	29.5	10	N/A	No	Monitors GW flow to Sand Creek
Demolition Area 2						
DA2-107	Unconsolidated	14.0	5	N/A	No	Downgradient of DA2 RCRA unit
DET-3**	Unconsolidated	12.0	5	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
DET-4**	Unconsolidated	11.0	5	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders

Ramsdell Quarry						
RQLmw-007**	Bedrock	16.2	10	N/A	Yes	Monitoring required by RVAAP Final Findings and Orders
RQLmw-008**	Bedrock	16.2	10	N/A	Yes	Monitoring required by RVAAP Final Findings and Orders
RQLmw-009**	Bedrock	16.5	10	N/A	Yes	Monitoring required by RVAAP Final Findings and Orders
Winklepeck Burning Grounds						
WBGmw-006	Unconsolidated	19.0	10	Yes	No	Monitors GW to Sand Creek Tributary
WBGmw-007	Unconsolidated	24.0	10	Yes	No	Monitors GW to Sand Creek Tributary
WBGmw-009	Unconsolidated	24.0	10	Yes	No	Monitors GW to Sand Creek Tributary

N/A = Analytical Results Not Available
*Included for initial monitoring period only.
**To be included in the FWGWMP for monitoring after May, 2005



RAMSDELL QUARRY
WINKLEPECK BURNING GROUNDS
BKGmw-006
BKGmw-018
BKGmw-021
BKGmw-004
BKGmw-008
BKGmw-015
LOAD LINE 11
RQLmw-008
RQLmw-007
RQLmw-009
COBBS POND
BKGmw-010
LL1mw-078
BKGmw-012
LL1mw-083
LL2mw-262
LL1mw-080
WBGmw-006
WBGmw-007
CBPmw-6
CBPmw-7
LL2mw-263
WBGmw-009
CENTRAL BURN PITS
DET-3
DET-4
DA2-107
LL3mw-238
L12mw-186
LOAD LINE 1
BKGmw-020
L11mw-2
L11mw-7
LL2mw-059
L12mw-153
LL3mw-242
L12mw-183
LL4mw-198
LL4mw-199
LOAD LINE 2
LOAD LINE 3
LOAD LINE 12
LOAD LINE 4
N
0 100 500 1000
METERS
See Detail
Legend
Monitoring well location
Portage ENVIRONMENTAL
Figure 3-5
Location of Wells Selected for Monitoring under the FWGWMP Ravenna Army Ammunition Plant
DWG NAME RAV_well_pmk.dwg
DATE 07/12/04
REV 3

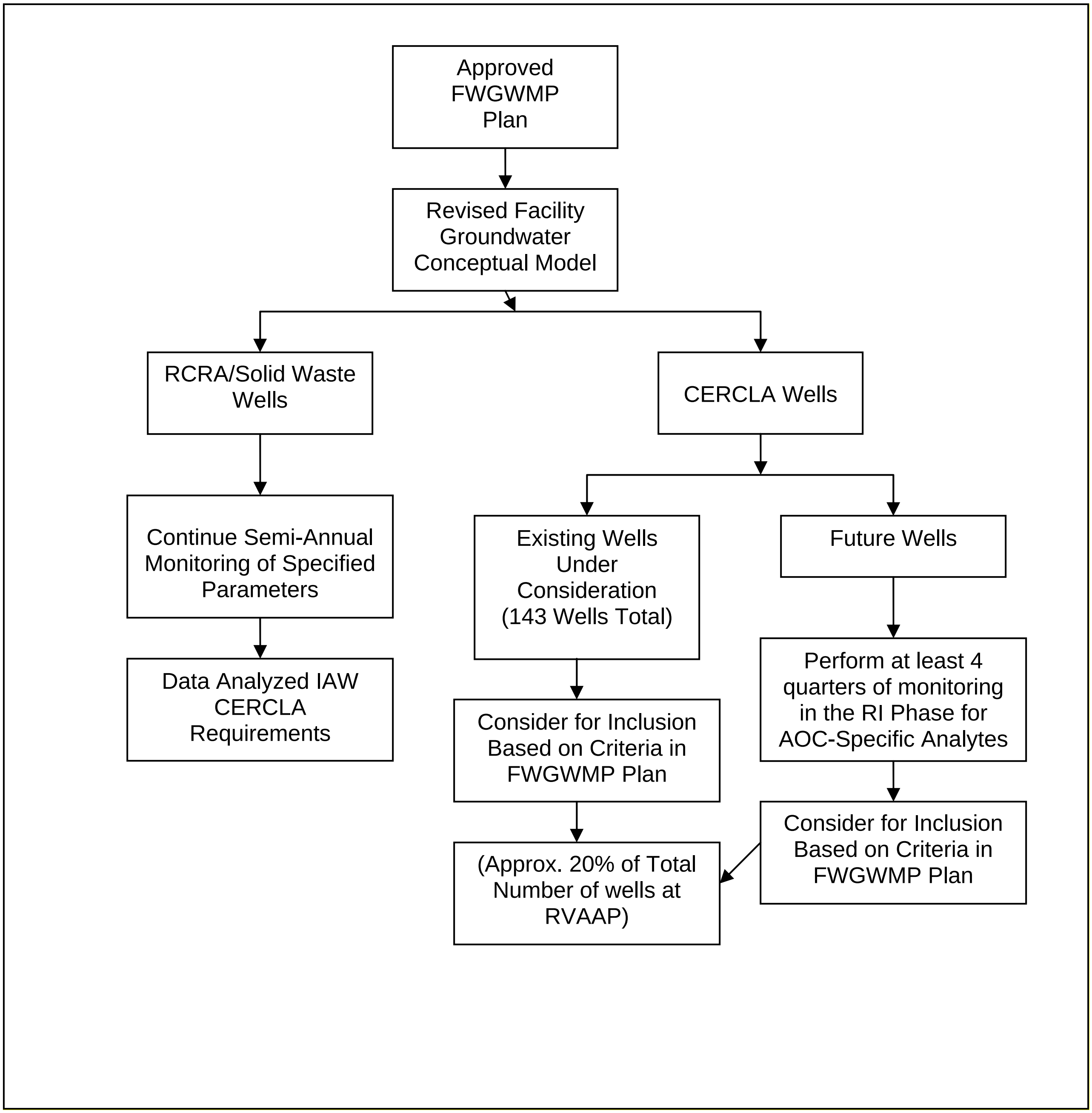


Figure 3-6 FWGWMP Monitoring Well Selection Decision Diagram

The wells designated as "Facility–Wide Monitoring Wells" in Table 3-4 are those wells located at the farthest downgradient location at the RVAAP and were selected to monitor regional groundwater quality for the entire site. There are no background wells located upgradient of the AOCs that are completed in bedrock. To determine background water quality, several of the BKG series wells were located in areas believed to be free of groundwater contamination. The use of these wells for background water quality was approved by the Ohio EPA during earlier site investigations.

No wells from the Cobbs Pond area were included in the site-wide monitoring well network. Groundwater in the Cobbs Pond area flows westward toward Sand Creek in the unconsolidated deposits. The monitoring wells selected for the Central Burn Pits are downgradient of the Cobbs Pond area and should detect groundwater contamination from either area before it enters Sand Creek. An additional monitoring well was selected from the Winklepeck Burning Grounds due to the complexity of the groundwater flow system in the area. Several drainages that are tributaries to Sand Creek dissect this area. Since all of the monitoring wells in the area are completed in unconsolidated deposits, several groundwater flow directions are possible in the area.

There are six monitoring wells in the Ramsdell area that are currently monitored under the RCRA program; three of these wells are to be included in the FWGWMP network. All of these wells are completed into the bedrock aquifer. Since these wells are located downgradient of the facility's other identified AOCs, these wells will also provide for the detection of potential regional groundwater contamination. Monitoring wells located in the Open Detonation Area # 2 (DET-1b, DET-2, DET-3, and DET-4) are also part of ongoing groundwater monitoring under the RCRA program and selected wells are also included for monitoring in the site-wide groundwater-monitoring program.

In summary, 36 wells are proposed for initial sampling as part of the Facility-Wide Groundwater Monitoring Program. Of these 36 wells, 10 are background wells that are not proposed for further monitoring after the initial period. RCRA wells at both Open Detonation Area #2 and Ramsdell Quarry Landfill are currently scheduled for monitoring by the RVAAP M&O Contractor through May, 2005 and therefore are not included for initial monitoring under this plan. Both unconsolidated and bedrock wells are included in the FWGWMP to detect contamination on a local scale and on a facility wide scale. Unconsolidated wells are targeted to detect contamination from specific AOCs before potentially contaminated groundwater can enter nearby streams. Some unconsolidated wells are used to detect regional groundwater conditions in the eastern portion of the site where the two aquifers converge. The bedrock wells provide regional control for any potential groundwater contamination that may enter the regional aquifer. In addition, bedrock wells are used to monitor AOCs where the unconsolidated aquifer is insufficient to produce reasonable quantities of water.

3.1.2.3 Criteria for Removal of Individual Wells from the FWGWMP Network

The decision process for permanently eliminating wells included in the network will take into consideration the rationale for initially including the well within the network, as well as the results of groundwater data analysis, modeling, risk estimates, etc. to determine if the well continues to contribute useful data to the facility-wide network.

3.1.3 Key Assumptions

Based on the site-wide groundwater conceptual model presented above, potential contaminant transport via the groundwater pathway can occur either in the shallow unconsolidated deposits and/or the bedrock aquifer – most specifically the Sharon Sandstone/Conglomerate. Groundwater in both aquifers flows in a general eastward direction, however, the numerous surface water streams flowing across the facility influence groundwater flow locally in the unconsolidated deposits. As a result, groundwater occurring in the unconsolidated deposits near surface water drainageways eventually discharges to the surface steams and may have local flow directions that vary from the regional hydraulic gradient.

For a large portion of the site, the hydraulic heads in the underlying bedrock aquifer are greater than the hydraulic heads in the unconsolidated deposits. This indicates that there is little potential for the downward migration of contaminants to the bedrock aquifer. The exception to this observation occurs in the eastern portion of the site where the bedrock and unconsolidated aquifers potentiometric surfaces are nearly identical. In the area east of Load Line 1, the unconsolidated and bedrock aquifers appear to be in hydraulic communication. Therefore, a key assumption for the Facility-Wide Groundwater Monitoring Program is that both unconsolidated wells and bedrock wells are available to detect groundwater contamination in the far eastern portion of the facility.

Several of the areas of concern (AOCs) are monitored exclusively by bedrock wells. For these areas it is assumed that the unconsolidated deposits do not yield sufficient quantities of water and therefore no wells were completed in this zone. It is further assumed that the bedrock wells are adequate to detect groundwater contamination resulting from activities at these AOCs. This assumption is validated at several locations by the presence of COPCs in monitoring wells completed in bedrock. For example, bedrock monitoring wells LL2mw-050, LL2mw-262, and LL2mw-263, down gradient of Load Line 2, all show the presence of COPCs (USACE, 2003b). Bedrock monitoring well LL3mw-234, downgradient of Load Line 3, also shows the presence of COPCs in groundwater samples collected as part of the Remedial Investigation (USACE, 2003c).

The uppermost aquifer at the site is found in the unconsolidated deposits that form a thin veneer over the underlying bedrock. These deposits will be the first to show groundwater contamination. For reasons of low permeability and lack of aerial extent, the unconsolidated aquifer is important only on a localized scale - with the exception of the glacial outwash in the eastern portion of the RVAAP. Consequently, unconsolidated wells selected for site wide monitoring focus on local areas immediately downgradient of potential AOCs.

As noted in the previous discussion on the site hydrogeology, the Sharon Sandstone/Conglomerate is the major aquifer underlying the site and a principle pathway for the potential migration of contamination off site. The potentiometric surfaces for the unconsolidated and bedrock aquifers merge just east of Load Line 1. In this region, possible groundwater contaminants from the entire site can be monitored. Selected bedrock wells downgradient of Load Line 1 are downgradient of the entire site. These wells form the basis of the facility-wide monitoring plan for indicating the potential for off-site groundwater contaminant migration.

3.1.4 Data Evaluation and Decision Rules

Table 3-1 of the FSAP presents key decisions that need to be made with regard to investigation data collection at RVAAP. Decision rules guide the sampling effort, which in turn, defines the level of characterization necessary for decision making. The primary decision rules governing groundwater for current land use under the FWGWMP are consistent with those presented in Section 3.2.6 of the FSAP and as set forth in section 3.1.4.1 below. Figure 3-6 presents a simplified illustration of the decision-making process related to groundwater monitoring activities under the FWGWMP. Inputs to the decision rule process will include results of the field investigation and data analysis, modeling, and risk estimates, etc.

Remedial action decisions may eventually need to be made for the groundwater exiting specific AOC boundaries or the RVAAP facility based on the results of the data assessment performed under the FWGWMP or on AOC-specific well installation and monitoring. Controlling the potential for making a decision error – a wrong decision - begins in the DQO process. A full discussion on how to limit decision errors is provided in Section 3.2.8 of the FSAP.

3.1.4.1 Definition of Contamination – Criteria for Action Decisions

Sampling and analysis for the RVAAP FWGWMP will focus on achieving the following objectives:

- determination of the presence of groundwater contamination,
- determination of the nature and extent of groundwater contamination, and
- identification of the connections between contaminant sources and pathway media.

An evaluation of chemical data collected from the network will be conducted to form a basis for remedial decision-making regarding groundwater at RVAAP. Decisions for appropriate follow-on action by the facility will be based upon contamination levels detected during sampling under the RVAAP FWGWMP or on AOC-specific well installation and monitoring. Analytical results will be screened against the media-appropriate final facility-wide background values for RVAAP developed as part of the Phase I/Phase II RI for Winklepeck Burning Grounds (WBG) (USACE 2001b). 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 will be used to determine if detected analytes are site-related compounds (SRCs) or if they are naturally occurring. Analytes determined to be SRCs in the screening step will be further characterized according to the following criteria:

- If contamination detected in groundwater at the facility boundary or AOC groundwater exit pathway wells is less than applicable, relevant, and appropriate requirements (ARARs), no additional action is required - facility continue monitoring.

- If contamination detected in groundwater at the facility boundary or AOC groundwater exit pathway wells is greater than ARARs - consider remedial or removal action alternatives to address the risk.

- If contamination detected in groundwater at the facility boundary or AOC groundwater exit pathway wells is greater than ARARs – consider cost-benefit before implementing an action (e.g., perform a Feasibility Study).

3.1.4.2 Remedial Action Alternatives

A major goal of implementing the DQO process is to ensure that all data critical for decision making are collected as part of the field investigations. This should include data necessary for selecting and implementing cost-effective remedial actions if such actions are required. Analytical data generated as part of the FWGWMP will serve as the basis for evaluating the need for remedial action with regard to facility groundwater at RVAAP as described above. In addition, during the investigation process of each individual AOC, potential remedies will be identified. Available information on proposed remedial activities at individual AOCs will be considered when evaluating and selecting analytical parameters and monitoring wells for inclusion into the FWGWMP to ensure that all data necessary for remedial decisions on a facility-wide basis are available.

3.2 SCHEDULE FOR IMPLEMENTATION

Within 60 to 90 days of FWGWMP Plan approval, the initial round of monitoring under the program will be performed. The schedule of reporting requirements under the FWGWMP is presented in Section 5.0 of this Plan.

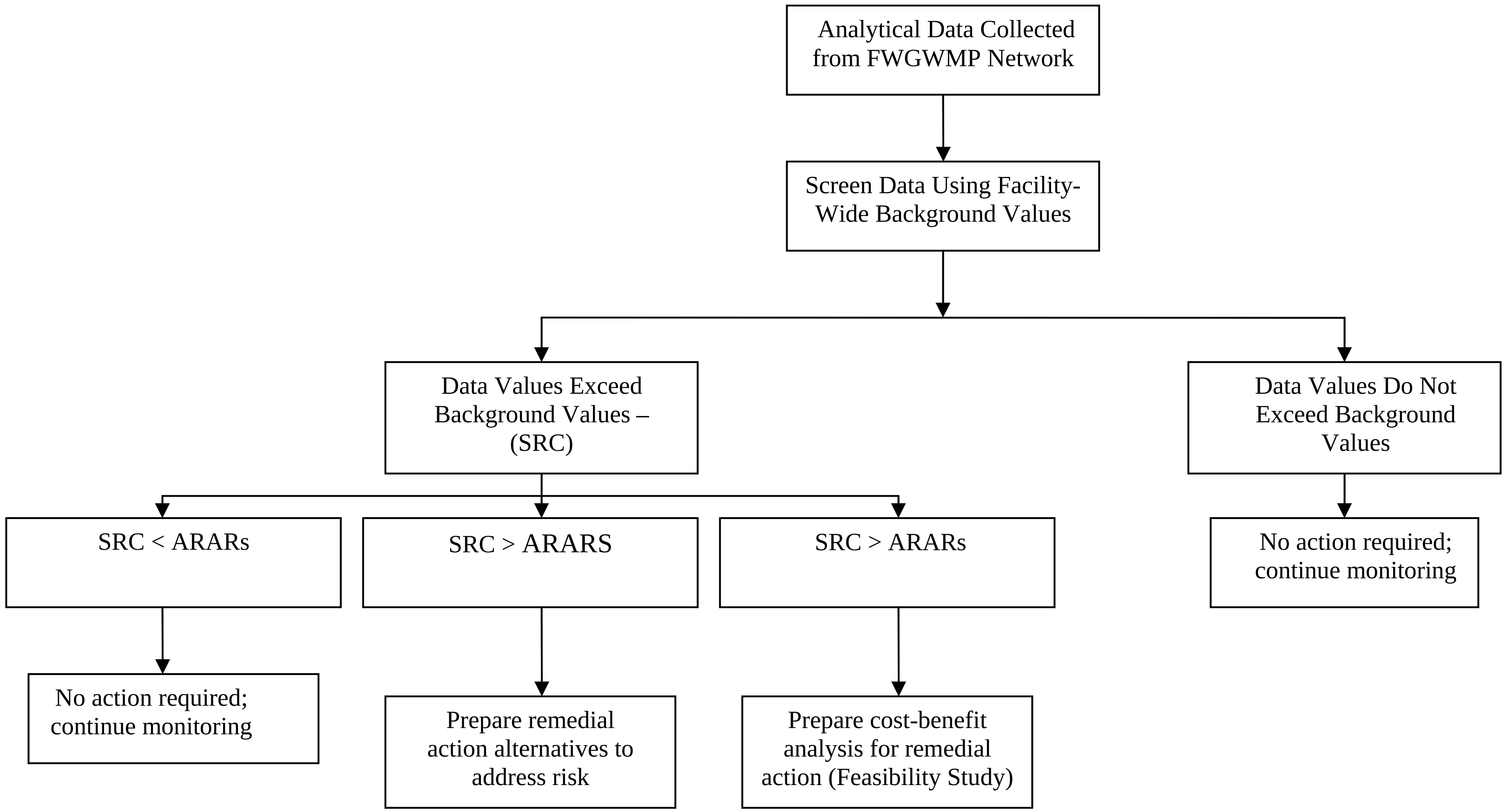


Figure 3-7 FWGWMP Decision Diagram

4.0 FIELD ACTIVITIES

4.1 SAMPLING METHODS

Collection of groundwater samples from network monitoring wells will involve three general steps: (1) measurement of field parameters, (2) well purging, and (3) groundwater sample collection. All of the activities would normally be accomplished within a 2- to 4-hour period per monitoring well. Procedures and criteria for the measurement of field parameters are discussed in Section 4.3.3 of the FSAP and are summarized below. Purging and sampling of monitoring wells will be accomplished using either a Teflon® or stainless steel bailer or a bladder or peristaltic pump. The integrity of each well will be checked on an annual basis prior to purging by visual examination of the condition of each well and completion of all elements specified by the RVAAP well maintenance checklist (Figure 4-1), and by performing an alignment test in accordance with Section 4.3.2.3.13 of the FSAP. Cracks or deterioration in the surface seal and structures, obstruction in the well, excessive silting in of the well, or excessive turbidity of the groundwater sample are indications that the well is not suitable for monitoring under the FWGWMP. In the event that the integrity of the monitoring well is questionable, the well will not be purged and sampled, and a different well will be selected, in conjunction with the U.S. Army Project Manager and the Ohio EPA, for monitoring as part of the network. If required, the questional or defective monitoring well will be properly abandoned, and a new well will be installed as directed by the U.S. Army Project Manager and the Ohio EPA.

Groundwater field measurements to be performed as part of the FWGWMP will include determination of static water level, pH, conductivity, and temperature. A description of each field instrument and associated calibration requirements and performance checks to be used for field measurements is presented in Table 4-3 of the FSAP. A summary of the procedures and criteria to be used for field measurements is presented below.

4.1.1 Field Measurements

The total depth of the well and static water level measurements will be made using an electronic water level indicator. The total depth of the well will be measured and recorded to the nearest 0.3 cm (.01 foot). Measurements will be made from the top of the solid well casing and will not be referenced to the rim of the protective casing. For static water level measurement, the indicator probe will be lowered into each monitoring well without touching the probe to the well casing until the alarm sounds and/or the indicator light illuminates. The probe will then be withdrawn several feet and slowly lowered again until the groundwater surface is contacted as noted by the alarm and/or indicator light. All probe cords used for measurement will be incrementally marked at 0.006-meter (0.02-feet) intervals. Water level measurements will be estimated to the nearest 0.003 m (0.01 feet) based on the difference between the nearest probe cord mark to the top of the well casing.

The distance between the top of casing and the groundwater surface will be recorded to within 0.3 cm (0.01 foot). The static water level measurement procedure will be repeated two or three times to ensure that the water level measurements are consistent (± 0.3 cm or 0.01 foot). If this is the case, then the first measured level will be recorded as the depth to groundwater. If this is not the case, the procedure will be repeated until consistent readings are obtained from three consecutive measurements.

RAVENNA ARMY AMMUNITION PLANT
WELL INSPECTION CHECKLIST

WELL INFORMATION

Well Number: _________ Location/Functional Area: ____________________

Casing Type: ______ Steel ______ Stainless Steel ______ PVC

Screened/Open-Hole Well Type: __________________ Monitor Interval Length: ________ ft

Flush-mount/Above-ground Completion: ______________________________

Reported Constructed Depth: ___________ ft BGS or BTOC (circle one)

INSPECTION ITEMS	YES	NO	N/A	COMMENTS
Well-head Completion:				
Above-ground completion:				
Number of guard posts at well: __________				
Are the posts positioned to prevent collision damage to the well?	[ ]	[ ]	[ ]	_____________________
Are any of the posts damaged or degraded?	[ ]	[ ]	[ ]	_____________________
Is a concrete pad installed?	[ ]	[ ]	[ ]	_____________________
Is the pad cracked or deteriorated?	[ ]	[ ]	[ ]	_____________________
Is steel protective casing installed?	[ ]	[ ]	[ ]	_____________________
Does the protective casing have a weep hole?	[ ]	[ ]	[ ]	_____________________
Flush-mount completion:				
Is the traffic cover securely bolted to the flush-mount box?	[ ]	[ ]	[ ]	_____________________
Does the well have a flush-mount box?	[ ]	[ ]	[ ]	_____________________
Is the traffic cover cracked or broken?	[ ]	[ ]	[ ]	_____________________
Is the concrete apron cracked or deteriorated?	[ ]	[ ]	[ ]	_____________________
Identification:				
Is the well labeled with the correct number?	[ ]	[ ]	[ ]	_____________________
Describe labeling: ____				
Security:				
Does the well have a cap or lid?	[ ]	[ ]	[ ]	_____________________
Does the well have a weatherproof lock?	[ ]	[ ]	[ ]	_____________________
Does the lock secure the well?	[ ]	[ ]	[ ]	_____________________
Does the inner casing have a water-tight cap?	[ ]	[ ]	[ ]	_____________________
Down-hole Condition:				
Is the well casing bent, corroded, or broken (at the surface?)	[ ]	[ ]	[ ]	_____________________
Is the well casing loose (at the surface?)	[ ]	[ ]	[ ]	_____________________
Is a measurement point marked at the top of the well casing?	[ ]	[ ]	[ ]	_____________________
Measured depth of the well from measurement point: ___________				
Thickness of sediment accumulation (reported depth-present measurement): ___________________________				
Are there any obstructions in the well?	[ ]	[ ]	[ ]	_____________________

Inspection Date: ______________ Inspected by: __________________________________

Figure 4-1 RVAAP Well Inspection Checklist

Field pH, conductivity, and temperature measurements will be made using a combination meter designed to measure these parameters. A groundwater sample will be retrieved from each monitoring well and immediately poured into a clean container placed onto a stable surface at the well. With the combination meter set in the appropriate mode, the meter electrode will be swirled at a slow constant rate within the sample until the meter reading reaches equilibrium.

Sample pH will be recorded to the nearest 0.1 pH unit. The pH measurement is considered stable when 3 consecutive readings produce less than 0.2 pH units variation. All recorded conductivity values will be converted to conductance at 25 ºC. Sample conductivity will be recorded to the nearest 10 μmhos/cm, and the temperature to the nearest 0.1 ºC, with stable measurements consisting of less than 10 percent variation for conductance and less than 0.5 ºC variation for temperature.

Field measurements of pH, temperature, specific conductance, and turbidity will be recorded for each groundwater sample. No samples will be collected for additional headspace analysis. Total well depth and water level measurements will be collected as described in Sections 4.3.2.6 and 4.3.3.1 of the FSAP immediately prior to sampling of each well. An unfiltered groundwater sample will be collected from each monitoring well and submitted for laboratory analysis as specified in Section 4.3. An ample volume of water will be collected so that filtered Target Analyte List (TAL) metals can be analyzed. Unfiltered samples for TAL metals will not be analyzed. Filtering will be performed in the field according to Section 4.3.5 of the Facility-wide SAP. All field measurement procedures and criteria will follow Section 4.3.3 of the Facility-wide SAP. Groundwater sampling from monitoring wells will follow conventional procedures discussed in Section 4.3.4.1 of the Facility-wide SAP.

4.1.2 Field Quality Control Sampling Procedures

QC duplicates, USACE QA split groundwater samples, equipment rinsate samples, and matrix spike/matrix spike duplicates will be collected during implementation of the FWGWMP. Duplicates and QA splits will be selected randomly (from the same locations, whenever possible) and analyzed for the same parameters as the environmental samples. Duplicate and QA split samples, representative of the sample parameters analyzed, will be collected at a frequency of 10 percent of environmental samples. Equipment rinsate samples will also be collected at a frequency of 10 percent of groundwater samples or one per day. Matrix spike/matrix spike duplicates will be collected at a rate of 10 percent of total number of field samples collected. Trip blanks, which originate in the laboratory, will accompany shipment of all VOC groundwater samples and will be analyzed for VOCs only. Split samples will be submitted to the following USACE contract laboratory (to be identified by the USACE) for independent analyses.

4.1.3 Purging

After initial measurement of field parameters, purging of each monitoring well will commence until pH, conductivity, and temperature have reached equilibrium as described in Section 4.3.3.2 of the FSAP. Equilibrium will be established by three consecutive readings, where one well casing volume is purged between each reading. However, purging will be terminated before establishment of equilibrium if one of the following conditions is met: (1) five well volumes, including the saturated filter pack assuming a porosity of 30%, have been removed from the well; or (2) the well is purged to dryness. Dedicated bailers used for purging/sampling may be stored in the wells between sampling events. Each bladder pump used for purging/sampling will be equipped with a Teflon®-coated retrieval wire that will be decontaminated upon completion of the purging and sampling activities. Dedicated Teflon tubing used for purging/sampling may be stored in the wells between sampling events. Existing dedicated tubing currently in storage may be used after undergoing decontamination procedures in accordance with the procedure presented in Section 4.3.8 of the Facility-wide SAP.

If a monitoring well is purged to dryness, sampling will be delayed for a time period of up to 24 hours to allow for recharge. During the delay period, the atmosphere of the well will be isolated to the greatest extent possible from the surface atmosphere. Upon sufficient recharge of groundwater into the well, i.e., if the well recharges to 90% of its initial water level within 4 hours, a sample will be collected without additional well purging. If sufficient well recharge does not occur within 24 hours after the initial purging, the U.S. Army Project Manager and the Ohio EPA Project Coordinator will be contacted for guidance.

In order to minimize the quantity of liquid IDW generated as a result of well purging, wells will be micro-purged where conditions permit, in accordance with Ohio EPA technical guidance (1995). When micro-purging cannot be accomplished for any reason, then purging of all monitoring wells in the particular AOC where micro-purging cannot be used will be conducted in accordance with the procedures for conventional purging as described above.

4.1.4 Groundwater Sampling

Sampling of the monitoring well will begin immediately after purging (unless purged to dryness; see Section 4.1.3 above). When a bailer is used, the device will be lowered slowly until it contacts the groundwater surface, allowed to sink and fill with a minimum of surface disturbance, and raised slowly to the surface. The sample will then be transferred to appropriate sample bottles by tipping the bailer so that a slow discharge of sample from the bailer top flows gently down the side of the sample bottle with minimum entry disturbance. Bottles designated for volatile organic analysis will be filled first and in a manner so that no headspace remains. Immediately after collection of each sample and completion of bottle label information, each sample container will be placed into a sealable plastic bag and then will be placed in an ice-filled cooler to ensure preservation.

When a bladder pump is used, the device will be lowered slowly until it contacts the groundwater surface, and then will continue to be lowered until the pump intake is located at the midpoint of the monitoring well screen. The pump will then be activated and allowed to operate until a steady flow of groundwater is expelled from the Teflon® return line at the ground surface. The discharge line will not be allowed to touch any part of the interior of the sample container or the sample matrix within the container. The sample will be collected and preserved in the same manner as described above.

4.1.4.1 Filtration

Per Section 4.3 of the Facility-wide SAP, filtered groundwater samples only for dissolved TAL metals will be collected. Filtration will be performed by using a disposable 0.45-µm pore size filter assembly. Filters will be replaced as they become restricted by solids buildup as well as between sample collection sites. The method used for collection of filtered groundwater samples from monitoring wells will depend on whether a bailer or bladder pump is used for the sample collection. Regardless of which of the two sampling devices is used, the measurement of field parameters and purging of the well will be conducted in the same manner as described above.

When a bailer is used for groundwater sampling, the device will be lowered into the monitoring well, filled with groundwater, and raised to the surface. The collected sample will then be slowly poured into a decontaminated holding vessel. The groundwater sample will be filtered using a hand-operated pump equipped with Teflon® intake and discharge tubing. A disposable, pre-sterilized 0.45-μm pore size filter assembly will be attached to the end of the Teflon® discharge tubing. The Teflon® intake tubing will be placed into the holding vessel and the groundwater sample will be pumped through the tubing and disposable filter. Sample bottles will be filled with discharge exiting the disposable filter. Immediately after collection of the sample and completion of bottle label information, each sample container will be placed into a sealable plastic bag and then will be placed in an ice-filled cooler to ensure preservation.

When a bladder pump is used for groundwater sampling, a disposable, pre-sterilized 0.45-μm pore size filter will be attached to the end of the pump's Teflon® return line. After the pump has been placed into the monitoring well, groundwater will be pumped through the tubing and disposable filter. During this flushing operation, the pumping rate will be adjusted as necessary to minimize turbulence. After flushing of the system has been completed, sample bottles will be filled with discharge exiting the disposable filter. The sample bottles will be packaged and preserved in the same manner as described above. The disposable filters used for collection of filtered groundwater samples will be discarded after each use.

4.1.5 Sample Containers and Preservation Techniques

Requirements for sample containers and preservation techniques for groundwater samples are presented in Section 4.3.6 of the Facility-wide SAP. Information regarding sample containers and preservation techniques for groundwater samples collected for chemical analyses is presented in Section 4.0 of the QAPP portion of the FSAP and is detailed in the FWGWMP specific QAPP. All sample containers will be provided by contracted laboratories, who will place into the containers or provide separately the required types and quantities of chemical preservatives. With regard to temperature preservation, all groundwater sample containers will be stored at 4 °C (± 2°C) immediately after sample collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

4.1.6 Decontamination Procedures

Decontamination of equipment associated with groundwater sampling will be in accordance with the procedure presented in Section 4.3.8 of the Facility-wide SAP. A final decontamination inspection of any equipment leaving RVAAP at the end of field activities will be conducted to ensure proper decontamination.

4.2 SAMPLING FREQUENCY

In order to establish background conditions for statistical comparison, an initial monitoring period of three consecutive quarters of groundwater sampling will be performed. After completion of the initial monitoring period, all wells included in the FWGWMP, with the exception of the OD#2 and RQL wells, will be sampled on an annual basis. In accordance with the Orders, the OD#2 and RQL wells will continue to be sampled at a minimum on a semi-annual basis to ensure that on-going activities or conditions are not adversely affecting groundwater quality at those units. The frequency of monitoring for all wells will continue to be reviewed and revised as part of the program's iterative annual review and modification process (Section 5.3).

4.3 ANALYTICAL PARAMETERS

Analytical parameters to be monitored in the FWGWMP will be determined based upon the COPCs for each individual AOC or for boundary conditions. For the initial monitoring period, all RVAAP background (BKG) wells, and all CERCLA wells included in the FWGWMP will be monitored for TAL metals, explosives, propellants, cyanide, SVOCs, VOCs, pesticides, and PCBs. Additional constituents that are a chemical of concern (COC) for a specific AOC will also be included for monitoring at that AOC (see Table 4-1). For AOC wells, all COPCs (with the exception of explosives and propellants) found to be below facility wide background values or at non-detect in the initial monitoring period will be dropped from the list of applicable analytical parameters for that particular well should that well be included for further monitoring under the FWGWMP. New wells added for monitoring under the FWGWMP after the initial monitoring period will be monitored for the COCs applicable to that AOC. For facility boundary monitoring wells, analytical parameters to be monitored after the initial monitoring period will be determined based upon the COCs that pose a risk of exiting the facility at those locations. In accordance with the Orders, wells at the RQL will continue to be monitored for TAL metals, explosives, VOC's, and cyanide, and wells at OD #2 will continue to be monitored for TAL metals, explosives, propellants, cyanide, SVOCs, VOCs, pesticides, and PCBs.

4.4 CHAIN OF CUSTODY AND DOCUMENTATION

4.4.1 Field Logbook

All information pertinent to sampling activities, including the well inspection checklist and field instrument calibration data, will be recorded in field logbooks. The logbooks will be bound and the pages will be consecutively numbered. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all activities, individuals involved in sampling activities, date and time of sampling, weather conditions, any problems encountered, and all field measurements. Lot numbers, manufacturer name, and expiration dates of standard solutions used for field instrument calibration will be recorded in the field logbooks. A summary of each day's activities will also be recorded in the logbooks.

Sufficient information will be recorded in the logbooks to permit reconstruction of all sampling activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be kept in the possession of field personnel responsible for completing the logbooks, or in a secure place when not being used during field work. Upon completion of the field activities, all logbooks will become part of the project evidence file. All field logbook information will follow structures identified in Section 5.1 of the Facility-wide SAP.

4.4.2 Photographs

Information regarding the documentation of photographs for the FWGWMP is presented in Section 5.2 of the Facility-wide SAP. Representative photographs will be taken during implementation of the FWGWMP, and also photographs of any significant observations that are made during the field effort will be taken. Photographs will be suitable for presentation in a public forum, as well as for documenting scientific information.

Table 4-1 FWGWMP Initial Round Sampling Identification Listing

Description	FWGWMP Well No.	Sample ID	Exp	Prop	TAL Metals	CN	Nitrate	SVOCs/ PCBs/ Pest	VOCs
Facility-Wide Monitoring	BKG-004	FWGBKGmw-004C-0001-GW	1	1		1		1	1
	BKG-004	FWGBKGmw-004C-0001-GF			1				
	BKG-005	FWGBKGmw-005C-0002-GW	1	1		1		1	1
	BKG-005	FWGBKGmw-005C-0002-GF			1				
	BKG-006	FWGBKGmw-006C-0003-GW	1	1		1		1	1
	BKG-006	FWGBKGmw-006C-0003-GF			1				
	BKG-008	FWGBKGmw-008C-0004-GW	1	1		1		1	1
	BKG-008	FWGBKGmw-008C-0004-GF			1				
	BKG-010	FWGBKGmw-010C-0005-GW	1	1		1		1	1
	BKG-010	FWGBKGmw-010C-0005-GF			1				
	BKG-012	FWGBKGmw-012C-0006-GW	1	1		1		1	1
	BKG-012	FWGBKGmw-012C-0006-GF			1				
	BKG-013	FWGBKGmw-013C-0007-GW	1	1		1		1	1
	BKG-013	FWGBKGmw-013C-0007-GF			1				
	BKG-015	FWGBKGmw-015C-0008-GW	1	1		1		1	1
	BKG-015	FWGBKGmw-015C-0008-GF			1				
	BKG-016	FWGBKGmw-016C-0009-GW	1	1		1		1	1
	BKG-016	FWGBKGmw-016C-0009-GF			1				
	BKG-017	FWGBKGmw-017C-0010-GW	1	1		1		1	1
	BKG-017	FWGBKGmw-017C-0010-GF			1				
	BKG-018	FWGBKGmw-018C-0011-GW	1	1		1		1	1
	BKG-018	FWGBKGmw-018C-0011-GF			1				
	BKG-019	FWGBKGmw-019C-0012-GW	1	1		1		1	1
	BKG-019	FWGBKGmw-019C-0012-GF			1				
	BKG-020	FWGBKGmw-020C-0013-GW	1	1		1		1	1
	BKG-020	FWGBKGmw-020C-0013-GF			1				
	BKG-021	FWGBKGmw-021C-0014-GW	1	1		1		1	1
	BKG-021	FWGBKGmw-021C-0014-GF			1				

Table 4-1 FWGWMP Initial Round Sample Identification Listing (cont'd)

Description	FWGWMP Well No.	Sample ID	Exp	Prop	TAL Metals	CN	Nitrate	SVOCs/ PCBs/ Pest	VOCs
Load Line 1	LL1-078	FWGLL1mw-078C-0015-GW	1	1		1		1	1
	LL1-078	FWGLL1mw-078C-0015-GF			1				
	LL1-080	FWGLL1mw-080C-0016-GW	1	1		1		1	1
	LL1-080	FWGLL1mw-080C-0016-GF			1				
	LL1-083	FWGLL1mw-083C-0017-GW	1	1		1		1	1
	LL1-083	FWGLL1mw-083C-0017-GF			1				
Load Line 2	LL2-059	FWGLL2mw-059C-0018-GW	1	1		1		1	1
	LL2-059	FWGLL2mw-059C-0018-GF			1				
	LL2-262	FWGLL2mw-262C-0019-GW	1	1		1		1	1
	LL2-262	FWGLL2mw-262C-0019-GF			1				
	LL2-263	FWGLL2mw-263C-0020-GW	1	1		1		1	1
	LL2-263	FWGLL2mw-263C-0020-GF			1				
Load Line 3	LL3-238	FWGLL3mw-238C-0021-GW	1	1		1		1	1
	LL3-238	FWGLL3mw-238C-0021-GF			1				
	LL3-242	FWGLL3mw-240C-0022-GW	1	1		1		1	1
	LL3-242	FWGLL3mw-240C-0022-GF			1				
Load Line 4	LL4-198	FWGLL4mw-198C-0023-GW	1	1		1		1	1
	LL4-198	FWGLL4mw-198C-0023-GW			1				
	LL4-199	FWGLL4mw-199C-0024-GW	1	1		1		1	1
	LL4-199	FWGLL4mw-199C-0024-GF			1				
Load Line 11	LL11-002	FWGLL11mw-002C-0025-GW	1	1		1		1	1
	LL11-002	FWGLL11mw-002C-0025-GF			1				
	LL11-007	FWGLL11mw-007C-0026-GW	1	1		1		1	1
	LL11-007	FWGLL11mw-007C-0026-GF			1				
Load Line 12	LL12-153	FWGLL12mw-153C-0027-GW	1	1		1	1	1	1
	LL12-153	FWGLL12mw-153C-0027-GF			1				
	LL12-182	FWGLL12mw-182C-0028-GW	1	1		1	1	1	1
	LL12-182	FWGLL12mw-182C-0028-GF			1				
	LL12-183	FWGLL12mw-183C-0029-GW	1	1		1	1	1	1
	LL12-183	FWGLL12mw-183C-0029-GF			1				

Table 4-1 FWGWMP Initial Round Sampling Identification Listing (cont'd)

Description	FWGWMP Well No.	Sample ID	Exp	Prop	TAL Metals	CN	Nitrate	SVOCs/ PCBs/ Pest	VOCs
Load Line 12 (cont'd)	LL12-186	FWGLL12mw-186C-0030-GW	1	1		1	1	1	1
	LL12-186	FWGLL12mw-186C-0030-GF			1				
Central Burn Pits	CBP-006	FWGCBPmw-006C-0031-GW	1	1		1		1	1
	CBP-006	FWGCBPmw-006C-0031-GF			1				
	CBP-007	FWGCBPmw-007C-0032-GW	1	1		1		1	1
	CBP-007	FWGCBPmw-007C-0032-GF			1				
Open Detonation Area #2	DA2-107	FWGDA2mw-DET1bR-0033-GW	1	1		1		1	1
	DA2-107	FWGDA2mw-DET1bR-0033-GF			1				
Winklepeck Burning Grounds	WBG-006	FWGWBGmw-005C-0034-GW	1	1		1		1	1
	WBG-006	FWGWBGmw-005C-0034-GF			1				
	WBG-007	FWGWBGmw-007C-0035-GW	1	1		1		1	1
	WBG-007	FWGWBGmw-007C-0035-GF			1				
	WBG-009	FWGWBGmw-009C-0036-GW	1	1		1		1	1
	WBG-009	FWGWBGmw-009C-0036-GF			1				
Total Groundwater Samples			36	36	36	36	4	36	36

4.4.3 Sample Numbering System

The basis of the sample numbering system that will be used to identify samples collected during implementation of the FWGWMP is explained in Section 5.3 of the Facility-wide SAP. The specific identifying information that will be used to implement this system under the FWGWMP is presented in Figure 4-2.

Table 4-1 presents the baseline sample identification listing for the initial monitoring period to be conducted under the FWGWMP. Follow-on samples collected will be identified sequentially by following the numbering system. If a sample in the baseline set is not collected or is reassigned to another location, a specific reason and notation will be given in the project field books.

4.4.4 Sample Documentation

All sample label, logbook, field record, and field form information will follow structures identified in the Facility-wide SAP. Documentation and tracking of samples and field information will follow the series of steps identified in Section 5.5 of the Facility-wide SAP. Any corrections to documentation will follow guidance established in Section 5.6 of the Facility-wide SAP.

4.5 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Sample packaging and shipping shall follow Chapter 6.0 of the Facility-wide SAP.

Coolers containing QA samples that are shipped to the USACE contract laboratory for independent analysis will be prepared and shipped in accordance with the Facility-wide SAP. On all shipments to all laboratories, a chain-of- custody form will be prepared for each cooler and the cooler number will be recorded on the chain-of-custody form.

4.6 INVESTIGATION-DERIVED WASTE REQUIREMENTS

All IDW, personal protective equipment (PPE), disposable sampling equipment, and decontamination fluids, will be properly handled, labeled, characterized, and managed in accordance with Chapter 7.0 of the Facility-wide SAP, federal and state of Ohio large-quantity generator requirements, and RVAAP's Installation Hazardous Waste Management Plan. In addition, all field personnel will become familiarized with the RVAAP Installation Spill Contingency Plan, and will implement the procedures contained within that plan in the event of a spill.

Several types of IDW, which must be contained separately, may be generated during implementation of the FWGWMP:

- Development and purge water from monitoring wells.

- Decontamination fluids, including those derived from decontamination of sampling equipment and/or drilling equipment.

- Expendables/solid wastes, including PPE and disposable sampling equipment.

4.6.1 IDW Collection and Containerization

All liquid indigenous (groundwater) IDW generated from monitoring well installation, development, and purging will be segregated by sample station. All liquid indigenous IDW will be collected in labeled DOT-approved, 55-gallon, closed-top drums.

All solid non-indigenous (expendable sampling equipment and trash) IDW will be segregated as non-contaminated and potentially contaminated material. Potentially contaminated and non-contaminated solid non-indigenous IDW will be identified in the field on the basis of visual inspection (e.g., soiled versus non- soiled), usage of the waste material (e.g., outer sampling gloves versus glove liners), and field screening of the material using available field instrumentation (e.g., organic vapor analyzer). All non-indigenous IDW will be contained in trash bags with potentially contaminated non-indigenous IDW being additionally contained in a labeled DOT-approved, open-top, 55-gallon drum equipped with plastic drum liner and sealed with bung-top lid.

All liquid non-indigenous (decontamination rinse water) IDW will be segregated by waste stream (e.g., soap and water/water rinses from methanol and hydrochloric acid rinses) and contained in labeled 55-gallon DOT-approved closed-top drums. All known potentially hazardous liquid non-indigenous IDW streams, such as methanol and hydrochloric acid rinses, will be contained separately in labeled 55-gallon DOT-approved closed-top drums.

4.6.2 Waste Container Labeling

All IDW containers will be labeled prior to placing IDW in them. All IDW containers will be labeled in accordance with Section 7.2 of the Facility-wide SAP.

4.6.3 IDW Field Staging

A Field Staging Area (FSA) for IDW will be designated at the beginning of each round of field activities performed under the FWGWMP. The FSA location(s) will be approved for use by the RVAAP Environmental Coordinator. Decontamination IDW containers will be stored at the sample staging area. All FSA will be managed according to the requirements of Section 7.3 of the Facility-wide SAP.

A final inventory of all IDW generated during implementation of the FWGWMP will be conducted prior to demobilization from the site and a letter report documenting the characterization and classification of wastes generated will be submitted to the USACE, Ohio EPA and the RVAAP Environmental Coordinator. All liquid waste not transported off of the facility within 30 days following project completion will require secondary containment.

4.6.4 IDW Characterization and Classification for Disposal

All indigenous IDW will be characterized for disposal on the basis of either: (1) analytical results from environmental samples collected from each sampling station; or (2) composite samples collected from segregated waste stream storage containers. Composite waste samples will be submitted for laboratory analysis of full toxicity characteristic leaching procedure (TCLP) to characterize each waste stream for disposal. Procedures for composite waste sampling are presented in Sections 7.4.1 and 7.4.2 of the Facility-wide SAP. PPE and expendable sampling equipment will be managed in accordance with Section 7.4 of the Facility-wide SAP.

Sampling Location Identification: FWGXXXmm-NNN(n)					
XXX	=	Area Designator	Examples		
			WBG	-	Winklepeck Burning Grounds
			RQL	-	Ramsdell Quarry Landfill
mm	=	Sample Location Type	MW	-	Groundwater Monitoring Well
NNN(n) =		Sequential Well Location Number	Examples		
[as assigned by AOC investigation]			004		
			012		
			099		
(n) can be used as a special identifier and is optional. For example: Use an A to identify an abandoned well (099A) Use a B to identify the well as a background location (012B) Use a C to identify the well as a CERCLA well Use a D to identify the well as an adjacent deep zone/aquifer well (004D) Use a R to identify the well as a RCRA well					
Sample Identification: FWGXXXmm-NNN(n)-####-tt					
###	=	Sequential Sample Number	Examples		
[must be unique for entire program]			0001		
			0002		
			0003		
Tt	=	Sample Type	Examples		
			GW	-	Groundwater Sample (unfiltered)
			GF	-	Groundwater Sample (filtered)
			TB	-	Trip Blank
			FB	-	Field Blank
			ER	-	Equipment Rinsate

Figure 4-2 FWGWMP Sample Numbering System

4.6.5 IDW Disposal

Upon approval of IDW classification reports, all solid and liquid IDW will be removed from the site and disposed of by a licensed waste disposal contractor or permitted wastewater treatment facility in accordance with Section 7.5 of the Facility-wide SAP and all applicable state and federal rules, laws, and regulations. All shipments of IDW off-site will be coordinated through the RVAAP Environmental Coordinator.

5.0 REVIEW, REVISION, AND REPORTING REQUIREMENTS

5.1 SAMPLING EVENT REPORTS

Analytical results for each sampling event conducted as part of the FWGWMP, verified and validated in accordance with Section 9.2 of the Facility-Wide QAPP, will be obtained within forty-five (45) days of completion of the sampling event. Within thirty (30) days of receipt of the verified/validated data a report documenting the event will be submitted to Ohio EPA. The sampling event report will include each of the following.

- A summary table of the groundwater data.
- Hard copy and 5dbf format electronic copy of the complete data set.
- Laboratory data sheets.
- QA/QC information – at a minimum, data regarding matrix spikes, matrix spike duplicates, surrogate recoveries, laboratory control samples, field and laboratory blanks, chain of custody and sample receipt forms and duplicate samples will be submitted.
- Documentation regarding data verification/validation.
- Documentation of any contamination detected in any of the wells.
- Groundwater flow maps using the elevation data obtained during the sampling event.
- Results of any statistical analyses, if performed, in accordance with “Statistical Analysis of Ground Water Monitoring Data and RCRA Facilities, Interim Final Guidance (U.S. EPA, April 1989)”, “Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance (U.S. EPA, July 1992)”, “Standard Guide for Developing Appropriate Statistical Approaches for Ground Water Detection Monitoring Programs, (American Society for Testing and Materials (ASTM) designation D 6312-98)”, or other mutually agreed upon guidance documents.

5.2 ANNUAL GROUNDWATER MONITORING REPORT

By December 15th of each year, RVAAP will submit a summary report of all groundwater monitoring activities conducted during the previous year that includes the following information:

- A summary of any additional hydrogeological investigations that were conducted.
- A summary table of additional wells installed during the year, including the depth of the wells, the screen length and slot size, the formation in which the wells are screened, elevation of top of well casing, and the casing type and diameter.
- A summary of any contamination detected in any of the newly installed wells.
- Estimates of groundwater flow velocities and/or contaminant migration rates.
- An evaluation of the current groundwater flow direction(s) based upon the water level elevation data collected during the previous year.
- An evaluation of the trends of contamination detected in groundwater.
- An assessment of the effectiveness of any groundwater remediation activities.
- Plot of concentration trends.
- Facility map.
- Monitoring well network map.
- Groundwater flow map, where applicable.

- Well logs of any newly installed monitoring wells.
- Results of the visual inspection of the integrity of each FWGWMP well and a summary of any corrective actions taken if restorative work on any of the wells was required.

5.3 ANNUAL FWGWMP REVIEW AND MODIFICATION

As part of the annual reporting process, the contractor will submit a review of the overall applicability and effectiveness of the FWGWMP. A description of any proposed modifications to the FWGWMP resulting from that review shall be submitted with the annual report to the team members from Army and Ohio EPA working on the FWGWMP. Modifications to the program plan may include changes in the sampling frequency, the addition or deletion of wells to or from the monitoring network, recommendations for installation of additional wells, changes in the parameters to be analyzed, and changes to the decision rules. All proposed modifications to the FWGWMP will be subject to review and approval by the Ohio EPA prior to implementation.

5.4 COMPLETION OF MONITORING ACTIVITIES UNDER THE FWGWMP

When Army and Ohio EPA concur that all environmental investigations and remedial activities at RVAAP are complete, the RVAAP may submit a request to cease all groundwater monitoring activities. All remaining groundwater monitoring wells on the facility will be abandoned in accordance with Ohio EPA's Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring (1995). However, the request to cease monitoring activities will be subject to Ohio EPA review and approval.

6.0 REFERENCES

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Kammer, H.W., 1982. A Hydrologic Study of the Ravenna Arsenal, Eastern Portage and Western Trumbull Counties, Ohio. Master Thesis, Kent State University.

Ohio EPA 1995. Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring.

USACE 1970. West Branch Reservoir Dam Final Report on Special Foundation and Embankment Treatment. U.S. Army Engineer District Corps of Engineers Pittsburgh, PA, October 1970

USACE 1994a. Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites, EM 1110-1-4000.

USACE 1994b. Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3.

USACE 1996. Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

USACE 1999. Phase II Remedial Investigation for Report for the Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio.

USACE 2001a. Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio.

USACE 2001b. Facility-Wide Safety and Health Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio.

USACE 2003a. Phase II Remedial Investigation Report for Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

USACE 2003b. Phase II Remedial Investigation Report for Load Line 2 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

USACE 2003c. Phase II Remedial Investigation Report for Load Line 3 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

USACE 2003d. Phase II Remedial Investigation Report for Load Line 4 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

USACE 2003e. Phase II Remedial Investigation Report for Load Line 12 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Prepared for the U.S. Army Corps of Engineers, Louisville District.

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USATHAMA 1982. Reassessment of Ravenna Army Ammunition Plant, Ohio.

USATHAMA 1978. Installation Assessment of Ravenna Army Ammunition Plant. Report No. 132.

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APPENDIX A - Areas of Concern at RVAAP

AOC	Name	Regulations
1	Ramsdell Quarry Landfill	Other Regulations
2	Erie Burning Grounds	CERCLA
3	Demolition Area #1	CERCLA
4	Open Detonation Area #2	RCRA/CERCLA
5	Winklepeck Burning Grounds	CERCLA
6	C Block Quarry	CERCLA
7	Bldg 1601 Hazardous Waste Storage	RCRA
8	Load Line 1 and Dilution/Settling Pond	CERCLA
9	Load Line 2 and Dilution/Settling Pond	CERCLA
10	Load Line 3 and Dilution/Settling Pond	CERCLA
11	Load Line 4 and Dilution/Settling Pond	CERCLA
12	Load Line 12 and Dilution/Settling Pond	CERCLA
13	Bldg 1200 and Dilution/Settling Pond	CERCLA
14	Load Line 6, Evaporation Unit	Other Regulations
15	Load Line 6, Treatment Plant	Other Regulations
16	Quarry Landfill/Former Fuze & Booster Burning Pits	CERCLA
17	Deactivation Furnace	RCRA
18	Load Line 12 Pink Waste Water Treatment	Other Regulations
19	Landfill North of Winklepeck Burning Ground	CERCLA
20	Sand Creek Sewage Treatment Plant	Other Regulations
21	Depot Sewage Treatment Plant	Other Regulations
22	George Road Sewage Treatment Plant	Other Regulations
23	Unit Training Site Waste Oil Tank	Other Regulations
24	Reserve Unit Maintenance Area Waste Oil Tank	Other Regulations
25	Building 1034 Motor Pool Waste Oil Tank	Other Regulations
26	Fuze Booster Area Settling Tanks	Other Regulations
27	Bldg 854-PCB Storage	Other Regulations
28	Mustard Agent Burial Site	CERCLA
29	Upper and Lower Cobbs Pond Complex	CERCLA
30	Load Line 7 Pink Wastewater Treatment Plant	Other Regulations
31	ORE Pile Retention Pond	Other Regulations
32	40 and 60 MM Firing Range	CERCLA
33	Load Line 6	CERCLA
34	Sand Creek Disposal Road Landfill	CERCLA
35	1037 Building-Laundry Wastewater Sump	Other Regulations
36	Pistol Range	CERCLA
37	Pesticide Storage Building T-4452	Other Regulations
38	NACA Test Area	CERCLA
39	Load Line 5/Fuze Line 1	CERCLA
40	Load Line 7/Booster Line 1	CERCLA
41	Load Line 8/Booster Line 2	CERCLA
42	Load Line 9/Detonator Line	CERCLA
43	Load Line 10/Percussion Element	CERCLA
44	Load Line 11/Artillery Primer	CERCLA
45	Wet Storage Area	CERCLA
46	Buildings F-15 and F-16	CERCLA
47	Building T-5301 Decontamination	CERCLA
48	Anchor Test Area	CERCLA
49	Central Burn Pits	CERCLA
50	Atlas Scrap Yard	CERCLA
51	Dump along Paris-Windham Road	CERCLA

APPENDIX B – Listing of Wells Considered for Inclusion in the Initial Round of Monitoring Under the FWGWMP

Location/Well No.	Analytical Available	Incorporated	Rationale For/Against Selection
RVAAP Background/Facility Wells			
BKG-004	Yes	Yes	Downgradient of all AOCs
BKG-005	Yes	Yes*	Establish background conditions
BKG-006	Yes	Yes*	Establish background conditions
BKG-008	Yes	Yes	Downgradient of all AOCs
BKG-010	Yes	Yes*	Establish background conditions
BKG-012	Yes	Yes*	Establish background conditions
BKG-013	Yes	Yes*	Establish background conditions
BKG-015	Yes	Yes	Downgradient of all AOCS
BKG-016	Yes	Yes*	Establish background conditions
BKG-017	Yes	Yes*	Establish background conditions
BKG-018	Yes	Yes*	Establish background conditions
BKG-019	Yes	Yes*	Establish background conditions
BKG-020	Yes	Yes*	Establish background conditions
BKG-021	Yes	Yes	Downgradient of all AOCS
Central Burn Pits			
CBP-001	No	No	Location not Downgradient of AOC
CBP-002	No	No	Location not Downgradient of AOC
CBP-003	No	No	Location not Downgradient of AOC
CBP-004	No	No	Location not Downgradient of AOC
CBP-005	No	No	Location not Downgradient of AOC
CBP-006	No	Yes	Monitors GW flow to Sand Creek
CBP-007	No	No	Captured by Wells Included in FWGWMP
CBP-008	No	Yes	Monitors GW flow to Sand Creek

Cobbs Pond Complex			
CPC-001	No	No	Captured by Selected CBP Wells
CPC-002	No	No	Captured by Selected CBP Wells
CPC-003	No	No	Captured by Selected CBP Wells
CPC-004	No	No	Captured by Selected CBP Wells
CPC-005	No	No	Captured by Selected CBP Wells
CPC-006	No	No	Captured by Selected CBP Wells
Open Detonation Area #2			
DET-1B	Yes	No	Location not Downgradient of AOC
DET-2	Yes	No	Location not Downgradient of AOC
DET-3	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
DET-4	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
DA2-104	N/A	No	Location not Downgradient of AOC
DA2-105	N/A	No	Location not Downgradient of AOC
DA2-106	N/A	No	Location not Downgradient of AOC
DA2-107	N/A	Yes	Downgradient of RCRA Unit
DA2-108	N/A	No	Location not Downgradient of AOC
DA2-109	N/A	No	Location not Downgradient of AOC
DA2-110	N/A	No	Location not Downgradient of AOC
DA2-111	N/A	No	Location not Downgradient of AOC
DA2-112	N/A	No	Location not Downgradient of AOC
DA2-113	N/A	No	Location not Downgradient of AOC
Erie Burning Grounds			
EBG-123	Yes	No	COPCs Not Present
EBG-124	Yes	No	COPCs Not Present
EBG-125	Yes	No	COPCs Not Present
EBG-126	Yes	No	COPCs Not Present
EBG-127	Yes	No	COPCs Not Present
EBG-128	Yes	No	COPCs Not Present

EBG-129	Yes	No	COPCs Not Present
EBG-130	Yes	No	COPCs Not Present
Load Line 1			
LL1-063	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-067	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-078	Yes	Yes	Site-wide/LL1 Downgradient Well
LL1-079	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-080	Yes	Yes	Site-wide/LL1 Downgradient Well
LL1-081	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-082	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-083	Yes	Yes	Site-wide/LL1 Downgradient Well
LL1-084	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-085	Yes	No	Location not Downgradient of AOC or No COPCs Present
Load Line 2			
LL2-059	Yes	Yes	Downgradient of LL2
LL2-060	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-261	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL1-262	Yes	Yes	Downgradient of LL2
LL2-263	Yes	Yes	Downgradient of LL2
LL2-264	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-265	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-266	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-267	Yes	No	Location not Downgradient of AOC or No COPCs Present

LL2-268	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-269	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL2-270	Yes	No	Location not Downgradient of AOC or No COPCs Present
Load Line 3			
LL3-232	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-233	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-234	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-235	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-236	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-237	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-238	Yes	Yes	Downgradient of LL3
LL3-239	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-240	Yes	No	Captured by Wells Included in FWGWMP
LL3-241	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL3-242	Yes	Yes	Downgradient of LL3
LL3-243	Yes	No	Location not Downgradient of AOC or No COPCs Present
Load Line 4			
LL4-193	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL4-194	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL4-195	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL4-196	Yes	No	Location not Downgradient of AOC or No COPCs Present

LL4-197	Yes	No	Location not Downgradient of AOC or No COPCs Present
LL4-198	Yes	Yes	Downgradient of LL4
LL4-199	Yes	Yes	Downgradient of LL4
LL4-200	Yes	No	Location not Downgradient of AOC or No COPCs Present
Load Line 11			
L11-001	No	No	Location not Downgradient of AOC or No COPCs Present
L11-002	No	Yes	Downgradient of LL11
L11-003	No	No	Location not Downgradient of AOC or No COPCs Present
L11-004	No	No	Location not Downgradient of AOC or No COPCs Present
L11-005	No	No	Captured by Wells Included in FWGWMP
L11-006	No	No	Location not Downgradient of AOC or No COPCs Present
L11-007	No	Yes	Downgradient of LL11
L11-008	No	No	Location not Downgradient of AOC or No COPCs Present
L11-009	No	No	Location not Downgradient of AOC or No COPCs Present
L11-010	No	No	Location not Downgradient of AOC or No COPCs Present
Load Line 12			
L12-088	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-107	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-113	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-128	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-153	Yes	Yes	Downgradient of LL12
L12-154	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-182	Yes	Yes	Downgradient of LL12
L12-183	Yes	Yes	Downgradient of LL12

L12-184	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-185	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-186	Yes	Yes	Downgradient of LL12
L12-187	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-188	Yes	No	Location not Downgradient of AOC or No COPCs Present
L12-189	Yes	No	Location not Downgradient of AOC or No COPCs Present
Ramsdell Quarry Landfill			
RQL-006	Yes	No	Location not Downgradient of AOC
RQL-007	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
RQL-008	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
RQL-009	Yes	Yes	Monitoring required by RVAAP Final Findings and Orders
RQL-010	Yes	No	Location not Downgradient of AOC
RQL-011	Yes	No	Location not Downgradient of AOC
RQL-012	Yes	No	Location not Downgradient of AOC
RQL-013	Yes	No	Location not Downgradient of AOC
RQL-014	Yes	No	Location not Downgradient of AOC
RQL-015	Yes	No	Location not Downgradient of AOC
RQL-016	Yes	No	Location not Downgradient of AOC
RQL-017	Yes	No	Location not Downgradient of AOC
Winklepeck Burning Grounds			
WBG-005	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-006	Yes	Yes	Monitors GW to Sand Creek Tributary
WBG-007	Yes	Yes	Monitors GW to Sand Creek Tributary

WBG-008	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-009	Yes	Yes	Monitors GW to Sand Creek Tributary
WBG-110	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-011	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-012	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-013	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-104	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-015	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-016	Yes	No	Location not Downgradient of AOC or No COPCs Present
WBG-017	Yes	No	Location not Downgradient of AOC or No COPCs Present

*Included for initial monitoring period only