Integrated Groundwater Monitoring Plan for the Portsmouth Gaseous Diffusion Plant, Piketon, Ohio

U.S. Department of Energy
DOE/PPPO/03-0032&D10

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By
Fluor-B&W Portsmouth LLC, under Contract DE-AC30-10CC40017

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ACRONYMS

AOC	area of concern
BRC	Big Run Creek
CAS	Cleanup Alternatives Study
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	chain-of-custody
DFF&O	Director's Final Findings and Orders
DIUF	deionized ultra-filtered
DNAPL	dense non-aqueous phase liquid
DOE	U.S. Department of Energy
EAB	enhanced anaerobic bioremediation
EDD	East Drainage Ditch
EPA	Environmental Protection Agency
GWQA	*Ground-Water Quality Assessment of Four RCRA Units for the Portsmouth Gaseous Diffusion Plant* [Martin Marietta Energy Systems (MMES) 1989a]
HRC®-X	Hydrogen Release Compound®-extended release formula
LBC	Little Beaver Creek
LNAPL	light non-aqueous phase liquid
IGWMP	*Integrated Groundwater Monitoring Plan*
IRM	interim remedial measure
ISWL	industrial solid waste landfill
MMES	Martin Marietta Energy Systems
mg/kg	milligram per kilogram
µg/L	microgram per liter
µS/cm	microsiemen per centimeter
NHP	North Holding Pond
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OAC	Ohio Administrative Code
Ohio EPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
pCi/L	picocurie per liter
PEMS	Project Environmental Measurements System
PK	Peter Kiewit
PORTS	Portsmouth Gaseous Diffusion Plant
ppb	part per billion
ppm	part per million
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SWL	static water level
SWMU	solid waste management unit
TCE	trichloroethene
UND	Unnamed Southwest Drainage Ditch
VOA	volatile organic analysis
VOC	volatile organic compound
WDD	West Drainage Ditch

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1. INTRODUCTION

Groundwater and surface water monitoring at the U.S. Department of Energy (DOE) Portsmouth Gaseous Diffusion Plant (PORTS) was initiated in the 1980s. Since that time, numerous investigative studies and routine monitoring programs have provided much geologic and hydrogeologic information at PORTS.

1.1 PURPOSE

The purpose of the *Integrated Groundwater Monitoring Plan* (IGWMP) is to capture in a single document the following regulatory and legal requirements for groundwater monitoring at PORTS:

- Regulatory requirements of the Ohio Administrative Code (OAC),
- Closure documents,
- The 1989 Consent Decree between the DOE and the State of Ohio, and
- DOE Orders.

The 1989 Administrative Order by Consent between DOE and the U.S. Environmental Protection Agency (EPA), as amended in 1994 and 1997, which the Ohio Environmental Protection Agency (Ohio EPA) became a party to in 1994, also provided legal requirements for the IGWMP. This agreement was terminated on February 13, 2017.

The IGWMP integrates into a single, unified document the regulatory and technical requirements for groundwater monitoring at PORTS. Per the Director's Final Findings and Orders (DFF&O) journalized on March 18, 1999 (the March 1999 DFF&O), and the revision to the March 1999 DFF&O that was journalized on December 16, 2011 (the December 2011 DFF&O), the IGWMP "is designed to integrate site-wide groundwater monitoring activities at PORTS by encompassing all groundwater monitoring requirements and the goals of multiple regulatory programs in order to maximize resources to support corrective action and to minimize the potential for conflicts in requirements between regulatory programs."

The initial IGWMP dated November 1998 was approved by Ohio EPA for implementation beginning in the second quarter of 1999. Revisions to the IGWMP are reviewed and approved by Ohio EPA. The following table provides the implementation dates and a summary of major changes in the previous revisions of the IGWMP.

IGWMP history change table

DOE document number and document date	Effective dates	Summary of monitoring changes in revision[a]
DOE/OR/11-1618&D7 November 1998	April 1, 1999 – March 31, 2001	Initial document
DOE/OR/11-1618&D10 January 2001	April 1, 2001 – December 31, 2001	Added three new monitoring areas: X-633 Former Recirculating Cooling Water Complex, X-533 Former Switchyard Complex, and X-734 Landfills. Added monitoring for metals and/or radionuclides to existing wells. Added wells to the monitoring programs at the X-749/X-120/PK Landfill, X-701B Former Holding Pond, and X-740 Former Waste Oil Handling Facility. Deleted one residential water sampling location.

IGWMP history change table (continued)

DOE document number and document date	Effective dates	Summary of monitoring changes in revision[a]
DOE/OR/11-1618&D11 October 2001	January 1, 2002 – December 31, 2002	Added wells to the monitoring program for the Quadrant I Groundwater Investigative (5-Unit) Area. Added monitoring for manganese to selected wells at the X-701B Former Holding Pond. Added three new residential water supply sampling locations.
DOE/OR/11-1618&D12 October 2002	January 1, 2003 – February 3, 2004	Added background wells to monitoring programs for X-749A Classified Materials Disposal Facility and X-735 Landfills. Added wells to monitoring programs for Quadrant II Groundwater Investigative (7-Unit) Area and X-701B Former Holding Pond. Added Appendix G, which provides the methodology for the statistical evaluations for the X-749A Classified Materials Disposal Facility and X-735 Landfills.
DOE/OR/11-1618&D13 October 2003	February 4, 2004 – December 31, 2004	Changed sampling parameters, monitoring frequencies, and/or added sampling locations to monitoring programs for X-749/X-120/PK Landfill, X-701B Former Holding Pond, X-616 Former Chromium Sludge Surface Impoundments, X-740 Former Waste Oil Handling Facility, and surface water.
DOE/OR/11-1618&D14 October 2004	January 1, 2005 – December 31, 2007	Added new monitoring wells to the monitoring programs for the X-749/X-120/PK Landfill and X-740 Former Waste Oil Handling Facility. Added parameters to selected wells in the X-749/X-120/PK Landfill and X-735 Landfills.
DOE/PPPO/03-0032&D1 August 2007	January 1, 2008 – June 30, 2009	Revised monitoring programs for the X-749/X-120/PK Landfill, Quadrant I Groundwater Investigative (5-Unit) Area, Quadrant II Groundwater Investigative (7-Unit) Area, and X-740 Former Waste Oil Handling Facility based on evaluations of the groundwater monitoring networks for each of these areas. Removed two surface water sampling locations. Deleted two residential water supply sampling locations. Changed groundwater elevation measurement frequency from quarterly to semiannual.
DOE/PPPO/03-0032&D3 June 2009	July 1, 2009 – December 31, 2010	Revised monitoring at X-749/X-120/PK Landfill based on the X-749/X-120 Area Groundwater Optimization Project. Removed X-701B monitoring wells west of Perimeter Road and north of the X-744G building from routine monitoring due to X-701B interim remedial measure and revised monitoring parameters and frequencies at wells east of Perimeter Road. Removed the X-740 Former Waste Oil Handling Facility from routine monitoring program due to pilot study of additional remedial options. Made minor changes to monitoring parameters and frequencies at X-616 Former Chromium Sludge Surface Impoundments, X-735 Landfills, X-734 Landfills, surface water, and water supply. Added a new monitoring area: X-344C Former Hydrogen Fluoride Storage Building. Added a residential water supply sampling location.

IGWMP history change table (continued)

DOE document number and document date	Effective dates	Summary of monitoring changes in revision[a]
DOE/PPPO/03-0032&D4 September 2010	January 1, 2011 – June 30, 2012	Made minor changes to monitoring parameters and frequencies at X-749/X-120/PK Landfill, Quadrant I Groundwater Investigative (5-Unit) Area, Quadrant II Groundwater Investigative (7-Unit) Area, and X-701B Former Holding Pond. Added a new surface water monitoring location.
DOE/PPPO/03-0032&D5 June 2012	July 1, 2012 – June 30, 2013	Added wells to the monitoring programs for the X-749/ X-120/PK Landfill and Quadrant II Groundwater Investigative (7-Unit) Area. Added numerous monitoring wells and revised monitoring parameters and frequencies at the X-701B Former Holding Pond to reflect the end of the X-701B interim remedial measure. Revised text and monitoring for the Berea wells at the X-735 Landfills and the X-749A Classified Materials Disposal Facility to include 2011 DFF&O (updated requirements for landfill monitoring).
DOE/PPPO/03-0032&D6 May 2013	July 1, 2013 – June 30, 2014	Changed monitoring frequency for one well at the X-616 Former Chromium Sludge Surface Impoundments. Updated special study information for the X-633 and X-630 Areas.
DOE/PPPO/03-0032&D7 May 2014	July 1, 2014 – June 30, 2015	Separated the X-749/X-120/PK Landfill Area into two monitoring areas: 1) X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility, and 2) PK Landfill. Separated the Quadrant I Groundwater Investigative (5-Unit) Area/X-749A Classified Materials Disposal Facility into two monitoring areas: 1) Quadrant I Groundwater Investigative (5-Unit) Area, and 2) X-749A Classified Materials Disposal Facility. Returned the X-740 Former Waste Oil Handling Facility to the routine IGWMP monitoring program. Removed one residential water supply sample location (RES-016) from water supply monitoring program. Made minor changes to the monitoring programs for the Quadrant II Groundwater Investigative (7-Unit) Area, X-701B Former Holding Pond, and X-616 Former Chromium Sludge Surface Impoundments.
DOE/PPPO/03-0032&D8 July 2015	July 1, 2015 –	Added two wells to the monitoring program for the X-701B Former Holding Pond and three wells to the monitoring program for the Quadrant I Groundwater Investigative (5-Unit) Area.

[a]Administrative changes are not included in the table. These changes include, but not limited to updates to area histories, minor changes in monitoring frequencies or parameters, well replacements, deletion of outdated or unnecessary information, changes to area names, changes in document formats, etc.

This IGWMP revision will replace the IGWMP dated July 2015 and implemented in the third quarter of 2015. This revision includes the following changes:

- Revisions to the monitoring program at the X-740 Former Waste Oil Handling Facility as previously agreed to by Ohio EPA in the *Final Report for the X-740 Pilot Study* (DOE 2016a). Monitoring parameters are reduced to volatile organic compounds (VOCs) and sampling frequency reduced to annual in pilot study monitoring wells;

- Deletion of well X737-08B from the monitoring program for the X-735 Landfills with the previous approval of Ohio EPA because the well required removal due to construction activities for the on-site waste disposal facility; and

- Other updates and clerical changes.

The IGWMP is designed to minimize the potential for confusion in interpreting requirements and to maximize resources for collecting the data needed for sound decision making. Keeping the intent of the regulatory directives and the objectives of various monitoring programs in mind, the IGWMP is designed to establish all groundwater monitoring requirements for PORTS. Ultimately this document will facilitate the efficient collection of groundwater monitoring data, simplify the process of conducting regulatory audits of the program, and improve the collection and representativeness of data needed to make the decisions required in the corrective action process.

DOE Order 458.1, *Radiation Protection of the Public and the Environment*, requires radiological monitoring. These radiological monitoring requirements are included in the IGWMP so that groundwater and surface water monitoring requirements associated with the IGWMP monitoring locations are captured in a single plan.

1.2 OVERVIEW OF APPROACH

The IGWMP establishes economies of scale for groundwater monitoring by focusing activities over larger areas rather than on individual wells or waste management units within an area. Specifically, the identity and location of the appropriate subset of monitoring wells, the identity of constituents for sampling, and the frequency of sampling are determined on the basis of an evaluation of historical monitoring results, process knowledge, and other information and requirements from previous investigations conducted at PORTS. The process of integrating groundwater monitoring at PORTS is shown schematically in Figure 1. DOE will implement changes to the IGWMP beginning in the calendar quarter following Ohio EPA approval, except for changes that have been previously approved by Ohio EPA and are already being implemented by DOE.

The IGWMP is organized into three large-scale divisions: Sections 1 through 3 comprise the introduction, background, history, and the regulatory and technical considerations for the groundwater monitoring program at PORTS; Sections 4 through 8 contain the monitoring programs for each of the quadrants at PORTS, surface water, and water supply monitoring; and Sections 9 through 11 discuss additional monitoring and procedures.

2. HISTORY OF GROUNDWATER MONITORING AT PORTS

The pre-integrated groundwater monitoring program at PORTS (monitoring prior to the second quarter of 1999) was conducted in accordance with the OAC, the 1989 Consent Decree between the DOE and the State of Ohio, and the 1989 Administrative Order by Consent between DOE and the U.S. EPA (as amended in 1994 and 1997). Ohio EPA became a party to the U.S. EPA Administrative Order by Consent in 1994. The U.S. EPA Administrative Order by Consent was terminated on February 13, 2017.

Routine groundwater monitoring was conducted at Resource Conservation and Recovery Act (RCRA) Subtitle C interim status units in accordance with OAC 3745-65 and OAC 3745-66, and at RCRA Subtitle D solid waste disposal units in accordance with OAC 3745-27 and 3745-29. Additionally, routine groundwater and surface water monitoring requirements were included in Closure/Post Closure Plans, Interim Remedial Measure (IRM) Plans, Corrective Measure Plans, and other Administrative Action documents. These plans and documents were written and approved in accordance with the regulations and/or the Consent Order and the Consent Decree. A listing of these documents includes the following:

- Ground-Water Quality Assessment of Four RCRA Units for the Portsmouth Gaseous Diffusion Plant
- Detection Monitoring Plan for the X-230J7 Holding Pond
- Closure Plan for the X-230J7 Holding Pond
- Closure Plan for the X-231B Oil Biodegradation Plot
- X-231B Oil Biodegradation Plot Closure Options Study
- X-231B Technology Demonstration Assessment Report
- X-231B Consolidated Closure Plan
- Decision Document for the X-611A Lime Sludge Lagoons
- Closure Plan for the X-616 Surface Impoundments
- Post Closure Plan for the X-616 Surface Impoundments
- Closure Plan for the X-701B Holding Pond and Sludge Containment Ponds
- X-701B Technology Demonstration Assessment Report
- Consolidated Closure Plan for the X-701B Holding Pond and Sludge Containment Ponds
- Closure Plan for the X-735 Landfill (Northern Portion)
- Final Closure/Post Closure Plan for the X-735 Industrial Solid Waste Landfill
- Closure Plan for the X-749 Contaminated Materials Disposal Facility, Northern Portion
- Closure Plan for the X-749 Contaminated Materials Disposal Facility, Southern Portion
- Interim Remedial Measures Plan for the X-749
- Closure Plan for the X-749A Classified Materials Disposal Facility
- Interim Measures Plan for the Peter Kiewit Landfill
- Peter Kiewit Landfill Cleanup Alternatives Study/Corrective Measures Study (CAS/CMS)
- Decision Document for the Peter Kiewit Landfill.

The *Ground-Water Quality Assessment of Four RCRA Units for the Portsmouth Gaseous Diffusion Plant* (GWQA) [Martin Marietta Energy Systems (MMES) 1989a] was completed in accordance with RCRA requirements in 1989. The document summarized the results of studies conducted at four units at PORTS regulated under RCRA: the X-701B Holding Pond, the X-231B Southwest Oil Biodegradation Plots, the X-749 Contaminated Materials Disposal Facility, and the X-616 Former Chromium Sludge Surface Impoundments. As a result of the groundwater contamination discovered during the GWQA investigation, an assessment monitoring program for the X-701B, the X-231B, and the X-749 was proposed by DOE and approved by the Ohio EPA in 1989. Routine groundwater monitoring has been conducted in the vicinity of these four units since 1989. The assessment monitoring program for the X-616 facility was initiated prior to the GWQA.

Another comprehensive effort at PORTS required by the Administrative Order by Consent and the Consent Decree was a RCRA Facility Investigation (RFI), conducted from 1991 to 1996, which included the investigation of 143 solid waste management units (SWMUs). The RFI identified a number of SWMUs as potential sources for groundwater contamination and confirmed the results of the GWQA. Some areas identified in the RFI as potential concerns associated with contamination include the following:

- X-120 Old Training Facility (Quadrant I)
- Quadrant I Groundwater Investigative (5-Unit) Area (includes the X-231B VOC plume)
- Quadrant II Groundwater Investigative (7-Unit)
- X-740 Former Waste Oil Handling Facility (Quadrant III).

Other areas noted as containing potential sources of contamination include the following:

- X-749 Contaminated Materials Disposal Facility (Quadrant I)
- Peter Kiewit (PK) Landfill (Quadrant I)
- X-749A Classified Materials Landfill (Quadrant I)
- X-611A Former Lime Sludge Lagoons (Quadrant IV)
- X-734 Old Sanitary Landfill (Quadrant IV)
- X-734A&B Construction Spoils Landfills (Quadrant IV)
- X-735 Landfill (Quadrant IV).

Based upon the results of the RFI, it was determined that groundwater monitoring should continue at some facilities, and special groundwater studies should be implemented at others in order to obtain additional data necessary for the development of corrective measure studies.

Under both RCRA Subtitle C and RCRA Subtitle D and prior to implementation of the IGWMP, detection monitoring was performed at units where there was no statistically significant exceedence of threshold levels of contaminants or indicator parameters at downgradient wells. In the event of such an occurrence, the groundwater contaminant plume associated with the unit would have been characterized during an assessment monitoring program. The assessment monitoring was performed on a quarterly basis under an approved groundwater quality assessment plan. The assessment monitoring program was conducted to continually characterize the extent and rate of migration, and the concentration of leachate or leachate-derived constituents in the groundwater upon determining a significant change in levels of contaminants or indicator parameters at downgradient wells.

Under the pre-integrated program, routine groundwater monitoring was required on a quarterly, semiannual, or annual basis at seven RCRA Subtitle C interim status hazardous waste units at PORTS. Detection monitoring was required at three units: (1) the X-701C Neutralization Pit, (2) the X-735 RCRA Landfill (northern portion of X-735), and (3) the X-230J7 Holding Pond. Assessment monitoring was required at two units not yet closed: (1) the X-231B Southwest Oil Biodegradation Plot, and (2) the X-701B Holding Pond, and at two units that were certified closed: (1) the X-616 Former Chromium Sludge Surface Impoundments, and (2) the X-749 North Contaminated Materials Storage Yard.

Under the pre-integrated program, routine groundwater monitoring was also conducted at three RCRA Subtitle D solid waste disposal units: the X-735 Industrial Solid Waste Landfill (southern portion of X-735), the X-749A Classified Materials Disposal Facility (certified closed), and the X-749 South Contaminated Materials Disposal Facility. Assessment monitoring was performed at the X-749 South Contaminated Materials Disposal Facility due to the site’s proximity to the X-749 northern portion. The northern portion is a RCRA Subtitle C facility which has been associated with a groundwater contamination plume, however, a determination that the X-749 South Contaminated Materials Disposal

Facility is a source of groundwater contamination has not been made. With the approval of the regulatory authority, and with their acknowledgment that the X-749 southern portion is not regulated as a hazardous waste unit, both the X-749 units are monitored as one unit.

On January 27, 1999, Ohio EPA approved the IGWMP for PORTS. The March 1999 DFF&O journalized the requirements and exemptions under multiple regulatory programs applicable to future IGWMP revisions. Implementation of the IGWMP began in the second quarter (April through June) of 1999. The December 2011 DFF&O was journalized on December 16, 2011 and replaced the March 1999 DFF&O.

Groundwater monitoring at the X-735 Landfills and X-749A Classified Materials Disposal Facility (part of the Quadrant I Groundwater Investigative [5-Unit] Area) was conducted in accordance with OAC 3745-29-10 as promulgated on June 1, 1994 from the second quarter of 1999 through the second quarter of 2012 (implementation of the June 2012 IGWMP). This rule was in effect when the March 1999 DFF&O was journalized.

The December 2011 DFF&O updated the regulations applicable to monitoring of areas regulated as industrial solid waste landfills (X-735 Landfills and X-749A Classified Materials Disposal Facility). Under the December 2011 DFF&O, the Berea wells at the X-735 Landfills and X749A Classified Materials Disposal Facility are evaluated as required by OAC 3745-29-10 and OAC 3745-30-08 (effective February 1, 2008). Appendix G provides a copy of OAC 3745-30-08 as promulgated on February 1, 2008. However, the Gallia wells at the X-735 Landfills are monitored in accordance with the *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a). The *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a) requires monitoring in accordance with OAC 3745-29-10 as promulgated on June 1, 1994 because these regulations were part of the March 1999 DFF&O, which was applicable to PORTS when the *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a) was prepared by DOE and approved by Ohio EPA.

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3. DEVELOPMENT OF AN INTEGRATED GROUNDWATER MONITORING PLAN

PORTS can more efficiently achieve groundwater monitoring/remediation objectives by integrating and consolidating monitoring requirements. In order to optimize the groundwater monitoring activities at PORTS, the monitoring program at a given Area of Concern (AOC) integrates historical information, the regulatory requirements stipulated in the regulations or other administrative directives, as well as requirements necessary to support corrective measures.

3.1 TECHNICAL CONSIDERATIONS FOR OPTIMIZING GROUNDWATER MONITORING

Groundwater monitoring resources are optimized by conducting a detailed evaluation of those systematic elements that would constitute an effective and efficient groundwater monitoring program: network configuration and well selection, sampling frequency(ies), analytical parameters, data interpretation and reporting, and monitoring program evaluation. Optimization of these elements is based on technical considerations, calculations, estimates, historical trends, and professional judgment. The following sections describe the process used at PORTS to evaluate the existing groundwater monitoring program, including general suggestions for changes.

3.1.1 Groundwater AOCs

The process of developing an integrated groundwater monitoring program at PORTS began by selecting or designating relatively large-scale contamination areas called groundwater AOCs. AOCs at PORTS are generally large areas containing multiple source/release sites contributing to physically contiguous or co-mingled contaminant plumes, or remediation concerns that are the subject of corrective actions or RCRA closures. By focusing monitoring activities over AOCs rather than on individual waste management units, the IGWMP establishes economies of scale for groundwater monitoring, and resources are used more efficiently.

The IGWMP designates AOCs on the basis of areas previously identified in three documents, or series of documents: the 1989 GWQA, the RFI Reports (DOE 1996b, DOE 1996c, DOE 1996d, and DOE 1996e), and the *Background Sampling Investigation of Soil and Groundwater Final Report* (DOE 1996a). The GWQA was discussed in Section 2. The RFI Reports (DOE 1996b, DOE 1996c, DOE 1996d, and DOE 1996e) delineated additional groundwater AOCs associated with predominantly VOC contamination. Additionally, areas were noted as containing potential sources of groundwater contamination. Figure 2 shows the groundwater AOCs at PORTS.

3.1.2 Well Selection and Network Configuration

Monitoring wells were selected to serve one or more of the following broad technical objectives: source/release monitoring, plume monitoring, and remedial action effectiveness monitoring. Source monitoring is designed to monitor as close as feasible to potential sources of groundwater contamination such as landfills and holding ponds. Plume monitoring is designed to assess the concentrations and extent of known contaminant plumes. Remedial action effectiveness monitoring is designed to evaluate the performance of interim remedial measures, corrective actions, or technology demonstrations. These broad technical purposes approximate the regulatory definitions of detection monitoring and assessment monitoring.

A single monitoring well may serve two or more of the technical objectives noted above. For instance, a well near a barrier wall at the edge of a landfill and located in the center of a groundwater plume would serve all three objectives. Wells may also be monitored for other purposes such as exit pathway monitoring or residential monitoring. More wells than necessary may be available to meet technical objectives for a given area. Therefore, additional technical information is used to determine the specific wells used for each area. Specific wells and the monitoring network's configuration have been determined on the basis of the following information:

- Potentiometric data is used to select at least one upgradient well. Regional flow data will be used if local flow is radial. Potentiometric data is also used to select appropriate upgradient and downgradient wells for monitoring potential or existing sources; plume extent, rate of migration, and concentration; and areas where remedial measures have been installed.

- Well spacing information is used to select wells which will adequately delineate contaminant plumes and address variations in hydraulic conductivity and flow directions.

- Geochemical-process parameters are used to help understand contaminant fate-and-transport mechanisms.

- Soil boring and subsurface geologic data is used to assure that at least one Gallia and one Berea well are located near the area of highest overall contamination, and to assure that selected wells are screened in the appropriate formation.

3.1.3 Sampling Frequency

Sampling frequencies of a well or wells may be changed during the implementation of the IGWMP due to changes in water quality results of the well or wells. A change to a more frequent sampling schedule may be necessary when:

- Wells are at plume margins,
- Concentrations are changing,
- Flow velocities are high,
- Parameters are detected that are mobile in groundwater, or
- When the Sunbury shale is thin (less than 2.5 inches) or absent at Berea wells.

A change to a less frequent sampling schedule may occur when:

- Wells are at the center of plumes,
- Concentrations vary slightly over time based upon historic data,
- Wells are in hydrogeologic strata where flow velocities are low,
- Parameters are detected that have low mobility in groundwater, or
- When the Sunbury shale is thick at Berea wells.

3.1.4 Analytical Parameters

Changes in the analytical parameters for groundwater sampling at PORTS (see Table 1) are selected on the basis of the following information:

- Historical data is used to identify potential chemicals of concern. Most groundwater AOCs have abundant historical data that can be used to safely infer long-term water-quality trends. Rather than requesting the same set of sample analyses for each well for each monitoring event, which is not an effective use of resources, the evaluation considers historical data trends to minimize the number of laboratory analyses needed for a given sampling event without sacrificing important information and without increasing risk to either human health or the environment. For example, on a historical basis selected VOCs and occasionally technetium-99 have proven to be very effective early indicators for plume migration. It is in fact much more effective than the existing process of using anions and cations. The approach used to develop the IGWMP relies heavily on parameters that indicate sudden plume movement, such as trichloroethene (TCE), to determine whether the analysis of additional parameters is necessary.

- Relative mobility of actual (or potential) contaminants is used in conjunction with contaminant transport knowledge about specific analytes. Some analytes migrate faster in groundwater than others; for instance, TCE moves much faster than polychlorinated biphenyls (PCBs). This information is used to tailor monitoring to the velocity of groundwater for each AOC.

- Geochemical-process parameters are used to help assess conditions favorable for natural attenuation or biological degradation of chlorinated solvents, or to help understand fate-and-transport mechanisms.

- Conventional indicator parameters (e.g., chlorides, sulfates) may be used in areas requiring source monitoring, and to a lesser degree, plume monitoring. Such parameters are often useful in determining characteristics unique to an individual groundwater area, or contaminant plume.

3.2 SPECIAL SHORT-TERM STUDY PROCESS

Over the course of long-term monitoring at PORTS, questions may arise about specific contaminant releases or transport mechanisms, or the application of a specific remediation technology that cannot be answered by the data collected under the integrated monitoring program outlined in the IGWMP. To address this need, the IGWMP allows for the inclusion of special monitoring activities that are highly focused on specific groundwater problems. Specific special studies may be proposed by the Ohio EPA or by DOE and implemented through an approved work plan. Specific special studies are discussed in Section 9 if long-term monitoring at PORTS is affected. The results of a special study may be presented in a separate report(s) and summarized in the annual Groundwater Monitoring Report (see Section 3.3.3).

3.3 EVALUATIONS AND REPORTING

The evaluation and reporting of information and data generated as a result of implementing the IGWMP are required by the Ohio EPA. Evaluations include, but are not limited to, the following: statistical analysis, trend analysis, and the evaluation of analytical results to ensure achievement of data quality objectives. Reporting of the data and the results of the evaluations are scheduled to occur on a routine basis of not less than annually. The Ohio EPA has also requested timely reporting by DOE of any event that may warrant any revision to the IGWMP prior to submission of the next respective annual report. Such finding may include the following: a significant increase in contaminant concentration, contamination discovered in previously uncontaminated monitoring well(s), and significant changes in groundwater flow direction. Such events may also prompt the initiation of a special short-term study as described in Section 3.2. The following sections describe the required statistical evaluations and reporting for the integrated groundwater monitoring program.

3.3.1 Statistical Evaluations and Reporting

Two units included in the integrated groundwater monitoring program, the X-749A Classified Materials Disposal Facility and the X-735 Industrial Solid Waste Landfill, are subject to monitoring programs under OAC 3745-29-10, which references OAC 3745-30-08 (effective February 1, 2008, see Appendix G). The X-749A Classified Materials Disposal Facility and the Berea wells that monitor the X-735 Landfills are subject to these regulations per the December 2011 DFF&O.

The Gallia wells at the X-735 Landfills are monitored under a Corrective Measures Program in accordance with OAC 3745-29-10 (F) (effective June 1, 1994) and the *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a). The Gallia wells at the X-735 Landfills are monitored in accordance with OAC 3745-29-10 (effective June 1, 1994) because these regulations were part of the March 1999 DFF&O, which was applicable to PORTS when the *Corrective Measures Plan for the X-735 Landfill*

(DOE 2007a) was prepared by DOE and approved by Ohio EPA. These requirements are summarized in Appendix F.

The monitoring programs for the X-749A Classified Materials Disposal Facility and Berea wells at the X-735 Landfills include the statistical evaluation of analytical results in order to determine if leachate or leachate-derived constituents from these units have impacted the surrounding groundwater. These evaluations are completed as described in Appendix F and Sections 4.4.4 and 7.2.4, respectively.

If the statistical evaluations performed under a detection monitoring program indicate a statistically significant increase for two consecutive semiannual statistical determination periods, DOE will notify the Ohio EPA no later than 15 days after receiving the second period's statistical results that indicate a statistically significant change. The notification will identify the wells and parameters that have shown a statistically significant change in accordance with OAC 3745-30-08(D), except as otherwise approved by Ohio EPA.

As described in OAC 3745-30-08(D)(9), DOE may choose to demonstrate that a source other than the landfill caused the contamination or that the statistically significant increase resulted from error in the sampling, analysis, statistical evaluation, or natural variation in groundwater quality. This demonstration may take the form of a special study as described in Section 3.2. A report documenting this demonstration will be submitted to the Ohio EPA and may include a request to continue the detection monitoring program. If DOE cannot successfully show that the identified contamination was not caused by the landfill, DOE will initiate an assessment monitoring program in accordance with OAC 3745-30-08(E), except for modifications otherwise approved by the Ohio EPA.

3.3.2 Assessment and Corrective Measures Reporting

DOE will follow, if and where monitoring results make applicable, OAC 3745-30-08(E) for assessment monitoring and reporting requirements, and OAC 3745-30-08(F) for corrective measures requirements, except for modifications otherwise approved by the Ohio EPA.

3.3.3 Annual Reporting

The integrated groundwater monitoring program defined in this document includes the preparation and submittal to the Ohio EPA of an annual Groundwater Monitoring Report. This report will be submitted by April 1 and will contain a summary of the groundwater monitoring completed during the previous year.

In addition to a summary and overview analysis of the groundwater data for each of the four quadrants, which may include graphs and charts necessary to explain fundamental changes in the data or the understanding of the data, the annual Groundwater Monitoring Report will specifically note any significant changes in the data occurring during the previous year. The report will especially note any anomalies in the groundwater quality or any changes in the monitoring programs at the X-749A or the X-735 Landfills. A description of any special studies conducted during the previous year will also be included, as well as descriptions of the rate, extent and concentration level of the existing contaminant plumes. Information about the groundwater treatment facilities, results of the surface water and water supply monitoring, and trends in the groundwater quality will also be provided.

Laboratory analytical data, groundwater elevations, and statistical analysis collected during the previous year will be presented in summary tables. The concentration and extent of the contaminant plumes will be shown on figures and the groundwater elevations will be shown on potentiometric surface water maps.

The format and content of the annual Groundwater Monitoring Report will be governed by the data collected and the evaluations performed during the previous year. Therefore, the report may be modified over time in order to best meet the needs of the Ohio EPA and DOE. Furthermore, results provided in the annual report may dictate that changes be made to the IGWMP. Changes to the IGWMP will be approved by the Ohio EPA.

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4. QUADRANT I

Four groundwater AOCs are located in Quadrant I, which is in the southern portion of the site: the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility, PK Landfill, Quadrant I Groundwater Investigative (5-Unit) Area, and X-749A Classified Materials Disposal Facility. Prior to 2014, these areas were considered two monitoring areas: the X-749/X-120/PK Landfill and the Quadrant I Groundwater Investigative (5-Unit) Area/X-749A Classified Materials Disposal Facility. The areas were separated to clarify that the PK Landfill and X-749A Classified Materials Disposal Facility are not sources to the groundwater plumes associated with the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility and Quadrant I Groundwater Investigative (5-Unit) Area. These monitoring areas are discussed in Sections 4.1 through 4.4, respectively.

4.1 X-749 CONTAMINATED MATERIALS DISPOSAL FACILITY/X-120 FORMER TRAINING FACILITY

The following sections contain an introduction and facility history of the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 4.1 concludes with discussions regarding regulatory evaluations and reporting for the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility.

4.1.1 Background and History

In the southern portion of Quadrant I, groundwater concerns focus on two contaminant sources: the X-749 Contaminated Materials Disposal Facility (both north and south portions) and the X-120 Former Training Facility (also called the X-120 Old [Goodyear] Training Facility). Integrating the monitoring programs for each of the areas into one plan provides for increased efficiency of data collection, enhances the decision making process, and minimizes the possibility of errors or confusion. A brief history of these units and their associated remedial actions is presented in this section. Additional historical information specific to the X-749 groundwater monitoring wells and analytical results is presented in Section 4.1.3.

4.1.1.1 X-749 Contaminated Materials Disposal Facility

The X-749 Contaminated Materials Disposal Facility is located in the south-central section of the facility. The landfill covers approximately 11.5 acres and was built in an area of highest elevation within the southern half of PORTS. Operation of the landfill was from 1955 to 1990, during which time buried wastes were generally contained in metal drums or other containers that were compatible with the waste.

The landfill is divided into a northern portion and southern portion. The northern portion (approximately 7.5 acres) contains waste contaminated with industrial solvents, waste oils from plant compressors and pumps, sludges that were classified as hazardous, and low-level radioactive materials. The southern portion (approximately 4 acres) contains non-hazardous, low-level radioactive scrap materials.

The X-749 facility was included in the 1989 GWQA. An assessment monitoring program for this unit was proposed in the 1989 GWQA. This assessment monitoring program was implemented at the completion of the GWQA investigation.

Separate closure plans for the northern and southern portions of the unit were prepared based on historical information about the types of waste disposed in each area; i.e., the closure plan for the northern portion was prepared in accordance with hazardous waste regulations and the closure plan for the southern portion was prepared in accordance with solid waste regulations. Closure of both units occurred concurrently and was completed in 1992 in accordance with both approved closure plans. Because a groundwater contaminant plume underlies both portions, and because they are adjacent to each other and were closed together, the X-749 Contaminated Materials Disposal Facility is considered a single unit for the purposes of groundwater monitoring. Therefore, in this document, the term "X-749" refers to the entire unit, including both the north and south portions, unless otherwise designated.

Elements of the closure included installation of a multimedia cap, a barrier wall along the north side and northwest corner of X-749, and subsurface groundwater drains on the northern half of the east side and the southwest corner, including one groundwater extraction well within each of the groundwater drains. The barrier wall and subsurface drains extend down to bedrock. After collection, groundwater is pumped from the subsurface drains to the X-622 Groundwater Treatment Facility, where the groundwater is treated prior to discharge in accordance with the applicable National Pollutant Discharge Elimination System (NPDES) permit.

In 2001, Ohio EPA issued the Decision Document for Quadrant I, which identified the selected remedial measures for X-749 Contaminated Materials Disposal Facility. An additional barrier wall was installed around the eastern and southern portions of X-749. Installation of this barrier wall required removal of the eastern groundwater extraction well installed during closure of the unit.

In 2007-2008, two additional groundwater extraction wells (X749-EW05G and X749-EW06G) were installed in the groundwater collection trench on the southwest side of the X-749 Contaminated Materials Disposal Facility to provide further control of contaminants emanating from the landfill. The extraction wells began operating in January 2008.

Phytoremediation was also required by the Decision Document to control groundwater flow and remove VOCs from portions of the X-749 groundwater plume. Hybrid poplar trees were planted in areas east, south, and west of the X-749 Landfill during 2002-2003. Additional groundwater monitoring wells were installed to monitor the effect of the trees on the groundwater plume.

A preliminary evaluation of the X-749/X-120 phytoremediation system, the *Preliminary Evaluation Report for the X-749/X-120 Phytoremediation System at the Portsmouth Gaseous Diffusion Plant* (DOE 2008c) was completed in January 2008. The trees selected for the phytoremediation system had just begun to develop sufficient leaf area (approximately equal to root volume) so that groundwater was transpired through the trees; therefore, a complete system evaluation could not be completed. Water level data and tree core sampling results indicated that contaminated groundwater was being transpired by the trees; however, the volume of contaminated groundwater uptake by the trees was uncertain. Continued operation of the phytoremediation system was recommended in order for the trees to grow and develop a more extensive root system.

In the early 1990s, the leading edge of the contaminated groundwater plume emanating from X-749 was determined to be approaching the southern boundary of the PORTS reservation. In 1994, an IRM subsurface barrier wall (X-749 South Barrier Wall) was completed across a portion of the facility's southern boundary. The X-749 South Barrier Wall, which extends from the surface into the Sunbury Shale, was designed to inhibit migration of the plume off plant property.

In 2004, injection of a reductive dechlorination compound, Hydrogen Release Compound®-extended release formula (HRC®-X), was performed near the X-749 South Barrier Wall to remediate VOCs in this area. Selected wells were monitored for additional parameters to monitor and evaluate the effectiveness of the HRC®-X in remediating VOCs. Sampling data collected through the second quarter of 2006 indicated that optimal reductive dechlorination of chlorinated solvents was briefly achieved in the treatment zones but was no longer effective due to depletion of the HRC®-X.

In 2007, four groundwater extraction wells (X749-EW01G, X749-EW02G, X749-EW03G, and X749-EW04G) were installed in the X-749 South Barrier Wall Area. These groundwater wells were successful in reducing the VOC concentrations detected in groundwater in the X-749 South Barrier Wall Area. In 2010, three additional groundwater extraction wells (X749-EW07G, X749-EW08G, and X749-EW09G) were installed within the X-749/X-120 plume to provide additional control and remediation of the plume.

The five-year review for the X-749/X-120 groundwater plume was submitted to Ohio EPA in 2011. The *First Five-Year Review for the X-749/X-120 Groundwater Plume* (DOE 2011b) found that the remedial actions implemented for the X-749/X-120 groundwater plume (both the remedial actions required by the Decision Document and the extraction wells installed in 2007 and 2008) were achieving remedial action objectives by preventing migration of contaminants from the X-749 Landfill and controlling migration of the X-749/X-120 groundwater plume. However, Ohio EPA and DOE agreed that the phytoremediation system was not as successful as anticipated in reducing concentrations of TCE in groundwater.

The *Second Five-Year Review for the X-749/X-120 Groundwater Plume* (DOE 2016b) found that the remedial actions implemented for the X-749/X-120 groundwater plume, with the exception of phytoremediation, were continuing to achieve remedial action objectives by preventing migration of contaminants from the X-749 Landfill and controlling migration of the X-749/X-120 groundwater plume. Ohio EPA approved the five-year review in 2016.

4.1.1.2 X-120 Former Training Facility

The X-120 Former Training Facility covered an area of approximately 11.5 acres near the present day XT-847 building. The X-120 facility, which no longer exists, included a machine shop, metal shop, paint shop, and several warehouses used during the construction of PORTS in the 1950s. The shops may have used solvents and various other materials. Disposal practices of these solvents are unknown.

A groundwater contaminant plume associated with this facility contains primarily TCE and lesser concentrations of other VOCs. The upgradient portion of the X-120 plume co-mingles with a portion of the X-749 plume; however, downgradient the X-120 plume migrates independently to the southwest. In 1996, a horizontal well was installed along the approximate axis of the X-120 plume. This well passively transmitted (by gravity drainage) contaminated groundwater to the X-625 Groundwater Treatment Facility. In July 2003, operation of the X-625 Groundwater Treatment Facility ceased and the horizontal well discharge was capped because of the limited amount of groundwater that was being treated at the facility. In 2010, a groundwater extraction well (X749-EW09G) was installed within the X-120 portion of the groundwater plume to remediate higher concentrations of VOCs present in groundwater in this area of the plume.

4.1.2 Regulatory Considerations for Optimizing Groundwater Monitoring

Regulatory requirements for the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility are summarized in the following section. As noted previously, the X-749 Contaminated Materials Disposal Facility comprises two units: a northern unit and a southern unit. Groundwater monitoring at the northern portion was governed by the hazardous waste regulations and an approved closure plan written in accordance with those regulations. Groundwater monitoring at the southern portion of the X-749 was governed by the solid waste regulations and an approved closure plan written in accordance with the solid waste regulations.

The closure plan for the southern portion included essentially the same requirements as specified in the northern portion closure plan; however, it also included a requirement that three surface water locations be monitored during closure of the unit. Other discrepancies between the two post-closure groundwater monitoring sections also existed.

It should also be noted that only three wells were included in the groundwater monitoring system described in the initial closure plans; however, as part of the pre-integrated monitoring program, 29 wells associated with the X-749 groundwater plume were routinely monitored with results reported to the Ohio EPA annually. Most of the wells were added to the original monitoring system as part of the 1989 GWQA, to support the 1994 X-749 IRM, or to further delineate the extent of the X-749 groundwater contaminant plume in accordance with OAC 3745-65-90 to 3745-65-94. All parameters specified in the closure plans were monitored at the three wells specified in the closure plans. The remaining wells were monitored for a different list of parameters.

4.1.3 Technical Considerations for Optimizing Groundwater Monitoring

The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility is presented in Appendix A, Table A-1. Because many wells meet one or more technical objectives for more than one unit, the parameter and frequency selection for wells meeting a particular objective may not be identical.

A known VOC groundwater contaminant plume emanates from X-749. Routine groundwater monitoring has occurred for X-749 since 1990. Prior to implementation of the IGWMP, analytical parameters for X-749 wells typically included VOCs, physical parameters, radiological parameters, metals, and inorganics. The specific list of VOCs varied from year to year; however, the primary plume VOCs were always included in the list (32 VOCs were included). The radiological parameters always included technetium-99 and total uranium. However, historical data indicates that only technetium-99 was a consistent plume constituent (since technetium-99 is a beta emitter, gross beta results generally mimic technetium-99 results). Physical parameters typically included temperature, pH, and specific conductance. Changes in sampling methodology also allowed some measurements of the physical parameters turbidity and dissolved oxygen. Hazardous metals parameters typically included cadmium, chromium, and lead. These metals are not believed to be associated with the VOC/technetium-99 plume at X-749/X-120 as a number of mid-plume wells have shown no detections for these metals. Other parameters at this unit have included metals and other inorganics used for mass balance and water quality analysis. These parameters included calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity. In addition to the parameters analyzed for each of the X-749 wells, a number of other parameters were included for the three closure wells (X749-26G, X749-32G, and X749-36G). These mid-plume wells were sampled for additional organics, radionuclides, metals, and other inorganics. These additional parameters were typically not detected or were below drinking water standards.

Figures A-1 and A-2 in Appendix A show the integrated monitoring wells and integrated monitoring parameters, respectively, for the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility.

4.1.3.1 X-749 Contaminated Materials Disposal Facility

The X-749 Contaminated Materials Disposal Facility is a landfill (source) with a groundwater contaminant plume for which a number of remedial actions have been performed including a cap, barrier walls, groundwater collection systems, and phytoremediation. Therefore, source monitoring, plume monitoring, and remedial action effectiveness monitoring are all conducted at X-749. Table A-1 in Appendix A lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-749 Contaminated Materials Disposal Facility.

Source monitoring is performed to detect changes in contaminant concentrations emanating from the X-749 Contaminated Materials Disposal Facility. Sampling of selected wells near the source on a biennial basis for the additional parameters contained in the Appendix to OAC 3745-54-98 is also conducted to determine if all hazardous constituents that may be present are identified. The following wells provide source monitoring for the X-749 Contaminated Materials Disposal Facility: X749-04G (upgradient), X749-06G (downgradient), X749-07G (downgradient), X749-08G (downgradient), X749-09GA (downgradient), and X749-10GA (downgradient).

Plume monitoring at X-749 is performed to determine the extent and concentration of the X-749 plume. Although the X-749 and X-120 plumes coalesce, plume monitoring for these units is presented separately in this section of the IGWMP.

The X-749 wells screened in the Berea sandstone were historically monitored at the same frequency as Gallia wells at this unit (prior to implementation of the IGWMP). The X-749 groundwater contaminant plume resides in the Gallia sand and gravel that overlies the Berea sandstone. However, a relatively impermeable layer of Sunbury shale separates the Gallia from the Berea in most of the area (the Sunbury is absent in the eastern portion of the X-749 plume near Big Run Creek), thus preventing the migration of groundwater from the Gallia into the Berea. Berea wells have shown no indication of X-749 plume contaminants, even in Berea wells that underlie the center of the X-749 Gallia groundwater contaminant plume. Groundwater flow velocities in the Berea are slower than in the Gallia, so even if X-749 plume constituents were able to migrate through the Sunbury shale into the Berea, these contaminants would move very slowly within the Berea. Therefore, Berea wells associated with the X-749/X-120 plume are generally sampled less frequently than Gallia wells.

Each of the wells used for remedial action effectiveness monitoring at X-749 is also used for plume monitoring at this unit. Table A-1 in Appendix A provides the monitoring frequency and parameters for the wells that monitor the X-749 Area.

4.1.3.2 X-120 Former Training Facility

At X-120, no source of groundwater contamination has been identified, therefore source monitoring is not conducted for this unit. However, a known groundwater contaminant plume exists for X-120, so plume monitoring is performed. Wells in the northwestern portion of the monitoring area provide this plume monitoring (see Table A-1, Figure A-1, and Figure A-2 in Appendix A).

In 1996, the X-120 horizontal well was installed along the axis of the X-120 groundwater plume. This well passively transmitted (by gravity drainage) contaminated groundwater to the X-625 Groundwater Treatment Facility. In July 2003, operation of the X-625 Groundwater Treatment Facility ceased and the horizontal well discharge was capped because of the limited amount of groundwater that was being treated at the facility. In 2010, a groundwater extraction well (X749-EW09G) was installed within the X-120 portion of the groundwater plume to remediate higher concentrations of VOCs present in groundwater in this area of the plume.

4.1.4 Evaluations and Reporting

Pre-integrated regulatory requirements concerning data evaluations and data reporting included the assessment and annual reporting of the concentration, rate of migration, and extent of the X-749 groundwater plume. However, monitoring of groundwater for the entire X-749/X-120 Area will more effectively determine whether remediation activities are sufficiently protective of human health and the environment. The groundwater data for X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility will be prepared and submitted annually to the Ohio EPA by April 1, as part of the annual Groundwater Monitoring Report.

4.2 PK LANDFILL

The following sections contain an introduction and facility history of the PK Landfill (also called the X-749B Peter Kiewit Landfill) and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 4.2 concludes with discussions regarding regulatory evaluations and reporting for the PK Landfill.

4.2.1 Background and History

The PK Landfill is located west of Big Run Creek just south of the X-230K Holding Pond. The landfill, which began operations in 1952, was used as a salvage yard, burn pit, and trash area during the construction of PORTS. After the initial construction, the disposal site was operated as a sanitary landfill until 1968, when soil was graded over the site and the area was seeded with native grasses. No manifests or records exist that characterize the material in the landfill.

During site investigations, intermittent seeps were observed emanating from the PK Landfill into Big Run Creek. In 1993, sampling was conducted at three of the seeps and at Big Run Creek approximately 40 ft downstream of the seeps. Sample results indicated that the seeps contained vinyl chloride; however, no vinyl chloride was detected in Big Run Creek.

In 1994, an IRM was implemented that involved the portion of Big Run Creek contiguous to the PK Landfill. This portion of Big Run Creek was relocated approximately 50 ft to the east. A groundwater collection system was installed in the old creek channel to capture the seeps emanating from the landfill. Contaminated groundwater is pumped from the collection system to the X-622 Groundwater Treatment Facility. The PK Landfill IRM required sampling of the groundwater collection system on a quarterly basis.

In accordance with the provisions of various regulatory requirements, the final Decision Document for the PK Landfill was issued by the Ohio EPA in July 1996, and the U.S. EPA in May 1997. The Decision Document required:

- Continued operation of seep collection system on the east side of the landfill,
- A landfill cap to contain wastes and reduce water infiltration that meets the requirements of RCRA, Subtitle D, and
- Environmental monitoring to ensure that the final remedial action is protective.

The PK Landfill Decision Document also required evaluation of the leachate volumes flowing to the seep collection system to determine the need for a vertical subsurface barrier (barrier wall) to minimize lateral migration of contaminants. The RCRA Subtitle D landfill cap completed at the PK Landfill in 1998 did not include the installation of a vertical barrier.

In April 1997, contaminated seeps were noted in the tributary to Big Run Creek on the south side of the PK Landfill. It was believed that these seeps were the result of the groundwater plume associated with the X-749 facility intersecting the ground surface at this location. The X-749/X-120 groundwater plume is near the western and southern boundary of the PK Landfill and the groundwater potentiometric surface is near the actual surface elevation in this area. The groundwater flow in the PK Landfill area was from the northwest to southeast.

As a result of the seeps discovered in April 1997, a second collection system was constructed south and east of the PK Landfill boundary in October 1997 to contain the groundwater plume migrating toward Big Run Creek. This additional collection system was tied into the previously installed system that delivers collected water to the X-622 Groundwater Treatment Facility.

After the 5-year evaluation of the remedial actions at the PK Landfill was completed in 2002 [*X-611A Prairie and the X-749B Peter Kiewit Landfill Five-Year Evaluation Report for the Portsmouth Gaseous Diffusion Plant* (DOE 2002b)], DOE developed the *Comprehensive Monitoring Plan for the X-749 and Peter Kiewit Landfill Areas* (DOE 2003a) to address Ohio EPA comments on the report. The plan described additional data to be collected to evaluate the remedial measures in place at the X-749 and PK Landfills and to determine whether additional remedial measures were needed, such as a barrier wall north and west of the PK Landfill. The *Annual (2004) Summary Report of the Comprehensive Monitoring Plan Data for the X-749/Peter Kiewit Landfill Areas* (DOE 2005) determined that the remedial measures in place were performing as expected and a barrier wall was not necessary.

The second five-year review for the PK Landfill was completed in 2008. The *Second Five-Year Review for the X-749B Peter Kiewit Landfill* (DOE 2008e) found that the remedial actions implemented at the PK Landfill (the groundwater collection systems, landfill cap, and institutional controls) were achieving remedial action objectives by eliminating exposure pathways and reducing the potential for contaminant transport. Concentrations of many of the VOCs detected in groundwater at the PK Landfill were decreasing significantly. In addition, VOCs detected at the PK Landfill were not detected in surface water samples collected from Big Run Creek adjacent to or downstream from PK Landfill. Monitoring data continued to indicate that a barrier wall north and west of the PK Landfill was not necessary.

The third five-year review for the PK Landfill was submitted to Ohio EPA in September 2013. This report, the *Third Five-Year Review for the X-749B Peter Kiewit Landfill* (DOE 2013d), found that the corrective actions implemented at the PK Landfill (the groundwater collection systems, landfill cap, and institutional controls) were continuing to achieve corrective action objectives by eliminating exposure pathways and reducing the potential for contaminant transport.

4.2.2 Regulatory Considerations for Optimizing Groundwater Monitoring

The PK Landfill is located on the eastern side of the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility Area, but is not considered a source to the groundwater plume associated with the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility. The pre-integrated requirements for conducting groundwater monitoring at the PK Landfill were specified in the Operation and Maintenance (O&M) Plan for the PK Landfill Corrective Measures Implementation (CMI).

4.2.3 Technical Considerations for Optimizing Groundwater Monitoring

In 1994, a portion of Big Run Creek contiguous to the PK Landfill was relocated to the east side of the creek valley. An interceptor trench was installed in the old Big Run Creek channel to capture seeps emanating from the landfill. Wells to the east of the PK Landfill and the interceptor trench, downgradient from the PK Landfill, monitor the effectiveness of this remedial action at the PK Landfill. Wells PK-10G and PK-11G provide upgradient source monitoring for the PK Landfill.

The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the PK Landfill is presented in Appendix A, Table A-2. Figures A-1 and A-2 in Appendix A show the integrated monitoring wells and integrated monitoring parameters, respectively, for the PK Landfill.

4.2.4 Evaluations and Reporting

The groundwater data for PK Landfill will be prepared and submitted annually to the Ohio EPA by April 1, as part of the annual Groundwater Monitoring Report.

4.3 QUADRANT I GROUNDWATER INVESTIGATIVE (5-UNIT) AREA

The following sections contain an introduction and facility history of the Quadrant I Groundwater Investigative (5-Unit) Area and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 4.3 concludes with discussions regarding regulatory evaluations and reporting for the Quadrant I Groundwater Investigative (5-Unit) Area. The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the Quadrant I

Groundwater Investigative (5-Unit) Area, is presented in Appendix A, Table A-3, and in Figures A-3 and A-4.

4.3.1 Background and History

During the RFI of Quadrant I, VOC contamination (primarily TCE) of the groundwater was detected in the Quadrant I Groundwater Investigative (5-Unit) Area. A number of potential sources for groundwater contamination in this area were investigated during the RFI including X-231A Southeast Oil Biodegradation Plot, X-231B Southwest Oil Biodegradation Plot, X-600 Coal-Fired Steam Plant, X-600A Coal Storage Yard, X-621 Coal-Pile-Runoff Treatment Facility, X-626 Recirculating Cooling Water Pump House and Cooling Tower, X-710 Technical Services Building (including X-710A Neutralization Pit and X-710 Radioactive Wastewater Tank), X-749A Classified Materials Disposal Facility (discussed separately in Section 4.4), and the X-760 Pilot Investigation Building/X-770 Mechanical Testing Facility. The X-231B Southwest Oil Biodegradation Plot is the only unit for which routine groundwater monitoring was required by Ohio EPA (see Section 4.3.2); therefore, only the history of X-231B is included in this section. The history of the other units can be found in the *Quadrant I RFI Final Report* (DOE 1996b).

The X-231B Southwest Oil Biodegradation Plot was used from 1976 to 1983 for land application of contaminated oil/solvent mixtures generated from the enrichment process and maintenance activities. The X-231B is located west of the X-600 Former Coal-Fired Steam Plant, and consisted of two disposal plots, each surrounded by an elevated soil berm, which were periodically fertilized and disced to enhance aeration and promote biological degradation of waste oil. The X-231B Southwest Oil Biodegradation Plot was not operated as a RCRA-regulated land treatment unit.

The X-231B Southwest Oil Biodegradation Plot was included in the 1989 GWQA, during which a VOC groundwater contaminant plume was shown to be emanating from this unit. An assessment monitoring program for this unit was proposed in the 1989 GWQA. Sampling completed in the 1990s after completion of the GWQA indicated that the X-231B groundwater plume is actually commingled with other contaminated groundwater as part of the Quadrant I Groundwater Investigative (5-Unit) Area plume. The X-231B was the only unit within the Quadrant I Groundwater Investigative (5-Unit) Area plume for which routine assessment monitoring was required by Ohio EPA; however, the monitoring wells selected for this unit were also effective at monitoring the downgradient portions of the entire plume.

DOE and Ohio EPA worked to develop a closure plan for the X-231B from the mid 1980s through 1995, at which time Ohio EPA approved the plan. Closure of the unit included in-situ treatment of the soil to remove VOCs and installation of an interim soil cover over the unit. Three groundwater extraction wells were installed in the Gallia south of the X-231B Southwest Oil Biodegradation Plot and aligned across the central portion of the VOC plume. The extracted groundwater is treated at the X-622 Groundwater Treatment Facility. Ohio EPA approved the "interim closure" in 1995, but indicated that final remediation of the unit would be integrated into the RCRA Corrective Action Program.

The March 1999 DFF&O integrated final remediation of the X-231B into the RCRA corrective action process for the Quadrant I Groundwater Investigative (5-Unit) Area. The Decision Document issued by Ohio EPA required installation of multimedia caps over both the X-231A and X-231B oil biodegradation plots and installation of 11 additional groundwater extraction wells in the Quadrant I Groundwater Investigative (5-Unit) Area. Installation of the multimedia caps was completed in 2000. Operation of the 11 new groundwater extraction wells began in 2002. Extracted groundwater is treated in the X-622 Groundwater Treatment Facility.

A five-year review of these remedial actions (groundwater extraction wells and multimedia caps) was submitted to Ohio EPA in 2008. The *First Five-Year Review for the Five-Unit Groundwater Investigative Area and X-231A/X-231B Oil Biodegradation Plots* (DOE 2008a) found that the remedial actions had eliminated potential exposure pathways to contaminants of concern and reduced concentrations of trichloroethene in the groundwater. However, the extraction wells were not removing VOCs from the groundwater beneath the area as effectively as originally predicted by the groundwater model used to develop the Decision Document. The model most likely overestimated the transmissive properties of the Gallia water-bearing zone in the Quadrant I Groundwater Investigative (5-Unit) Area, thereby overestimating the predicted rate of plume reduction. The possible presence of VOC sources not included in the model may have also prevented the contaminant plume from achieving the size and volume reductions predicted by the model. An additional groundwater extraction well was installed in 2009 in the western portion of the plume, south of the X-326 Process Building, to address a possible VOC source beneath the building.

In 2008 and 2010, soil sampling completed as part of the demolition of the X-770 Mechanical Testing Facility (in the northern portion of the groundwater plume in the Quadrant I Groundwater Investigative [5-Unit] Area) identified areas of vadose zone soil contaminated with VOCs. These areas of contaminated soil, south and east of the former X-770 building, were removed in 2010. Removal of these VOC source areas is expected to reduce concentrations of VOCs in groundwater and shorten the length of time needed to remediate the groundwater plume in the Quadrant I Groundwater Investigative (5-Unit) Area.

The second five-year review of the groundwater extraction system for the Quadrant I Groundwater Investigative (5-Unit) Area and the multi-layered caps for the X-231A and X-231B Oil Biodegradation Plots was submitted to Ohio EPA in 2013. This report, the *Second Five-Year Review for the Five-Unit Groundwater Investigative Area and X-231A/X-231B Oil Biodegradation Plots* (DOE 2013a), found that the remedial actions implemented for the X-231A and X-231B Oil Biodegradation Plots and the Five-Unit Groundwater Investigative Area (the multimedia caps and groundwater extraction system) were continuing to eliminate potential exposure pathways to contaminants, control migration of the groundwater plume, and remove VOCs from groundwater.

4.3.2 Regulatory Considerations for Optimizing Groundwater Monitoring

There are no pre-integrated regulatory requirements for groundwater monitoring at the Quadrant I Groundwater Investigative (5-Unit) Area, with the exception of the requirements for monitoring the X-231B Southwest Oil Biodegradation Plot. The pre-integrated regulatory requirements governing groundwater monitoring at the X-231B are contained in the approved consolidated closure plan. Routine groundwater monitoring has also been conducted at the X-231B monitoring wells specified in the GWQA. Since the requirements of the closure plan have been in effect, there have not been any instances where contradictory requirements, or instances of confusing direction, have been encountered. Therefore, based on the regulatory history of the groundwater monitoring conducted at this facility, no changes to the monitoring program other than those indicated by technical considerations are included herein.

4.3.3 Technical Considerations for Optimizing Groundwater Monitoring

A known VOC groundwater contaminant plume exists within the Quadrant I Groundwater Investigative (5-Unit) Area. Groundwater has been routinely monitored in portions of this area since 1990. In other PORTS plumes where wells have gone from below-detection to above-detection for plume contaminants, VOCs are typically first detected at the leading edge of the plume. No such correlation has been noted for metals or any other parameters at this unit. Therefore, VOCs are monitored more frequently than other parameters at this area.

Prior to implementation of the IGWMP, analytical parameters for the Quadrant I Groundwater Investigative (5-Unit) Area wells typically included VOCs, physical parameters, radiological parameters, metals, and inorganics. The specific list of VOCs varied from year to year; however, the primary plume VOCs were always included in the list (32 VOCs were included). The radiological parameters always included technetium-99 and total uranium. Physical parameters typically included temperature, pH, and specific conductance. Some pre-IGWMP sampling events included measurements of the physical parameters turbidity and dissolved oxygen.

Prior to implementation of the IGWMP, hazardous metals parameters typically included barium, lead, and nickel, and sometimes cadmium and manganese. These metals are not believed to be associated with the VOC plume at the Quadrant I Groundwater Investigative (5-Unit) Area as a number of mid-plume wells have shown no detections for these metals. Other parameters at this unit have included metals and other inorganics used for mass balance and water quality analysis. These parameters include calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity. Other parameters monitored at this unit included nitrates, total organic carbon, total organic halogens, and fluoride per the X-231B Consolidated Closure Plan.

The Quadrant I Groundwater Investigative (5-Unit) Area consists of several potential sources for groundwater contamination. It includes a groundwater contaminant plume for which a number of remedial actions have been performed. Therefore, source monitoring, plume monitoring, and remedial action effectiveness monitoring are all conducted at the Quadrant I Groundwater Investigative (5-Unit) Area.

Source monitoring is performed to detect changes in contaminant concentrations emanating from X-231A and X-231B. Sampling of selected wells near the source on a biennial basis for the additional parameters contained in the Appendix to OAC 3745-54-98 is also conducted to determine if all hazardous constituents that may be present are identified. The following wells provide source monitoring for X-231A and X-231B: X231A-01G (downgradient), X231A-04G (upgradient), X231B-02G (upgradient), X231B-03G (downgradient), and X231B-06G (downgradient).

Plume monitoring at the Quadrant I Groundwater Investigative (5-Unit) Area is performed to determine the extent and concentration of the contamination. Although the eastern margin of the Quadrant I Groundwater Investigative (5-Unit) Area coincides with the western margin of X-749A Classified Materials Disposal Facility, there is no VOC plume observed that is associated with X-749A Classified Materials Disposal Facility.

The X-231B wells screened in the Berea sandstone were historically monitored at the same frequency as Gallia wells at this unit (prior to implementation of the IGWMP). The Quadrant I Groundwater Investigative (5-Unit) Area contaminant plume resides in the Gallia sand and gravel that overlies the Berea sandstone. A relatively impermeable layer of Sunbury shale separates the Gallia from the Berea in this area that limits the downward migration potential of groundwater from the Gallia into the Berea. Berea wells have historically shown no indication of the Quadrant I Groundwater Investigative (5-Unit) Area plume contaminants, including Berea wells which underlie the center of the plume. Groundwater flow velocities in the Berea are slower than in the Gallia; therefore, contaminants would move very slowly within the Berea if the plume constituents were able to migrate through the Sunbury shale into the Berea. Therefore, the Berea wells associated with the Quadrant I Groundwater Investigative (5-Unit) Area Plume are generally sampled less frequently than Gallia wells.

Each of the wells used for remedial action effectiveness monitoring at X-231B is also used for plume monitoring at this unit. Table A-3 in Appendix A lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the Quadrant I Groundwater

Investigative (5-Unit) Area. Figures A-3 and A-4 in Appendix A show the integrated monitoring wells and integrated monitoring parameters, respectively, for the Quadrant I Groundwater Investigative (5-Unit) Area. Locations of the extraction wells installed in this area are included on Figures A-3 and A-4 in Appendix A so that the effect of the extraction wells on the groundwater plume and/or specific monitoring wells can be evaluated.

4.3.4 Evaluations and Reporting

Pre-integrated data evaluations and data reporting for the Quadrant I Groundwater Investigative (5-Unit) Area included an evaluation of the concentration, rate of migration, and extent of the existing contaminated groundwater plume in the vicinity of the X-231B Area. Verification and validation of the laboratory analytical data were also required.

In accordance with the December 2011 DFF&O (which replaced the March 1999 DFF&O), comprehensive groundwater data for the Quadrant I Groundwater Investigative (5-Unit) Area is evaluated annually and included in the annual Groundwater Monitoring Report submitted to the regulators by April 1 of each year.

4.4 X-749A CLASSIFIED MATERIALS DISPOSAL FACILITY

The following sections contain an introduction and facility history of the X-749A Classified Materials Disposal Facility and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 4.4 concludes with discussions regarding regulatory evaluations and reporting for X-749A Classified Materials Disposal Facility. The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the X-749A Classified Materials Disposal Facility, is presented in Appendix A, Table A-4, and in Figures A-3 and A-4.

4.4.1 Background and History

The X-749A Classified Materials Disposal Facility is a six acre unit located just south of the plant's former main administration building (X-100 Former Administration Building), and immediately east and northeast of the X-600 Former Coal-Fired Steam Plant and the X-231B, respectively. The location of this facility is shown in Appendix A, Figure A-3.

The facility was operational from 1953 to 1988 as a landfill for the disposal of wastes whose nature was classified or whose content might include classified information. Available records indicate that the contents of the facility include aluminum dross (slag), security ashes, barrier scrap, tube sheets, seal parts, floor sweepings (lube oil and sawdust that may contain PCBs, asbestos, and radionuclides), and parts from a nickel powder processing plant that may contain nickel carbonyl. Available records indicate that contents underwent decontamination, as necessary, before disposal in the unit.

Waste materials disposed of in the landfill are classified under the Atomic Energy Act. Security regulations require that any classified waste placed in a trench must receive at least four ft of soil cover or an equivalent barrier to visual or physical access within the same day. A description of the other types of materials disposed includes magnetic media (computer tapes, floppy disks, etc.) that contained or might have contained classified information, classified documents (both as shredded material and as ashes from burned documents), decontaminated machine parts whose nature (function, design, etc.) or materials of construction were classified, and process equipment from a metal working plant that manufactured machine parts for PORTS.

The X-749A Classified Materials Disposal Facility is no longer in operation. Historically, the generation of classified waste at PORTS was highly dependent on activities at the plant. During process upgrades, large amounts of obsolete process equipment and classified information may have been disposed of at X-749A. During its use, a trench typically was surveyed and marked by plant engineering to accommodate a specific amount of waste that had already accumulated aboveground or was anticipated as a result of a specific renovation or demolition project. The trench was excavated to approximately 14 ft deep and filled with 8 ft of waste materials. The remaining 6 ft was backfilled with native clay overburden. The surface was compacted with a tracked bulldozer. If a depression was created by the compaction, extra clay was mounded on the trench surface and recompacted. Normally, trenches were opened and filled one at a time.

Active use of the landfill ceased in 1988. The DFF&O issued on December 1, 1988, required the submittal of a Closure Plan for the X-749A Classified Materials Disposal Facility. On December 31, 1988, the DOE and the Ohio EPA finalized plans to close the solid waste landfill by installing a multi-media clay cover over the six acre facility. A Closure Plan for the X-749A facility was submitted in May 1989. The Closure Plan was written in accordance with the requirements of the OAC Chapter 3745-27 in effect at that time. The closure plan was revised to incorporate Ohio EPA comments in December 1989, June 1990, September 1990, and October 1991. The closure plan was approved by the Ohio EPA on April 9, 1992.

Closure of the landfill was accomplished in two phases in accordance with the approved closure plan. The first phase of construction was to install a drainage system on the west side of the landfill to collect surface water run-off. This phase was begun in January 1993 and was completed on May 26, 1993. The drainage system collects run-off from the landfill and drains surface water into a permitted discharge location where it is monitored before leaving the plant property. Work on the second phase, construction of the multi-layered cap, began in mid-May 1993 and was finished in just less than a year. Final surface grading and seeding were completed on the X-749A Classified Materials Disposal Facility in April 1994. The X-749A Classified Materials Disposal Facility was closed in place, with the inventory left undisturbed. The independent engineer's certification of closure was submitted in June 1994 and approved by Ohio EPA on January 13, 1995.

4.4.2 Regulatory Considerations for Optimizing Groundwater Monitoring

Requirements for groundwater monitoring at the X-749A were identified in the approved closure plan for the X-749A Classified Materials Disposal Facility. However, the requirements specified in the approved closure plan differed slightly from the requirements for groundwater monitoring specified in the 1990 version of OAC 3745-27-10 (solid waste regulations).

After the requirements of the closure plan had been in effect, the Ohio EPA promulgated new solid waste regulations in 1994 that included requirements for conducting groundwater monitoring. However, the monitoring program at the X-749A was not modified to incorporate these changes. Instead, groundwater monitoring at the X-749A was changed to follow the requirements for industrial solid waste regulations (OAC 3745-29-10) upon implementation of the IGWMP in 1999. Groundwater monitoring at the X-749A in accordance with the industrial solid waste regulations is more appropriate due to the type of waste disposed of in the X-749A. This change also makes the monitoring program at the X-749A consistent with the monitoring program of the other solid waste unit at PORTS (the X-735 Landfills, Section 7.2), while providing information necessary to determine whether or not leachate or leachate-derived constituents from the X-749A unit have adversely impacted the groundwater surrounding the unit.

Assessment monitoring was conducted at the X-749A Classified Materials Disposal Facility in 1997, 2000-2001, and 2007-2009. In 1997, pH was shown to be anomalously low in well X749A-02G. Because no contaminants were detected in the groundwater surrounding the unit, the Director of the Ohio EPA, in a letter dated December 11, 1997, approved DOE's request to reinstate the detection monitoring program at the X-749A facility.

In 2000, an assessment monitoring program was initiated at the X-749A because of a statistically significant increase in the concentration of alkalinity in well X749A-14G. Alkalinity was one of the parameters added to the statistical evaluation of data at this unit upon implementation of the IGWMP in 1999. Historical data indicated that the concentration of alkalinity in this well had been higher than the upper tolerance limit for several years. The assessment monitoring program completed in 2001 determined that a release from the landfill had not occurred and recommended additional upgradient (background) wells and a new statistical procedure for data evaluation as part of resuming the detection monitoring program for this unit.

Assessment monitoring was initiated in 2007 based on an exceedence of the control limits for alkalinity in well X749A-01G. Alkalinity was also determined to be elevated in well X231A-01G. The assessment monitoring program determined that neither well X749A-01G nor well X231A-01G yielded groundwater samples that were representative of groundwater quality directly downgradient of the X-749A Landfill. Three new wells were installed to monitor groundwater quality on the west side of the X-749A Landfill (downgradient in 2007-2009). Ohio EPA approved the return to a detection monitoring program at the X-749A Landfill in March 2010.

4.4.3 Technical Considerations for Optimizing Groundwater Monitoring

Routine groundwater monitoring has occurred at X-749A since 1993. Eleven wells, all screened in the Gallia, were initially used to monitor this unit. The wells used to monitor this area varied somewhat between 1993 and 1999, prior to implementation of the IGWMP.

Although the eastern margin of the Quadrant I Groundwater Investigative (5-Unit) Area coincides with the western margin of X-749A, there is no VOC plume associated with X-749A; therefore, only source monitoring is performed at X-749A. Groundwater flows in the vicinity of the X-749A Classified Materials Disposal Facility can fluctuate from southeast to southwest because of remedial actions in progress at the Quadrant I Groundwater Investigative (5-Unit) Area; therefore, background (upgradient) wells and compliance (downgradient) wells at the X-749A can also change. Appendix F provides the evaluation methodologies for monitoring at the X-749A Classified Materials Disposal Facility. All integrated wells, parameters, and frequencies for the X-749A Classified Materials Disposal Facility are presented in Appendix A, Table A-4. Figures A-3 and A-4 in Appendix A show the integrated monitoring wells and integrated monitoring parameters, respectively, for the X-749A Classified Materials Disposal Facility.

4.4.4 Evaluations and Reporting

Pre-integrated data evaluations and reporting for the X-749A Classified Materials Disposal Facility included verification and validation of the laboratory analytical data, the completion of a statistical evaluation of the data, and reporting on a semi-annual basis.

In accordance with the December 2011 DFF&O (which replaced the March 1999 DFF&O), comprehensive groundwater data for the X-749A Classified Materials Disposal Facility is evaluated annually and included in the annual Groundwater Monitoring Report submitted to the regulators by April 1 of each year. A statistical analysis is conducted for the X-749A wells as described in Appendix F.

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5. QUADRANT II

Two groundwater AOCs are located in Quadrant II, which is in the eastern portion of the site: the Quadrant II Groundwater Investigative (7-Unit) Area and the X-701B Former Holding Pond. These areas are discussed in Sections 5.1 and 5.2, respectively. One additional area in Quadrant II, the X-633 Former Recirculating Cooling Water Complex, is also monitored as a result of a completed special study (see Section 9.1).

5.1 QUADRANT II GROUNDWATER INVESTIGATIVE (7-UNIT) AREA

The following sections contain an introduction and facility history of the Quadrant II Groundwater Investigative (7-Unit) Area and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 5.1 concludes with discussions regarding regulatory evaluations and reporting for the Quadrant II Groundwater Investigative (7-Unit) Area. The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the Quadrant II Groundwater Investigative (7-Unit) Area is presented in Appendix B, Table B-1, Figure B-1, and Figure B-2.

5.1.1 Background and History

In the western portion of Quadrant II, groundwater concerns are focused on the Quadrant II Groundwater Investigative (7-Unit) Area. During the RFI of Quadrant II, VOC contamination (primarily TCE) of the groundwater was detected in the Quadrant II Groundwater Investigative (7-Unit) Area. A number of potential sources for groundwater contamination exist within this area. These potential sources include Process Lines, X-700 Chemical Cleaning Facility, X-701C Neutralization Pit, X-705 Decontamination Building, and the X-720 Maintenance Building. The X-701C Neutralization Pit is the only unit for which routine groundwater monitoring was required by the Ohio EPA (see Section 5.1.2); therefore, only the history of X-701C is included in this section. The history of the other units can be found in the *Quadrant II RFI Final Report* (DOE 1996c).

The X-701C Neutralization Pit was an 18 ft deep, 25 ft by 25 ft, open-topped neutralization pit that received process effluents and basement sump wastewaters from the X-700 Chemical Cleaning Facility from approximately 1953 to 1988, when the X-701C was deactivated. Waste received included acid and alkali solutions, and rinse water contaminated with VOCs resulting from metal cleaning operations. Wastes were released on a batch basis to the X-701C Neutralization Pit, where lime was added to neutralize the pH. When the X-701C Neutralization Pit was in use, effluent was discharged (at different times) to the X-701B Holding Pond and the X-616 Liquid Effluent Control Facility. From late 1988 until early 1992, some wash water and decontamination solutions were occasionally pumped from tanks in the X-700 Chemical Cleaning Facility directly to the X-701C Neutralization Pit and then discharged to a temporary carbon treatment system located inside the X-700 Chemical Cleaning Facility.

The soil and groundwater in the vicinity of the X-701C Neutralization Pit were sampled as part of the Quadrant II RFI in 1991. Results of this sampling showed that the X-701C was located within an existing VOC groundwater plume for which multiple sources were likely, as evidenced by the configuration of the plume. To determine whether X-701C contributed to this plume, routine detection monitoring was required by the Ohio EPA. Detection monitoring was conducted from 1993 until implementation of the IGWMP. The detection monitoring plan was not typical because of the size of X-701C and its location in an existing contaminated groundwater plume. Detection monitoring at X-701C used the three existing wells installed into the Gallia sand (X701-68G, X701-69G, and X701-70G). These wells surround X-701C; however, they were not adequate to monitor the entire Quadrant II Groundwater Investigative (7-Unit) Area plume.

Due to the nature of the wastewaters discharged to the X-701C Neutralization Pit, a closure plan for the unit was developed in accordance with Ohio hazardous waste regulations. The closure plan was submitted to the Ohio EPA in July 1992. The closure plan was revised to incorporate Ohio EPA comments and resubmitted in April 1994. In March 1995, Ohio EPA submitted a Notice of Deficiency and additional comments on the closure plan. In April 1995, Ohio EPA and DOE agreed that DOE would not submit a revised closure plan for the X-701C Neutralization Pit until after the two parties could meet to discuss integration of the closure of several units (including X-701C) with the RCRA Corrective Action process.

In a letter dated August 2, 1995, the Ohio EPA detailed procedures to be followed by both Ohio EPA and DOE prior to the development of the DFF&O that would address the integration of the closure of the X-701C with the RCRA corrective action process (the March 1999 DFF&O). The letter further stated that the DFF&O would supersede the X-701C Closure Plan, and that DOE was to remove wastewater and sludge from the X-701C Pit, decontaminate the unit, and, if contamination was discovered, remove the bricks and dispose of them as hazardous waste. The decontamination and sampling work was completed in 1996. The X-701C Neutralization Pit was removed in 2001 in accordance with a work plan approved by Ohio EPA that met the substantive RCRA closure requirements for this area. Oxidant was introduced into the excavation after the pit was removed to address VOC contamination in this area.

The X-720 Neutralization Pit, at the northeast corner of the X-720 Maintenance Building in the southeastern portion of the Quadrant II Groundwater Investigative (7-Unit) Area, was removed in 1998. Removal of contaminated soil near the former neutralization pit was completed in 2001.

Special sampling of well X333-01G, which is approximately 650 ft north of well X705-04G (the northwest edge of the VOC plume in the Quadrant II Groundwater Investigative [7-Unit] Area) was conducted in September 2004 and the first quarter of 2008 to determine whether the plume in the Quadrant II Groundwater Investigative (7-Unit) Area extended north to well X333-01G. TCE was not detected in well X333-01G in either sampling event.

In 2009, an investigation was conducted in the Quadrant II Groundwater Investigative (7-Unit) Area to identify potential sources of groundwater contamination in the eastern and southeastern portions of the plume and to further define the western portion of the groundwater plume. The investigation determined that the western edge of the groundwater plume is further west than previously known and appears to extend beneath the X-330 Process Building. The investigation also identified continuing sources of VOC contamination in the southeastern portion of the plume near the former X-720 Neutralization Pit and in the vicinity of the X-700T Aboveground Storage Tank.

An IRM consisting of enhanced anaerobic bioremediation (EAB) took place in 2011-2013 to remediate VOCs in groundwater in the southeastern portion of the plume. The *Final Report for the 7-Unit Interim Remedial Measure* (DOE 2014a) was submitted to Ohio EPA in 2014. Overall, the results indicated that appropriate redox conditions can be established at the site, and contaminant degradation can be stimulated despite the high TCE concentrations. EAB successfully reduced TCE to *cis*-1,2-dichloroethene, and with bioaugmentation, some of the *cis*-1,2-dichloroethene was converted to ethane. The report concluded that after the six injection events plus a bioaugmentation event, overall there was not a measureable reduction in the average concentration of TCE in groundwater, most likely due to the potential presence of dense non-aqueous phase liquid (DNAPL) TCE in the area, and the decision was made to conclude the IRM.

5.1.2 Regulatory Considerations for Optimizing Groundwater Monitoring

Prior to implementation of the IGWMP, routine groundwater monitoring was conducted at three X-701C groundwater monitoring wells. The intent of the monitoring program proposed in the X-701C Pit Closure Plan was to determine if the unit was contributing to the existing plume; therefore, it was considered a detection monitoring program. Alternatives for groundwater remediation in the vicinity of X-701C were evaluated in the *Quadrant II CAS/CMS Final Report* (DOE 2001).

With implementation of the IGWMP in 1999, changes to the monitoring program included converting from a detection monitoring program at the X-701C to an assessment monitoring program for the Quadrant II Groundwater Investigative (7-Unit) Area. This conversion enabled monitoring of the rate of migration, extent, and concentration of the entire Quadrant II Groundwater Investigative (7-Unit) Area plume. This conversion was in addition to those changes dictated by technical considerations.

5.1.3 Technical Considerations for Optimizing Groundwater Monitoring

The integrated monitoring program, including all well numbers, monitoring frequencies, and parameters for the Quadrant II Groundwater Investigative (7-Unit) Area, is presented in Appendix B, Table B-1. Because many wells will meet one or more technical objectives for more than one unit, the parameter and frequency selection for wells meeting a particular objective may not be identical.

As stated in Section 5.1.1, a known groundwater VOC contamination plume emanates from multiple potential or historic sources within the Quadrant II Groundwater Investigative (7-Unit) Area. The majority of wells within this plume were only sampled during Phase I and Phase II of the Quadrant II RFI. However, detection monitoring was performed at three wells surrounding X-701C (X701-68G, X701-69G, and X701-70G) from 1993 until implementation of the IGWMP. Because this unit was located within a known VOC plume, detection monitoring was somewhat inconclusive, although higher VOC concentrations were found in well X701-69G, which was typically upgradient of X-701C.

A primary technical consideration for this area is that groundwater is being drawn into the building sumps at X-700 and X-705. Approximately 10 million gallons of contaminated groundwater per year are removed by these sumps for treatment at the X-627 Groundwater Treatment Facility, which replaced the X-622T Groundwater Treatment Facility in September 2004. Synoptic water level measurements in the area have shown that groundwater flow in the Quadrant II Groundwater Investigative (7-Unit) Area is toward these sumps that are in the interior of the plume. Therefore, it is believed that the plume will continue to be drawn toward the sumps.

Prior to implementation of the IGWMP, analytical parameters for the X-701C wells included organics, physical parameters, radiological parameters, metals, and inorganics. Organics generally included total organic carbon, total organic halogens, phenolics, and VOCs. The specific list of VOCs varied from year to year; however, the primary plume VOCs were always included in the list. The radiological parameters always included technetium-99 and total uranium. Physical parameters typically included temperature, pH, and specific conductance. Some sampling events also included measurements of additional physical parameters (turbidity and dissolved oxygen). Other routinely monitored parameters at this unit included metals and other inorganics used for charge balance and water quality analysis. These parameters include calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity.

Hazardous metals parameters previously sampled for typically included cadmium, chromium, lead, manganese, and nickel. These metals are not believed to be associated with the VOC/technetium-99 plume at the Quadrant II Groundwater Investigative (7-Unit) Area because metals were not consistently detected in the X-701C monitoring wells and a number of mid-plume wells showed no detections for these metals during the RFI. However, sporadic elevated levels of these metals were detected in samples with high turbidity. Low-flow sampling techniques are being used to provide more consistent metals results. Elevated levels of gross alpha, gross beta, and technetium-99 have also been detected in this area. Low-flow sampling was conducted during the period from 1998 through the first quarter of 1999 for a Special Metals Study in accordance with specifications of the 1998 version of the IGWMP. This study concluded that low-flow sampling methods reduce turbidity of samples compared to samples collected with a bailer. Decreases in specific metal concentrations, gross alpha, and gross beta activities also corresponded with decreases in turbidity [see *Special Study for Metals and Radiological Parameters in Groundwater* (DOE 2000)].

The Quadrant II Groundwater Investigative (7-Unit) Area consists of several potential sources for groundwater contamination. Because the potentiometric surface indicates that the plume is migrating inward (toward the X-700 and X-705 building sumps), emphasis is placed on assessing the plume (plume monitoring) rather than monitoring specific sources.

Plume monitoring at the Quadrant II Groundwater Investigative (7-Unit) Area is performed to determine the extent and concentration of the contamination. The investigation conducted in this area in 2009 (see Section 5.1.1) determined that the former X-701C unit was not a continuing source of groundwater contaminants; therefore, a well near the former X-720 Neutralization Pit is monitored on a biennial basis for the additional parameters contained in the Appendix to OAC 3745-54-98 to determine if all hazardous constituents that may be present are identified. Table B-1 in Appendix B lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the Quadrant II Groundwater Investigative (7-Unit) Area. Figures B-1 and B-2 in Appendix B show the integrated monitoring network and integrated monitoring parameters, respectively, for the Quadrant II Groundwater Investigative (7-Unit) Area.

The Quadrant II Groundwater Investigative (7-Unit) Area contaminant plume resides in the Gallia sand and gravel that overlies a relatively impermeable layer of Sunbury shale. The Sunbury shale separates the Gallia from the Berea in most of the Quadrant II Area, thus limiting the downward migration potential of groundwater from the Gallia into the Berea. The Sunbury shale thins westward and is absent in the far western portion of Quadrant II. Due to groundwater extraction by the sumps in the X-705 building, and the confined nature of the groundwater in the Berea, there is a strong upward gradient from the Berea to the Gallia in the western portion of Quadrant II. This upward gradient prevents migration of contaminants downward from the Gallia into the Berea.

Historically, none of the Quadrant II Groundwater Investigative (7-Unit) Area plume contaminants have been detected in the Berea wells in this area. Groundwater flow velocities in the Berea are slower than in the Gallia, so that even if the plume constituents were able to migrate through the Sunbury shale into the Berea, these contaminants would move very slowly within the Berea.

5.1.4 Evaluations and Reporting

As part of the pre-integrated monitoring program, required data evaluations and data reporting for the Quadrant II Groundwater Investigative (7-Unit) Area included an evaluation of the concentration, rate of migration, and extent of the existing contaminated groundwater plume in the vicinity of the X-701C Area. Verification and validation of the laboratory analytical data were also required, as well as a statistical analysis of the following parameters: pH, specific conductance, total organic carbon, and total organic halogens. The results were reported annually to the regulators by March 1.

The results of the integrated monitoring of the Quadrant II Groundwater Investigative (7-Unit) Area will be evaluated in the annual Groundwater Monitoring Report for PORTS, including an evaluation of the concentration, rate, and extent of the existing plume, and will be submitted to the regulators by April 1 of each year. A statistical analysis is no longer conducted for the X-701C monitoring wells.

5.2 X-701B FORMER HOLDING POND

The following sections contain an introduction and facility history of the X-701B Former Holding Pond Area and the regulatory and technical considerations for optimizing groundwater monitoring in the X-701B Holding Pond AOC. Section 5.2 concludes with discussions regarding the regulatory evaluations and reporting for the X-701B Former Holding Pond Area.

5.2.1 Background and History

In the eastern portion of Quadrant II, groundwater concerns focus on three areas: the X-701B Former Holding Pond, the X-230J7 Holding Pond, and the X-744G Bulk Storage Building. Integrating the monitoring programs for the three areas into one plan provides economy of scale savings and reduces the possibility of errors or omission in data. The X-701B Former Holding Pond and the X-230J7 Pond are the only units for which routine groundwater monitoring was required prior to implementation of the IGWMP; therefore, only the history of those units is included in this section. The history of the X-744G unit can be found in the *Quadrant II RFI Final Report* (DOE 1996c). Additional historical information specific to the X-701B groundwater monitoring wells and analytical results is presented in Section 5.2.3.

5.2.1.1 X-701B Former Holding Pond

The X-701B Former Holding Pond was an unlined, 200-ft by 50-ft pond which was intended for the neutralization and settling of metal-bearing wastewater and acidic wastewater. The X-701B Former Holding Pond was in use from 1954 to November 1988. Most of the metal-bearing and corrosive wastes discharged to the pond (via the X-701C) originated at the X-700 Chemical Cleaning Facility and the X-705 Decontamination Building. Solvents, specifically TCE, were commonly used throughout the X-701B Area from 1955 until 1991. It is assumed that many improper land disposal activities took place, but the origins and release dates of the TCE in the groundwater remain unknown. Beginning in 1974 and continuing until 1988, slaked lime was added to the X-701B influent at the X-701E Neutralization Facility to neutralize the low pH and induce precipitation. This precipitation caused large amounts of sludge to accumulate in the pond, which was dredged annually. The pond was last dredged in 1985. The sludge recovered during dredging was stored in two retention basins located northwest of X-701B.

The X-701B Former East and West Retention Basins were unlined sludge retention basins used for the settling, dewatering, and storage of sludge removed from the X-701B Holding Pond. The East Retention Basin was the first of the two basins to be constructed. Built in 1973, the east basin was approximately 220 ft by 65 ft (narrowing to 25 ft wide in the northeast corner) and the basin bottom was 3½ ft below land surface. The east basin was in use from 1973 until about 1980. The West Retention Basin was built in 1980, when the east basin reached capacity. The west basin was approximately 220 ft by 45 ft (narrowing to 35 ft wide in the northern portion) and the basin bottom was three ft below land surface. The west basin was in use from 1980 until 1988.

In the mid 1980s, a number of monitoring wells were installed near X-701B. DNAPL consisting primarily of separate phase TCE was found in one of these wells, X701-BW2G. Several hundred gallons of TCE and TCE emulsion were removed from this well. Subsequently, DNAPL was also found in an extraction well east of the X-701B Former Holding Pond.

The X-701B Former Holding Pond was included in the 1989 GWQA, and an assessment monitoring program was proposed in the final document because groundwater in the X-701B Area was found to be contaminated with several VOCs, of which TCE was the most predominant. The assessment monitoring program was initiated following approval of the GWQA report. A closure plan for this unit was submitted to the Ohio EPA in June 1988. A list of groundwater monitoring wells was included in the plan but was cited as a tentative list pending completion of the GWQA. The closure plan was revised twice in 1989 and was approved by the Ohio EPA in July 1989. In 1989, PORTS initiated a phased closure of the unit. As part of the first phase, sludge and one ft of soil was excavated from the holding pond and the two retention basins. The sludge was dewatered, placed in containers, and transported to on-site storage. The retention basins were backfilled, graded, and seeded.

A Closure Options Study was completed and submitted to the Ohio EPA in March 1990 and approved in March 1992. Because a narrow TCE plume extended from the X-701B Former Holding Pond east along the south side of the X-230J7 Pond toward Little Beaver Creek, a groundwater interceptor trench was installed in 1991 as part of IRM activities to prevent contaminated groundwater from discharging into Little Beaver Creek.

In 1992, a Technology Demonstration Assessment at the X-701B unit was completed and submitted to the Ohio EPA in July and approved in December 1992. In April 1993, PORTS submitted a revised closure plan that included relevant portions of the Closure Options Study and the Technology Demonstration Report. The revised closure plan (Consolidated Closure Plan) was further revised in October 1994 and approved by the Ohio EPA in March 1995. The second phase of closure at the X-701B began in 1994 and included construction of a groundwater pump-and-treat system with three extraction wells and *in-situ* treatment of the soils in the bottom of the holding pond with thermally enhanced vapor extraction. Limestone rip-rap and gravel were placed on the bottom of the holding pond to support the soil treatment equipment.

Use of thermally enhanced vapor extraction was terminated after it failed to achieve identified performance standards; however, the limestone rip-rap and gravel material remained in the holding pond. In a letter dated August 2, 1995, the Ohio EPA detailed procedures to be followed by both Ohio EPA and DOE prior to integration of the closure of the X-701B with the RCRA corrective action process. The letter further stated that DOE was to install a dewatering system in the bottom of the pond and pipe collected water to the vault for extraction well X623-EW01G for subsequent treatment at the X-623 Groundwater Treatment Facility. These activities were completed in 1995. Additional technology demonstration projects to remediate VOCs at the X-701B Former Holding Pond Area include *in situ* chemical oxidation and underground steam stripping/hydrous pyrolysis.

In December 2003, Ohio EPA issued the X-701B Decision Document with separate remedial actions for soil and groundwater. Remedial actions required for soil in the X-701B Area included removal of contaminated soil in the western portion of the area and consolidation of the soil under two landfill caps to be constructed over the X-701B Holding Pond/East Retention Basin and the West Retention Basin. Two landfill caps were proposed so that an existing storm water drainage pipe would not be covered. Groundwater remediation was initiated in October 2006 by injection of a chemical oxidant in the source area of the western portion of the groundwater plume. Six injection events took place between October 2006 and October 2008.

Upon completion of the sixth injection event in October 2008, data evaluated by DOE and Ohio EPA indicated that additional oxidant injections would not be able to address the TCE source area in the upper portion of the Sunbury formation. Therefore, Ohio EPA approved an IRM to directly mix oxidant into the contaminated soils of the Minford, the entire thickness of the Gallia, and the upper Sunbury within the source area of the western portion of the plume. The three extraction wells east of the X-701B Former Holding Pond and the sump at the bottom of the X-701B Former Holding Pond were excavated and removed during the IRM.

During this IRM (2010 and 2011), groundwater monitoring wells in the western portion of the plume (the area west of Perimeter Road and north of the X-744G building) were removed from the IGWMP monitoring program and monitored as required by the IRM. Monitoring of the area continued into 2012 as a special study under the IRM Work Plan. With completion of the IRM, IRM monitoring of the western portion of the X-701B Area was discontinued in 2012 and monitoring of the area was added back into the IGWMP.

The *Completion Report for the X-701B Solid Waste Management Unit Interim Remedial Measure—Oxidant Mixing* (DOE 2011a) provides information about the X-701B IRM. TCE concentrations decreased in soil samples collected during the IRM; however, groundwater monitoring data indicated a rebound in groundwater TCE concentrations.

5.2.1.2 X-230J7 Holding Pond

The X-230J7 Holding Pond consists of a holding pond and an oil retention basin. The holding pond system was constructed in 1981 to control sedimentation resulting from stormwater run-off. The primary source of the water in the system is once-through non-contact cooling water and surface run-off. Effluent from the X-701B Holding Pond was discharged through the X-230J7 Holding Pond until November 1988. The X-230J7 Holding Pond was regulated as a hazardous waste surface impoundment because effluent containing hazardous waste (primarily TCE) was discharged to the X-230J7 Holding Pond.

As stated in Section 5.2.1.1, a narrow TCE plume extending from near the X-701B Former Holding Pond east along the south side of the X-230J7 ponds toward Little Beaver Creek was identified in the Quadrant II RFI. The only hazardous constituents detected in sediments at X-230J7 were polynuclear aromatic hydrocarbons. The only hazardous constituent detected in surface water at X-230J7 was TCE.

A detection monitoring program for the X-230J7 Holding Pond was developed in May 1992; however, Ohio EPA found the plan to be deficient. Ohio EPA approved a closure plan and associated groundwater monitoring plan in June 1995, but subsequently withdrew approval as a result of negotiations with DOE. A risk-based plan was submitted to Ohio EPA in November 1996, but DOE subsequently requested formal withdrawal of the plan due to agency concerns regarding its adequacy. The closure and groundwater monitoring requirements for the unit were formally integrated into the RCRA corrective action process in the March 1999 DFF&O.

5.2.2 Regulatory Considerations for Optimizing Groundwater Monitoring

Pre-integrated regulatory requirements for groundwater assessment monitoring at the X-701B Area include those requirements included in the GWQA, as well as the approved consolidated closure plan for the X-701B Former Holding Pond. Although groundwater monitoring was included in the closure plan for the X-230J7 Holding Pond, the plan was not approved, and routine monitoring in the area was limited to monitoring the plume associated with the X-701B Former Holding Pond. The pre-integrated regulatory requirements governing groundwater monitoring at the X-701B are contained in the approved consolidated closure plan. Because the requirements of the X-701B closure plan were in effect, no contradictory requirements or instances of confusing direction have been encountered. Therefore, on the basis of regulatory history of the groundwater monitoring conducted at this facility, no changes to the monitoring program other than those indicated by technical considerations are included.

5.2.3 Technical Considerations for Optimizing Groundwater Monitoring

The integrated monitoring program, including all well numbers, monitoring frequencies, and parameters for the X-701B Former Holding Pond Area is presented in Appendix B, Table B-2. Because many wells will meet one or more technical objectives for more than one unit, the parameter and frequency selection for wells meeting a particular objective may not be identical.

As stated in Section 5.2.1.1, a known VOC groundwater contaminant plume emanates from X-701B Former Holding Pond. Groundwater has been routinely monitored in portions of this area since 1990 although the unit was monitored prior to 1990 as part of a number of special sampling events including the 1989 GWQA. In other PORTS plumes where wells have gone from below detection limits to above detection limits for plume contaminants, VOCs are typically first detected, which indicates that these constituents migrate at the leading edge of the plume. No such correlation has been noted for metals or any other parameters at this unit. Therefore, VOCs are monitored more frequently than other parameters at this area.

Prior to implementation of the IGWMP, the sampling frequency was quarterly from 1990 to 1999 for all wells at this unit. Wells were generally sampled by bailer through 1996. Since January 1997, most wells have been sampled by a low-flow technique using bladder pumps. Pre-IGWMP analytical parameters for the X-701B wells typically included VOCs, physical parameters, radiological parameters, metals, and inorganics. The specific list of VOCs varied from year to year; however, the primary plume VOCs were always included in the list. The radiological parameters always included technetium-99 and total uranium. Physical parameters typically included temperature, pH, and specific conductance. Some sampling events included measurements of additional physical parameters (turbidity and dissolved oxygen). Hazardous metals parameters typically included cadmium, chromium, lead, and nickel. Other parameters at this unit included metals and other inorganics used for mass balance and water quality analysis. These parameters include calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity. Table B-2 in Appendix B lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-701B Former Holding Pond. Figures B-3 and B-4 in Appendix B show the integrated monitoring network and integrated monitoring parameters, respectively, for the X-701B Former Holding Pond.

5.2.3.1 X-701B Former Holding Pond

Monitoring wells in the X-701B Former Holding Pond Area provide a combination of source monitoring, plume monitoring, and/or remedial action effectiveness monitoring. The plume monitoring wells are also used to assess remedial action effectiveness. Table B-2 in Appendix B lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-701B Former Holding Pond Area.

The X-701B wells screened in the Berea sandstone were historically monitored at the same frequency as Gallia wells at this unit (prior to implementation of the IGWMP). The X-701B VOC plume resides in the Gallia sand and gravel that overlies the Berea sandstone. A relatively impermeable layer of Sunbury shale separates the Gallia from the Berea in this area, thus limiting the downward migration potential of groundwater from the Gallia into the Berea. Berea wells that underlie the plume have historically shown no indication of the X-701B plume contaminants. Groundwater flow velocities in the Berea are slower than in the Gallia, so that even if the plume constituents were able to migrate through the Sunbury shale into the Berea, these contaminants would move very slowly within the Berea. Therefore, the Berea wells selected for the X-701B Area are generally sampled less frequently than Gallia wells.

5.2.3.2 X-230J7 Holding Pond

The X-230J7 Holding Pond is located along the northern edge of the X-701B VOC plume; therefore, all monitoring for X-230J7 is incorporated into the X-701B plume monitoring program. Four monitoring wells surround X-230J7 (X230J7-01GA, X230J7-02GA, X230J7-03GA, and X230J7-04GA), and these wells are included in the X-701B plume monitoring program. Wells X230J7-01GA, X230J7-02GA, and X230J7-03GA, are located south of X-230J7 and within the X-701B plume. Well X230J7-04GA is located north of X-230J7 and outside of the X-701B plume.

5.2.4 Evaluations and Reporting

Pre-integrated data evaluations and data reporting for the X-701B Former Holding Pond included an evaluation of the concentration, rate of migration, and extent of the existing contaminated groundwater plume in the vicinity of the X-701B Area. Verification and validation of the laboratory analytical data were also required. The results were reported annually to the regulators by March 1.

The results of the integrated monitoring of the X-701B Former Holding Pond will be evaluated in the annual Groundwater Monitoring Report for PORTS, which will be submitted to the regulators by April 1 of each year.

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6. QUADRANT III

Two groundwater AOCs are located in Quadrant III, which is in the western portion of the site: the X-616 Former Chromium Sludge Surface Impoundments and the X-740 Former Waste Oil Handling Facility. These areas are discussed in Sections 6.1 and 6.2, respectively.

6.1 X-616 FORMER CHROMIUM SLUDGE SURFACE IMPOUNDMENTS

The following sections contain an introduction and facility history of the X-616 Former Chromium Sludge Surface Impoundments and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 6.1 concludes with discussions regarding regulatory evaluations and reporting for the X-616 Former Chromium Sludge Surface Impoundments.

6.1.1 Background and History

A portion of the X-616 Liquid Effluent Control Facility system consisted of two unlined surface impoundments that were used from 1976 to 1985 for storage of sludge generated by the treatment of recirculating cooling water blowdown from the PORTS process cooling system. A hexavalent chromium-based corrosion inhibitor was used in the cooling water system. The chromium in the blowdown was reduced to a trivalent chromium at the X-616 Liquid Effluent Control Facility by adding sulfur dioxide to the water, which produced sulfurous acid. The resulting chromium hydroxide sludge was then precipitated in a clarifier by pH adjustment with slaked lime and a polymer coagulant. The sludge was then pumped to the X-616 Former Chromium Sludge Surface Impoundments for storage.

From February to May 1987, treated process effluent from the X-700 Chemical Cleaning Facility, via the X-701C Neutralization Pit, was diverted to the X-616 Liquid Effluent Control Facility to reduce the high concentration of suspended solids discharged from the X-701B Holding Pond. In addition, chlorinated organic solvents were discovered in the X-700 Chemical Cleaning Facility basement sump that discharged to the X-701C Neutralization Pit.

The X-616 Former Chromium Sludge Surface Impoundments were initially identified as a hazardous waste unit requiring closure in December 1986. A closure plan was subsequently prepared and submitted to the Ohio EPA and the U.S. EPA in June 1988. The plan was revised to incorporate Ohio EPA comments in February 1989 and May 1989, and was approved in July 1989. The Ohio EPA mandated that clean closure of the unit shall not be certified until the results of a groundwater quality assessment, which indicates that the impoundments have not adversely impacted the groundwater, were submitted to the Ohio EPA. As part of the closure, the chromium sludge and surrounding soil were removed from the impoundments and placed in special cells in the X-735 Landfill.

The X-616 Former Chromium Sludge Surface Impoundments were included in the GWQA completed in 1989. Based on the results of the GWQA and other sampling data, the Ohio EPA determined that the unit could not be clean closed because of the presence of groundwater contamination at the site that was potentially due to releases from the X-616 Former Chromium Sludge Surface Impoundments. Ohio EPA also mandated a modification to the closure plan and the development and submittal of a post-closure plan for the X-616 Former Chromium Sludge Surface Impoundments that included post-closure groundwater monitoring. Revised pages to the closure plan were submitted in October 1991, and a post-closure plan was submitted in December 1991. The revised closure plan was approved by the Ohio EPA in March 1992, and the post-closure plan was approved in August 1992.

During the GWQA study for the X-616 Former Chromium Sludge Surface Impoundments, 22 groundwater monitoring wells were sampled. Some VOCs were found in isolated wells at concentrations below 10 parts per billion (ppb). In November 1989, four wells were sampled for analytes as defined in 40 CFR, Part 264, Appendix IX and elevated levels of total chromium were detected. In 1990, quarterly sampling for chromium was conducted at 12 wells, and some total chromium results exceeded regulatory limits. By the completion of the GWQA, a total of 28 monitoring wells had been installed in the vicinity: 3 in the Minford clay/silt, 20 in the Gallia sand, and 5 in the Berea sandstone.

Quarterly assessment monitoring was performed at X-616 Former Chromium Sludge Surface Impoundments through calendar year 1993. This unit was certified closed in 1993, and was monitored semi-annually under an approved post closure plan from 1994 through implementation of the IGWMP. Since the GWQA, groundwater monitoring has focused primarily on the detection of metals (from the treatment of recirculating cooling water) and VOCs (from the X-700 Chemical Cleaning Facility process effluent).

6.1.2 Regulatory Considerations for Optimizing Groundwater Monitoring

The pre-integrated regulatory requirements governing groundwater monitoring at the X-616 Former Chromium Sludge Surface Impoundments are contained in the approved post-closure plan. Since the requirements of the post-closure plan have been in effect, there have not been any instances where contradictory requirements, or instances of confusing direction, have been encountered. Therefore, based on the regulatory history of the groundwater monitoring conducted at this facility, no changes to the monitoring program other than those indicated by technical considerations are recommended.

6.1.3 Technical Considerations for Optimizing Groundwater Monitoring

Prior to implementation of the IGWMP, isolated detections for metals and VOCs were identified in a number of wells in the X-616 Area. Routine groundwater monitoring at the X-616 Former Chromium Sludge Surface Impoundments has occurred since 1990 for metals and since 1991 for VOCs.

Wells were typically sampled by bailer until late 1996. Since December 1996, wells generally have been sampled by low-flow techniques using bladder pumps. Prior to implementation of the IGWMP, analytical parameters for X-616 wells included VOCs, physical parameters, radiological parameters, metals, and inorganics. The specific list of VOCs varied from year to year; however, the few VOCs that were constituents of concern for X-616 Former Chromium Sludge Surface Impoundments were always included in the list. The radiological parameters included technetium-99 and total uranium. Physical parameters included temperature, pH, and specific conductance. Some sampling events included measurements of additional physical parameters (turbidity and dissolved oxygen). Other parameters at this unit included metals and other inorganics used for mass balance and water quality analysis. These parameters include calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity.

While VOCs are not a major concern in the X-616 Former Chromium Sludge Surface Impoundments Area, VOCs (primarily TCE) were detected in four wells (X616-09G, X616-16G, X616-20B, and X616-28B) routinely sampled for this unit prior to implementation of the IGWMP. Three of these wells (X616-09G, X616-16G, and X616-20B) are grouped near the southwest corner of X-616 Former Chromium Sludge Surface Impoundments.

During development of the IGWMP, it was believed that natural attenuation would cause VOC concentrations to continue to decrease in these wells. Historical monitoring results of groundwater for this unit (prior to implementation of the IGWMP) indicated that annual sampling would be sufficient to monitor such attenuation.

Prior to implementation of the IGWMP, analyses were performed for the hazardous metals barium, cadmium, chromium, lead, manganese, and nickel. Historically, well X616-05G is the only well with chromium concentrations that consistently exceed the drinking water standard (100 ppb). However, sporadic elevations of these metals were detected in samples with high turbidity. These metals are not believed to occur as a plume at the X-616 Area because the metals were not consistently detected, they were seldom in any spatial pattern resembling a plume, they do not correspond to wells that have VOC contamination, and the dissolved (filtered metals) were generally much lower than the total (unfiltered) metals. Low-flow, low-turbidity sampling techniques used since December 1996 provide more consistent metals results.

Results of the GWQA and routine assessment monitoring prior to the IGWMP indicated that radionuclides are not present in the groundwater beneath this unit, with the exception of technetium-99, which was sporadically detected at levels below 3790 picocuries per liter (pCi/L) (the preliminary remediation goal). These results were believed to be analytical anomalies.

Table C-1 in Appendix C lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-616 Former Chromium Sludge Surface Impoundments. Figure C-1 in Appendix C shows the integrated monitoring network for the X-616 Former Chromium Sludge Surface Impoundments.

6.1.4 Evaluations and Reporting

Pre-integrated regulatory requirements concerning data evaluations and data reporting included the assessment of the concentration, rate of migration, and extent of groundwater contaminants associated with the X-616 Former Chromium Sludge Surface Impoundments. Verification and validation of the laboratory analytical data were also required because hazardous constituents associated with the X-616 Former Chromium Sludge Surface Impoundments were detected. All data was presented in the annual RCRA report for PORTS, which was submitted to the regulators by March 1 of each year.

Because the integrated monitoring program for the X-616 Former Chromium Sludge Surface Impoundments AOC continues to be an assessment monitoring program, the data will continue to be reported in the annual Groundwater Monitoring Report for PORTS by April 1 of each year.

6.2 X-740 FORMER WASTE OIL HANDLING FACILITY

The following sections contain an introduction and facility history of the X-740 Former Waste Oil Handling Facility and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 6.2 concludes with discussions regarding regulatory evaluations and reporting for the X-740 Former Waste Oil Handling Facility AOC.

6.2.1 Background and History

The X-740 Former Waste Oil Handling Facility, which was demolished in 2006, was located on the western half of the PORTS plant site immediately south of the X-530A switchyard. The X-740 Area includes approximately 5 acres encompassing the X-740 Former Waste Oil Handling Facility, the X-109A Personnel Monitoring Building, and the area west of X-740 and X-109A that was formerly occupied by an electric power substation used during plant construction. The only remaining evidence of the substation is concrete pads. A VOC groundwater plume extends approximately 700 ft west of the X-740 Former Waste Oil Handling Facility. The X-740 Former Waste Oil Handling Facility operated from 1983 until 1991. The tank/sump was only operated until 1990. The units were initially identified as hazardous waste management units in 1991.

The X-740 Former Waste Oil Handling Facility was constructed in 1982 and consisted of a diked concrete pad, a roof, corrugated steel siding on three sides and a plastic windbreak on the fourth side. The unit was approximately 120 ft by 50 ft. During its period of operation, the facility was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. The drums were staged at the facility pending analysis of their contents and subsequent final disposition. Empty drums, resulting from combining partially full drums, were crushed in a hydraulic drum crusher located in the northwest corner of the building and then disposed of at the X-735 Landfill. The tank, or sump, was installed in 1986 and was used to collect residual waste oil and waste solvents from the drum crushing operation. No drainage system was associated with the tank/sump area.

Closure plans for both of the X-740 units were developed and submitted to the Ohio EPA as a result of the determination of the units' status. Both closure plans were written in accordance with OAC 3745-66. The closure plan for the tank/sump was submitted in April 1991, revised in May 1992, and approved in September 1992. The closure plan for the facility was submitted in April 1991, revised in May 1992, and approved in September 1992.

The Quadrant III RFI Phase I field investigation was conducted from June 1992 through August 1992. The Quadrant III confirmatory investigation was conducted in November and December 1992. Closure activities began in May 1993. During these operations, unexpected soil contamination was discovered beyond the boundaries stipulated in the approved closure plan. As a result, an extension to the closure schedule was requested in order to determine the extent of the contamination, and to prepare an amended closure plan. In November 1993, an amended closure plan was submitted which combined the closure of the building and the tank/sump. The Ohio EPA approved the amended closure plan for the combined X-740 facility in June 1994.

Phase II of the RFI conducted at this facility was combined with additional closure activities performed in September and October of 1994. During these investigations, groundwater contamination was identified, but was thought to be associated with a demolished substation utilized during former construction activities at PORTS. Therefore, in 1995, in accordance with the approved closure plan, it was determined that the X-740 unit and adjacent soils would be closed under the RCRA closure process to risk-based closure levels and groundwater contamination in the vicinity would be addressed through the CMS/CMI process.

The amended closure plan approved in 1994 was revised in May of 1996 to incorporate the findings of a human health risk assessment conducted to support completing a risk-based closure of the unit. The revised closure plan was subsequently submitted to the Ohio EPA for approval. After the public was given the opportunity to submit comments and no comments were received, Ohio EPA approved the risk-based closure on December 31, 1997.

The *Quadrant III CAS/CMS Final Report* (DOE 1998), submitted in April 1998, presented alternatives for remediation of the contaminated groundwater in the vicinity of the X-740 Former Waste Oil Handling Facility. In May 1999, Ohio EPA finalized the Quadrant III Decision Document identifying phytoremediation as the preferred remedy for cleanup of groundwater in the vicinity of the X-740 Former Waste Oil Handling Facility. The phytoremediation system was installed in 1999.

In 2003, a five-year review was completed for the X-740 groundwater plume to evaluate the effectiveness of the phytoremediation system. The report, entitled *Five-Year Evaluation Report for the X-740 Phytoremediation Project* (DOE 2003b), indicated that the trees in the phytoremediation system did not noticeably affect the overall groundwater flow in the Gallia at this area, although the trees appeared to influence water levels in individual wells. Upon review of the 2003 Five-Year Evaluation Report, the Ohio EPA required another evaluation of this area in three years to determine if the phytoremediation system is effective in remediating the groundwater plume. The *Supplemental Evaluation to the Five-Year Evaluation Report for the X-740 Phytoremediation System* (DOE 2007b), submitted to Ohio EPA in January 2007, found that the phytoremediation system had not performed as predicted by groundwater modeling included in the *Quadrant III CAS/CMS Final Report* (DOE 1998).

DOE evaluated other remedial options for this area, and three rounds of oxidant injections (modified Fenton's reagent) were completed in 2008. Data indicated that the oxidant had little effect on TCE contamination in soil and groundwater.

In 2010, EAB was approved by Ohio EPA for a pilot study of remedial options to address the groundwater plume associated with the X-740 Former Waste Oil Handling Facility. Emulsified oil, a slow-acting fermentable carbon compound, was chosen for injection in the X-740 Area because of the lower TCE concentrations and thinness of the Gallia water-bearing unit in the area (and corresponding lower flow rates in the Gallia).

Emulsified oil was injected in the X-740 Area during December 2010 and January 2011. As requested by Ohio EPA, the X-740 Area was removed from the routine IGWMP monitoring program beginning in July 2009 and was monitored as required by the pilot study. The X-740 Area was returned to the routine IGWMP monitoring program in 2014, with monitoring for the EAB pilot study continuing through 2015 (see Chapter 9, Section 9.2.3).

The *Final Report for the X-740 Pilot Study* (DOE 2016a) found that the EAB pilot study achieved both objectives of 1) determining if EAB could successfully treat TCE contamination present in the X-740 groundwater plume, and 2) obtaining specific design parameters for optimization. Based on the successful results of the EAB pilot study, optimization and full scale implementation was not required, as the pilot study itself met the objectives with the degradation of TCE contamination. DOE and Ohio EPA therefore agreed that this remedy should be presented as the preferred alternative corrective measure for this unit, and that groundwater monitoring should continue in accordance with the IGWMP. TCE concentrations in groundwater in the area have continued to decrease as a result of the EAB pilot study.

DOE plans to memorialize the EAB pilot study as the final remedy for the X-740 groundwater plume, thereby replacing the failed phytoremediation remedy. The summary of the results of the pilot study will be included in the Deferred Unit Resource Conservation and Recovery Act Facility Investigation/ Corrective Measures Study Report, and DOE proposes to include this remedy in the Deferred Units Preferred Plan and Decision Documents.

6.2.2 Regulatory Considerations for Optimizing Groundwater Monitoring

The original closure plans written for the X-740 Former Waste Oil Handling Facility Area (X-740 Waste Storage Facility and the X-740 Hazardous Waste Storage Tank) both stated there was no evidence of groundwater contamination, and neither closure plan addressed the installation of additional monitoring wells, or the completion of additional groundwater sampling. However, the amended closure plan, which combined the closure of the two separate units, included measures to address the unexpected contamination discovered at the facility during initial closure operations. The amended plan also described the installation of groundwater monitoring wells and the collection of groundwater samples. These efforts were to be coordinated with the RFI efforts in order to define the extent of the identified contamination.

The results of the closure/RFI sampling indicated that closure activities, or risk-based closure activities, of the X-740 unit were complete. Furthermore, contamination in the soil did not indicate a definitive source for the groundwater contamination identified in the vicinity of the former X-740 facility. The RFI recommended that the western edge of the plume be further defined by conducting additional groundwater sampling, but stated that a final evaluation of whether or not additional delineation of the plume was necessary would be addressed in the Quadrant III CAS/CMS. It was anticipated that data resulting from implementation of the integrated monitoring plan for the X-740 Former Waste Oil Handling Facility Area described herein would be adequate to evaluate the effectiveness of the CMI in remediating the groundwater contamination.

6.2.3 Technical Considerations for Optimizing Groundwater Monitoring

A known VOC plume exists near the X-740 Former Waste Oil Handling Facility. Results from previous sampling events have shown that the X-740 Former Waste Oil Handling Facility is not likely the source for this contamination. The objective for monitoring this unit will be to determine the effectiveness of the CMI on the extent and concentration of the X-740 plume contamination.

The Sunbury Shale is absent at the X-740 Former Waste Oil Handling Facility Area; therefore, the Gallia Sand is in contact with the Berea Sandstone. As a result, the VOC contaminant plume is detectable in both Gallia and Berea wells. The plume will migrate more quickly in the Gallia because the hydraulic conductivity is higher in the Gallia than in the Berea.

6.2.4 Evaluations and Reporting

Data from the X-740 Former Waste Oil Handling Facility were not routinely evaluated prior to implementation of the IGWMP.

Groundwater monitoring data collected for the X-740 Former Waste Oil Handling Facility will be summarized in the annual Groundwater Monitoring Report for PORTS, which is submitted to the regulators by April 1 of each year.

7. QUADRANT IV

Three groundwater AOCs are located in Quadrant IV, which is in the northern portion of the site: the X-611A Former Lime Sludge Lagoons, the X-735 Landfills, and the X-734 Landfills. These areas are discussed in Sections 7.1, 7.2, and 7.3, respectively. Two additional areas in Quadrant IV, the X-533 Former Switchyard Complex and the X-344C Former Hydrogen Fluoride Storage Building, are also monitored as a result of completed special studies or characterizations (see Section 9.1).

7.1 X-611A FORMER LIME SLUDGE LAGOONS

The following sections contain an introduction and facility history of the X-611A Former Lime Sludge Lagoons and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 7.1 concludes with discussions regarding regulatory evaluations and reporting for the X-611A Area. The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the X-611A Former Lime Sludge Lagoons Area is presented in Appendix D, Table D-1. Well locations are shown in Figure D-1.

7.1.1 Background and History

The X-611A Area consists of three unlined sludge retention lagoons constructed in 1954. The lagoons were constructed in a low-lying area that included Little Beaver Creek. To accommodate construction of the X-611A Lime Sludge Lagoons, approximately 1500 ft of Little Beaver Creek was relocated to a new channel just east of the lagoons. The lagoons were referred to as the north, middle, and south lagoons. Together they covered a surface area of approximately 18 acres, and had a maximum combined volume of approximately 295,000 cubic yards.

Unconsolidated material cut from the construction area was used to form the elevated earthen dikes that make up the sides of the lagoons. Construction documents suggest that the majority of the unconsolidated material that was overlying the Sunbury in this area was used to construct the earthen dikes; therefore, it is believed that the Sunbury forms much of the bottom surface of the X-611A Lime Sludge Lagoons. In general, lagoon depths ranged between 12 and 14 ft, and depths generally increased from west to east.

Between 1954 and 1960, the X-611A Lime Sludge Lagoons received waste lime sludge from the X-611 Water Treatment Plant. Between 1956 and 1957, the X-611A lagoons also received recirculating cooling water and chromium contaminated lime sludge resulting from chromate reduction activities performed in a storm sewer system. Receipt of waste lime sludge from the X-611 Water Treatment Plant was discontinued in 1960; subsequently, the sludge process lines to the X-611A Lime Sludge Lagoons were disconnected.

Sludge in the X-611A Lime Sludge Lagoons consisted primarily of white, saturated lime. Sparse, grassy vegetation became established in the western portions of all three lagoons, and the eastern portions of the lagoons contained shallow surface water. In October 1995, approximately 10 acres of land south of the X-611A lagoons were delineated as a jurisdictional wetland by the U.S. Army Corps of Engineers. Approximately 0.4 acres of this wetland is between the south boundary of the X-611A lagoons and Little Beaver Creek. The remaining 9.6 acres of wetland habitat are south of Little Beaver Creek.

Phase I of the Quadrant IV RFI (which included the X-611A SWMU) was conducted between December 1992 and April 1993. Phase II of the investigation was conducted between February 1994 and July 1994. Additional sampling of the sediments to determine the extent of PCB contamination in the middle lagoon and chromium contamination in the north lagoon was conducted in July 1994.

In June 1996, the Ohio EPA and U.S. EPA issued a Decision Document for the X-611A Former Lime Sludge Lagoons that specified the selected remedy to be used to achieve the remedial goals. This selected remedy required the following actions: 1) placement of a minimum 2 ft-thick soil cover over the lagoons, 2) development of a prairie habitat on the soil cover placed over the north, middle, and south lagoons, 3) construction of a soil berm outside the northern boundary of the north lagoon to facilitate shallow accumulation of water in this low-lying area, and 4) groundwater monitoring to ensure that no contaminants of concern are migrating to the groundwater. Construction of the selected remedy was completed in 1996. Ohio EPA approved the CMI in September 1997.

In 2002, a five-year review was completed for the X-611A Former Lime Sludge Lagoons to evaluate the effectiveness of the corrective measures implemented at this area. The report, *X-611A Prairie and the X-749B Peter Kiewit Landfill Five-Year Evaluation Report* (DOE 2002b), found that the soil cover and prairie habitat constructed at the X-611A Former Lime Sludge Lagoons was meeting the remedial action objectives for this unit by eliminating exposure pathways to the contaminants of concern in the sludge at this area.

The *Second Five-Year Review for the X-611A Prairie* (DOE 2008) was submitted to Ohio EPA in 2008. The report found that the soil cover and prairie habitat continued to meet the remedial action objectives for this unit by eliminating exposure pathways to the contaminants in the sludge at this area.

The *Third Five-Year Review for the X-611A Prairie* (DOE 2013c) was submitted to Ohio EPA in June 2013. The report found that the soil cover and prairie habitat continued to meet the corrective action objectives for this unit by eliminating exposure pathways to the contaminants in the sludge at this area.

7.1.2 Regulatory Considerations for Optimizing Groundwater Monitoring

Prior to implementation of the IGWMP, regulatory requirements for groundwater monitoring were included in the O&M Plan developed as part of the corrective action for the X-611A Former Lime Sludge Lagoons. Under the requirements of the O&M Plan, there were no instances where contradictory requirements, or instances of confusing direction, were encountered. Therefore, based on the regulatory history of the groundwater monitoring conducted at this facility, no changes to the monitoring program other than those indicated by technical considerations, are included.

7.1.3 Technical Considerations for Optimizing Groundwater Monitoring

The integrated monitoring program, including all well numbers, monitoring frequencies, and parameters for the X-611A Former Lime Sludge Lagoons, is presented in Appendix D, Table D-1. As part of the pre-integrated monitoring program, this unit was monitored semiannually at six wells for the metals beryllium and chromium as well as PCBs, specifically Aroclor-1242 and Aroclor-1248.

Historically, PCBs have not been detected in PORTS groundwater, except when dissolved in DNAPL such as at X-701B. PCBs have been detected in the DNAPL at X-701B at concentrations greater than 500 parts per million (ppm), yet PCBs are not detected in the surrounding groundwater. For example, the DNAPL removed from an extraction well at X-701B (X236-1) contained primarily TCE, but also had PCB concentrations in excess of 500 ppm. However, PCBs were not detected in nearby monitoring well X701-14G, even though TCE concentrations in this well exceeded 200,000 ppb which indicates that the PCBs are relatively insoluble and do not readily migrate through the Gallia unless dissolved in DNAPL.

Previously, PCBs were detected in some of the soil samples from the middle lagoon at X-611A. However, PCBs have not been detected in any of the groundwater samples collected at this unit. Because of their relative insolubility, the PCBs would not be expected to migrate from the soil into the groundwater. There is no evidence of DNAPL, or any VOCs, at this unit which might otherwise allow the PCBs to migrate. Therefore, the integrated monitoring program includes total PCBs for this unit only once every five years for use in the five-year evaluation of the remedial action.

Only source monitoring is performed for the X-611A Former Lime Sludge Lagoons. The locations of integrated wells are shown in Appendix D, Figure D-1. Table D-1 in Appendix D lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-611A Former Lime Sludge Lagoons.

7.1.4 Evaluations and Reporting

Pre-integrated regulatory requirements directed by the O&M Plan concerning data evaluations and data reporting included annual evaluations completed to determine if the contaminants of concern were impacting the surrounding groundwater. Verification and validation of the laboratory analytical data were also completed.

Because an integrated approach to groundwater monitoring has been developed in this document, data for the X-611A Former Lime Sludge Lagoons will be reported in the annual Groundwater Monitoring Report submitted to the Ohio EPA by April 1 of each year.

7.2 X-735 LANDFILLS

The following sections contain an introduction and facility history of the X-735 Landfills and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 7.2 also includes discussions regarding regulatory evaluations and reporting for the X-735 Area. The integrated monitoring program, including all well names, monitoring frequencies, and parameters for the X-735 Landfills is presented in Appendix D, Table D-2. Figure D-2 in Appendix D shows the integrated monitoring network for the X-735 Landfills.

7.2.1 Background and History

Several distinct waste management units are contained within the X-735 Landfills. The main units consist of the hazardous waste landfill, referred to as the X-735 Landfill (Northern Portion), and the X-735 Industrial Solid Waste Landfill (ISWL). The X-735 ISWL includes the industrial solid waste cells, asbestos disposal cells, and the closed chromium sludge monocells A and B. The chromium sludge monocells contain a portion of the chromium sludge generated during the closure of the X-616 Chromium Sludge Surface Impoundments (see Section 6.1).

Initially, a total of 17.9 acres was approved by the Ohio EPA and Pike County Department of Health for landfill disposal of conventional solid wastes. The landfill began operation in 1981, and the original design of the facility included 15 cells for solid waste disposal. The term "cells" refers to sections of the landfill that outline the locations where trenches were constructed for material disposal. Waste disposal was accomplished by shallow land burial using the trench and fill method. Wastes were delivered to the landfill by compactor trucks, pickup trucks and dump trucks, and unloaded near the active trench. The waste was then spread and compacted by a bulldozer and/or landfill compactor. Daily cover material (soil) was applied to the compacted solid waste at the end of each work day.

Previous PORTS investigations indicated that approximately 12,000 pounds of wipe rags contaminated with solvents had inadvertently been disposed in Cells 1 through 6 of the landfill. Historical data indicated that the wipe rags contaminated with solvents most likely contained methyl ethyl ketone, which has a hazardous waste code of F005. The contaminated rags were immediately removed from the solid waste stream by instituting new management controls to isolate contaminated rags as hazardous waste.

Waste disposal in Cells 1 through 6 ceased at the end of December 1991. Ohio EPA subsequently determined that Cells 1 through 6 were to be closed as a RCRA hazardous waste landfill. Consequently, this unit of the sanitary landfill was identified as the X-735 Landfill (Northern Portion). A buffer zone was left unexcavated to provide space for groundwater monitoring wells and a space between the RCRA landfill unit and the remaining southern portion, the X-735 ISWL. A Closure/Post Closure Plan for the hazardous X-735 Landfill (Northern Portion) was submitted to the Ohio EPA in June 1991, and resubmitted with revisions in December 1992. The submittal and subsequent revisions were approved in September 1993. Additional groundwater monitoring wells were installed in the buffer area as part of the closure. Routine groundwater monitoring has been conducted at the X-735 Landfills since 1991.

In October 1991, DOE submitted a plan to Ohio EPA Southeast District Office for utilization of the remainder of the X-735 Landfill. The remaining portion of the landfill is referred to as the X-735 ISWL and includes a solid waste section and an asbestos waste section. The X-735 ISWL, not including the chromium sludge monocells, encompasses a total area of approximately 4.1 acres. The proposed utilization plan for the X-735 ISWL was approved by the Ohio EPA in November 1991.

In 1997, the Ohio EPA denied the approval of a Permit to Install for modifications to the X-735 ISWL, and issued the DFF&O requiring DOE to cease accepting waste, prepare a revision to the Closure/Post Closure Plan submitted in June 1993, and to initiate closure of the X-735 ISWL by January 31, 1998.

A revised Closure/Post Closure Plan for the X-735 ISWL had previously been submitted in April 1995. The plan was revised and resubmitted in April 1997 following incorporation of Ohio EPA comments dated September 1995 and November 1996. The plan was again revised to incorporate Ohio EPA comments, and resubmitted in October 1997. The X-735 ISWL ceased accepting waste on December 31, 1997, and the closure plan was approved by the Ohio EPA on January 23, 1998. Closure of the unit was completed in 1998.

Assessment monitoring was conducted at the X-735 Landfills in 1997-1998 and 2000-2002 and was initiated again in 2005. The program at the southern portion changed to an assessment monitoring program in August 1997 while the program at the northern portion continued to be a detection monitoring program. This change was due to the statistically significant increase in the sulfate concentration in well X735-05GA. Subsequent sampling under the assessment program indicated that the sulfate concentration in well X735-05GA was not due to a release of leachate or leachate-derived constituents but was most likely the result of natural variation in the groundwater quality. The Ohio EPA therefore granted DOE’s April 1998 request to reinstate the detection monitoring program for the X-735 ISWL in a letter dated June 29, 1998.

An assessment monitoring program was initiated at the X-735 Landfills in 2000 because of a statistically significant increase in the concentrations of alkalinity, sodium, sulfate, and/or total dissolved solids at wells X735-17B, X735-18B, X735-19G, and X735-20B. Statistical evaluation of these monitoring parameters was not required at these wells, which were part of the monitoring program for the X-735 Landfill (Northern Portion), until implementation of the IGWMP in 1999. Historical data from these wells indicated that the concentrations of these parameters usually exceeded the upper tolerance limit calculated based on data from three upgradient wells. The assessment monitoring program, completed in 2002, determined that a release had not occurred from the landfill and recommended additional upgradient (background) wells and a new statistical procedure for data evaluation as part of resuming the detection monitoring program for this unit (see Sections 7.2.3 and 7.2.4).

Assessment monitoring was initiated at the X-735 Landfills in 2005 following the second consecutive exceedence of a control limit for total dissolved solids in well X735-21G. Based on the results of the assessment monitoring program, Ohio EPA concluded that a small release of leachate is occurring, or has occurred, from the X-735 Landfills and that the release consists of alkalinity, cobalt, mercury, nickel, sodium, and total dissolved solids. Although DOE was not able to conclusively determine if a release was occurring or had occurred, DOE moved forward and submitted the *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a) pursuant to OAC Rule 3745-29-10(F) (as effective June 1, 1994). The Corrective Measures Plan was approved by Ohio EPA in March 2008.

Gallia wells at the X-735 Landfills are monitored in accordance with the *Corrective Measures Plan for the X-735 Landfill* (DOE 2007a) pursuant to OAC Rule 3745-29-10(F) (as effective June 1, 1994). Berea wells at the X-735 Landfills are monitored under OAC 3745-29-10, which references OAC 3745-30-08 (effective February 1, 2008, see Appendix G). Appendix F provides the evaluation methodologies for monitoring at the X-735 Landfills. Appendix D, Table D-2 provides the analytical parameters and sampling frequencies for the X-735 wells.

7.2.2 Regulatory Considerations for Optimizing Groundwater Monitoring

As noted previously, the X-735 Landfills comprise two units: a northern hazardous waste disposal unit and a southern non-hazardous waste disposal unit. Prior to implementation of the IGWMP, groundwater monitoring at the northern portion was governed by the hazardous waste regulations and an approved closure plan written in accordance with those regulations. Groundwater monitoring at the southern portion of the X-735 was governed by the solid waste regulations and a Groundwater Quality Assessment Plan.

In accordance with the December 2011 DFF&O (which replaced the March 1999 DFF&O), this document provides a consolidated, integrated monitoring program for the X-735 Landfills to eliminate potential confusion and overlaps between the hazardous waste requirements and the solid waste requirements, while efficiently providing information necessary to determine if a release of leachate or leachate-derived constituents has adversely impacted the groundwater beneath the X-735 Landfills.

7.2.3 Technical Considerations for Optimizing Groundwater Monitoring

Prior to implementation of the IGWMP, analytical parameters for X-735 Landfills historically included VOCs, physical parameters, radiological parameters, and inorganics including metals. The specific list of parameters varied from year to year; depending on the regulatory status of this area (see Section 7.2.1). Physical parameters included temperature, pH, and specific conductance. Some sampling events also included measurements of additional physical parameters (turbidity and dissolved oxygen). Other parameters measured at this unit included metals and other inorganics used for mass balance and water quality analysis. These parameters include calcium, iron, magnesium, potassium, sodium, chloride, sulfate, and alkalinity.

Figure D-2 in Appendix D shows the integrated monitoring network for the X-735 Landfills. Table D-2 in Appendix D lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-735 Landfills. Appendix F provides the evaluation methodologies for monitoring at the X-735 Landfills.

7.2.4 Evaluations and Reporting

Pre-integrated regulatory requirements concerning data evaluations and data reporting included verification and validation of the laboratory analytical data and the quarterly (for the northern portion) or semi-annual (for the southern portion) statistical evaluations completed to determine if leachate or leachate-derived constituents are impacting the surrounding groundwater. Pre-integrated statistical evaluations for the northern, hazardous landfill included a comparison of analytical data to background upper tolerance limits specified in the closure plan. Tolerance limits were established for the following parameters: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and turbidity. Pre-integrated statistical evaluations conducted for the southern, industrial landfill included a tolerance interval procedure used for the following parameters: total dissolved solids, sodium, chloride, sulfate, and alkalinity. An intra-well comparison was conducted for sulfate (only) in well X735-05GA. As part of the pre-integrated monitoring program, a summary report for the northern portion of the facility was presented in the annual RCRA report for PORTS, which was submitted to the regulators by March 1 of each year. The pre-integrated monitoring program also included the submittal of results of the evaluations for the southern portion of the landfill on a semi-annual basis, within 75 days of sampling the wells.

In accordance with the December 2011 DFF&O (which replaced the March 1999 DFF&O, comprehensive groundwater data for the X-735 Landfills is evaluated annually and included in the annual Groundwater Monitoring Report submitted to the regulators by April 1 of each year. A statistical analysis is conducted for the X-735 wells as described in Appendix F.

7.3 X-734 LANDFILLS

The following sections contain an introduction and facility history of the X-734 Landfills and the regulatory and technical considerations for optimizing groundwater monitoring in this AOC. Section 7.3 concludes with discussions regarding regulatory evaluations and reporting. The integrated monitoring program, including all wells, monitoring frequencies, and parameters is presented in Appendix D, Table D-3. Figure D-3 in Appendix D shows the monitoring wells that are part of the integrated monitoring network for the X-734 Landfills.

7.3.1 Background and History

The X-734 Landfills AOC consists of three landfill units; the X-734 Old Sanitary Landfill, the X-734A Construction Spoils Landfill, and the X-734B Construction Spoils Landfill. The X-734 Old Sanitary Landfill has a total area of approximately 3.8 acres, the X-734A Construction Spoils Landfill has a total area of approximately 3.5 acres, and the X-734B Construction Spoils Landfill has a total area of approximately 4.6 acres. Waste disposal activities at the X-734 Old Sanitary Landfill was discontinued in 1981 when the X-735 Landfill began operations. Waste disposal operations at the X-734A and X-734B Construction Spoils Landfills were discontinued in 1985.

Dumping and filling techniques used at X-734 consisted of solid wastes being delivered to the landfill by a compactor truck that deposited the refuse over the face of the fill. After being crushed under a bulldozer, the fill was covered with several inches of coal ash from the X-600 Steam Plant. The ash was packed to form a hard layer and to provide a base for the next layer of trash.

Detailed records of materials disposed in the landfill were not kept. However, waste known to be disposed of at X-734 include: trash and garbage, construction spoils, and waste containing unspecified levels of heavy metals. While not substantiated, plant personnel have indicated that organic solvents may have been disposed of in the unit. The X-734A Construction Spoils Landfill has a total area of approximately 3.5 acres. In March 1985 empty drums were being disposed in the spoil area; the practice was subsequently discontinued.

Disposal of radioactive materials was not permitted in X-734, X-734A, or X-734B. The approved waste stream included the following: construction spoils, trees, railroad ties, broken concrete, stumps, roots, brush, rotten wood, and other wastes from clearing and grubbing operations. While not substantiated, other materials reportedly disposed of at X-734B may have included sanitary waste from contractors for the gaseous centrifuge enrichment plant, empty paint cans, empty 55-gal drums, and uranium-contaminated soil from the X-342 Area. The results from composite soil samples taken from the X-342 Area before burial indicated that the uranium content varied from 14 to 240 milligrams per kilogram (mg/kg).

Monitoring well sampling data collected before the RFI indicated the possibility of elevated levels of TCE, total organic halogens, and Freon-113 in one of three wells near the unit; however, available data were insufficient for statistical confirmation.

Ohio EPA issued a Decision Document for the X-734 Landfills in 1999. Remedial actions required by the Decision Document included construction of a multimedia cap over the northern portion of the landfills and a soil cap over the southern portion of the area. These caps were installed in 1999 and 2000.

The *First Five-Year Review for the X-734 Landfill Area* (DOE 2008b) found that construction of the caps on the landfills was achieving remedial action objectives by 1) isolating contaminants in soil and sediment from potential receptors, and 2) preventing contaminants in soil and sediment from migrating to groundwater and surface water.

The *Second Five-Year Review for the X-734 Landfill Area* (DOE 2013b) was submitted to Ohio EPA in December 2013. The report found that the landfill caps have continued to achieve corrective action objectives by isolating contaminants in soil and sediment from potential receptors. The caps were also preventing contaminants from migrating from soil to groundwater and from groundwater to surface water.

7.3.2 Regulatory Considerations for Optimizing Groundwater Monitoring

The X-734, X-734A, and X-734B Landfills were closed in accordance with the solid waste regulations in effect at that time, and no groundwater monitoring of the units was required. However, the X-734 Landfills Area has been capped as part of the remedial actions required for Quadrant IV. Therefore, remedial action effectiveness monitoring is included in the IGWMP for the X-734 Landfills Area.

7.3.3 Technical Considerations for Optimizing Groundwater Monitoring

In the X-734 Landfills Area, the geologic formations (and hydrogeologic properties) beneath the landfills are influenced by the pre-construction surface topography. The Gallia and Berea become absent in the northern and eastern portions of the area due to erosion by the North Drainage Ditch and Little Beaver Creek, respectively. Prior to construction of PORTS, Little Beaver Creek and the North Drainage Ditch incised deep valleys in the X-734 Landfills Area through the Berea Sandstone and upper portion of the Bedford Shale. In the early 1950s, a large amount of compacted fill was placed across the Little Beaver Creek valley to construct the railroad bridge and spur to PORTS, which is on the west side of the X-734 Landfills Area. The X-734 Old Sanitary Landfill construction debris, sanitary waste, and fly ash were subsequently placed in the valley between the railroad embankment on the west and the North Drainage Ditch and Little Beaver Creek on the east and north, respectively. The thickest area of waste occurs at the northeastern point of the X-734 Landfill and is underlain by the Bedford Shale.

In the northern portion of the area, the Gallia and Berea units are absent. Bedrock wells, designated with a "B" at the end of the well name, are screened in the Bedford Shale. Wells screened in the unconsolidated material above the bedrock are designated with a "G" at the end of the well name. High downward gradients are observed between the wells screened in the unconsolidated materials (or fill) and the Bedford wells, e.g., X734-18G and X734-17B. The Bedford is an effective aquitard and the rate of vertical flow from the unconsolidated materials into the Bedford is very slow.

In general, the water levels measured in the base of the unconsolidated materials in the area of the landfills are at or below the pre-PORTS construction topography, which indicates a low potential for lateral groundwater flow through the waste. The limited amount of groundwater that intersects the erosional surface flows along the eroded bedrock surface below any fill or disposal waste that is present.

Groundwater monitoring was not routinely performed at this unit prior to inclusion of the unit in the IGWMP. The groundwater monitoring data for X-734 is limited primarily to that collected during Phase I of the RFI and one round of special sampling in January 1998. Additionally, detailed data concerning the amounts and types of waste disposed in the landfills are also unavailable.

Pre-IGWMP analytical data for the X-734 groundwater monitoring wells have shown detectable levels of VOCs at several wells. The highest levels of VOCs were found in well X734-09G, which had TCE concentrations of less than 100 ppb in both of the two sampling events. Several of the deeper wells in the Bedford shale have shown various hydrocarbon constituents; however, these constituents are believed to be naturally occurring. The Bedford shale is known to produce hydrocarbons in certain areas. Neither technetium-99 nor uranium were detected in the groundwater at this unit during the RFI.

Figure D-3 in Appendix D presents the integrated monitoring network for the X-734 Landfills. Table D-3 in Appendix D lists the location/purpose, analytical parameters, and sampling frequency for each well that is part of the monitoring program for the X-734 Landfills.

7.3.4 Evaluations and Reporting

Because an integrated approach to groundwater monitoring has been developed in this document, a Groundwater Monitoring Report will be completed for the entire PORTS site, including the X-734 Landfills AOC, and will be submitted to the Ohio EPA by April 1 of each year.

8. SURFACE WATER AND WATER SUPPLY MONITORING

Additional monitoring at PORTS that supports an integrated approach to groundwater monitoring includes sampling selected surface water locations and surrounding residents' water supplies (drinking water wells). These programs are discussed in the following sections.

8.1 SURFACE WATER MONITORING

Surface water monitoring is conducted at PORTS for both the groundwater monitoring program and NPDES Permits. Because the NPDES Program is not considered a groundwater-related program, it is not discussed in this document.

Surface water sampling from Little Beaver Creek (LBC), Big Run Creek (BRC), the Unnamed Southwest Drainage Ditch (UND), West Drainage Ditch (WDD), North Holding Pond (NHP), and the East Drainage Ditch (EDD) is conducted quarterly as part of the integrated monitoring program. This sampling is conducted because the streams and drainage channels have been determined to be groundwater discharge areas and may indicate the discharge of contamination. A summary of the surface water monitoring sites and a sampling location map are included in Appendix E.

8.2 WATER SUPPLY MONITORING

Routine monitoring of residential drinking water sources is completed at PORTS in accordance with the requirements of Section VIII of the September 1989 Consent Decree between the State of Ohio and DOE. Prior to implementation of the IGWMP, residential water supply monitoring was conducted in accordance with the *Offsite Residential Drinking Water Quality Monitoring Plan* (MMES 1989b) approved by the Ohio EPA on May 10, 1989. The monitoring program described in this section is a revision to the monitoring plan developed in 1989. Chapter 10, Section 10.1.5, discusses collection of water supply samples.

The purpose of the program is to determine whether residential drinking water sources have been adversely affected by plant operations. While this program may provide an indication of contaminant transport off-site, it should not be interpreted as an extension of the on-site groundwater monitoring program, which bears the responsibility for detection of contaminants and determining the rate and extent of contaminant movement. Due to the lack of knowledge of how residential wells were constructed and to the presence of various types of pumps, which may not be ideal equipment for sampling, in residential wells, data from this program will not be used in hydrogeologic or geochemical investigations. The PORTS water supply is also sampled as a part of this program.

Appendix E, Table E-2, identifies the drinking water sources participating in the program, analytical parameters, and sampling frequencies. Sampling locations may be added or deleted as resident requests and program requirements dictate. Typically, sampling locations are deleted when a resident obtains a public water supply. Sampling locations are added upon request if there is a probable hydrogeologic connection between PORTS and the resident's water supply.

9. SPECIAL SHORT-TERM STUDIES

As discussed in Section 3.2, special short-term evaluations can be triggered by additional data needs, physical changes at an AOC (for example, new site conditions or new data), changes in monitoring policy, or the need to evaluate technical demonstrations or innovative remediation technologies. Future special studies may be proposed by the Ohio EPA or by DOE and implemented through an approved work plan.

The following sections describe those special studies that have been conducted or are planned at PORTS that have had or may have long-term impact on IGWMP monitoring. Completed special studies that did not affect the IGWMP are not necessarily included in this chapter.

9.1 COMPLETED SPECIAL STUDIES

Numerous special studies have been conducted since implementation of the IGWMP on April 1, 1999. A special study for metals and radiological parameters, *Special Study for Metals and Radiological Parameters in Groundwater*, (DOE 2000), investigated ten AOCs as identified by DOE and Ohio EPA to evaluate potential metals and radiological groundwater contamination and was completed in 2000. The report includes an evaluation of the data as well as conclusions regarding the potential for metals or radiological contamination in the areas investigated. Based on the report findings, monitoring for selected metals has been conducted in specific IGWMP wells that monitor the PK Landfill, X-701B Former Holding Pond, and X-734 Landfills. The X-633 Former Recirculating Cooling Water Complex (Quadrant II) and the X-533 Former Switchyard Complex (Quadrant IV) have also been added to the IGWMP.

In addition, investigations have been conducted to corroborate previous studies regarding residual manganese and radionuclides in groundwater. DOE conducted a study in 2000 to determine the potential effects of permanganate injection (from pilot projects to remediate VOC contamination in Quadrants I and II) on residual manganese concentrations in groundwater. Monitoring for manganese has been conducted for selected IGWMP wells in Quadrants I and II. The *Radionuclide Verification Investigation Risk Estimate for the Portsmouth Gaseous Diffusion Plant* (DOE 2002a) indicated that the rate and extent of radiological contaminants at PORTS had been adequately defined by previous studies.

Characterization to determine the extent of soil and groundwater contamination in the vicinity of the X-344C Former Hydrogen Fluoride Storage Building was conducted in 2009. Two VOCs, *cis*-1,2-dichloroethene and *trans*-1,2-dichloroethene, were detected at concentrations below 2 micrograms per liter (µg/L) in well X344C-01G, which is south of the former facility. Based on these detections, the X-344C Area and well X344C-01G have been added to the IGWMP and are sampled annually for VOCs as described in Appendix D, Table D-5.

Additional special studies or investigations have taken place within the IGWMP monitoring areas. The Background and History section for the monitoring area provides additional information about completed special studies or investigations.

9.2 CURRENT SPECIAL STUDIES

IGWMP data are evaluated annually to determine whether changes to monitoring requirements in some wells or areas are necessary and/or feasible. Based on this evaluation, changes in monitoring may be proposed in future IGWMP revisions.

The following special studies were being conducted during 2017. Based on the results of these studies, changes may be made to the IGWMP in the future, as warranted.

9.2.1 Quadrant I

No special studies are in progress in Quadrant I.

9.2.2 Quadrant II

The following special studies are in progress in Quadrant II.

9.2.2.1 X-701B Former Holding Pond Area

The X-237 Groundwater Collection System collects groundwater contaminated with TCE from the X-701B groundwater plume. A special study was begun in 2012 near the X-237 Groundwater Collection System and Little Beaver Creek based on elevated concentrations of TCE detected in Little Beaver Creek. The special study monitored selected groundwater monitoring wells near the X-237 Groundwater Collection System and surface water in the East Drainage Ditch, Little Beaver Creek, and swales near the X-237 Groundwater Collection System.

In the first quarter of 2014, elevated concentrations of TCE were detected again in Little Beaver Creek and one of the monitoring wells near the X-237 Groundwater Collection System. Evaluation and monitoring of this area are ongoing. To monitor the performance of the X-237 Groundwater Collection System, groundwater elevations are measured at 15-minute intervals at four wells in the X-701B area near the X-237 Groundwater Collection System (X701-142G, X701-143G, X701-IRMPZ05G, and X701-IRMPZ08G). Sustained groundwater elevations above 638 feet above mean sea level may indicate the need for corrective maintenance or other actions at the X-237 Groundwater Collection System. If necessary, changes to the groundwater elevation monitoring or additional sample locations, monitoring parameters, and monitoring frequencies will be agreed upon by Ohio EPA and DOE. Results of this monitoring will be discussed with Ohio EPA and summarized in the annual Groundwater Monitoring Report.

9.2.2.2 X-633 Former Recirculating Cooling Water Complex

As a result of the RCRA investigation of soils and groundwater conducted at the X-633 Former Recirculating Cooling Water Complex during 2010-2011 (DOE 2010b), DOE agreed to complete a special study to continue evaluation of chromium and TCE in groundwater at this area. The wells and analytical parameters included in the special study are listed in the following table.

Well	Parameter[a]
F-05G	V1, Cr
X633-01G	V1
X633-02G	V1
X633-03G	V1
X633-04G	V1
X633-08G	V1
X633-10G	V1, Cr
X701-44G	Cr

[a]V1 (VOCs as defined in Table 1) Cr – chromium

Samples will be collected annually beginning in 2013.

9.2.3 Quadrant III

No special studies are in progress in Quadrant III.

9.2.4 Quadrant IV

The following special study is in progress in Quadrant IV.

9.2.4.1 X-630 Former Recirculating Cooling Water Complex

As a result of the RCRA investigation of soils and groundwater conducted at the X-630 Former Recirculating Cooling Water Complex during 2010-2011 (DOE 2010c), DOE agreed to complete a special study to continue evaluation of chromium and TCE in groundwater at this area. The wells and analytical parameters included in the special study are listed in the following table.

Well	Parameter[a]
X630-01G	V1
X630-02G	Cr
X630-03G	V1
X330-PZ05G	V1

[a]V1 (VOCs as defined in Table 1) Cr – chromium

Samples will be collected annually beginning in 2013.

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10. SAMPLING AND ANALYSIS

The following sections describe the procedures and techniques for obtaining information associated with groundwater samples collected at PORTS. Sections 10.1 through 10.4 describe sample collection activities, Section 10.5 discusses analytical procedures, and Section 10.6 contains information on sample quality assurance and quality control (QA/QC). Section 10 concludes with a description of the data management plan.

The Project Environmental Measurements System (PEMS) is an electronic data management system that is used to support environmental data collection at PORTS. PEMS is used in all phases of sampling from creating sample labels and chain-of-custody (COC) forms to sample tracking and analyses reporting. All samples and QA/QC samples collected under the IGWMP are assigned unique sequential identification numbers in PEMS. Each sample can be traced to its point of origin through PEMS.

10.1 SAMPLE COLLECTION

Several procedures for sample collection have been developed for site-wide use in the groundwater monitoring program at PORTS. These procedures are maintained on site and are available for review by Ohio EPA. The following sections briefly describe the process for obtaining water level measurements, detecting immiscible layers, well purging techniques, obtaining field parameter measurements and sample withdrawal methods.

10.1.1 Water Level Measurements

The static water level (SWL) elevation of a well is measured and recorded prior to each well sampling event in accordance with applicable procedure(s). The total depth of the well is also measured and recorded if necessary. If a total depth measurement is not possible (for instance, if a dedicated bladder pump is installed in the well), then the historical total depth measurement may be used. The SWL and total depth are required to calculate the well bore volume and purge volume when conventional purging methods are used. The SWL and total depth are measured from a permanent reference point located at the top of the monitoring well casing (or from the north side of the casing if a permanent reference is not present). If the monitoring well has a bladder pump installed, then the measurement is taken from the bladder pump cap. The bladder pump cap is at the same level as the permanent reference point.

The SWLs are also collected semiannually from predetermined wells (groundwater wells and piezometers) to generate groundwater flow maps for the Gallia and the Berea formations. The SWLs are collected in the shortest reasonable time to obtain accurate data on groundwater flow. To the extent possible, water levels in a given area are collected in a single day. The water level snapshots are typically completed site-wide within three days.

10.1.2 Detection of Immiscible Layers

Before purging and sample collection, wells that have historically exhibited high concentrations (greater than 100 ppm) of an organic constituent are often inspected for the presence of light nonaqueous-phase liquid (LNAPL) and DNAPL. Sampling this groundwater may result in anomalously high concentrations of dissolved and emulsified contaminants in the well. DNAPL, specifically separate phase TCE, has been detected at PORTS. Wells with typical TCE concentrations greater than 100 ppm have historically been inspected for DNAPL, but, DNAPL was not detected in any of these routinely monitored wells. Most of these wells are now equipped with dedicated bladder pumps, which yield optimal samples if the pump remains stationary prior to sampling. The pumps in these wells would have to be removed prior to inspection for DNAPL. Therefore, because of the sampling history at these wells, and to allow the most representative groundwater samples, these wells will not be inspected for DNAPL during each sampling event. However, they may occasionally be inspected for DNAPL as conditions warrant.

An interface probe may be used to identify the presence, level, and thickness of non-aqueous phase liquids in the well. The interface probe is slowly lowered into the well, and the depth to organic liquid and the organic liquid/water interface(s) are carefully recorded to establish a measurement of the free product thickness. Free-floating product is measured at the potentiometric surface, and DNAPL immiscible layers are detected by lowering the probe to the bottom of the well. A transparent bailer may be used in place of an interface probe to check for the presence of LNAPL or DNAPL. The bailer can be lowered less than two ft into the water column to check for LNAPL or lowered to the bottom of the well to check for DNAPL. The liquid in the bailer can then be visually inspected for the presence of a separate phase. If free product is detected, field personnel will document the measured thickness of the layer on the well sampling log. If free product is detected, the well may, or may not, be sampled.

10.1.3 Well Purging

The water standing in a well before purging is not representative of formation groundwater. Therefore, monitoring wells are purged before sampling to remove any water that is not representative of the groundwater. If conventional purging is conducted, the standing water in the well and filter pack is purged. If micro-purging is conducted, water in the pump and discharge line is purged, and additional groundwater is purged until stabilization is achieved as verified through field measurements. Purging of the wells is typically accomplished using approved bladder pumps, impeller pumps (such as Redi-flow), or bailers. However, gas-lift pumps, peristaltic pumps, or other purging devices may be used in certain applications, though not typically for regulatory sampling. The purge water is containerized and treated on-site in one of the groundwater treatment facilities.

All wells are purged until stabilization has been achieved to ensure that fresh formation water rather than stagnant water is sampled. This is determined by stabilization of the indicator parameters (i.e., pH, specific conductance, and temperature). When conventional purging is conducted, in most instances, a volume equal to approximately three well volumes is removed before sampling. However, some wells are incapable of yielding this much groundwater. In these instances, the well is purged dry and allowed to recover until a sufficient volume of groundwater is present in the well to allow sampling. This usually occurs in 0.3 to 4 hours, but sometimes up to 24 hours is required before sampling can occur. If the well does not recharge sufficiently within 24 hours, it will be noted as a dry well on the well sampling log.

10.1.4 Field Parameters

Temperature, pH, and specific conductance are measured in the field with portable field instruments once purging has been initiated and at specific intervals during the purging process. This ensures that groundwater stabilization has occurred. Other field parameters such as turbidity, dissolved oxygen, or redox potential may also be collected, and these parameters may or may not be used as stabilization parameters. Many of the field parameters are typically measured in a parameter cup at specified purge intervals. However, the field measurements also may be continuously measured as the groundwater is pumped through a flow-through cell. If a flow-through cell is used, the field parameter measurements are recorded at specified time intervals, usually 10 minutes, but always a minimum of 5 minutes. If conventional purging methods are used, the field parameter measurements are recorded after the removal of each well volume. Typically three to five well volumes are removed to achieve stabilization during conventional well purging.

Field parameters are considered to be stabilized when, during two consecutive measurements, the temperature is within $1^{o}C$, pH is within 0.2 units, and specific conductance is within 10% for readings over 500 microsiemens per centimeter (µS/cm) or within 50 µS/cm for readings less than or equal to 500 µS/cm. If the field parameters still fail to stabilize, the field sampling team leader may make a field decision to proceed with sampling, provided he or she documents this decision on the sampling log. If the well is purged dry, these data are measured in the field after sample collection with any remaining well water that is available.

The temperature of a groundwater sample can be measured with a thermometer or other approved equipment such as a combination pH/temperature meter. Temperature measurements are required to calibrate most instruments such as pH meters or conductivity meters unless these instruments automatically compensate for temperature. Probes for temperature, conductivity, pH or other parameters are routinely cleaned; however, to avoid possible cross-contamination resulting from probes, samples that are collected for laboratory analyses do not come in contact with field instruments.

Other analyses performed in the field may include screening of the well site and well head for radiation and organic vapors. This information is also recorded on the sampling log.

10.1.5 Sample Withdrawal

After monitoring wells have been sufficiently purged, groundwater samples are collected using dedicated bladder pumps or dedicated/disposable Teflon and/or stainless steel bailers. Sampling techniques are utilized that minimize agitation and aeration of the samples.

Samples from residential wells should be collected from as close to the wellhead as possible. In addition, samples should not be collected from sources through which the water has been filtered, softened, or otherwise treated. If possible, pressure or holding tanks should be bypassed. Basement or outside faucets are more likely to meet these criteria and are preferred sampling points.

All private wells must be purged before sample collection. If the plumbing is not purged, samples taken from a tap or faucet will not be representative of the aquifer; therefore, evacuating the plumbing and/or water storage tank before obtaining any samples is essential. The resident shall be informed as to the volume of water to be purged and the reason. Many off-site locations are low recharge wells, thus the potential for temporarily dewatering the well is high. If possible, the samplers shall provide information to allow residents to make informed decisions as to whether the well purging is acceptable. If the volume of water to be purged is unacceptable to the resident, the sample will not be collected, and this information will be noted on the sampling log.

10.2 SAMPLE PRESERVATION AND HANDLING

The following sections describe the sample containers and routine sample preservation and handling techniques utilized during the collection of groundwater samples at PORTS.

10.2.1 Sample Containers

Various containers are used when collecting groundwater samples. Sample containers are typically specified by the analytical laboratory in accordance with the analytical method. Sample containers are purchased as "certified clean" from a laboratory supplier. Bottle lot numbers and certification records shall be maintained.

10.2.2 Sample Preservation

Because many chemical constituents and physicochemical parameters evaluated in the sampling and analysis program are not chemically stable, sample preservation is required. The most prevalent sample preservation methods used at PORTS are pH control and the maintenance of sample temperature at $4^{o}C$ plus or minus $2^{o}C$. The pH of samples may be reduced to less than 2 by the addition of acid to the sample containers or increased by adding a base to a pH greater than 12. Samples are preserved as required by the analytical laboratory and the analytical method.

10.2.3 Sample Handling

Samples for volatile organic analysis (VOA) are collected in such a way that no headspace exists in the sample containers; this process minimizes the possibility of loss of organic compounds through volatilization. Groundwater samples that are to be analyzed for dissolved metals or total mobile metals may be filtered through an appropriate media to remove any residual particulate material that could alter the preserved metals content in the sample. Samples are packed, screened, and transported to the laboratory.

10.3 CHAIN-OF-CUSTODY

To ensure the security of samples from collection to final disposition, a COC form is used. A COC form is completed before transfer of sample custody. The COC form provides an accurate written record that can be used to trace the possession and handling of samples from the time of collection through data analysis and reporting. The basic components of the COC program include sample labels, field records, and COC forms.

If samples are shipped off-site, a signed or initialed custody seal is affixed to the shipping container to ensure that the samples have not been disturbed during transportation.

10.4 FIELD DOCUMENTATION

Field activities are documented on sample log forms pertaining to the type of sampling performed. A separate log form is used to record field data at each sampling location. The forms are completed in the field before leaving the site. Sampling locations are identified on the applicable sampling log form.

10.5 ANALYTICAL PROCEDURES

Analytical parameters are based on contaminants detected during groundwater quality assessments performed at the facility and on potential contaminants associated with activities conducted at the facility. Table 1 and the tables contained in Appendices A through D identify the analytical suites utilized for the integrated groundwater monitoring program. The selected analytical methods (and their associated precision, accuracy, and detection limits) provide sufficient data for statistical analysis of the results and are determined and documented in the data review and evaluation process (Section 10.7.3).

10.6 QA/QC PROCEDURES

Data collection, analysis, and validation will be conducted in accordance with the *Sample Analysis Data Quality Assurance Project Plan (SADQ) at the Portsmouth Gaseous Diffusion Plant* (DOE 2014b, or latest revision) to analytical support level D. The following sections describe the site-specific QA/QC procedures to be used during groundwater monitoring activities at PORTS.

In defining the number of field blanks and field duplicates to be collected, a sampling event is the number of locations sampled per well field or sampling program (surface water and water supply monitoring) within a calendar quarter. Trip blanks, equipment rinsates, field blanks, and field duplicates are defined in the following sections.

10.6.1 Field QA/QC Samples

QA/QC samples collected during routine groundwater sampling activities are described in the following sections, including the collection of trip blanks, equipment rinsates, field blanks, and field duplicates.

10.6.1.1 Trip blanks

Trip blanks are used to detect contamination by VOCs during sample shipping and handling. Trip blanks are prepared using 40-milliliter VOA vials of deionized ultra-filtered (DIUF) water (or water that meets or exceeds the standards for DIUF water) that are filled in the sample preparation area, transported to the sampling site, and transported to the analytical laboratory with VOC samples. Trip blanks are not opened in the field. One trip blank accompanies each cooler containing VOC samples. Each trip blank is stored at the laboratory with associated samples and analyzed with those samples. Trip blanks are typically analyzed only for VOCs. The appropriate QA/QC data is recorded on the associated sampling log.

10.6.1.2 Equipment rinsates

Equipment rinsates are samples of DIUF water (or water that meets or exceeds the standards for DIUF water) that has been used to rinse decontaminated sampling equipment to assess the effectiveness of decontamination. An equipment rinsate sample is not required when dedicated or disposable sample equipment that has been certified pre-cleaned is used for sample collection. If an equipment rinsate sample is required, an equipment rinsate for each type of sampling equipment will be collected. For example, if groundwater samples are collected by both bailer and pump, an equipment rinsate for each type of equipment will be identified on the sampling log.

Equipment rinsates are collected at a frequency of one per twenty uses of each type of equipment in the same container types used for the analytical samples. Equipment rinsates for bailers will be collected at a frequency of one sample per quarter, if less than twenty bailers are used in a quarter. Equipment rinsates are preserved and handled in the same manner as analytical samples. Equipment rinsates are typically analyzed for nearly all routine groundwater parameters; however, certain parameters that typically are below detection may be eliminated to reduce the hazards and waste associated with their analyses (e.g. cyanide). QC sample information is recorded on the appropriate sampling log.

10.6.1.3 Field blanks

Field blanks are collected at one per twenty sampling locations per well field or sampling program (surface water and water supply monitoring). The field blank will be analyzed for all analytes of concern for the sampling location. The appropriate QC data is recorded on the appropriate sampling log.

10.6.1.4 Field duplicates

Field duplicates are QA/QC samples collected from the same location, at the same time, and from the same sampling device as the actual sample. For example, if a bailer is used to collect a VOC analysis, the same bailer-full of groundwater that is used for the VOC analysis is also used for the duplicate sample, if possible. Field duplicates are collected at one per twenty sampling locations per well field or sampling program (surface water and water supply monitoring). The sample and its field duplicate will have the same set of parameters. Sampling sites where duplicates are collected are selected so that all analytes of concern are included. Care is taken to routinely collect duplicates from wells where known contamination exists. The appropriate QA/QC data is recorded on the appropriate sampling log.

10.6.2 Laboratory QA/QC

The PORTS analytical laboratory, as well as all contract laboratories used by PORTS, follow an established QA/QC program for sampling, handling, and analysis. The analytical methods are based on *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods*, (U.S. EPA, most recent edition) and/or *Methods for Chemical Analysis of Water and Waste* (U.S. EPA, most recent edition). Methods and procedures are applied to radiological, organic, and inorganic constituents.

10.7 DATA MANAGEMENT

Data management procedure(s) have been developed to insure effective and consistent handling of data generated from groundwater sampling activities conducted at PORTS. Data related to groundwater investigations at PORTS are collected as part of effluent monitoring and environmental surveillance activities. Groundwater investigations at PORTS have resulted in the development of two discrete types of databases: a hydrogeological database and a spatial database. The hydrogeological database encompasses analytical data for samples collected from on-site monitoring wells and off-site monitoring wells, monitoring well water level data, and water quality data for groundwater treatment units. The spatial database includes a Geographic Information System reference map of PORTS and engineering drawings of plant facilities and waste disposal areas. PORTS maintains a repository for validated groundwater analytical data and much of the geologic, hydrogeologic, and geotechnical data.

10.7.1 Field Data

Data generated during the groundwater monitoring program is collected by field personnel and recorded on applicable sampling logs. Field data is reviewed by the sampling team supervisor or designee for completeness; the field data is maintained in a database file. At a minimum, field parameters include pH, temperature, specific conductance, groundwater elevations, and well depth (when appropriate). Data entered into the field database are the stabilized pH, temperature, and specific conductance. Data generated during the groundwater monitoring program are collected by field personnel and recorded on applicable sampling logs. In addition, the field database tracks QC samples (identified in Section 10.6.1) associated with each sample.

10.7.2 Analytical Data

Analytical data are obtained from the analytical laboratory in written as well as digital format.

10.7.3 Evaluation of Field and Analytical Data

The laboratory review of analytical results include laboratory QA/QC samples (i.e. calibrations, holding times, and spikes) required for analytical procedures. Analytical data not meeting the prescribed quality, as described in the analytical procedure, are qualified by the laboratory and reported. If an inquiry into a laboratory result is necessary, the laboratory is contacted and the quality assurance file is reviewed.

Subsequently, an evaluation of the QA/QC samples associated with each sample from the field is conducted. Field data are examined for acceptance and development of required field documentation, which includes QA/QC sampling requirements, such as duplicates, and trip, field and equipment rinsate blanks. Trip, field and equipment rinsate blanks are reviewed to determine if any cross contamination may have occurred during the collection, transport or storage of the samples. In the event that an organic or a metal constituent is detected in a QA/QC blank, the constituent may be qualified.

Analytical laboratory data is independently validated by the data validation group to provide a systematic process for reviewing data against established QA/QC criteria. The data validation and verification process is described in procedures maintained at PORTS. At a minimum, the following items are evaluated for data validation (as applicable):

- Data completeness
- Gas chromatograph/mass spectrometer tuning documentation: results, data and time
- Initial calibration: results, date and (for organics) time
- Continuing calibration: results, date, and (for organics) time
- Internal standard peak areas and retention time summaries
- Blank: results of all associated blanks, date of run
- Surrogates: recovery results
- Alpha chemical tracer (yields): results
- Spikes: results and dates
- Spike duplicates: results and dates
- Laboratory duplicates (replicates): results and dates
- Pesticides and PCB calibrations.

The data validation group will perform data validation and apply the appropriate data qualifiers. Independent data validation will help reveal whether the analytical laboratory is providing quality data and may identify systemic inaccuracies for correction.

10.7.4 Database Management

All analytical data will be entered into a computerized data base and categorized as quantitative, qualitative, or unusable. Invalid or unusable data will not be included as part of the interpretation process.

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11. MONITORING WELL INSPECTIONS

Groundwater monitoring well inspection and maintenance is conducted on a routine basis in order to extend the life of the existing wells, maintain compliance with appropriate regulations and guidance, and to ensure that representative water levels and water quality samples can be obtained. Wells which are routinely sampled as part of the IGWMP are inspected on a quarterly basis in accordance with the applicable procedure. A checklist is used to note observations made during the inspection, and includes the following items:

- *Locked* - The lock appears to be in and should remain in good working order until the next inspection.
- *Locking Cap Hinge/Hasp OK* - The hinge and hasp appears to be in and should remain in good working order until the next inspection.
- *Grout to Land Surface* - Cement/grout level inside the outer casing is slightly above ground level in the void between the well casing and the protective outer casing for wells without gravel above the cement/grout layer.
- *Well Cap OK* - The monitoring well cap appears to be in and should remain in good working order until the next inspection.
- *Outer Casing OK* - The casing is not cracked, dented, bent, crimped or severely rusted and appears firmly imbedded in the cement pad. The well label is legible and not peeling.
- *Gravel Present* - The void between the well casing and the outer casing is filled with gravel to a level above weep hole. The gravel is only required if the outer protective casing diameter is greater than 2 times the diameter of the well casing.
- *Cement Pad* - Approximately 3 ft by 3 ft pad, not cracked or chipped, tapered away from the outer casing and at least slightly above ground level. There should be no evidence of frost heaving.
- *Weep Hole Present* - A weep hole has been bored in the outer casing to allow for drainage. If a well lacks an inner casing, no weep hole should be present and this column marked "n/a."

If any problems are noted during the inspections, repairs are completed throughout the year. Additionally, any problems reported by personnel other than the designated inspector are repaired as they are identified.

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FIGURES

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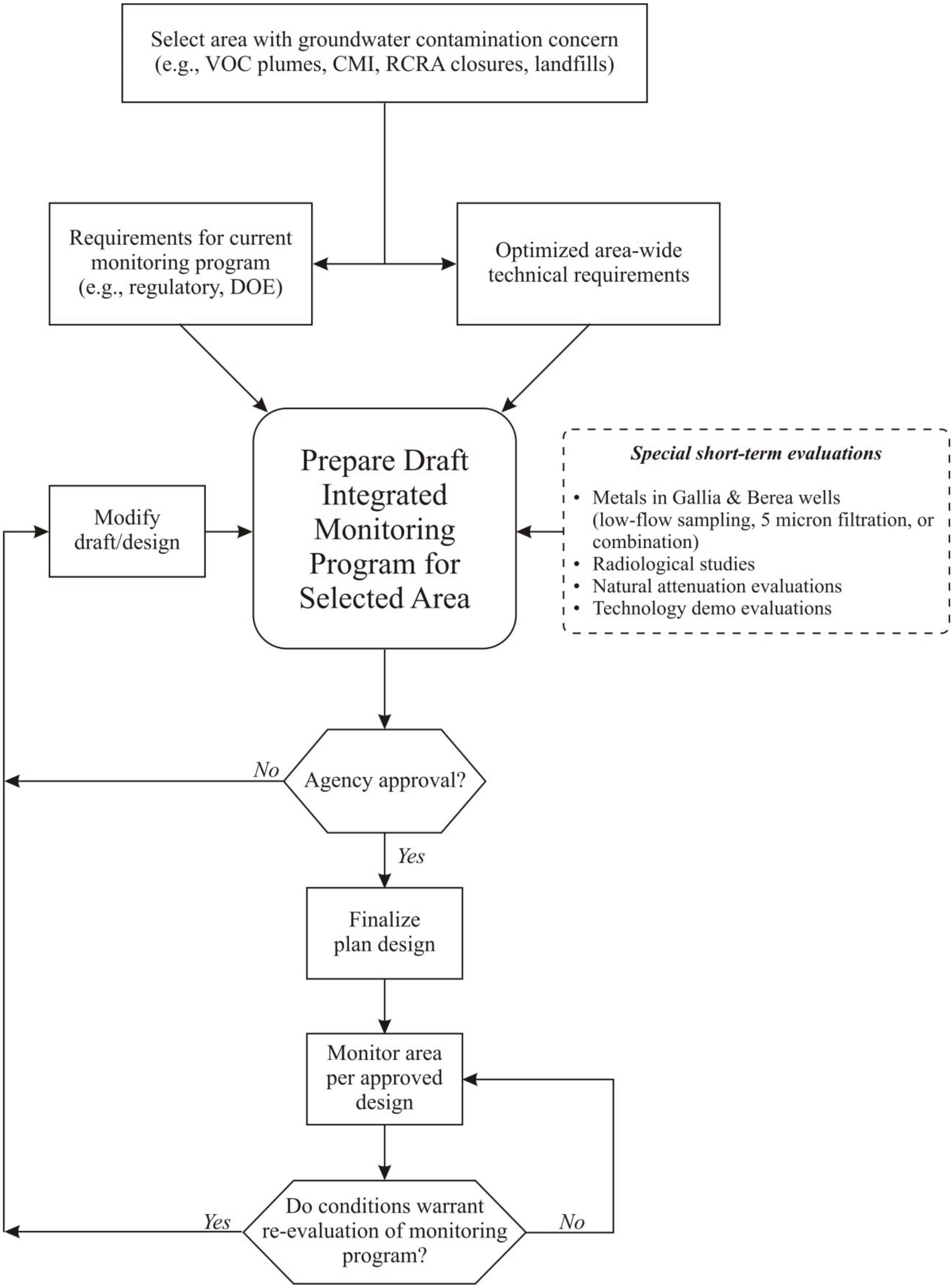

Figure 1. Process flow for the PORTS Integrated Groundwater Monitoring Plan.

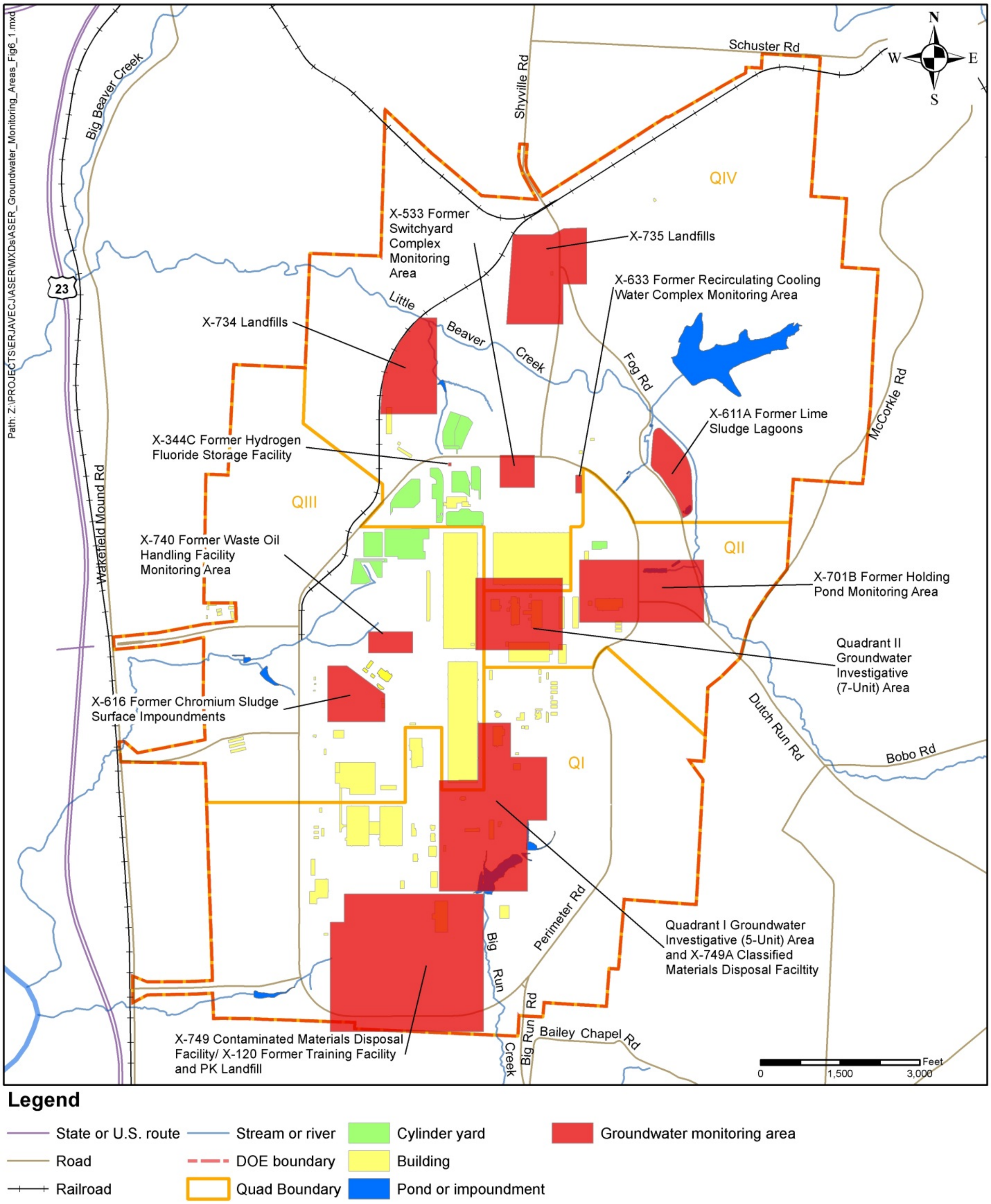

Figure 2. Groundwater areas of concern.

TABLES

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Table 1. Integrated groundwater analytical suites for the Portsmouth Gaseous Diffusion Plant

Parameter suite	Analyte	Method number[a]
LF1	Landfill parameters #1: Ammonia Nitrate/nitrite Chloride Sulfate Alkalinity Total metals: Ca, Fe, K, Na	 350.1 353.2 300 300 310.1 or 2320B 6010 or 6020
LF2	Landfill parameters #2: Volatile organic compounds: V1 parameters and the following: 1,1,1,2-tetrachloroethane, 1,2,3-trichloropropane, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, 1,2-dichloropropane, 2-hexanone, acrylonitrile, bromochloromethane, *cis*-1,3-dichloropropene, dibromomethane, iodomethane, styrene, *trans*-1,3-dichloropropene, *trans*-1,4-dichloro-2-butene, vinyl acetate Total metals: Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mg, Mn, Ni, Se, Ag, Tl, V, Zn Chemical oxygen demand Total dissolved solids	 8260 6010 or 6020 410.4 SM 2540 C
LF3	Landfill parameters #3: Total metals: Co, Hg, Ni Total dissolved solids	6010 or 6020 and 7470 (Hg) SM 2540 C
LF5	Landfill parameters #5: Chloride Sulfate Alkalinity Total dissolved solids Total metals: Na Ammonia Chemical oxygen demand Nitrate/nitrite	 300 300 310.1 or 2320B SM 2540 C 6010 or 6020 350.1 410.4 353.2

Table 1. Integrated groundwater analytical suites for the Portsmouth Gaseous Diffusion Plant (continued)

Parameter suite	Analyte	Method number[a]
M2	Total metals #2: Be, Cd, Cr, Mn, Ni	6010 or 6020
M3	Total metals #3: Cr	6010 or 6020
M4	Total metals #4: Be, Cr	6010 or 6020
M5	Total metals #5: Cd, Ni	6010 or 6020
R1	Radionuclides #1: transuranics (Am-241, Np-237, Pu-238, Pu-239/240), technetium-99, uranium, isotopic uranium (U-233/234, U-235/236, U-238)	
R2	Radionuclides #2: technetium-99, uranium, isotopic uranium (U-233/234, U-235/236, U-238)	
R3	Radionuclides #3: alpha activity	
V1	Volatile organic compounds #1: 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichlorobenzene, 1,2-dichloroethane, 1,4-dichlorobenzene, 2-butanone, 4-methyl-2-pentanone, acetone, benzene, bromodichloromethane, bromoform, bromomethane, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, chloromethane, *cis*-1,2-dichloroethene, dibromochloromethane, ethylbenzene, methylene chloride, tetrachloroethene, toluene, *trans*-1,2-dichloroethene, trichloroethene, trichlorofluoromethane, vinyl chloride, xylenes (1,2-dimethylbenzene and M+P xylene)	8260
WQ1	Water quality parameters #1: Alkalinity Chloride Sulfate Total dissolved solids	 310.1 or 2320B 300 300 SM 2540 C
IX	Appendix to OAC rule 3745-54-98 (Appendix IX)	Various

Field measurements taken at each well: water level, temperature, pH, dissolved oxygen, specific conductance, and turbidity.
[a]Samples are analyzed for the listed analyte(s) in accordance with the referenced method number or equivalent. Standard approved methods do not exist for radiological parameters; therefore, method numbers are not listed for these analytes.

APPENDIX A

QUADRANT I SUMMARY TABLES AND FIGURES

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TABLES

FIGURES

Table A-1. Integrated monitoring at the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
WP-03G	Monitors off site south of the X-749 plume	Quarterly	V1-Q, R2-B
WP-07G	Monitors off site south of the X-749 plume	Quarterly	V1-Q, R2-B
X749-44G	Monitors western edge of X-749 South Barrier Wall; exit pathway monitoring	Quarterly	V1-Q, R1-B
X749-45G	Monitors center of X-749 South Barrier Wall; exit pathway monitoring	Quarterly	V1-Q, R1-B
X749-67G	Monitors southern portion of X-749 plume	Quarterly	V1-Q, M2-B, R2-B
X749-97G	Monitors DOE property boundary downgradient of X-749 South Barrier Wall; exit pathway monitoring	Quarterly	V1-Q, R1-B
X749-102G	Monitors DOE property boundary west of X-749 South Barrier Wall	Quarterly	V1-Q
X749-103G	Monitors southwestern portion of monitoring area	Quarterly	V1-Q
X749-PZ04G	Monitors area upgradient of X-749 South Barrier Wall	Quarterly	V1-Q, M2-B, R2-B
X749-PZ05G	Monitors area upgradient of X-749 South Barrier Wall	Quarterly	V1-Q
STSW-101G	Monitors southern portion of X-749 plume	Semiannual	V1-S, R2-B
STSW-102G	Monitors southern portion of X-749 plume	Semiannual	V1-S, R2-B
WP-01G	Monitors off site south of the X-749 plume	Semiannual	V1-S, R2-B
WP-02G	Monitors off site south of the X-749 plume	Semiannual	V1-S, R2-B
WP-04G	Monitors off site south of the X-749 plume	Semiannual	V1-S, R2-B
WP-05G	Monitors off site south of the X-749 plume	Semiannual	V1-S, R2-B
WP-06G	Monitors off site south of the X-749 plume	Semiannual	V1-S, R2-B
X120-11G	Monitors northwestern portion of X-749/X-120 plume and extraction well X749-EW09G	Semiannual	V1-S, M2-B
X749-06G	Monitors western perimeter of X-749 Landfill; within middle of plume; provides monitoring of trench/cap	Semiannual	V1-S, R2-B
X749-07G	Monitors western perimeter of X-749 Landfill, middle of plume, and X-749 trench/cap	Semiannual	V1-S, R1-B, IX-B
X749-08G	Monitors southern perimeter of X-749 Landfill and X-749 trench/cap	Semiannual	V1-S, R1-B, IX-B
X749-09GA	Monitors eastern perimeter of X-749 Landfill and X-749 cap	Semiannual	V1-S, M2-B

Table A-1. Integrated monitoring at the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X749-10GA	Monitors eastern perimeter of X-749 Landfill and X-749 cap	Semiannual	V1-S, R1-B, IX-B
X749-13G	Monitors southeastern portion of X-749 plume and extraction well X749-EW07G	Semiannual	V1-S, R2-B
X749-14B	Monitors the Berea near Big Run Creek; exit pathway monitoring	Semiannual	V1-S, R1-B
X749-21G	Monitors northeastern portion of plume	Semiannual	V1-S
X749-22G	Monitors eastern portion of monitoring area	Semiannual	V1-S
X749-23G	Monitors eastern portion of X-749 plume	Semiannual	V1-S
X749-24G	Monitors eastern portion of monitoring area	Semiannual	V1-S
X749-26G	Monitors middle of X-749 plume	Semiannual	V1-S, R2-B
X749-27G	Monitors X-749 plume west of X-749 Landfill	Semiannual	V1-S, R2-B
X749-33G	Monitors middle of X-749 plume	Semiannual	V1-S, R2-B
X749-37G	Monitors middle of X-749 plume	Semiannual	V1-S, R2-B
X749-38G	Monitors southern portion of X-749 plume	Semiannual	V1-S
X749-41G	Monitors northern portion of X-749/X-120 plume and extraction well X749-EW09G	Semiannual	V1-S
X749-42G	Monitors western portion of X-749/X-120 plume	Semiannual	V1-S
X749-54B	Monitors Berea south of PK Landfill	Semiannual	V1-S, R2-B
X749-96G	Monitors DOE property boundary downgradient of X-749 South Barrier Wall; exit pathway monitoring	Semiannual	V1-S, R1-B
X749-98G	Monitors DOE property boundary downgradient of X-749 South Barrier Wall; exit pathway monitoring	Semiannual	V1-S, R1-B
X749-104G	Monitors southeastern portion of monitoring area	Semiannual	V1-S
X749-105G	Monitors DOE property boundary at western edge of X-749 South Barrier Wall	Semiannual	V1-S
X749-106G	Monitors phytoremediation system and western portion of X-749/X-120 plume	Semiannual	V1-S, R2-B
X749-107G	Monitors phytoremediation system and western portion of X-749/X-120 plume	Semiannual	V1-S

Table A-1. Integrated monitoring at the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X749-108G	Monitors phytoremediation system and western portion of X-749/X-120 plume	Semiannual	V1-S, R2-B
X749-109G	Monitors phytoremediation system and area north of Perimeter Road	Semiannual	V1-S, R2-B
X749-110G	Monitors phytoremediation system and plume north of Perimeter Road	Semiannual	V1-S, R2-B
X749-112G	Monitors eastern portion of monitoring area	Semiannual	V1-S
X749-113G	Monitors phytoremediation system and middle of X-749 plume	Semiannual	V1-S, R2-B
X749-BG9G	Monitors southeastern corner of X-749 Landfill	Semiannual	V1-S
X749-PZ02G	Monitors eastern portion of monitoring area	Semiannual	V1-S, R2-B
X749-PZ03G	Monitors area upgradient of X-749 South Barrier Wall	Semiannual	V1-S
X749-PZ06G	Monitors southwestern portion of X-749 plume	Semiannual	V1-S
X749-PZ10G	Monitors east of X-749 Landfill	Semiannual	V1-S, R2-B
X749-WPW	Monitors X-749 groundwater interceptor trench	Semiannual	V1-S, R1-B
PK-09G	Monitors northern portion of X-749/X-120 plume	Annual	V1-A
X120-05G	Monitors northern portion of X-749/X-120 plume	Annual	V1-A
X120-08G	Monitors western portion of X-749 plume	Annual	V1-A, R2-B
X120-10G	Monitors western portion of X-749/X-120 plume	Annual	V1-A
X749-04G	Monitors northern perimeter of X-749 Landfill	Annual	V1-A
X749-05G	Monitors western side of X-749 Landfill	Annual	V1-A
X749-20G	Monitors eastern portion of X-749 plume and western PK Landfill perimeter	Annual	V1-A, R2-B
X749-28G	Monitors middle of X-749 plume	Annual	V1-A, R2-B
X749-29G	Monitors middle of X-749 plume	Annual	V1-A
X749-30G	Monitors middle of X-749 plume	Annual	V1-A

Table A-1. Integrated monitoring at the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X749-35G	Monitors eastern portion of X-749 plume and southern PK Landfill perimeter	Annual	V1-A
X749-36G	Monitors X-749 plume west of X-749 Landfill	Annual	V1-A
X749-40G	Monitors northern portion of X-749 plume	Annual	V1-A
X749-43G	Monitors western portion of X-749/X-120 plume	Annual	V1-A
X749-50B	Monitors Berea below center of plume	Annual	V1-A
X749-51B	Monitors Berea east of X-749 Landfill	Annual	V1-A
X749-64B	Monitors Berea beneath the southern X-749 Gallia plume; exit pathway monitoring	Annual	V1-A, R1-B
X749-66G	Monitors western portion of monitoring area at Perimeter Road	Annual	V1-A
X749-68G	Monitors southeastern portion of plume; exit pathway monitoring	Annual	V1-A, R1-B
X749-99M	Monitors Minford at DOE property boundary	Annual	V1-A
X749-100M	Monitors Minford at DOE property boundary	Annual	V1-A
X749-101M	Monitors Minford at DOE property boundary	Annual	V1-A
X749-114G	Monitors northwest portion of monitoring area	Annual	V1-A
X749-115G	Monitors the area north of the X-749 Landfill	Annual	V1-A
X749-117G	Monitors within the X-749 Landfill at the north boundary wall paired with well X749-04G	Annual	V1-A
X749-118G	Monitors within the X-749 Landfill at the northwest boundary wall paired with well X749-05G	Annual	V1-A
X749-119G	Monitors within the X-749 Landfill (northern portion)	Annual	V1-A
X749-120G	Monitors within the X-749 Landfill at the west boundary wall paired with well X749-06G	Annual	V1-A, R2-B
X749-121G	Monitors within the X-749 Landfill (middle portion)	Annual	V1-A, R2-B
X749-122G	Monitors within the X-749 Landfill (southern portion)	Annual	V1-A
X749-PZ07G	Monitors western portion of X-749/X-120 plume	Annual	V1-A

Table A-1. Integrated monitoring at the X-749 Contaminated Materials Disposal Facility/X-120 Former Training Facility (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
F-27G	Monitors Gallia downgradient of the X-120 plume	Biennial / odd	V1-B
PK-07G	Monitors area east of X-749 Landfill and west of PK Landfill	Biennial / odd	V1-B
PK-08G	Monitors northern margin of X-749 plume north of X-749 Landfill	Biennial / odd	V1-B
X120-03G	Monitors northern upgradient margin of X-749 plume perimeter	Biennial / odd	V1-B
X120-06B	Monitors Berea beneath X-120 plume	Biennial / odd	V1-B
X120-09G	Monitors western portion of X-749/X-120 plume	Biennial / odd	V1-B
X749-60B	Monitors Berea in the southern X-749 Gallia plume	Biennial / odd	V1-B
X749-111G	Monitors eastern portion of monitoring area	Biennial / odd	V1-B
X749-PZ01G	Monitors eastern portion of monitoring area	Biennial / odd	V1-B
X749-PZ08G	Monitors northern portion of monitoring area; generally upgradient	Biennial / odd	V1-B
X749-PZ09G	Monitors within the landfill (northeast side) paired with well X749-PZ10G	Biennial / odd	V1-B, R2-B
X749-PZ11G	Monitors within the landfill (east side) paired with well X749-10GA	Biennial / odd	V1-B, R2-B
X749-PZ12G	Monitors within the landfill (southeast side) paired with well X749-09GA	Biennial / odd	V1-B, R2-B
X749-PZ13G	Monitors within the landfill (south side)	Biennial / odd	V1-B, R2-B

[a]Table 1 defines the parameter suites (M2, R1, R2, V1, and IX). Parameter suites are followed by a letter that indicates the monitoring frequency. Q = quarterly; S = semiannual; A = annual; B = biennial.

Table A-2. Integrated monitoring at the PK Landfill

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
PK-PL6	Monitors sump of groundwater collection trench for northern portion of the PK Landfill	Quarterly	V1-Q
PK-PL6A	Monitors sump of groundwater collection trench for southern portion of the PK Landfill and east lobe of X-749 plume	Quarterly	V1-Q
PK-10G	Monitors northern upgradient boundary of X-120 plume and west perimeter of PK Landfill	Semiannual	V1-S
PK-11G	Monitors upgradient of boundary of PK Landfill	Semiannual	V1-S, M2-B
PK-14G	Monitors downgradient of the PK collection system	Semiannual	V1-S, M2-B
PK-15B	Monitors downgradient of the PK collection system	Semiannual	V1-S
PK-16G	Monitors downgradient of the PK collection system	Semiannual	V1-S
PK-17B	Monitors downgradient of the X-749 IRM collection system	Semiannual	V1-S, M2-B
PK-18B	Monitors downgradient of the PK collection system	Semiannual	V1-S
PK-19B	Monitors downgradient of the X-749 IRM collection system	Semiannual	V1-S, M2-B
PK-21B	Monitors downgradient of the X-749 IRM collection system	Semiannual	V1-S
MH GW-4	Monitors PK groundwater collection system	Biennial / odd	V1-B
MH GW-5	Monitors PK groundwater collection system	Biennial / odd	V1-B

[a]Table 1 defines the parameter suites (M2 and V1). Parameter suites are followed by a letter that indicates the monitoring frequency.
Q = quarterly; S = semiannual; B = biennial.

Table A-3. Integrated monitoring at the Quadrant I Groundwater Investigative (5-Unit) Area

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X231B-02G	Monitors within the Quad I GW Investigative (5-Unit) Area plume at the eastern margin of X-231B	Semiannual	V1-S, M2-B, R2-B
X231B-03G	Monitors within the Quad I GW Investigative (5-Unit) Area plume at the eastern margin of X-231B	Semiannual	V1-S, R1-B, IX-B
X231B-06G	Monitors within the Quad I GW Investigative (5-Unit) Area plume at the western margin of X-231B	Semiannual	V1-S, R1-B, IX-B
X326-09G	Monitors the western portion of the Quad I GW Investigative (5-Unit) Area plume	Semiannual	V1-S, M2-B, R2-B
X626-07G	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume	Semiannual	V1-S, M2-B, R2-B
X770-17GA	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume near the former X-770 building	Semiannual	V1-S
X230K-14G	Monitors the southern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X230K-15G	Monitors the southern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231A-01G	Monitors the eastern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A, M2-A, R2-B
X231A-02G	Monitors within the Quad I GW Investigative (5-Unit) Area plume at the western margin of X-231A	Annual	V1-A, M2-B, R2-B
X231A-04G	Monitors within the Quad I GW Investigative (5-Unit) Area plume at the northern margin of X-231A	Annual	V1-A, M2-B, R2-B
X231B-12G	Monitors the southwestern edge of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231B-14G	Monitors within the Quad I GW Investigative (5-Unit) Area plume southeast of X-231B	Annual	V1-A
X231B-15G	Monitors within the Quad I GW Investigative (5-Unit) Area plume near extraction well X231B-B10G	Annual	V1-A
X231B-16G	Monitors the southwestern margin of Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231B-20G	Monitors the western portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231B-23G	Monitors within the Quad I GW Investigative Area plume near extraction wells X231B-B11G and X231B-B12G	Annual	V1-A
X231B-32B	Monitors the Berea beneath the southern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A

Table A-3. Integrated monitoring at the Quadrant I Groundwater Investigative (5-Unit) Area (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X231B-36G	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231B-37G	Monitors the southern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X326-10G	Monitors the western portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X749A-09G	Monitors the Quad I GW Investigative (5-Unit) Area plume near extraction well X622-EW08G	Annual	V1-A
X760-03G	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume between the X-760 and X-770 buildings	Annual	V1-A
X760-07G	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume	Annual	V1-A
X231B-07G	Monitors the middle of the Quad I GW Investigative (5-Unit) Area plume east of the X-326 building	Biennial / odd	V1-B
X231B-11G	Monitors the western portion of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B
X231B-24B	Monitors the Berea beneath the Quad I GW Investigative (5-Unit) Area plume near extraction well X231B-B10G	Biennial / odd	V1-B
X231B-29G	Monitors the northern portion of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B
X231B-38G	Monitors the western margin of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B
X622-PZ01G	Monitors the southeastern margin of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B
X622-PZ02G	Monitors the southern portion of the Quad I GW Investigative (5-Unit) Area plume near the X-622 Facility	Biennial / odd	V1-B
X622-PZ03G	Monitors the eastern margin of the Quad I GW Investigative (5-Unit) Area plume near extraction well X622-EW06G	Biennial / odd	V1-B
X710-01G	Monitors the northern margin of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B
X760-02G	Monitors the northeastern margin of the Quad I GW Investigative (5-Unit) Area plume	Biennial / odd	V1-B

[a]Table 1 defines the parameter suites (M2, R1, R2, V1, and IX). Parameter suites are followed by a letter or number that indicates the monitoring frequency. S = semiannual; A = annual; B = biennial.

Table A-4. Integrated monitoring at the X-749A Classified Materials Disposal Facility

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X749A-02G	Monitors southeast corner of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-03G	Monitors south (downgradient) of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-04G	Monitors east of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-07G	Monitors north (upgradient) of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-12G	Monitors west of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-14G	Monitors east of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-16G	Monitors east of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-17G	Monitors west of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-18G	Monitors west of the X-749A	Semiannual	LF1-S, LF2-A, R2-B
X749A-19G	Monitors west of the X-749A	Semiannual	LF1-S, LF2-A, R2-B

[a]Table 1 defines the parameter suites (LF1, LF2, and R2). Parameter suites are followed by a letter or number that indicates the monitoring frequency. S = semiannual; A = annual; B = biennial.

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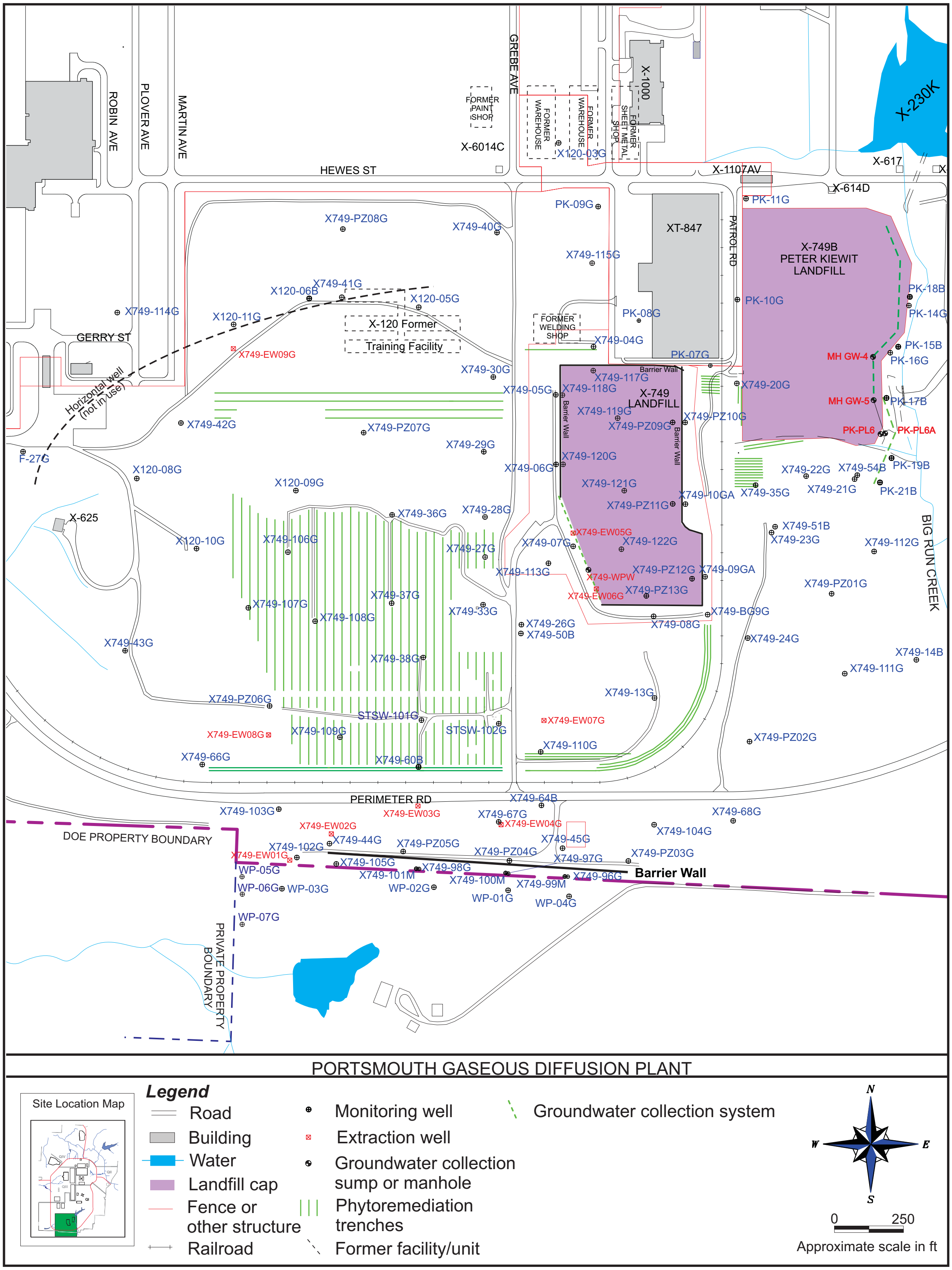

Figure A-1. Integrated monitoring wells X-749 Contaminated Materials Disposal Facility/ X-120 Former Training Facility and PK Landfill.

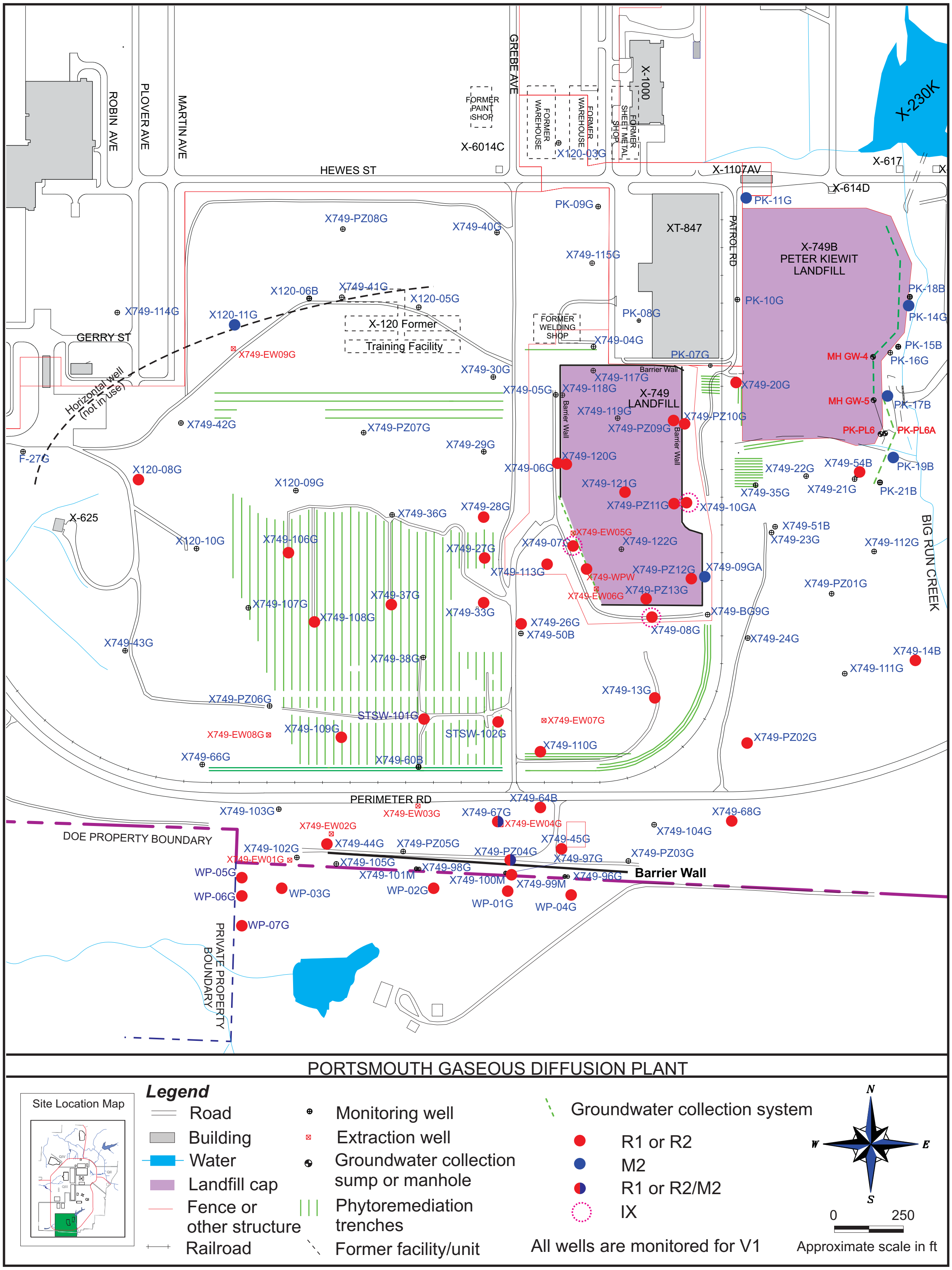

Figure A-2. Integrated monitoring parameter suites X-749 Contaminated Materials Disposal Facility/ X-120 Former Training Facility and PK Landfill.

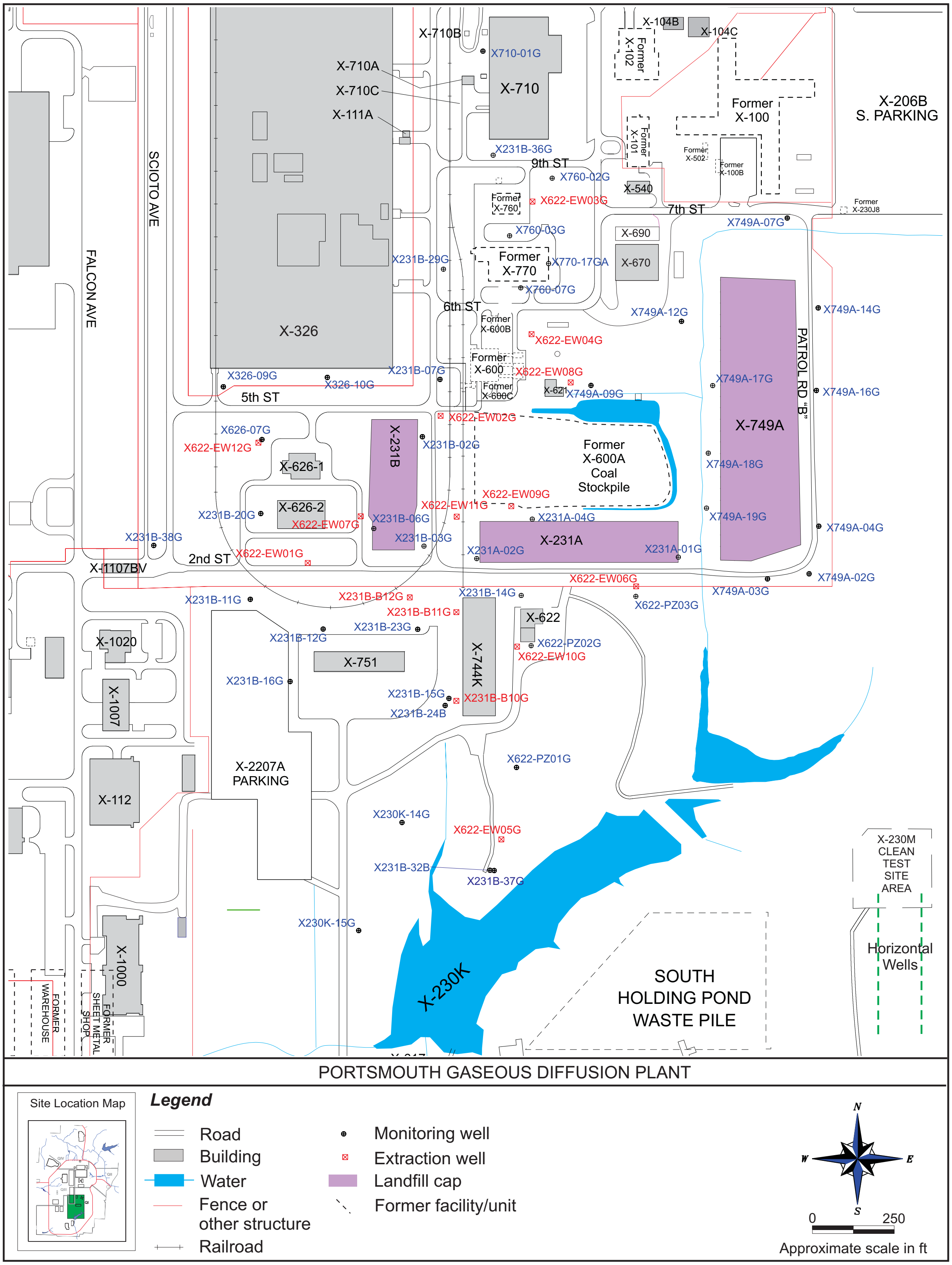

Figure A-3. Integrated monitoring wells Quadrant I Groundwater Investigative (5-Unit) Area and X-749A Classified Materials Disposal Facility.

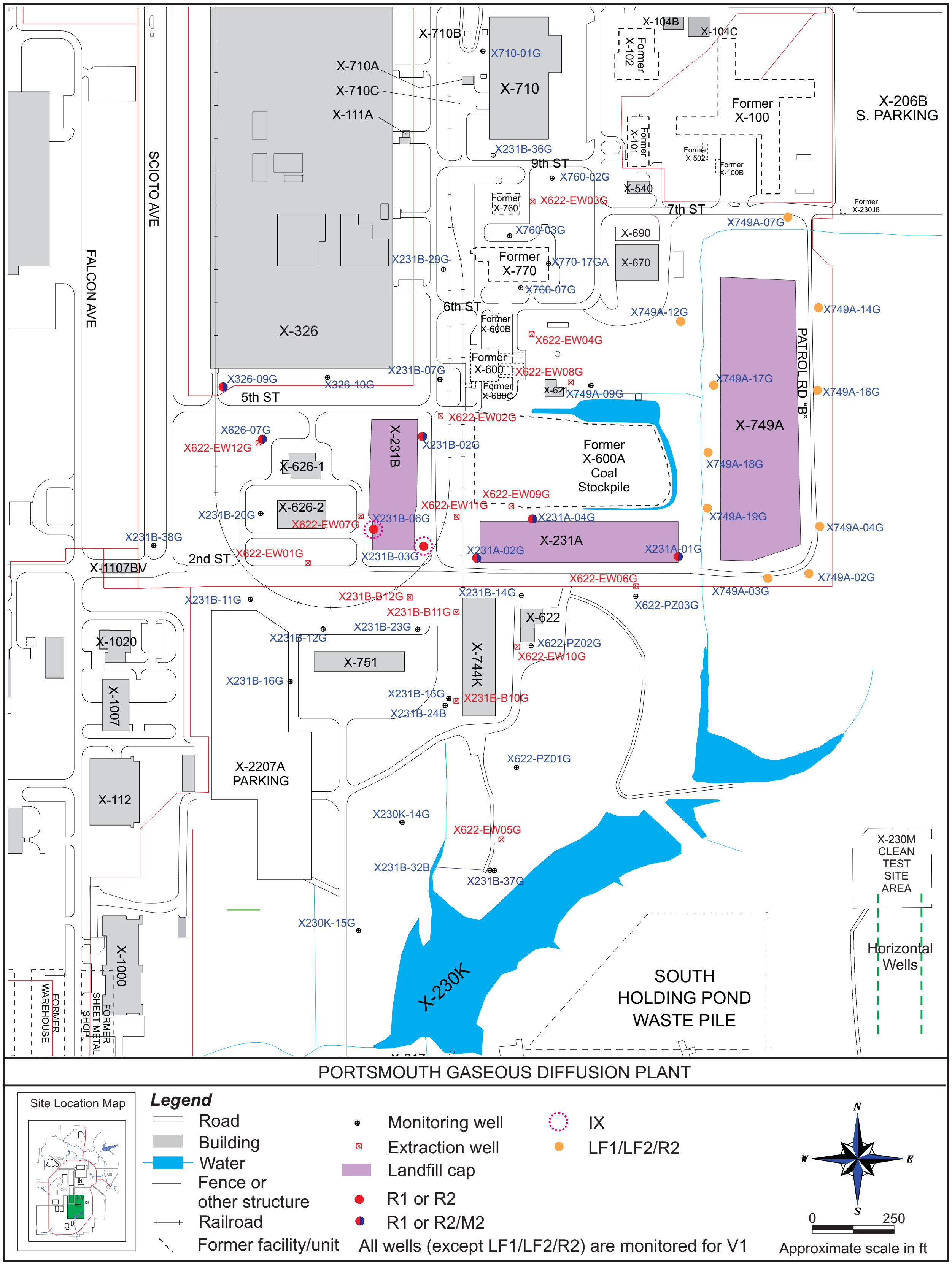

Figure A-4. Integrated monitoring parameter suites Quadrant I Groundwater Investigative (5-Unit) Area and X-749A Classified Materials Disposal Facility.

APPENDIX B

QUADRANT II SUMMARY TABLES AND FIGURES

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TABLES

FIGURES

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Table B-1. Integrated monitoring at the Quadrant II Groundwater Investigative (7-Unit) Area

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X700-03G	Monitors potential groundwater movement towards the X-701B area	Semiannual	V1-S
X701-26G	Monitors the eastern margin of the QII VOC plume and potential groundwater movement towards the X-701B area	Semiannual	V1-S, R2-B
X701-27G	Monitors potential groundwater movement towards the X-701B area	Semiannual	V1-S
X700-02G	Monitors the interior of the QII VOC plume	Annual	V1-A, R2-B, M2-B
X700-04G	Monitors the IRM immediately west of the X-700T Aboveground Storage Tank	Annual	V1-A, R2-B
X700-05G	Monitors the IRM immediately north of the X-700T Aboveground Storage Tank	Annual	V1-A, R2-B
X700-06G	Monitors the IRM immediately east of the X-700T Aboveground Storage Tank	Annual	V1-A, R2-B
X701-69G	Monitors east of the former X-701C Neutralization Pit and potential groundwater movement towards the X-701B area	Annual	V1-A, R2-B
X705-02G	Monitors the western interior of the QII VOC plume	Annual	V1-A, R2-B, M2-B
X705-03G	Monitors the western margin of the QII VOC plume	Annual	V1-A
X705-04G	Monitors the northwestern corner of QII VOC plume	Annual	V1-A
X720-01G	Monitors the southeastern interior of the QII VOC plume and the former X-720 Neutralization Pit	Annual	V1-A, R2-B, IX-B
X720-08G	Monitors the southeastern plume perimeter	Annual	V1-A, R2-B
X720-09G	Monitors the IRM near the former X-720 Neutralization Pit	Annual	V1-A, R2-B
X701-28GA	Monitors upgradient[c] north of the QII VOC plume	Biennial / odd	V1-B
X701-45G	Monitors the southern margin of QII VOC plume	Biennial / odd	V1-B
X701-68G	Monitors within the QII VOC plume northwest of the former X-701C Neutralization Pit	Biennial / odd	V1-B, R2-B
X701-70G	Monitors within the QII VOC plume southwest of the former X-701C Neutralization Pit	Biennial / odd	V1-B, R2-B
X701-117GA	Monitors within the QII VOC plume west of the former X-701C Neutralization Pit	Biennial / odd	V1-B, M2-B
X705-01GA	Monitors the western interior of the QII VOC plume	Biennial / odd	V1-B, R1-B, M2-B
X705-06G	Monitors the northern margin of the QII VOC plume	Biennial / odd	V1-B
X705-07G	Monitors the northern interior of the QII VOC plume	Biennial / odd	V1-B, R2-B, M2-B

Table B-1. Integrated monitoring at the Quadrant II Groundwater Investigative (7-Unit) Area (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X705-08G	Monitors upgradient[b] south of QII VOC plume	Biennial / odd	V1-B
X705-10B	Monitors the Berea beneath the QII VOC plume and the former X-701C Neutralization Pit	Biennial / odd	V1-B

[a]Table 1 defines the parameter suites (M2, R1, R2, V1, and IX). Parameter suites are followed by a letter that indicates the monitoring frequency. S = semiannual; A = annual; B = biennial.
[b]The Quadrant II Groundwater Investigative (7-Unit) Area Plume is being drawn inward to the X-700 and X-705 building sumps; therefore, wells outside of the plume are considered upgradient.

Table B-2. Integrated monitoring at the X-701B Former Holding Pond

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters
X701-21G	Monitors northern interior of X-701B VOC plume	Quarterly	WQ1-Q, V1-S, R2-A
X701-EW121G	Monitors X-701B VOC plume immediately downgradient of IRM area	Quarterly	WQ1-Q, V1-S, R2-S
X701-EW122G	Monitors X-701B VOC plume immediately downgradient of IRM area	Quarterly	WQ1-Q, V1-S, R2-S
LBC-PZ03G	Monitors X-701B VOC plume near downgradient (eastern) margin	Semiannual	V1-S, R2-A
LBC-PZ06G	Monitors outside of X-701B VOC plume near Little Beaver Creek	Semiannual	V1-S, R2-A
X230J7-01GA	Monitors south of X-230J7 and along north margin of X-701B VOC plume	Semiannual	V1-S, WQ1-S, R2-A
X230J7-02GA	Monitors south of X-230J7 and along north margin of X-701B VOC plume	Semiannual	V1-S, WQ1-S, R2-A
X230J7-03GA	Monitors south of X-230J7 and along north margin of X-701B VOC plume	Semiannual	V1-S, WQ1-S, R1-A
X701-01G	Monitors TCE plume south of X-744G	Semiannual	V1-S, M2-S, R2-A
X701-02G	Monitors western edge of X-701B VOC plume	Semiannual	V1-S, WQ1-S, R2-A
X701-06G	Monitors western edge of X-701B VOC plume	Semiannual	V1-S, WQ1-S, R2-A
X701-15G	Monitors downgradient of the X-237 groundwater collection system	Semiannual	V1-S, R2-A
X701-16G	Monitors downgradient of north end of the X-237 groundwater collection system	Semiannual	V1-S, R2-A
X701-19G	Monitors outside of the southern margin of the X-701B plume	Semiannual	V1-S, R2-A
X701-20G	Monitors interior of X-701B VOC plume along plume axis	Semiannual	V1-S, WQ1-S, M2-S, R1-S
X701-24G	Monitors downgradient of the X-237 groundwater collection system, along original plume axis	Semiannual	V1-S, WQ1-S, R1-A
X701-25G	Monitors outside of the northern margin of X-701B plume	Semiannual	V1-S, R2-A
X701-30G	Monitors isolated TCE hit south of X-744G	Semiannual	V1-S, M2-S, R2-A
X701-66G	Monitors western interior of X-701B plume near the former X-701B pond.	Semiannual	V1-S, WQ1-S, R1-S. IX-B
X701-127G	Monitors interior of X-701B VOC plume along plume axis and downgradient of oxidant injection area	Semiannual	V1-S, WQ1-S, M2-S, R1-S
X701-128G	Monitors inside plume perimeter	Semiannual	V1-S, WQ1-S, R1-A

Table B-2. Integrated monitoring at the X-701B Former Holding Pond (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters
X701-142G	Monitors area immediately upgradient of the X-237 Groundwater Collection System	Semiannual	V1-S
X701-143G	Monitors area immediately upgradient of the X-237 Groundwater Collection System	Semiannual	V1-S
X701-BW4G	Monitors northwest portion of monitoring area	Semiannual	V1-S, WQ1-S, R2-A
X701-IRMPZ03G	Monitors downgradient of the X-237 Groundwater Collection System near Little Beaver Creek	Semiannual	V1-S
X701-IRMPZ08G	Monitors downgradient of the X-237 Groundwater Collection System	Semiannual	V1-S
X701-TC01G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC03G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC05G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC10G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC17G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC22G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC28G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S, IX-B
X701-TC48G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC54G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC61G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X701-TC67G	Monitors western portion of the plume within the IRM treatment area	Semiannual	V1-S, WQ1-S, R1-S
X744G-01G	Monitors southwest of X-744G	Semiannual	V1-S, M2-S
X744G-02G	Monitors near southwest corner of X-744G	Semiannual	V1-S, M2-S
X744G-03G	Monitors south of X-744G	Semiannual	V1-S, M2-S
LBC-PZ07G	Monitors northeast portion of monitoring area	Annual	V1-A
X230J7-04GA	Monitors north of X-230J7	Annual	V1-A, R2-A

Table B-2. Integrated monitoring at the X-701B Former Holding Pond (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters
X237-EPW	Monitors the east-west portion of the X-237 Groundwater Collection System	Annual	V1-A
X237-WPW	Monitors the east-west portion of the X-237 Groundwater Collection System	Annual	V1-A
X701-18G	Monitors downgradient/sidegradient of X-701B VOC plume	Annual	V1-A, R2-A
X701-23G	Monitors outside of the southern margin of X-701B plume	Annual	V1-A, R2-A
X701-31G	Monitors south (downgradient) of X-744G	Annual	V1-A, R2-A
X701-38G	Monitors northwest portion of monitoring area	Annual	V1-A, R2-A
X701-42G	Monitors north of the IRM area	Annual	V1-A, R2-A
X701-48G	Monitors east of Little Beaver Creek; exit pathway monitoring	Annual	V1-A, R1-A
X701-58B	Monitors Berea near northern edge of the X-237 groundwater collection system	Annual	V1-A, R2-A
X701-61B	Monitors Berea near the X-237 groundwater collection system	Annual	V1-A, R2-A
X701-77G	Monitors south of the IRM area	Annual	V1-A, R2-A
X701-79G	Monitors south of the IRM area	Annual	V1-A, R2-A
X701-130G	Monitors northwest of the IRM area	Annual	V1-A, R2-A
X701-141G	Monitors upgradient of the X-237 Groundwater Collection System	Annual	V1-A
X701-144G	Monitors downgradient of the X-237 Groundwater Collection System near Little Beaver Creek	Annual	V1-A
X701-BW1G	Monitors northwest portion of monitoring area	Annual	V1-A, R2-A
X701-BW2G	Monitors western edge of X-701B VOC plume	Annual	V1-A, WQ1-A, R2-A
X701-BW3G	Monitors north of the IRM area	Annual	V1-A, R2-A
X701-IRMPZ05G	Monitors downgradient of the X-237 Groundwater Collection System	Annual	V1-A
X701-IRMPZ07G	Monitors upgradient of the X-237 Groundwater Collection System	Annual	V1-A

[a]Table 1 defines the parameter suites (V1, WQ1, M2, R1, and R2). Parameter suites are followed by a letter that indicates the monitoring frequency. Q = quarterly; S = semiannual; A = annual.

Table B-3. Integrated monitoring at the X-633 Former Recirculating Cooling Water Complex

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters
X633-07G	Monitors west of the former X-633-2C Cooling Tower basin	Semiannual	M3-S
X633-PZ04G	Monitors west of the former X-633-2C Cooling Tower basin	Semiannual	M3-S

[a]Table 1 defines the parameter suite (M3). The parameter suite is followed by a letter that indicates the monitoring frequency. S = semiannual.

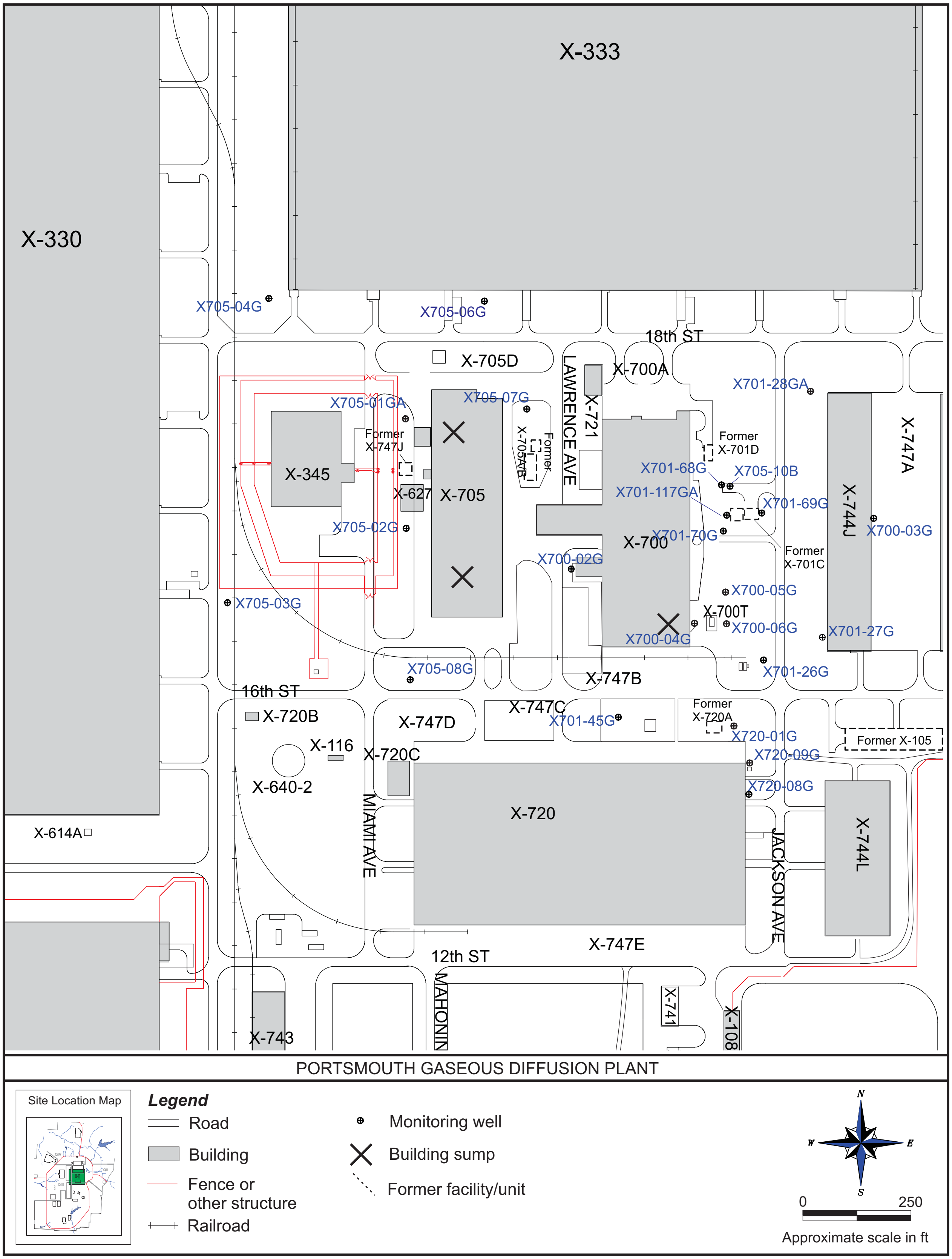

Figure B-1. Integrated monitoring wells Quadrant II Groundwater Investigative (7-Unit) Area.

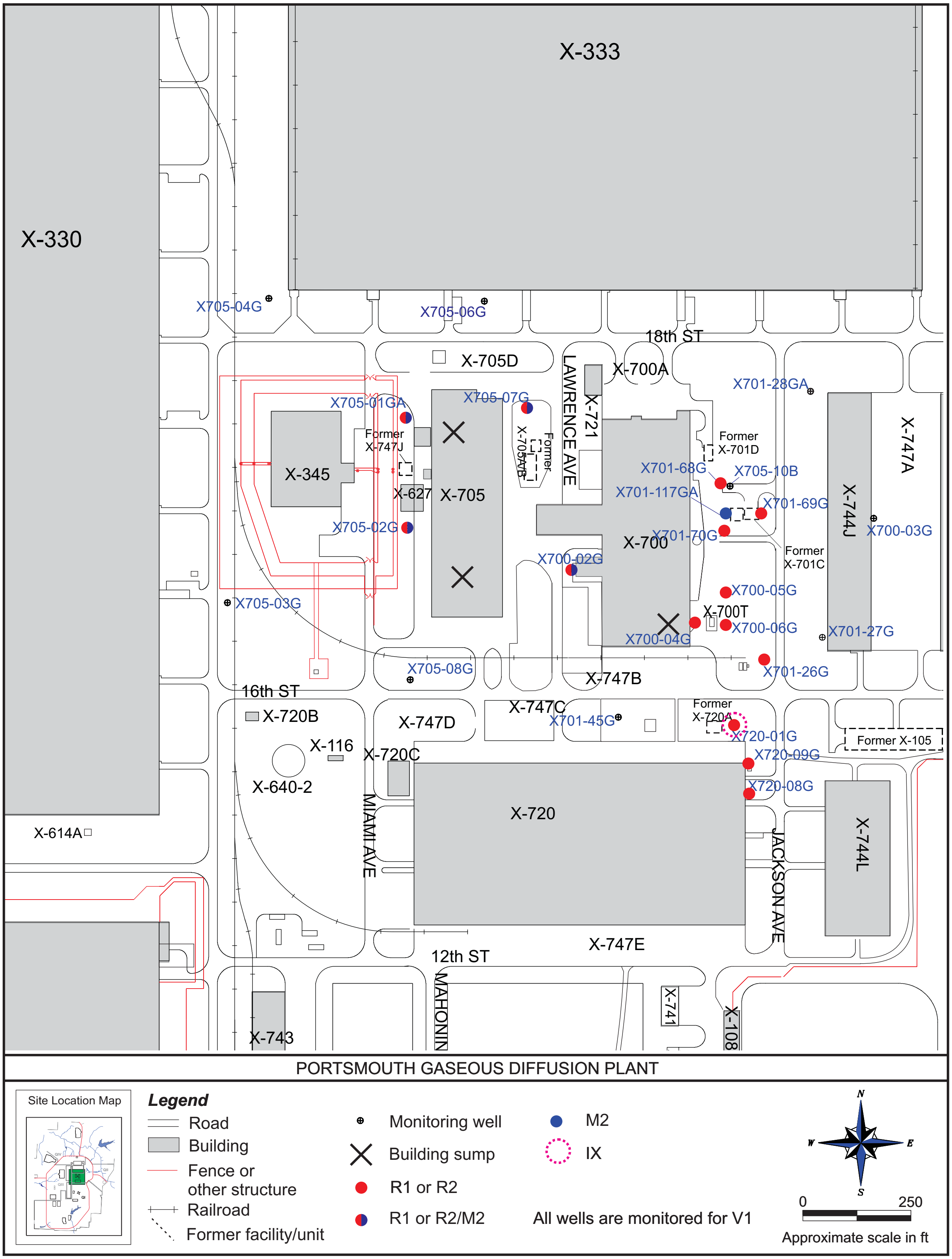

Figure B-2. Integrated monitoring parameter suites Quadrant II Groundwater Investigative (7-Unit) Area.

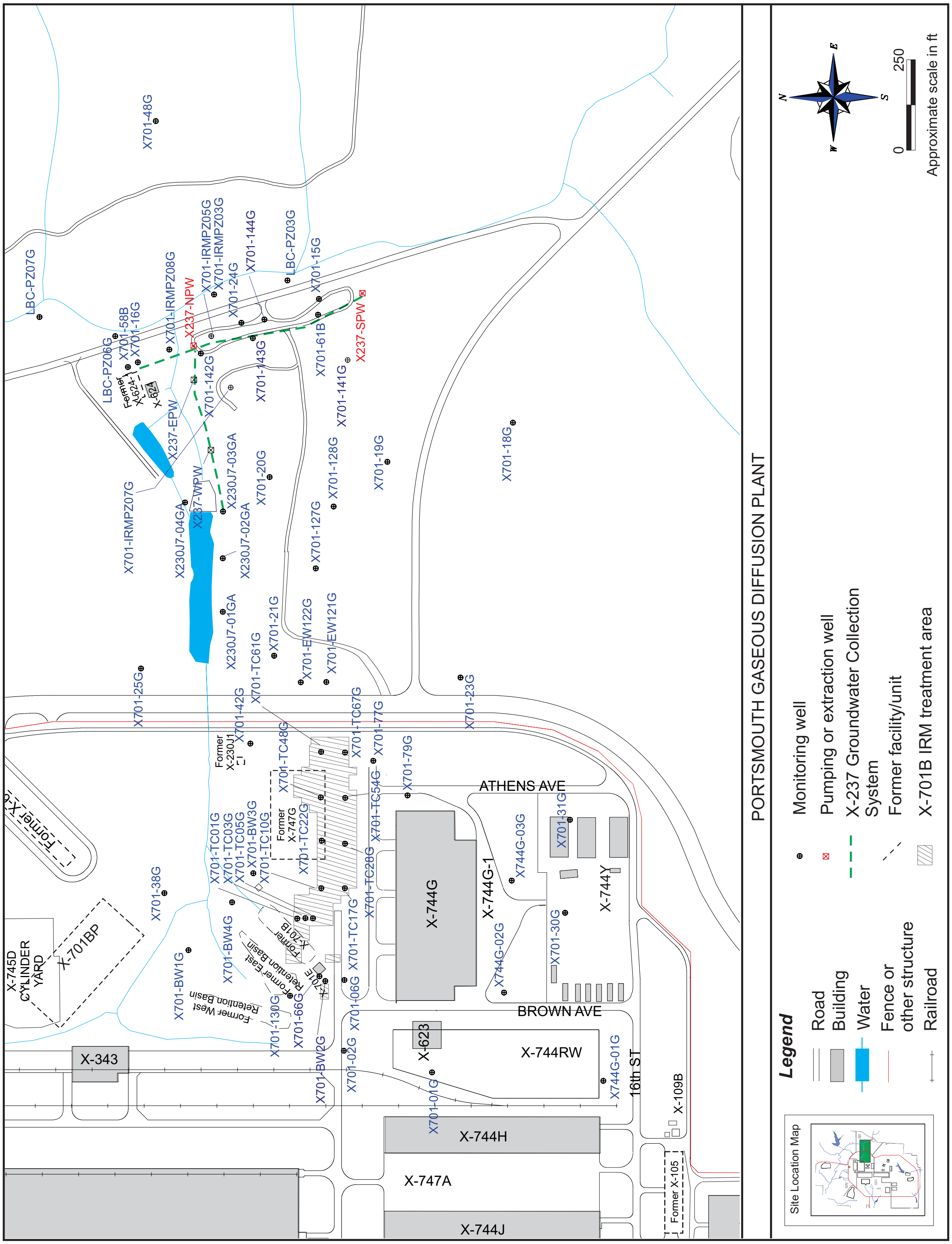

Figure B-3. Integrated monitoring wells X-701B Former Holding Pond.

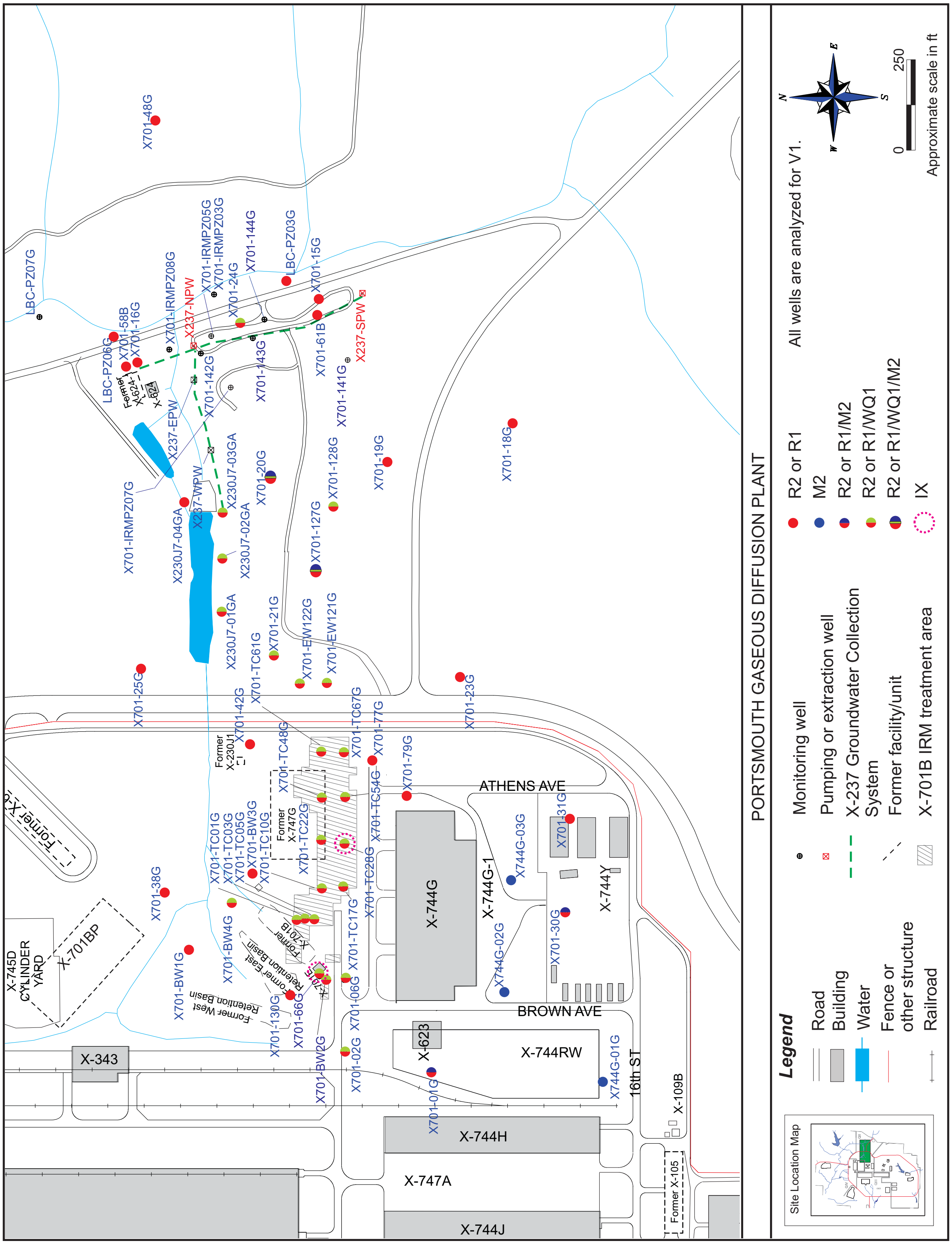

Figure B-4. Integrated monitoring parameter suites X-701B Former Holding Pond.

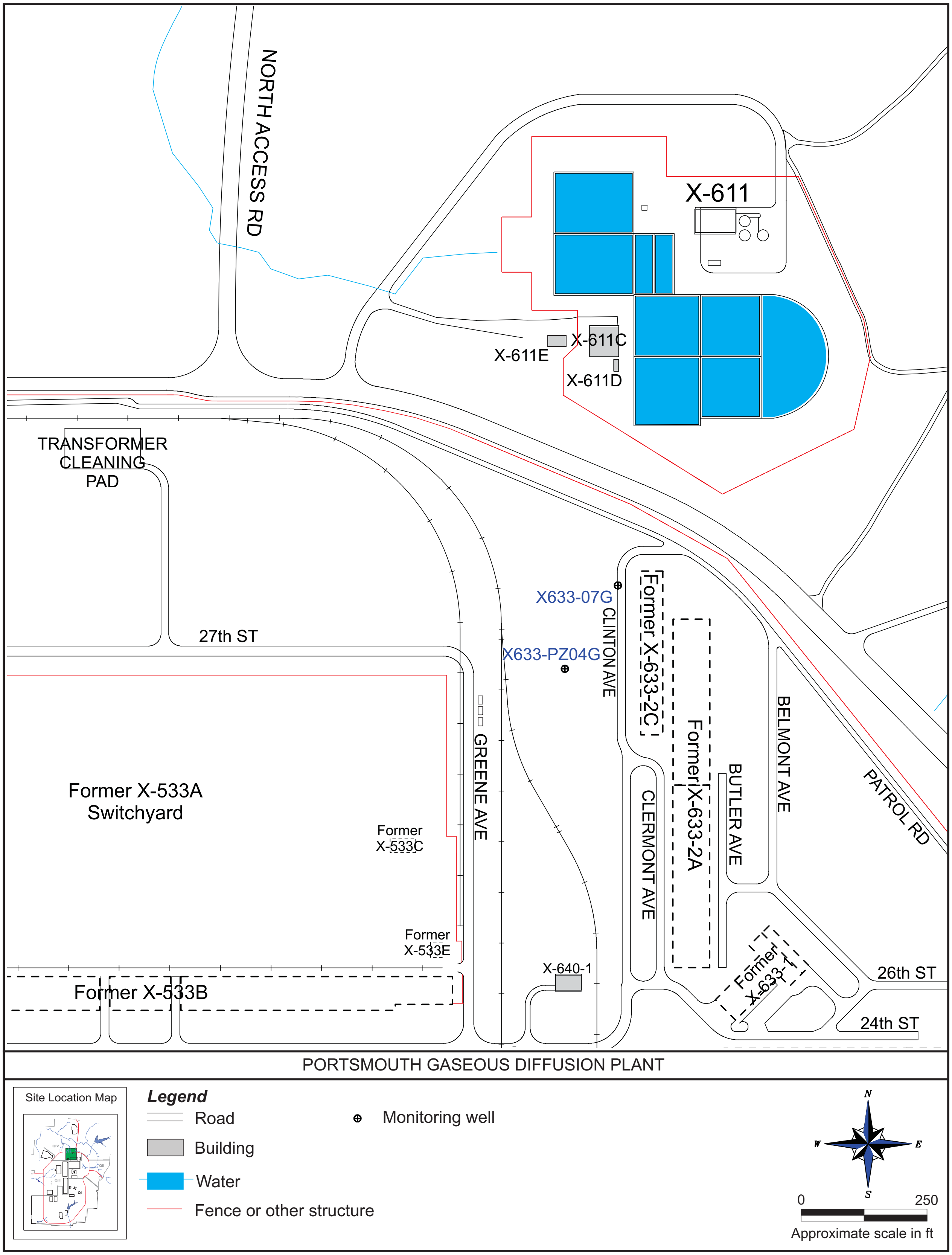

Figure B-5. Integrated monitoring wells X-633 Former Recirculating Cooling Water Complex.

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APPENDIX C

QUADRANT III SUMMARY TABLES AND FIGURES

TABLES

FIGURES

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Table C-1. Integrated monitoring at the X-616 Former Chromium Sludge Surface Impoundments

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X616-09G	Monitors downgradient to western boundary of X-616	Semiannual	V1-S, M2-B
X616-13G	Monitors downgradient to western boundary of X-616	Semiannual	V1-S, M2-B
X616-14G	Monitors downgradient to the northwest boundary of X-616	Semiannual	V1-S, M2-B
X616-20B	Monitors downgradient to the southwest boundary of X-616	Semiannual	V1-S, M2-B
X616-25G	Monitors downgradient southwest of X-616	Semiannual	V1-S, M2-B
X616-02G	Monitors upgradient to the eastern boundary of X-616	Annual	V1-A, M2-B
X616-05G	Monitors to the northeast, down/side-gradient to X-616	Annual	V1-A, M2-A
X616-16G	Monitors downgradient to the southwest boundary of X-616	Annual	V1-A, M2-B
X616-28B	Monitors to the southeast, up/side-gradient to X-616	Annual	V1-A, M2-B
X616-10G	Monitors to the southeast, up/side-gradient to X-616	Biennial / odd	V1-B, M2-B
X616-17G	Monitors to the northeast, upgradient to X-616	Biennial / odd	V1-B, M2-B
X616-19B	Monitors northern downgradient boundary of X-616	Biennial / odd	V1-B, M2-B
X616-21G	Monitors downgradient to the northwest of X-616	Biennial / odd	V1-B, M2-B
X616-22G	Monitors downgradient to the west of X-616	Biennial / odd	V1-B, M2-B
X616-24B	Monitors downgradient to the west of X-616	Biennial / odd	V1-B, M2-B
X616-26G	Monitors to the southeast, up/side-gradient to X-616	Biennial / odd	V1-B, M2-B

[a]Table 1 defines the parameter suites (V1 and M2). Parameter suites are followed by a letter that indicates the monitoring frequency.
S = semiannual; A = annual; B = biennial.

Table C-2. Integrated monitoring at the X-740 Former Waste Oil Handling Facility

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X740-02G	Monitors eastern edge of the X-740 Gallia VOC plume	Annual	V1-A
X740-03G	Monitors the eastern portion of the X-740 Gallia VOC plume and X-740 EAB Pilot Study area	Annual	V1-A, IX-B
X740-08G	Monitors the eastern margin of the X-740 Gallia VOC plume	Annual	V1-A
X740-09B	Monitors the Berea in the eastern portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-10G	Monitors the eastern portion of the X-740 Gallia VOC plume and X-740 EAB Pilot Study area	Annual	V1-A
X740-11G	Monitors the western margin of the X-740 Gallia VOC plume	Annual	V1-A
X740-13G	Monitors the western margin (downgradient) of the X-740 Gallia VOC plume	Annual	V1-A
X740-14B	Monitors the Berea downgradient of well X740-09B	Annual	V1-A
X740-18G	Monitors the eastern portion of the X-740 Gallia VOC plume and EAB Pilot Study area	Annual	V1-A
X740-19G	Monitors the eastern portion of the X-740 Gallia VOC plume and EAB Pilot Study area	Annual	V1-A
X740-20G	Monitors the middle portion of the X-740 Gallia VOC plume and EAB Pilot Study area	Annual	V1-A
X740-21G	Monitors the middle portion of the X-740 Gallia VOC plume and EAB Pilot Study area	Annual	V1-A
X740-22G	Monitors the middle portion of the X-740 Gallia VOC plume and EAB Pilot Study area	Annual	V1-A
X740-23M	Monitors the Minford in the eastern portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-PZ04M	Monitors the Minford in the eastern portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-PZ10G	Monitors the central portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-PZ12G	Monitors the central portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-PZ14G	Monitors the south-central portion of the X-740 Gallia VOC plume	Annual	V1-A
X740-PZ17G	Monitors the western portion of the X-740 Gallia VOC plume	Annual	V1-A

Table C-2. Integrated monitoring at the X-740 Former Waste Oil Handling Facility (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X740-01G	Monitors the southern margin of the X-740 Gallia VOC plume	Biennial / odd	V1-B
X740-04G	Monitors the northern margin of the X-740 Gallia VOC plume	Biennial / odd	V1-B
X740-06G	Monitors the Gallia in northern portion of the monitoring area	Biennial / odd	V1-B
X740-12B	Monitors the Berea at the western margin of the of X-740 Gallia VOC plume	Biennial / odd	V1-B

[a]Table 1 defines the parameter suites (V1 and IX). Parameter suites are followed by a letter that indicates the monitoring frequency. A = annual; B = biennial.

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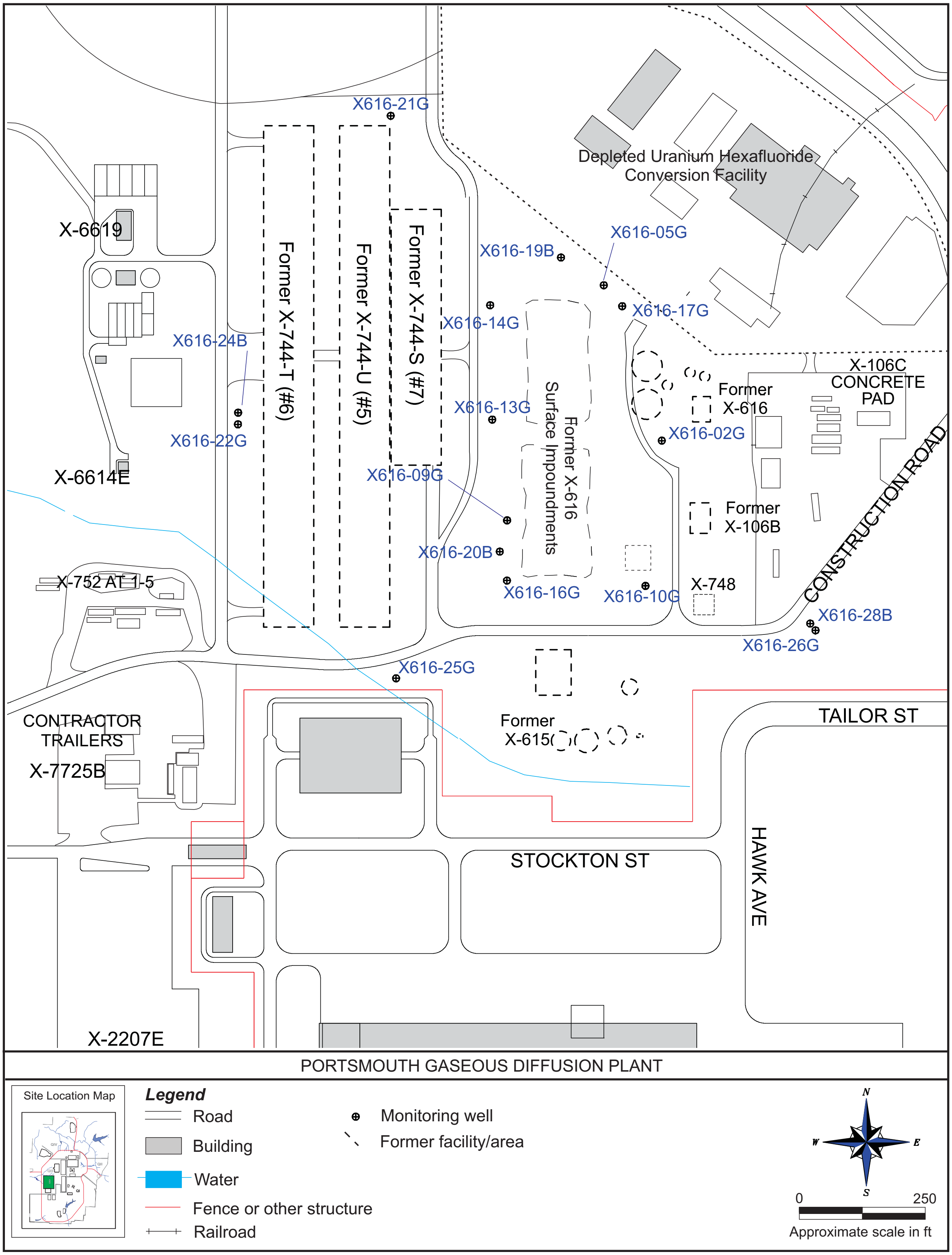

Figure C-1. Integrated monitoring wells X-616 Former Chromium Sludge Surface Impoundments.

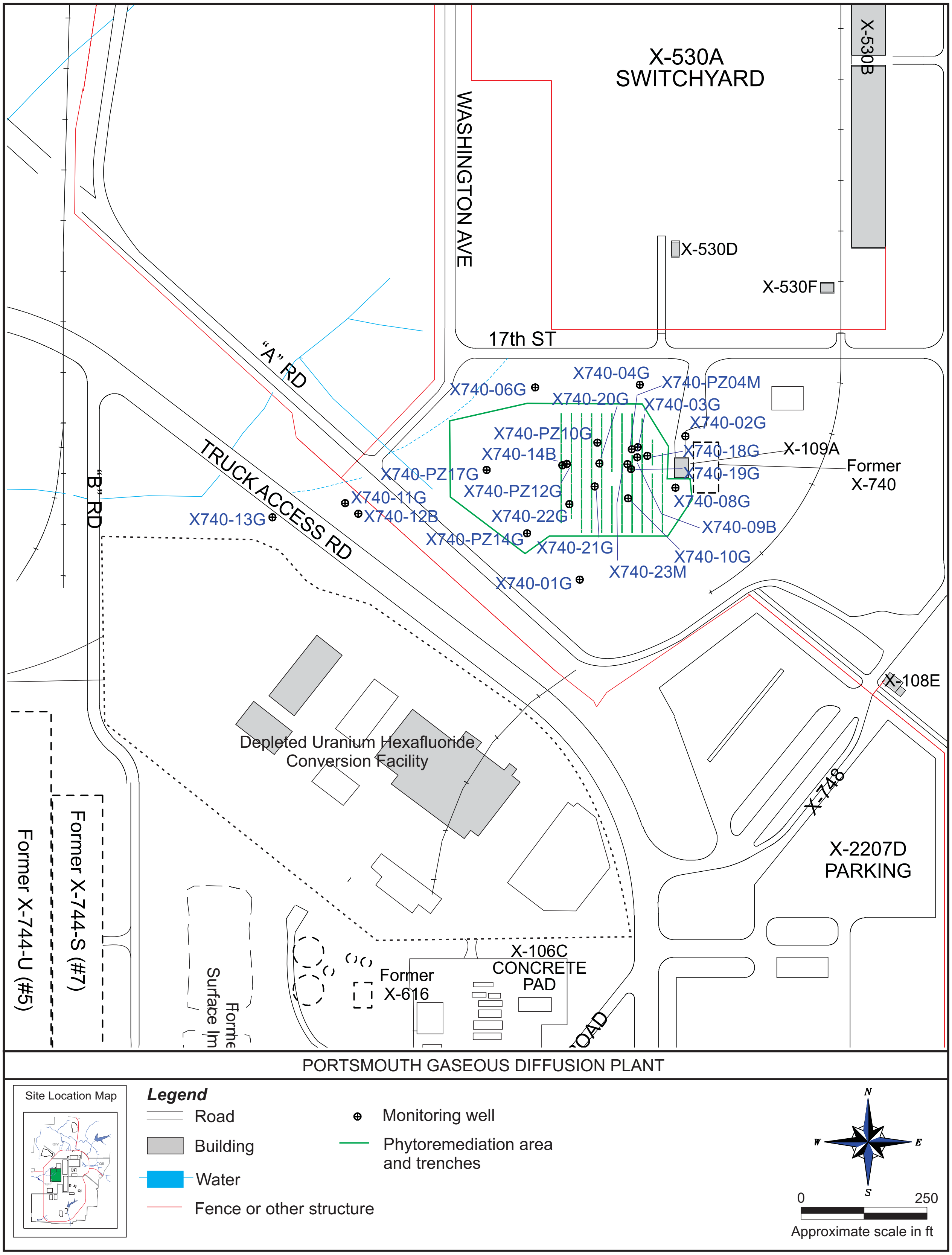

Figure C-2. Integrated monitoring wells X-740 Former Waste Oil Handling Facility.

APPENDIX D

QUADRANT IV SUMMARY TABLES AND FIGURES

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TABLES

FIGURES

Table D-1. Integrated monitoring at the X-611A Former Lime Sludge Lagoons

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
F-07G	Monitors unconsolidated material upgradient of X-611A	Semiannual	M4-S
F-08B	Monitors Berea upgradient of X-611A	Semiannual	M4-S
X611-01B	Monitors Berea downgradient of X-611A	Semiannual	M4-S
X611-02BA	Monitors Berea downgradient of X-611A	Semiannual	M4-S
X611-03G	Monitors unconsolidated material downgradient of X-611A	Semiannual	M4-S
X611-04BA	Monitors Berea downgradient of X-611A	Semiannual	M4-S
Wells X611-02BA, X611-03G and X611-04BA will be sampled for total PCBs in 2017 to support the five-year review for this area due in 2018 and will be sampled for total PCBs every five years thereafter.			

[a]Table 1 defines the parameter suite (M4). The parameter suite is followed by a letter that indicates the monitoring frequency. S = semiannual.

Table D-2. Integrated monitoring at the X-735 Landfills

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X735-01GA	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-02GA	Monitors north and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-03GA	Monitors west and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-04GA	Monitors west and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-05GA	Monitors southwest and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-06GAA	Monitors south and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-13GA	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-16B	Monitors Berea sandstone east and upgradient of X-735	Semiannual	LF1-S, LF2-A, R2-B
X735-17B	Monitors Berea sandstone north and downgradient of X-735	Semiannual	LF1-S, LF2-A, R2-B
X735-18B	Monitors Berea sandstone west and downgradient of X-735	Semiannual	LF1-S, LF2-A, R2-B
X735-19G	Monitors within the buffer zone between the northern and southern portions of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X735-20B	Monitors Berea sandstone within the buffer zone between the northern and southern portions of X-735	Semiannual	LF1-S, LF2-A, R2-B
X735-21G	Monitors west and downgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X737-05B	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF2-A, R2-B
X737-06G	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B
X737-07B	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF2-A, R2-B
X737-09G	Monitors east and upgradient of X-735	Semiannual	LF1-S, LF3-S, LF2-A, R2-B

Table D-2. Integrated monitoring at the X-735 Landfills (continued)

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X735-03G	Former assessment monitoring well west and downgradient of X-735	Every 3 years	LF1-3, LF2-3, LF3-3, R2-3
X735-04G	Former assessment monitoring well west and downgradient of X-735	Every 3 years	LF1-3, LF2-3, LF3-3, R2-3
X735-05G	Former assessment monitoring well west and downgradient of X-735	Every 3 years	LF1-3, LF2-3, LF3-3, R2-3
X735-12G	Former assessment monitoring well west and downgradient of X-735	Every 3 years	LF1-3, LF2-3, LF3-3, R2-3

[a]Table 1 defines the parameter suites (LF1, LF2, LF3, and R2). Parameter suites are followed by a letter that indicates the monitoring frequency. S = semiannual; A = annual; B = biennial; 3 = every 3 years beginning in 2008 (2008, 2011, 2014, 2017, 2020, etc.).

Table D-3. Integrated monitoring at the X-734 Landfills

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
RSY-02B	Monitors Berea upgradient of X-734 Landfills	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-01G	Monitors unconsolidated material northwest and downgradient of X-734	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-02B	Monitors Bedford Shale northeast and downgradient of X-734	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-03G	Monitors unconsolidated material northeast and downgradient of X-734	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-04G	Monitors unconsolidated material east and downgradient of X-734	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-05B	Monitors Bedford Shale east and downgradient of X-734A	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-06G	Monitors unconsolidated material east and downgradient of X-734A	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-10G	Monitors Gallia east and downgradient of X-734B	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-14G	Monitors Gallia upgradient of X-734/X-734A	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-15G	Monitors Gallia southwest and upgradient of X-734/X-734A	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-16G	Monitors unconsolidated material west of X-734/X-734A	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-18G	Monitors unconsolidated material west of X-734	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-20G	Monitors Gallia northeast and downgradient of X-734B	Semiannual	V1-S, M2-A, LF5-A, R1-B
X734-22G	Monitors Gallia west and upgradient of X-734B	Semiannual	V1-S, M2-B, LF5-A, R1-B
X734-23G	Monitors Gallia east and downgradient of X-734B	Semiannual	V1-S, M2-A, LF5-A, R1-B

[a]Table 1 defines the parameter suites (V1, M2, LF5, and R1). Parameter suites are followed by a letter that indicates the monitoring frequency. S = semiannual; A = annual; B = biennial.

Table D-4. Integrated monitoring at the X-533 Former Switchyard Complex

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
F-03G	Monitors downgradient (north) of transformer cleaning pad	Semiannual	M5-S
X533-03G	Monitors near northwest corner of the former X-533A Switchyard	Semiannual	M5-S
TCP-01G	Monitors adjacent to transformer cleaning pad	Semiannual	M5-S

[a]Table 1 defines the parameter suite (M5). The parameter suite is followed by a letter that indicates the monitoring frequency. S = semiannual.

Table D-5. Integrated monitoring at the X-344C Former Hydrogen Fluoride Storage Building

Well ID	Location/purpose	IGWMP sample frequency	IGWMP parameters[a]
X344C-01G	Monitors upgradient (south) of the former X-344C building	Annual	V1-A

[a]Table 1 defines the parameter suite (V1). The parameter suite is followed by a letter that indicates the monitoring frequency. A = Annual.

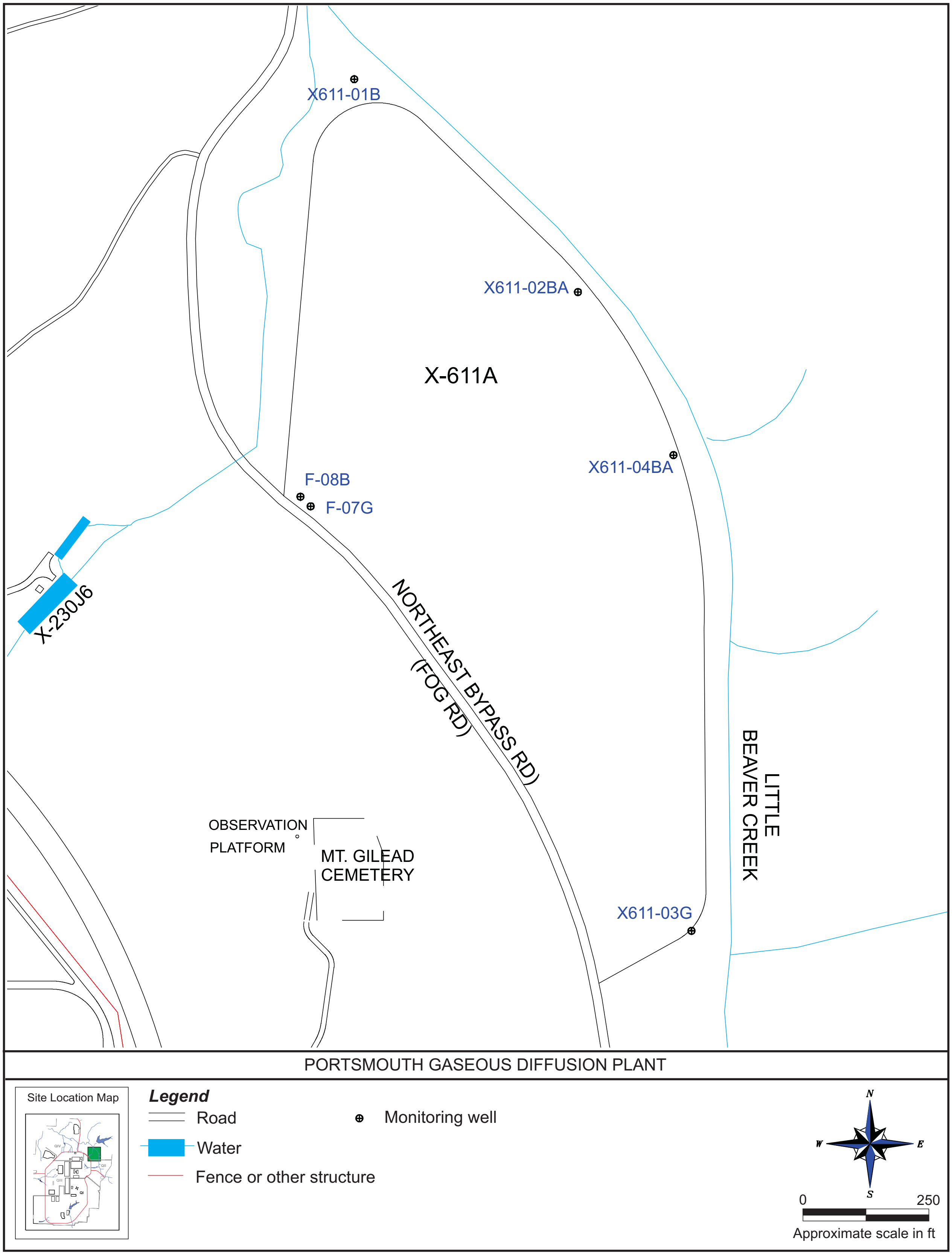

Figure D-1. Integrated monitoring wells X-611A Former Lime Sludge Lagoons.

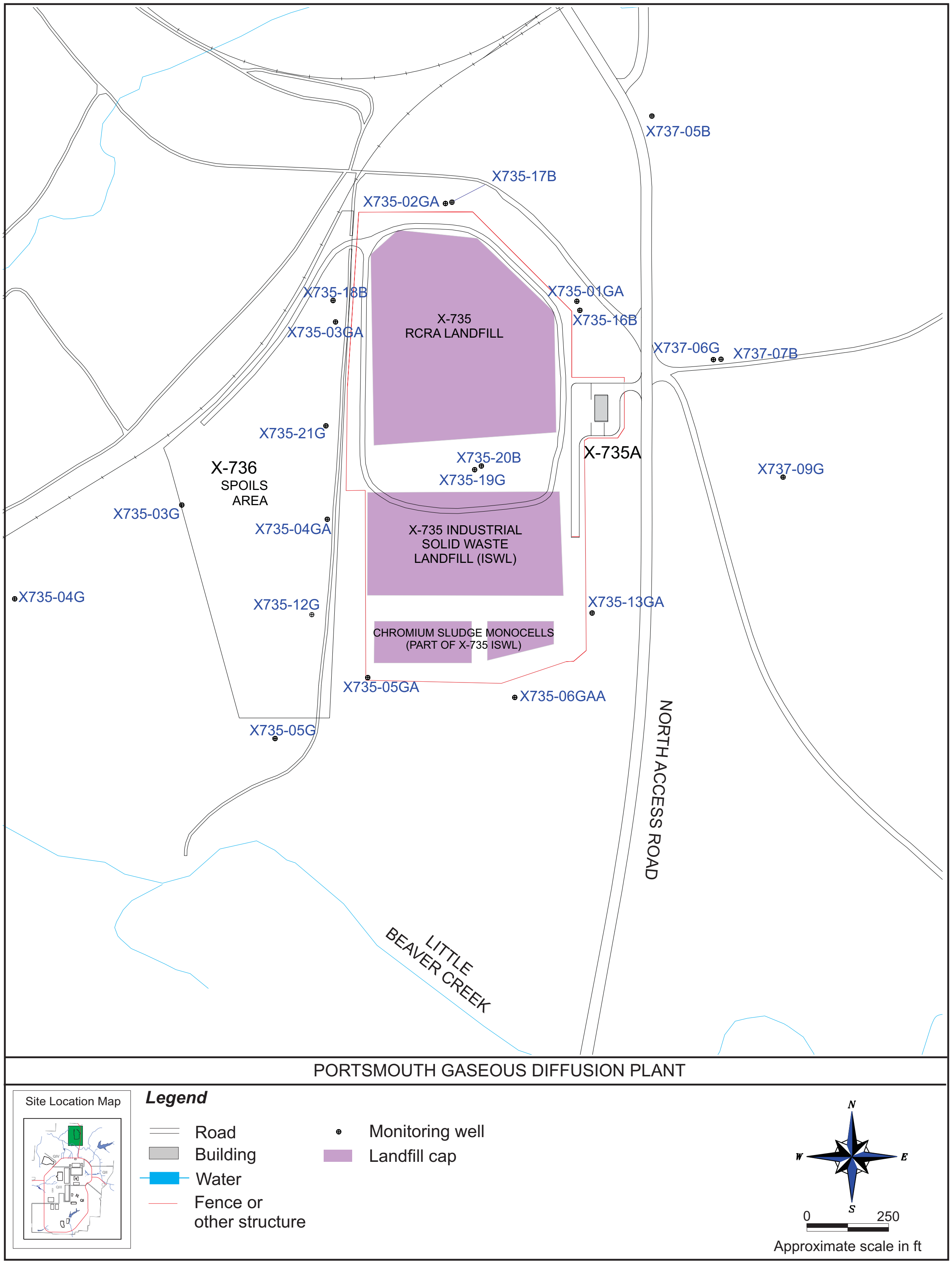

Figure D-2. Integrated monitoring wells X-735 Landfills.

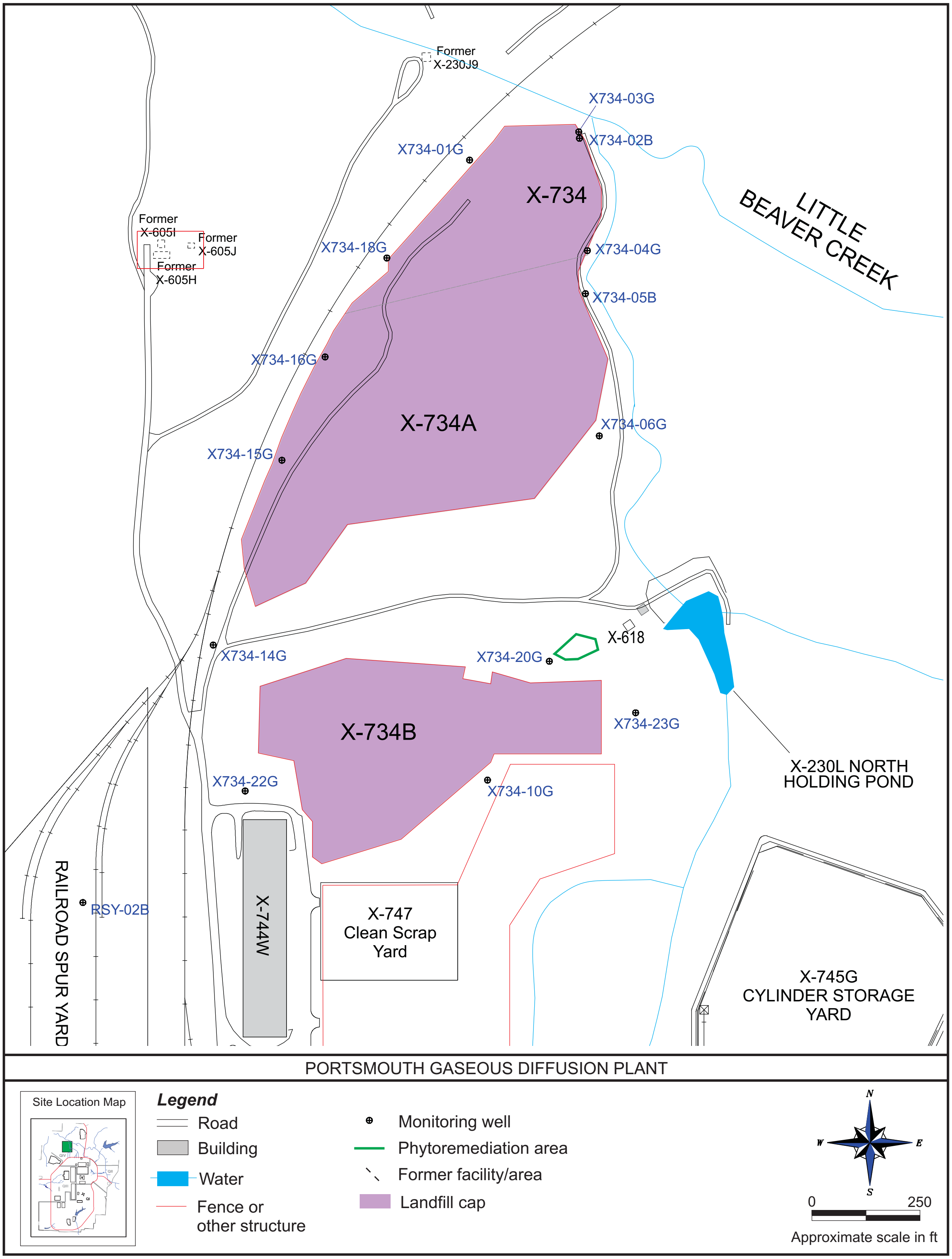

Figure D-3. Integrated monitoring wells X-734 Landfills.

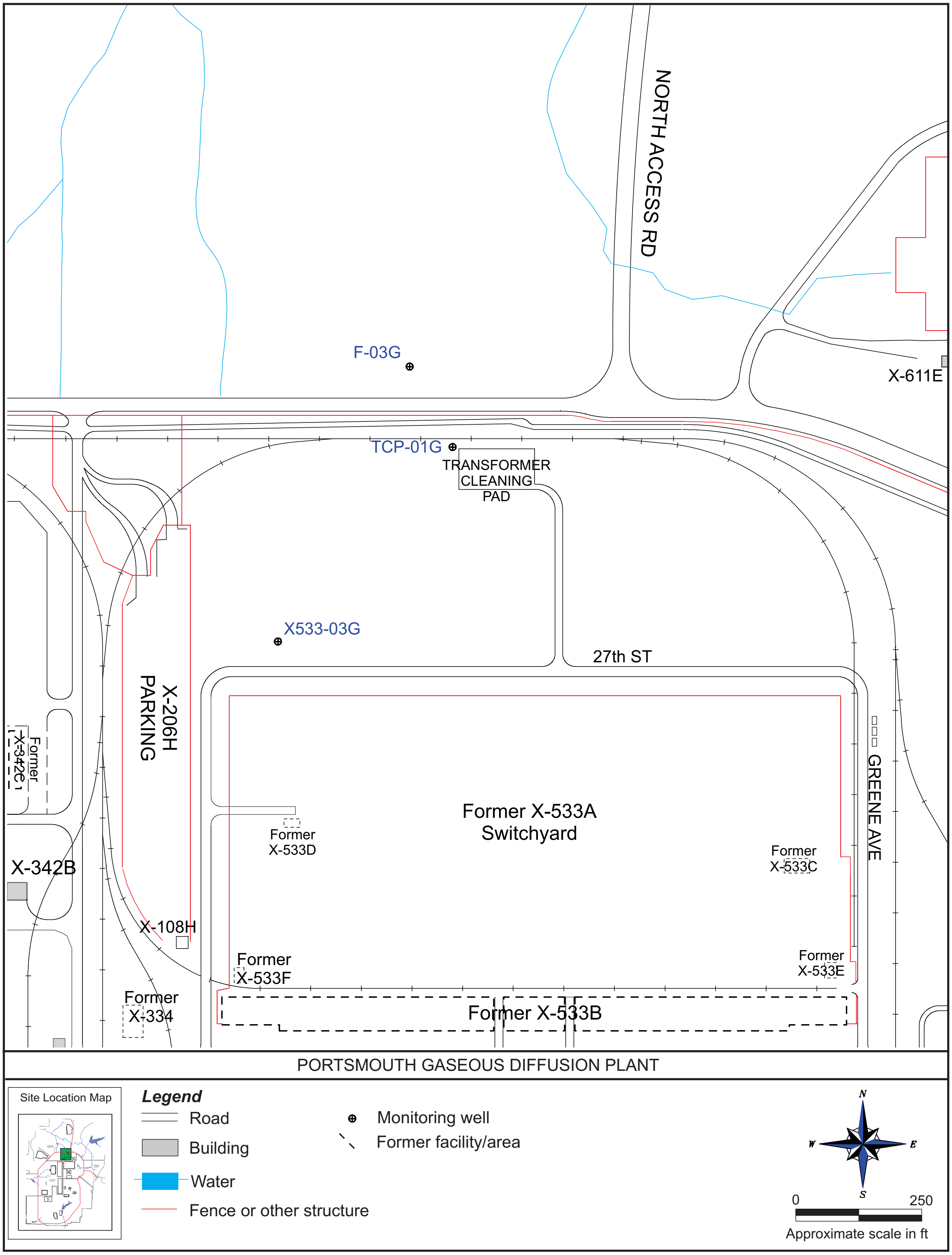

Figure D-4. Integrated monitoring wells X-533 Former Switchyard Complex.

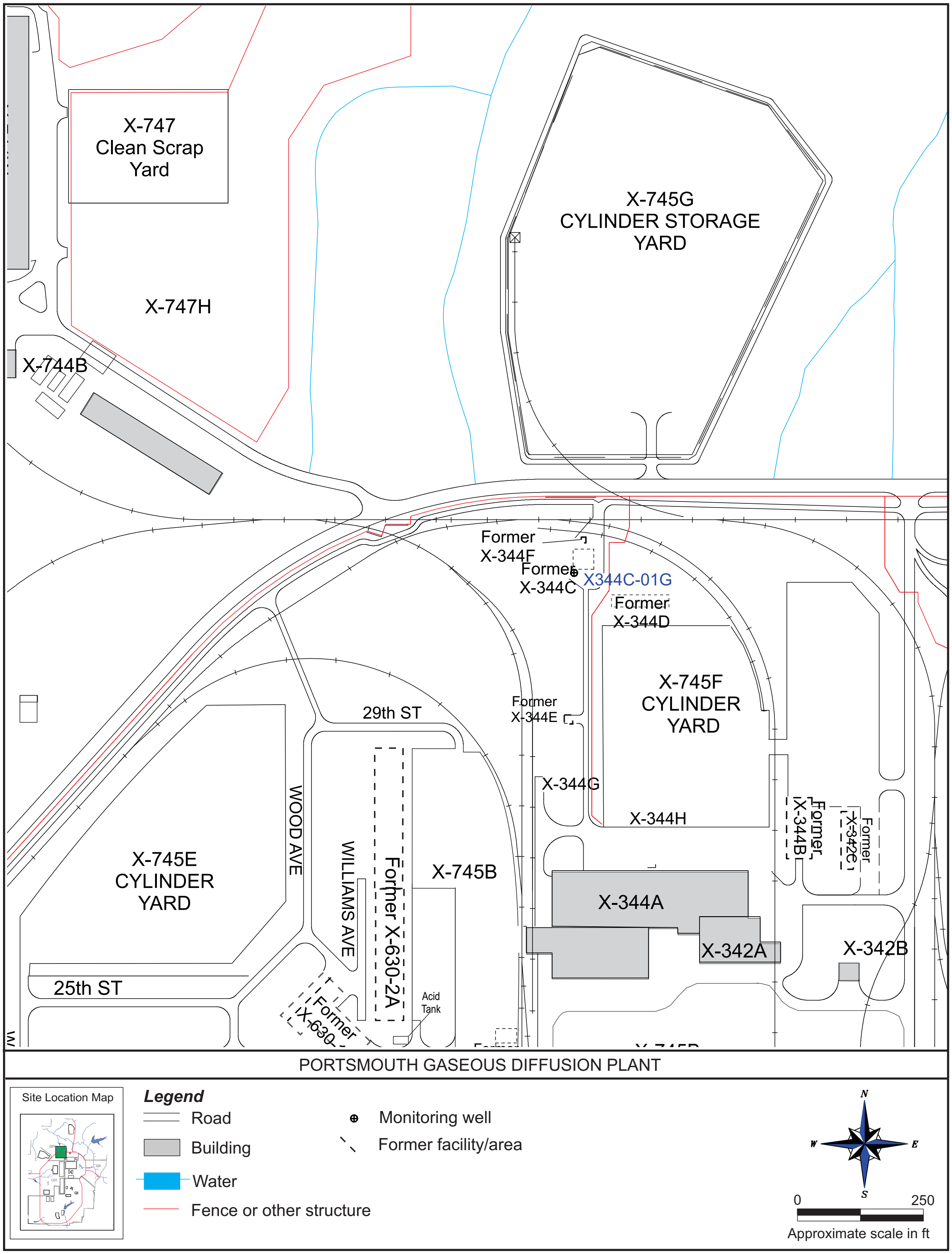

Figure D-5. Integrated monitoring wells X-344C Former Hydrogen Fluoride Storage Building.

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APPENDIX E

SURFACE WATER AND WATER SUPPLY MONITORING SUMMARY TABLES

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TABLES

FIGURE

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Table E-1. Integrated surface water monitoring summary

Location ID	IGWMP sample frequency	IGWMP parameters[a]
BRC-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
BRC-SW02	Quarterly	V1-Q, R1-S, R2-S[b]
BRC-SW05	Quarterly	V1-Q, R1-S, R2-S[b]
EDD-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
LBC-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
LBC-SW02	Quarterly	V1-Q, R1-S, R2-S[b]
LBC-SW03	Quarterly	V1-Q, R1-S, R2-S[b]
LBC-SW04	Quarterly	V1-Q, R1-S, R2-S[b]
NHP-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
UND-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
UND-SW02	Quarterly	V1-Q, R1-S, R2-S[b]
WDD-SW01	Quarterly	V1-Q, R1-S, R2-S[b]
WDD-SW02	Quarterly	V1-Q, R1-S, R2-S[b]
WDD-SW03	Quarterly	V1-Q, R1-S, R2-S[b]

[a]Table 1 defines the parameter suites (V1, R1, and R2). Parameter suites are followed by a letter that indicates the monitoring frequency. S = semiannual; Q = quarterly.
[b]Samples will be analyzed for radionuclides on a quarterly basis. R1 parameters will be analyzed semiannually, and remaining quarterly samples will be analyzed for R2 parameters.

Table E-2. Water supply monitoring summary

Location ID	Location	IGWMP sample frequency	IGWMP parameters[a]
RES-004	64 Bailey Chapel Road (old well)	Semiannual	V1-S, R1-S, R3-S
RES-005	64 Bailey Chapel Road (new well)	Semiannual	V1-S, R1-S, R3-S
RES-012	PORTS plant water supply	Semiannual	V1-S, R1-S, R3-S
RES-014	884 Wakefield Mound Road	Semiannual	V1-S, R1-S, R3-S
RES-015	49 Vanmeter Road	Semiannual	V1-S, R1-S, R3-S
RES-017	2156 Big Run Road	Semiannual	V1-S, R1-S, R3-S
RES-018	3174 Wakefield Mound Road	Semiannual	V1-S, R1-S, R3-S

[a]Table 1 defines the parameter suites (V1 and R1). Parameter suites are followed by a letter that indicates the monitoring frequency. S = semiannual.
Missing numbers represent sites no longer in the program.

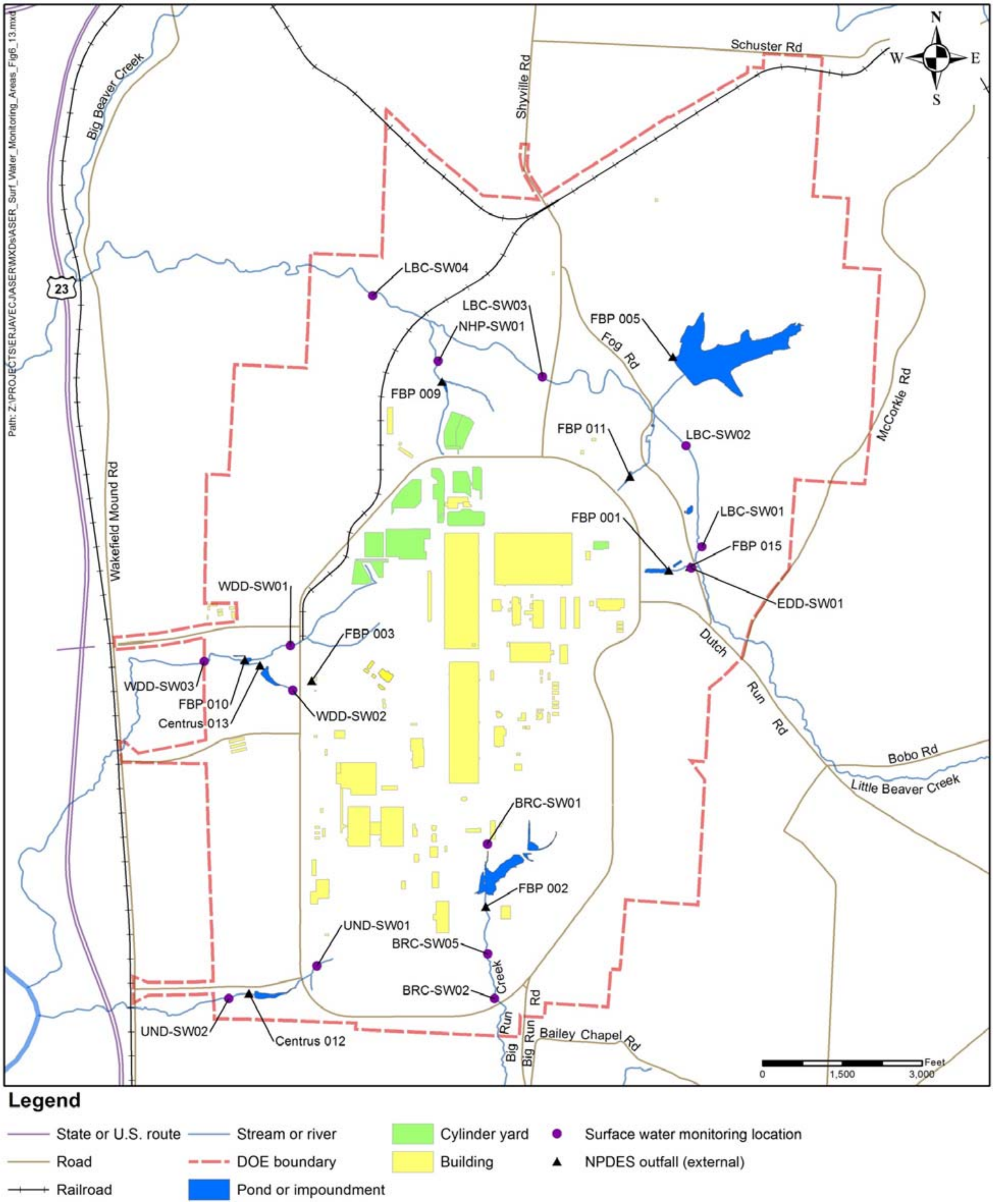

Figure E-1. Integrated surface water monitoring points.

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APPENDIX F

EVALUATION PROCEDURES FOR THE X-749A CLASSIFIED MATERIALS DISPOSAL FACILITY AND X-735 LANDFILLS

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CONTENTS

ACRONYMS

CUSUM	cumulative summation
EPA	Environmental Protection Agency
h	decision internal value
OAC	Ohio Administrative Code
SCL	Shewhart control limit

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F.1. INTRODUCTION

Statistical evaluation of certain parameters is part of the monitoring programs for the X-749A Classified Materials Disposal Facility (Quadrant I) and the X-735 Landfills (Quadrant IV) at the U.S. Department of Energy's Portsmouth Gaseous Diffusion Plant. This appendix provides the statistical evaluation procedures applicable to wells that are part of the monitoring programs for the X-749A and X-735 Landfills. The X-749A Classified Materials Disposal Facility (also called the X-749A Landfill) is currently in detection monitoring. The X-735 Gallia wells are currently evaluated under a corrective measures monitoring program and the X-735 Berea wells are evaluated under a detection monitoring program.

The statistical evaluation procedures provided herein are based on guidelines provided by the American Society of Testing and Materials (2005), Gibbons (2009), and Gibbons (1999). Figure F-1 provides a flow chart of the statistical evaluation approach for detection monitoring. Figure F-2 provides a flow chart of the evaluation approach for corrective measures monitoring. Because it is desirable to minimize false positive errors and the effects of spatial variability, an intra-well statistical analysis is used whenever possible for monitoring at the X-749A Classified Materials Disposal Facility and the X-735 Landfills. Under the intra-well approach, historical compliance well data is used to determine baseline conditions for each compliance well to compare with future monitoring results at these wells. The background well data is used to evaluate suspected trends and their influence on compliance well data to ensure that any increasing trends found in compliance wells are due to actual releases or impacts and are not due to overall increasing trends in background data at the groundwater monitoring area.

The first step is to determine the appropriate type of intra-well statistical comparison method to use. The preferred method is Alternative 1 (intra-well control charts). This method is used in cases where the baseline data contain less than 50% nondetects (i.e., less than half of the results are reported below the analytical reporting limit), in which case one-half the reporting limit will be used in calculating the control limits. In cases where greater than 50% nondetects are present, Alternative 2 (intra-well prediction limits) is used.

For some wells and/or parameters, a sufficient quantity of historical data (at least eight measurements) is not available to develop intra-well control charts or intra-well prediction limits. In these cases, prediction limits based on upgradient/background data will be used until eight historical measurements are available to develop control charts or intra-well upper prediction limits.

The following information is provided herein:

- Detection monitoring wells and indicator parameters for X-749A
- Detection monitoring wells (background and compliance wells) and indicator parameters for X-735
- Corrective measures monitoring wells and parameters for X-735
- Concentration limits applicable to X-735 corrective measures monitoring wells
- Methodology for Alternative 1 – Control charts
- Methodology for Alternative 2 – Prediction limits
- References.

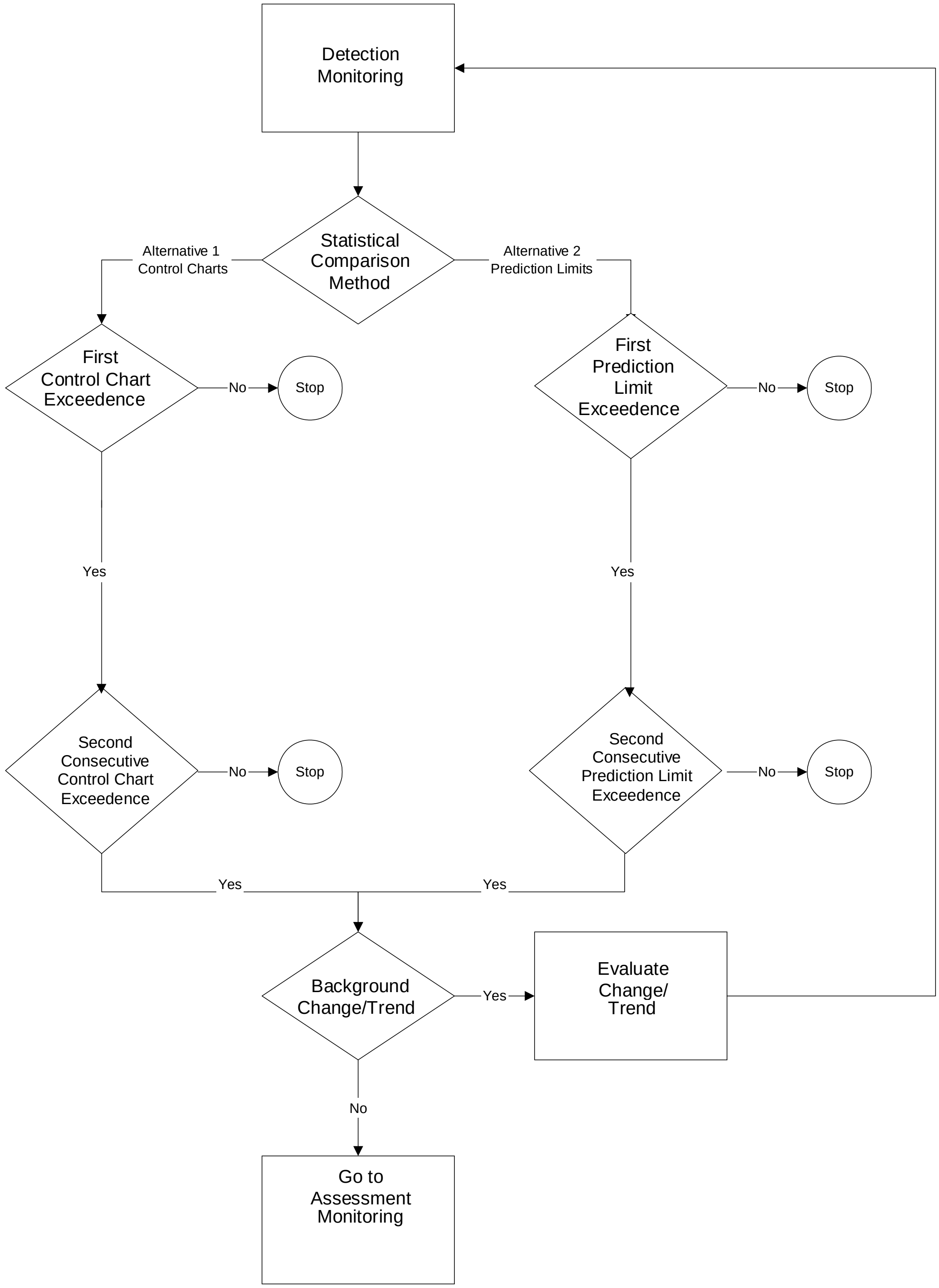
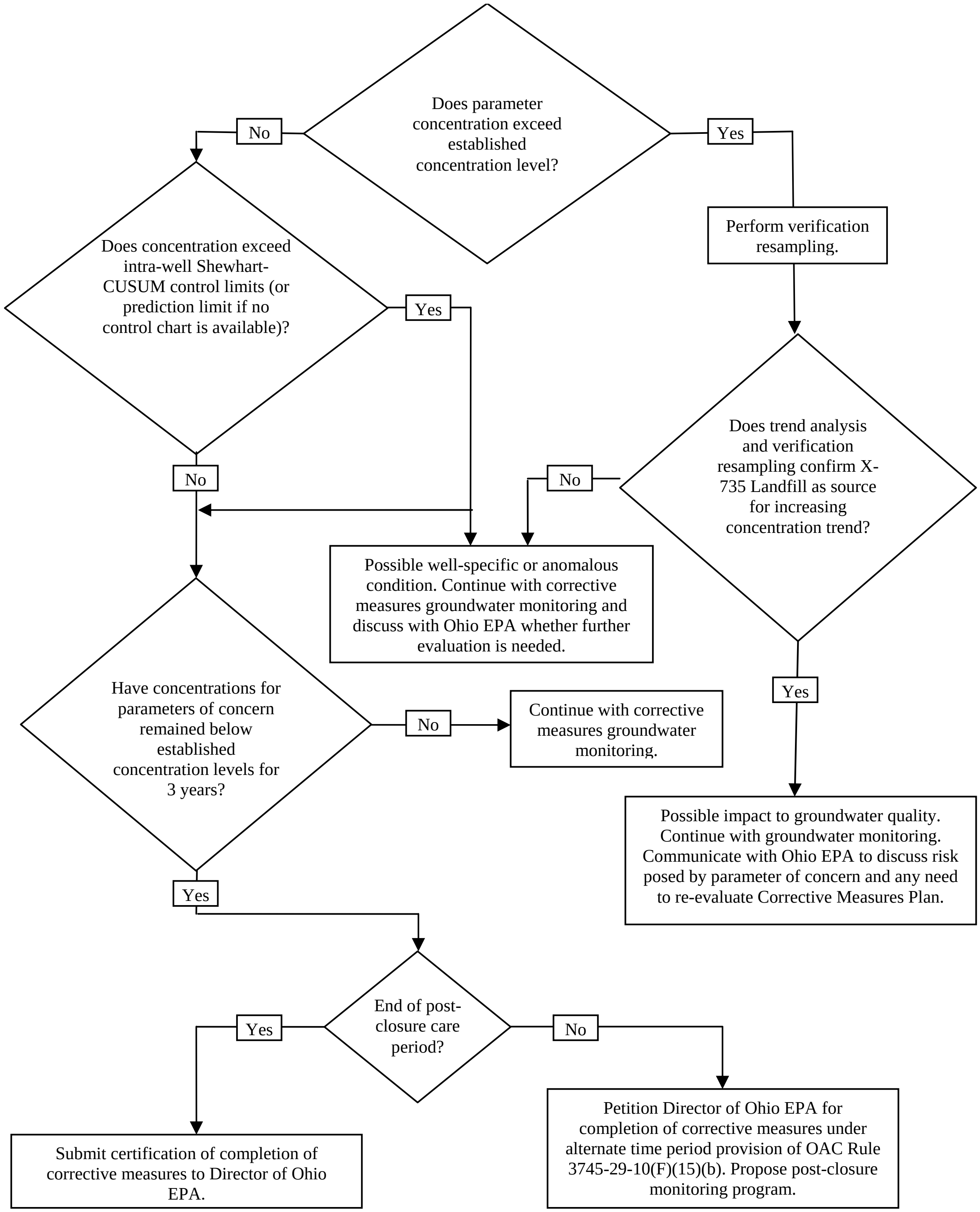


Figure F-1. Statistical evaluation approach for detection monitoring.



Note: The corrective measures monitoring program for Gallia wells at the X-735 Landfills was prepared and approved in accordance with OAC 3745 29-10 effective June 1, 1994, which was required by the 1999 DFF&O that was in effect in 2008 when the Corrective Measure Plan was approved by Ohio EPA.

Figure F-2. Corrective measures monitoring decision logic diagram.

F.2 X-749A CLASSIFIED MATERIALS DISPOSAL FACILITY

Table F-1 lists the wells that comprise the detection monitoring program for the X-749A Classified Materials Disposal Facility. Because of remedial actions in progress at the Quadrant I Groundwater Investigative (5-Unit) Area, groundwater flows in the vicinity of the X-749A Classified Materials Disposal Facility can fluctuate from southeast to southwest. Therefore, background (upgradient) wells and compliance (downgradient) wells at the X-749A can also change. Detection monitoring wells will be sampled as described in Appendix A, Table A-4.

Table F-1. Detection monitoring wells and parameters for the X-749A Classified Materials Disposal Facility

Compliance/background wells		Parameters	
X749A-02G[a]	X749A-03G[b]	Alkalinity, Total	Nitrate/Nitrite
X749A-04G[a]	X749A-07G[c]	Ammonia	Potassium
X749A-12G[d]	X749A-14G[a]	Calcium	Sodium
X749A-16G[a]	X749A-17G[a]	Chloride	Sulfate
X749A-18G[a]	X749A-19G[a]	Iron	

[a]Upgradient or downgradient well based on groundwater flow direction.
[b]Downgradient well
[c]Upgradient well
[d]Side-gradient well (not used as a compliance well for statistical evaluation)

F.3. X-735 LANDFILLS

Table F-2 lists the background (upgradient) wells, compliance (downgradient) wells, and indicator parameters used for the detection monitoring program for Berea wells at the X-735 Landfills.

Table F-2. Background wells, compliance wells, and indicator parameters for the detection monitoring program at the X-735 Landfills

Background wells	Compliance wells	Indicator parameters		
X735-16B	X735-17B	Alkalinity, Total	Chloride	Potassium
X737-05B	X735-18B	Ammonia	Iron	Sodium
X737-07B		Calcium	Nitrate/Nitrite	Sulfate

Table F-3 lists the wells that comprise the corrective measures monitoring program for the X-735 Landfills. Monitoring wells that are part of the corrective measures monitoring program will also be sampled as described in Appendix D, Table D-2.

Table F-3. Corrective measures monitoring wells and parameters for the X-735 Landfills

Background wells	Compliance wells	Parameters
X735-01GA	X735-02GA	Alkalinity, Total
X735-13GA	X735-03GA	Chloride
X737-06G	X735-04GA	Dissolved Solids, Total
X737-09G	X735-05GA	Sodium
	X735-06GAA	Sulfate
	X735-21G	Cobalt
	X735-03G[a]	Mercury
	X735-04G[a]	Nickel
	X735-05G[a]	
	X735-12G[a]	

[a]Former X-735 assessment monitoring well to be sampled once every three years beginning in 2008.

Groundwater samples will continue to be collected at wells X735-19G and X735-20B; however, these wells are not listed in the tables above because they are located in the buffer zone between the northern and southern portions of the landfill. Therefore, a statistical exceedence in any indicator parameter or corrective measures monitoring parameter at these wells does not correspond with a release from the overall landfill unit.

In support of the *Corrective Measures Plan for the X-735 Landfill* approved by Ohio EPA in March 2008, analytical results for the corrective measures monitoring parameters are evaluated as summarized in Figure F-2. Table F-4 provides the concentration limits for the monitoring parameters of concern in the downgradient X-735 wells. Analytical results from each sampling event are compared to these concentration limits. If the concentration limits are not exceeded, statistical evaluations are completed on an annual basis to determine whether statistically significant increases in parameters of concern have occurred in the downgradient wells.

Table F-4. Concentration limits applicable to downgradient X-735 wells

Parameter	Limit
Alkalinity, Total	434 mg/L
Chloride	250 mg/L
Cobalt	153 µg/L
Mercury	2 µg/L
Nickel	100 µg/L
Sodium	250 mg/L
Sulfate	500 mg/L
Dissolved Solids, Total	500 mg/L

F.4. ALTERNATIVE 1 –CONTROL CHARTS

Intra-well Shewhart-CUSUM (cumulative summation) control charts are constructed using historical baseline data for each compliance well. Initially, eight samples representing the previous eight sampling rounds were used to represent the baseline. Control charts are constructed showing two control limits calculated using the baseline compliance well data. The Shewhart control limit (SCL) is sensitive to rapid increases in compliance well concentrations, while the decision internal value (*h*) threshold, or limit, is sensitive to gradual concentration increases.

The CUSUM control chart is designed to indicate a "long-term" trend or accumulation above baseline and is used as an internal indicator for the early detection of gradual concentration increases at a well, but shall not be used to determine a statistically significant change requiring notification under OAC 3745-30-08(D)(8). The Shewhart control chart is designed to indicate a "short-term" or immediate spike in the concentration of an indicator parameter in a compliance well and shall be used to determine whether a statistically significant change has occurred requiring notification to Ohio EPA under OAC 3745-30-08(D)(8).

Control Limits. The SCL and *h* limits used for the control charts are based on the goal of attaining a site-wide 5% false positive rate while maintaining at least a 20% false negative rate (or 80% statistical power). Gibbons (1999) provides tables used to establish appropriate thresholds. In addition, verification resampling is incorporated into the control chart scheme if necessary to achieve the 5%/20% goal. An additional parameter (k) is used in calculating the CUSUM for future compliance well data, which are then compared to the *h* threshold. Selection of the k value (commonly selected to be approximately one-half the size of an important displacement, D) in conjunction with the *h* threshold is such that together they allow a displacement of two standard deviations (above baseline) to be detected quickly (i.e., between sampling rounds).

Updating Baseline Data. Baseline data are updated in groups of four or more statistically independent samples. These data are added to the original pooled historical compliance well data used for calculating the baseline. The SCL and *h* limits are then recalculated for comparisons with subsequent samples.

Background Trend Analysis. Periodically, the upgradient (background) well data may be tested for trends to ensure that apparent trends in compliance well data (shown on the control charts) are due to actual trends and not due to trends in background well concentrations. A trend analysis using the Mann-Kendall test may be conducted when a control chart exceedence occurs. If increasing trends in background are identified, the compliance well data may be de-trended using the procedure detailed in Gibbons (2009), and the control charts adjusted accordingly.

F.5. ALTERNATIVE 2 –PREDICTION LIMITS

Nonparametric or Poisson prediction limits are calculated in cases where the percentage of nondetects exceeds 50%. In these cases, the pooled historical compliance well data (and possibly background well data) is used to calculate the prediction limits. Pooling of the historical compliance well data is necessary to obtain sufficient numbers of baseline/background data to attain a site-wide false positive rate of approximately 5% ($\alpha^* \sim 0.05$) using an individual test false positive rate of approximately 1% ($\alpha \sim 0.01$). These performance standards are consistent with OAC 3745-30-08(C)(6)(b) and Federal regulations promulgated by U.S. EPA and codified in Title 40 of the *Code of Federal Regulations* Part 264, Subpart F, which are designed to provide an adequate balance between the site-wide and individual test false positive rates.

For some wells and/or parameters, a sufficient quantity of historical data (at least eight measurements) are not available to develop control charts or non-parametric/Poisson prediction limits. In these cases, prediction limits based on upgradient/background data will be used until eight historical measurements are available to develop control charts or non-parametric/Poisson upper prediction limits.

Updating Baseline Data. Baseline data are updated in groups of four or more statistically independent samples. These data are added to the original pooled historical compliance well data used for calculating the initial prediction limit. The upper prediction limit is then recalculated for comparisons with subsequent samples.

Background Trend Analysis. As with the control chart approach, the upgradient (background) well data may be evaluated when prediction limit exceedences occur to ensure that apparent prediction limit exceedences in compliance well data are due to actual exceedences and not due to changes in background well concentrations. If required, the evaluation will include trend analysis using the Mann-Kendall test. If changes in background are identified, including increasing trends in background, the background data may be added to the pooled historical compliance well data for purposes of calculating the prediction limits. This is necessary to minimize false positives due to background changes over time.

F.6. REFERENCES

American Society for Testing and Materials 2005. *Standard Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs,* (Method D6312-98[2005]).

Gibbons, R.D. 2009. *Statistical Methods for Groundwater Monitoring*, John Wiley & Sons, Inc.

Gibbons, R.D. 1999. "Use of Combined Shewhart-CUSUM Control Charts for Ground Water Monitoring Applications", *Ground Water*, V. 37, No. 5, p. 682.

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APPENDIX G

OHIO ADMINISTRATIVE CODE (OAC) 3745-30-08 GROUNDWATER MONITORING PROGRAM FOR AN INDUSTRIAL SOLID WASTE LANDFILL FACILITY

(FEBRUARY 1, 2008)

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3745-30-08 **Ground water monitoring program.**

(A) Applicability.

(1) The owner or operator, of any new residual or industrial solid waste landfill facility, of all lateral and vertical expansions of any existing residual or industrial solid waste landfill facility, of any facility where the owner or operator is required to submit a permit to install application in response to division (A)(3) or (A)(4) of section 3734.05 of the Revised Code, and of any landfill facility undergoing closure according to rule 3745-30-09 of the Administrative Code or rule 3745-29-11 of the Administrative Code, shall implement and maintain a ground water monitoring program capable of determining the impact of the landfill facility on the quality of ground water occurring within the uppermost aquifer system and all significant zones of saturation above the uppermost aquifer system underlying the landfill facility. The ground-water monitoring program shall comply with paragraphs (B) to (F) of this rule and shall be protective of human health and safety and the environment. The ground water monitoring program shall be documented as a written ground water monitoring program plan and submitted to the director as part of a landfill facility's permit to install application or closure plan. The ground water monitoring program plan shall describe the owner or operator's program and how the plan complies with this rule. The ground water monitoring program shall be implemented when the director issues final approval of the permit to install application or closure plan. The owner or operator shall use the methods documented in the plan. Changes to an approved plan shall be submitted to Ohio EPA sixty days before implementation of those changes.

(2) The owner or operator of an industrial solid waste landfill facility, permitted and operating under Chapter 3745-29 of the Administrative Code, subject to any operational requirements in rule 3745-29-19 of the Administrative Code, subject to any closure requirements in rule 3745-29-11 of the Administrative Code, or subject to any post-closure requirements in rule 3745-29-14 of the Administrative Code, shall comply with the requirements of this rule and as follows:

(a) A ground water monitoring plan previously submitted as part of an industrial solid waste landfill facility permit to install or closure plan shall be revised to comply with this rule and submitted to Ohio EPA within two hundred seventy days after the effective date of this rule. The previously submitted plan shall remain in effect until sixty days after the revised plan is submitted.

(b) Unless otherwise ordered, an alternate parameter list previously approved by the director or his authorized representative shall remain in effect.

[Comment: The owner/operator of an industrial solid waste landfill regulated under rule 3745-29-10 of the Administrative Code is only required to revise the portions of their current ground water monitoring plan that do not comply with this rule and are not required to submit a whole new plan. All variance approvals issued per rule 3745-29-10 of the Administrative Code continue in effect.]

(c) A permit applicant acting to comply with paragraph (C)(3)(e) of rule 3745-29-06 of the Administrative Code shall analyze the ground water for all of the parameters in appendix III (H) of this rule.

(d) An owner or operator acting to comply with paragraph (M)(5) of rule 3745-29-19 of the Administrative Code shall analyze the leachate for all of the parameters in appendix III (H) of this rule.

(B) Monitoring system.

(1) The ground water monitoring system shall include a sufficient number of wells, installed at appropriate locations and depths, to yield ground water samples from both the uppermost aquifer system and any significant zones of saturation that exist above the uppermost aquifer system that do the following:

(a) Represent the quality of the ground water that has not been affected by past or present operations at the landfill facility.

(b) Represent the quality of the ground water passing directly downgradient of the limits of solid waste placement.

(c) Based on site-specific situations, surface water monitoring of seeps, springs, or streams in addition to or as a partial alternative to the ground water monitoring may be proposed by the owner or operator or may be required by the director.

[Comment: The director's authorization to conduct surface water monitoring under this rule should include provisions for: sampling procedures; constituents to be analyzed; and analyzing the resulting data.]

(2) Where the uppermost aquifer system exists more than one hundred fifty feet beneath base of the waste or the recompacted clay liner of the landfill facility, the ground water monitoring system shall consist of a sufficient number of wells, installed at appropriate locations and depths, to yield ground water

samples from an adequate number of significant zones of saturation, in accordance with paragraphs (B)(1)(a) and (B)(1)(b) of this rule, to ensure detection of any contaminant release from the facility.

(3) All monitoring wells, included in the ground water monitoring program shall be designed, installed, and developed in a manner that allows the collection of ground water samples that are representative of ground water quality in the geologic unit being monitored, and in accordance with the following criteria:

(a) Monitoring wells shall be cased in a manner that maintains the integrity of the monitoring well boreholes.

(b) The annular space (i.e., the space between the borehole and the well casing) above the sampling depth shall be sealed to prevent the contamination of the samples and the ground water.

(c) The casing shall be screened or perforated and surrounded by sand or gravel in such a way that allows for the following:

(i) For the minimization of the passage of formation materials into the well.

(ii) For the monitoring of discrete portions of the uppermost aquifer system or any significant zones of saturation above the uppermost aquifer system.

(d) The design, installation, development, maintenance procedures, and abandonment of any monitoring wells, piezometers, and other measurement, sampling, and analytical devices shall be documented in the ground water monitoring program plan.

(e) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices shall be operated and maintained to perform to design specifications throughout the life of the ground water monitoring program.

(f) Monitoring wells constructed or used for the purposes of this rule are not required to comply with Chapter 3745-9 of the Administrative Code.

(4) The number, spacing, and depth of ground water monitoring wells, included in the ground-water monitoring system shall be as follows:

(a) Based on site-specific hydrogeologic information.

(b) Capable of detecting a release from the landfill facility to the ground water at the closest practicable location to the limits of solid waste placement.

(5) Unless the ground water is monitored to satisfy the requirements of paragraphs (E) and (F) of this rule, the owner or operator shall, at least annually, evaluate the ground water surface elevation data obtained in accordance with paragraph (C)(2) of this rule to determine whether the requirements of paragraph (B) of this rule for locating the monitoring wells continue to be satisfied. The results of this evaluation shall be included in the report required in accordance with rule 3745-30-14 of the Administrative Code. If the evaluation shows that paragraph (B) of this rule is no longer satisfied, the owner or operator shall immediately modify the number, location, and/or depth of the monitoring wells to bring the ground-water monitoring system into compliance with this requirement.

(C) Sampling, analysis, and statistical methods.

(1) The ground water monitoring program shall include consistent sampling and analysis procedures that are protective of human health and safety and the environment and that are designed to ensure monitoring results that provide an accurate representation of ground water quality at the background and downgradient wells installed in accordance with paragraph (B) of this rule. Sampling and analysis procedures employed in the ground water monitoring program shall be documented in a sampling and analysis plan which shall be included in the ground water monitoring program plan required by paragraph (A) of this rule, and which shall also be available for inspection at the landfill facility. The owner or operator shall use the methods documented in the sampling and analysis plan. Changes to the plan shall be submitted to Ohio EPA sixty days before implementation. This plan shall, at a minimum, include a detailed description of the equipment, procedures, and techniques to be used for the following:

(a) Measurement of ground water elevations.

(b) Collection of ground water samples, including the following:

(i) Well evacuation.

(ii) Sample withdrawal.

(iii) Sample containers and handling.

(iv) Sample preservation.

(c) Performance of field analysis, including the following:

(i) Procedures and forms for recording raw data and the exact location, time, and facility-specific conditions associated with the data acquisition.

(ii) Calibration of field devices.

(d) Decontamination of equipment.

(e) Analysis of ground water samples.

(f) Chain of custody control, including the following:

(i) Standardized field tracking reporting forms to record sample custody in the field prior to and during shipment.

(ii) Sample labels containing all information necessary for effective sample tracking.

(g) Field and laboratory quality assurance and quality control, including the following:

(i) Collection of replicate samples.

(ii) Submission of field-bias blanks.

(iii) Potential interferences.

(2) Ground water elevations shall be measured within a single twenty-four-hour period in all monitoring wells at least semi-annually and in each well prior to purging and sampling. The owner or operator shall determine, for the uppermost aquifer system and for all significant zones of saturation monitored, the direction of ground-water flow at least semi-annually. The ground water elevations and direction(s) of flow shall be shown on a

potentiometric map(s) submitted with the sampling data.

(3) The owner or operator shall establish background ground water quality, unless the exception in paragraph (C)(4) of this rule applies, by analyzing ground water samples collected from hydraulically upgradient well(s) for each of the monitoring parameters or constituents required in the particular ground water monitoring program that applies to the landfill facility as determined by paragraph (D), (E), or (F) of this rule.

(4) Background ground water quality at existing landfill facilities may be based on sampling of wells that are not hydraulically upgradient where the following occur:

(a) Hydrogeologic conditions do not allow the owner or operator to determine which wells are upgradient.

(b) Sampling of other wells will provide an indication of background ground water quality that is as representative or more representative than that provided by upgradient wells.

(5) The owner or operator shall, within ninety days of obtaining the final sample which completes the initial year of ground water monitoring, specify one of the following statistical methods to be used in evaluating ground water monitoring data. The statistical method chosen shall be conducted separately for each of the parameters required to be statistically evaluated in paragraph (D)(4) of this rule. The statistical method specified shall ensure protection of human health and safety and the environment and shall comply with the performance standards outlined in paragraph (C)(6) of this rule. The statistical method specified shall be selected from the following:

(a) A tolerance or prediction interval procedure in which an interval for each parameter is established from the distribution of the background data, and the level of each parameter in each monitoring well is compared to the upper tolerance or prediction limit.

(b) A control chart approach that gives control limits for each parameter.

(c) A parametric analysis of variance ("ANOVA") followed by multiple comparisons procedures to identify statistically significant evidence of contamination. This shall include estimation and testing of the contrasts between each monitoring well's mean and the background mean levels for each parameter.

(d) An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. This shall include estimation and testing of the contrasts between each monitoring well's median and the background medial levels for each parameter.

(e) Another statistical test method submitted by the owner or operator and approved by the director or his authorized representative.

(6) Any statistical method chosen in accordance with paragraph (C)(5) of this rule shall comply with the following performance standards as appropriate:

(a) The statistical method used to evaluate ground water monitoring data shall be appropriate for the distribution of chemical parameters or waste-derived constituents. If the distribution of the chemical parameters or waste-derived constituents is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(b) If an individual well comparison procedure is used to compare an individual monitoring well constituent concentration with background constituent concentrations or a ground water concentration level, the test shall be conducted at a type I error level not less than 0.01 for each testing period. If multiple comparisons procedures are used, the type I experimentwise error rate for each testing period shall be not less than 0.05; however, the type I error rate of not less than 0.01 for individual monitoring well comparisons shall be maintained. This performance standard does not apply for tolerance intervals, prediction intervals, or control charts.

(c) If a control chart approach is used to evaluate ground water monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and safety and the environment. The parameter values shall be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration values for each parameter.

(d) If a tolerance interval or a prediction interval is used to evaluate ground water monitoring data, then the levels of confidence and the percentage of the population contained in any tolerance or prediction interval shall be protective of human health and safety and the environment. These statistical parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(e) The statistical method shall account for data below the limit of detection with one or more statistical procedures that ensure protection of human health and safety and the environment. Any practical quantitation limit (PQL) used in the statistical method shall be the lowest concentration level that can be reliably achieved within the specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(f) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

(g) Background data can be added only in blocks of data resulting from the analysis of four or more statistically independent samples after the data have been statistically compared to the current background data and no statistical differences are detected, unless another method is deemed acceptable to the director.

(h) Prior to initially using an intra-well statistical method for the detection monitoring program, the owner or operator shall demonstrate the ground water is not impacted by a release from the landfill facility within the relevant well(s), unless approved otherwise by Ohio EPA.

(7) The owner or operator shall determine whether or not there is a statistically significant increase (or change in the case of pH) from background values for each parameter or constituent required by paragraph (D), (E), or (F) of this rule, as applicable. The owner or operator shall make this statistical determination either semi-annually, if paragraph (D) of this rule applies, or as specified in the ground water quality assessment plan required by paragraph (E) of this rule if that paragraph applies, or as specified by the director in the corrective measure selected in accordance with paragraph (F) of this rule if that paragraph applies. To determine whether a statistically significant increase or decrease has occurred, the owner or operator shall compare the ground water quality of each parameter or constituent at each downgradient ground water monitoring well to the background value of that parameter or constituent according to the statistical procedures specified in paragraphs (C)(5) and (C)(6) of this rule.

(8) All ground water analysis results, statistical analysis results, and ground-water elevation data generated in accordance with paragraphs (C), (D), (E), and (F) of this rule shall be submitted to Ohio EPA not later than seventy-five days after sampling the well. All ground water data and accompanying text shall be submitted on a form specified by the director.

(D) Detection monitoring.

(1) The owner or operator shall determine the concentration or value of the applicable parameters from the applicable list(s) in appendix III of this rule for the owner or operator's waste(s). The concentration or value shall be determined in accordance with paragraphs (D)(3) to (D)(6) of this rule.

(2) The owner or operator of a residual or industrial waste landfill may propose an alternate list of parameters to meet the requirements of paragraphs (D)(3) to (D)(6) of this rule. The list of alternate parameters shall be submitted by the owner or operator and approved by the director prior to use. The alternate parameter list shall be indicative of the waste stream(s) deposited at the landfill facility and shall be protective of human health and safety and the environment. In proposing the alternate parameter list, the owner or operator shall, at a minimum, specify the following:

(a) The parameters to be analyzed in the ground water samples during the initial year of ground water monitoring in accordance with paragraph (D)(3) of this rule.

(b) The parameters to be analyzed in the ground water samples at least semi-annually in accordance with paragraph (D)(4) of this rule.

(c) The parameters to be analyzed in the ground water samples at least annually after the initial year in accordance with paragraph (D)(5) of this rule.

(d) The parameters specified in paragraph (D)(2)(b) of this rule to have their analytical results statistically evaluated in accordance with paragraph (D)(4) of this rule.

(e) The chemical composition of the solid waste(s) which have been, and are to be, deposited at the landfill facility.

(f) The chemical composition of leachate, if available, from an existing landfill facility being used to dispose of a similar waste(s).

(g) Any other relevant information that the director deems necessary.

(3) During the initial year of ground water monitoring, which shall commence prior to waste placement for newly permitted landfill facilities, the initial background concentrations or values shall be established for the background water quality parameters specified either in appendix III of this rule for the owner or operator's waste(s) or in the alternate parameter list approved in accordance with paragraph (D)(2) of this rule. The sampling frequency shall be at least quarterly for the initial year of ground water monitoring. The number and kinds of samples collected to establish background water quality for those background water quality parameters which are also listed as indicator parameters for the owner or operator's waste(s) in appendix III of this rule, shall be consistent with the appropriate statistical procedures employed pursuant to paragraphs (C)(5) and (C)(6) of this rule. The sample size shall be as large as necessary to ensure with reasonable confidence that a contaminant release from the facility will be detected. The sampling frequency shall assure, to the greatest extent technically feasible, that an independent sample is obtained, by reference to the monitored zone of saturation, effective porosity, hydraulic conductivity, hydraulic gradient, and the fate and transport characteristics of the potential contaminants.

(4) After the initial year, all monitoring wells shall be sampled at least semi-annually and the samples analyzed for the indicator parameters specified either in appendix III of this rule for the owner or operator's waste(s) or in the alternate parameter list approved in accordance with paragraph (D)(2) of this rule. The owner or operator shall statistically analyze the results for these required indicator parameters in accordance with paragraph (C)(7) of this rule. The number and kinds of samples collected shall be consistent with the statistical method used to analyze the data and shall be as often as necessary to ensure, with reasonable confidence, that a contaminant release to the ground water from the facility will be detected.

(5) After the initial year, all monitoring wells shall be sampled at least annually and the samples analyzed for the water quality annual parameters specified either in appendix III of this rule for the owner or operator's waste(s) or in the alternate parameter list approved in accordance with paragraph (D)(2) of this rule.

(6) Ground water samples shall be field analyzed for temperature, specific conductance, and pH whenever a sample is withdrawn from a monitoring well.

(7) An alternative frequency for ground water sampling and/or statistical analysis required by paragraph (D)(5) of this rule may be proposed, in writing, by the owner or operator during the active life (including final closure) of a landfill facility and the post-closure care period. The director or his authorized representative may approve a proposed alternative frequency provided that the alternative sampling frequency and/or analysis frequency is not more than annually. Upon approval by the director or his authorized representative, the owner or operator may use the alternative sampling/analysis frequency. The owner or operator shall, at a minimum, consider the following factors in proposing an alternative sampling and/or analysis frequency:

(a) Lithology of the aquifer system and all stratigraphic units above the uppermost aquifer system.

(b) Hydraulic conductivity of the uppermost aquifer system and all stratigraphic units above the uppermost aquifer system.

(c) Ground water flow rates for the uppermost aquifer system and all zones of saturation above the uppermost aquifer system.

(d) Minimum distance between the upgradient edge of the limits of waste placement of the landfill facility and the downgradient monitoring well system.

(e) Resource value of the uppermost aquifer system.

(8) If at any monitoring well, the owner or operator determines, for two consecutive semi-annual statistical determination periods, that there has been a statistically significant increase (or change in the case of pH) from background values for one or more of the applicable indicator parameters specified in appendix III of this rule according to the statistical method specified by the owner or operator pursuant to paragraphs (C)(5), (C)(6), and (D)(9) of this rule, the owner or operator shall notify Ohio environmental protection agency not later than fifteen days after receiving the second period's statistical or analytical results which indicate a statistically significant change. The notification must indicate which parameters have shown a statistically significant change from background levels.

(9) The owner or operator may demonstrate that a source other than the landfill facility is the cause of the contamination or that the statistically significant increase results from error in the sampling, analysis, or statistical evaluation, or from natural variation in ground water quality.

(a) When resampling demonstrates the increase to be an error, the resampling results shall be submitted to Ohio EPA in accordance with paragraph (C)(8) of this rule. If the owner or operator demonstrates using a resampling method that the statistically significant increase over background was a false positive, then the owner or operator may return to detection monitoring. The owner or operator shall comply with paragraphs (D)(8) to (D)(12) of this rule until this demonstration is submitted.

(b) When the owner or operator demonstrates that the statistically significant increase to be an error in statistical procedure or from natural variation in ground water quality, a report documenting this demonstration shall be submitted as an addendum to the results and data required in paragraph (C)(8) of this rule for approval by the director or his authorized representative. The owner or operator shall comply with paragraphs (D)(8) to (D)(12) of this rule until the demonstration report is approved.

(10) The owner or operator shall, within fifteen days of notifying Ohio EPA in accordance with paragraph (D)(8) of this rule, sample the leachate and/or the affected well(s) and analyze for constituents as follows:

(a) For facilities with leachate collection systems completely or partially underlying the waste disposal area, comply with one of the following:

(i) For facilities not characterizing their leachate, class I residual waste facilities, and industrial solid waste facilities, the leachate collection system shall be sampled and analyzed for those parameters listed in appendix II of rule 3745-27-10 of the Administrative Code and then within seventy-five days of sampling the leachate collection system, the affected well(s) shall be sampled and analyzed for the waste-derived constituents detected in the sample(s) from the leachate collection system, unless otherwise approved by the director or his authorized representative.

(ii) For class II, III, and IV residual waste facilities with previously characterized leachate in accordance with paragraph (F) of rule 3745-30-03 of the Administrative Code, rule 3745-30-04 of the Administrative Code, or rule 3745-30-14 of the Administrative Code, the affected well(s) shall be sampled and analyzed for all waste-derived constituents that have been detected and reported in the leachate.

(b) For facilities without leachate collection systems comply with one of the following:

(i) For facilities not characterizing their leachate, class I residual waste facilities, and industrial solid waste facilities, the affected well(s) shall be sampled and analyzed for those parameters listed in appendix II of rule 3745-27-10 of the Administrative Code, unless otherwise approved by the director or his authorized representative.

(ii) For class II, III, and IV residual waste facilities, the affected well(s) shall be sampled and analyzed for those parameters listed in appendix II of this rule, unless otherwise approved by the director or his authorized representative.

(11) The owner or operator shall, within ninety days of sampling the affected well(s) in accordance with paragraph (D)(10) of this rule, sample all background wells for all waste-derived constituents detected in the samples from the affected well(s).

(12) The owner or operator shall, within ninety days of sampling the background wells as required by paragraph (D)(11) of this rule, sample all monitoring wells not sampled in accordance with the provisions of paragraphs (D)(10) and (D)(11) of this rule and those samples shall be analyzed for those waste-derived constituents found to be above background levels in the affected monitoring wells sampled in accordance with paragraph (D)(10) of this rule.

(13) If the owner or operator determines, based on the results of the sampling required by paragraph (D)(10), (D)(11), or (D)(12) of this rule, that there has not been an increase above background levels of waste-derived constituents at any monitoring well downgradient of the facility, then the owner or operator shall request that the director approve reinstatement of the detection monitoring program described in paragraphs (C) and (D)(1) to (D)(8) of this rule. Until the director or his authorized representative approves reinstatement of the detection monitoring program, the owner or operator shall continue to comply with paragraphs (D)(10) to (D)(12) and (E) of this rule.

(14) The director may consider the following information submitted by the owner or operator when evaluating a request made under paragraphs (D)(13), (E)(5), and (E)(7) of this rule:

(a) The type of constituents and concentrations found in ground water monitoring wells at the facility;

(b) The ground water use and quality in the vicinity of the facility; and

(c) Potential threats to human health or safety and the environment.

(E) Assessment

(1) The owner or operator shall, within one hundred eighty days of conducting the sampling required under paragraph (D)(12) of this rule, submit to Ohio EPA and implement a specific plan for a ground water quality assessment program to determine the concentration and the rate and extent of migration of waste-derived constituents in the ground water at the landfill facility. This plan shall, at a minimum, include:

(a) A summary of the hydrogeologic conditions at the landfill facility; and

(b) A description of the detection monitoring program implemented by the landfill facility, including:

(i) The number, location, depth, and construction of detection monitoring wells with documentation; and

(ii) A summary of detection monitoring ground water analytical data; and

(iii) A summary of statistical analyses applied to the data; and

(c) A detailed description of the investigatory approach to be followed during the assessment, including but not limited to:

(i) The proposed number, location, depth, installation method, and construction of assessment monitoring wells; and

(ii) The proposed method(s) for gathering additional hydrogeologic information; and

(iii) The planned use of supporting methodology (i.e., soil gas or geophysical survey(s)); and

(d) A detailed description of the techniques, procedures, and analytical equipment to be used for ground water sampling during the assessment, including but not limited to, the items listed in paragraphs (C)(1)(a) to (C)(1)(g) of this rule.

(e) A detailed description of the data evaluation procedures to be used, including but not limited to:

(i) Planned use of statistical data evaluation; and

(ii) Planned use of computer models; and

(iii) Planned use of previously gathered information; and

(iv) Criteria which will be utilized to determine if additional assessment activities are warranted; and

(f) A schedule of implementation.

(2) The owner or operator shall implement the ground water quality assessment plan which satisfies the requirements of paragraph (E)(1) of this rule to determine The concentrations and the rate and extent of migration of the waste-derived constituents in the ground water. The owner or operator shall make this determination within the time frame specified in the submitted ground water quality assessment plan. The owner or operator shall submit to Ohio EPA, not later than fifteen days after making this determination, a written report containing an assessment of the ground water quality including all data generated as part of implementation of the ground water quality assessment plan.

(3) All monitoring wells not affected by the ground water quality assessment program required by paragraph (E) of this rule shall be monitored in accordance with paragraphs (C) and (D) of this rule.

(4) The owner or operator shall Analyze on a semiannual basis the applicable indicator parameters in appendix III of this rule and those constituents determined to be released and on an annual basis all the parameters applicable for the facility in appendix III until relieved by the director in accordance with paragraph (D)(9), (E)(5), or (F)(16) of this rule.

(5) If the owner or operator determines, based on the results of the determination

made according to paragraph (E)(2) of this rule, that no waste-derived constituents from the facility have entered the ground water, then the owner or operator shall request that the director approve reinstatement of the detection monitoring program described in paragraphs (C) and (D) of this rule. Until the director approves reinstatement of the detection monitoring program, the owner or operator shall comply with paragraphs (E)(6) and (F) of this rule.

(6) If the owner or operator determines, based on the determination made according to paragraph (E)(2) of this rule, that waste-derived constituents from the facility have entered the ground water, then the owner or operator shall continue to make the determination required in accordance with paragraph (E)(2) of this rule on a semiannual basis until released from this obligation by the director or unless an alternate time interval is established by the director.

(7) If the owner or operator determines, based on the determination made according to paragraph (E)(2) of this rule, that waste-derived constituents from the facility have entered the ground water, then the owner or operator may, prior to meeting the requirements of paragraph (F) of this rule, request that the director approve a compliance monitoring program at the facility. Any request made under this paragraph shall include a description of the compliance monitoring program including the following:

(a) The monitoring wells to be included in the compliance monitoring program.

(b) The constituents for which ground water samples will be analyzed and the proposed concentration level for each constituent, which shall act as a ground water trigger level. The ground water trigger levels shall be established using the criteria described in paragraph (F)(5) of this rule.

(c) The sampling, at least annually, of all compliance monitoring wells and background wells for all waste-derived constituents.

(d) The techniques, procedures, and analytical equipment to be used for ground water sampling including, but not limited to, the items listed in paragraphs (C)(1)(a) to (C)(1)(g) of this rule.

(e) The sampling of all compliance wells specified under paragraph (E)(7)(a) of this rule at least semi-annually and the analysis of those samples for those constituents specified under paragraph (E)(7)(b) of this rule. The frequency of sampling shall be consistent with the statistical method used to analyze the data and shall be determined based on the criteria listed in paragraph (D)(4) of this rule.

(f) A description of the statistical method to be used in evaluating the ground water analytical data generated under paragraph (E)(7)(e) of this rule. The statistical method shall be selected from those statistical methods contained in paragraph (C)(5) of this rule and shall meet all criteria listed in paragraphs (C)(5) and (C)(6) of this rule.

(g) Provisions for determining, at least semi-annually, if there has been a statistically significant increase above the trigger levels for those constituents specified under paragraph (E)(7)(b) of this rule. This determination shall be consistent with the criteria stated in paragraph (C)(7) of this rule.

(h) Provisions for controlling the source(s) of releases in order to reduce or eliminate, to the extent practicable, further releases of waste-derived constituents into the environment.

(i) Provisions for submitting a corrective measures plan in accordance with paragraph (F) of this rule if a statistically significant increase above the trigger levels for those constituents specified under paragraph (E)(7)(b) of this rule is detected and confirmed.

(F) Corrective measures.

(1) Unless excused in accordance with paragraph (E)(5) or (E)(7) of this rule, the owner or operator shall submit a corrective measures study to the director not later than one hundred eighty days after making the determination in accordance with paragraph (E)(2) of this rule, or not later than one hundred eighty days after submitting a request in accordance with paragraph (E)(7) of this rule. This study shall evaluate all practicable remediation procedures which are available for remediating any contamination discovered during the ground water quality assessment. The evaluated remediation procedures shall, at a minimum do the following:

(a) Be protective of human health and safety and the environment.

(b) Attain the proposed ground water concentration levels specified in accordance with paragraph (F) of this rule.

(c) Control the source(s) of releases to reduce or eliminate, to the extent practicable, further releases of waste-derived constituents into the environment.

(d) Comply with standards for management of wastes as specified in paragraph (F)(13) of this rule.

(2) The owner or operator shall evaluate each proposed remediation procedure within the corrective measures study. This evaluation shall, at a minimum, consider the following:

(a) Any potential remediation procedure, which shall be assessed for the long-term and short-term effectiveness and the protection it affords. This shall include the degree of certainty that the remediation procedure will prove successful. Factors to be considered include the following:

(i) Magnitude of reduction of existing risks.

(ii) Magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of a remediation procedure.

(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance.

(iv) Short-term risks that may affect the community, workers, or the environment during implementation of such a remediation procedure, including potential threats to human health and safety and the environment associated with excavation, transportation, redisposal, or containment.

(v) Potential for human and environmental receptor exposure to remaining wastes, considering the potential threat to human health and safety and the environment associated with excavation, transportation, redisposal, or containment.

(vi) Long-term reliability of the engineering and institutional controls.

(vii) Potential need for replacement of the remediation procedure.

(b) The effectiveness of the remediation procedure in controlling the source in order to reduce further releases, including the following:

(i) The extent to which containment practices will reduce further releases.

(ii) The extent to which treatment technologies may be used.

(c) The need to coordinate with, and obtain necessary approvals and permits from, other agencies.

(d) The available capacity and location of needed treatment, storage, and disposal services.

(e) The performance, reliability, ease of implementation, and potential impacts of the potential remediation procedures, including safety impacts, cross-media impacts, and control of exposure to any residual contamination.

(f) A schedule for initiating and completing each remediation procedure discussed in the study. In establishing this schedule, the owner or operator shall consider the following:

(i) The extent and nature of any contamination.

(ii) The practical capability of remedial technologies to achieve compliance with ground water concentration levels established in accordance with paragraph (F)(6) of this rule and other objectives of the remediation procedure.

(iii) The availability of treatment or disposal capacity for wastes managed during implementation of the remediation procedure.

(iv) The desirability of utilizing technologies that are not currently available, but which may offer significant advantages over currently available technologies in terms of protection, reliability, safety, or the ability to achieve remedial objectives.

(v) Potential risks to human health and safety and the environment from contaminant exposure prior to completion of the remediation procedure.

(vi) Practicable capability of the owner or operator.

(vii) Other relevant factors.

(g) Resource value of the aquifer system, including the following:

(i) Current and future uses.

(ii) Proximity and withdrawal rate of users.

(iii) Ground water quantity and quality.

(iv) The potential damage to wildlife, crops, vegetation, and physical structures resulting from exposure to waste constituents.

(v) The hydrogeologic characteristics of the facility and surrounding area.

(vi) Ground water removal and treatment costs.

(vii) The cost and availability of alternate water supplies.

(3) Unless excused in accordance with paragraph (E)(5) or (E)(7) of this rule, the owner or operator shall make public notice of the existence of the assessment report and the corrective measures study and place those documents in the public library closest to the facility for public inspection not later than one hundred eighty days after making a first determination in accordance with paragraph (E)(2) of this rule.

(4) The director or his authorized representative may require the owner or operator to evaluate, as part of the corrective measures study, one or more specific potential remediation procedure(s).

(5) If, at any time during the assessment described in paragraphs (E) and (F) of this rule, the director determines that the facility threatens human health or safety or the environment, the director may require the owner or operator to implement the following measures:

(a) Notify all persons, via certified mail or any other form of mail accompanied by a receipt, who own the land or reside on the land that directly overlies or lies adjacent to any part of the plume of contamination.

(b) Take any interim measures deemed necessary by the director to ensure the protection of human health and safety and the environment. Interim measures should, to the extent practicable, be consistent with the objectives of and contribute to the performance of any remediation procedure that may be required pursuant to paragraphs (F)(1), (F)(2), and (F)(6) of this rule. The following factors may be considered by the director in determining whether interim measures are necessary:

(i) The amount of time required to develop and implement a final remediation procedure.

(ii) Actual or potential exposure of nearby populations or environmental receptors to waste-derived constituents.

(iii) Any further degradation of the ground water that may occur if remedial action is not initiated expeditiously.

(iv) Weather conditions that may cause waste-derived constituents to migrate or be released.

(v) Risks of fire, explosion, or potential for exposure to waste-derived constituents as a result of an accident or failure of a container or handling system.

(vi) Other situations that threaten human health and safety and the environment.

(6) The corrective measures study shall propose a concentration level for each waste-derived constituent which has been detected in the ground water at levels above background levels. These shall be established as follows:

(a) The proposed concentration levels in the ground water shall be protective of human health and safety and the environment.

(b) Unless an alternate level is deemed necessary to protect environmental receptors, then the following apply:

(i) For known or suspected carcinogens, the proposed concentration levels shall be established at concentration levels below those that represent a cumulative excess upper-bound lifetime risk to an individual within the 1×10^{4} to 1×10^{-6} range.

(ii) For noncarcinogens, the proposed concentration levels shall be reduced to levels to which the human population (including sensitive subgroups) could be exposed on a daily basis without appreciable risk of deleterious effects during a lifetime.

(c) In establishing the proposed concentration levels that meet the requirements of paragraph (F)(6)(b) of this rule, the owner or operator shall consider the following:

(i) Multiple contaminants in the ground water.

(ii) Exposure threat to sensitive environmental receptors.

(iii) Other site-specific exposure or potential exposure to ground water.

(iv) The reliability, effectiveness, practicability, and other relevant factors of the remediation procedure.

(d) For ground water that is a current or potential source of drinking water, the owner or operator shall evaluate and justify any concentration level that is higher than a federal safe drinking water act maximum contaminant level or a secondary drinking water standard.

(e) The proposed concentration levels shall not be set below background levels unless the director determines the following:

(i) Cleanup to levels below background levels is necessary to protect human health and safety and the environment.

(ii) Such cleanup is in connection with an area-wide remedial action under other authorities.

(7) The director shall select from the corrective measures report, or designate according to paragraph (F)(4) of this rule, the remediation procedure which best meets the criteria listed in paragraphs (F)(1), (F)(2) and (F)(6) of this rule. The owner or operator shall implement the remediation procedure designated by the director in accordance with the schedule of implementation selected by the director.

(8) In implementing the remediation procedure approved by the director in

accordance with paragraph (F)(7) of this rule, the owner or operator shall achieve the designated concentration levels, as determined by paragraph (F)(6) of this rule, at all points within the plume of contamination that lie beyond the limits or solid waste placement.

(9) Upon completion of the remediation procedure, when the ground water quality meets the designated concentration levels as specified in paragraphs (F)(6) and (F)(8) of this rule, the owner or operator shall demonstrate on a semiannual basis for a period of five years or until the landfill facility's post-closure care period ends, whichever is longer, that the designated concentration levels have not been exceeded as provided in paragraph (F)(8) of this rule before being released from compliance with the ground water monitoring requirements.

(10) If the concentrations of the constituents monitored in accordance with paragraph (F)(9) of this rule exceed the concentration levels determined in accordance with paragraph (F)(6) of this rule, the owner or operator shall reimplement the designated remediation procedure or submit new remediation procedures in accordance with the criteria in paragraphs (F)(1) and (F)(2) of this rule.

(11) The director may determine, based on information developed by the owner or operator after implementation of the remediation procedure has begun, or from other information, that compliance with the requirements(s) for the remediation procedure selected under paragraphs (F)(1) and (F)(2) of this rule is not technically practicable. In making such a determination, the director shall consider the following:

(a) The owner or operator's efforts to achieve compliance with the requirement(s).

(b) Whether other currently available or new methods or techniques could practicably achieve compliance with the requirements.

(12) If the director determines that compliance with a remediation procedure requirement is not technically practicable, then the director may require that the owner or operator do the following:

(a) Implement alternate measures to control human or environmental receptor exposure to residual contamination, as necessary, to protect human health and safety and the environment.

(b) Implement alternate measures for control of the sources of contamination, or for removal or decontamination of equipment, units, devices, or structures required to implement the remediation procedure(s), that are both of the following:

(i) Technically practicable.

(ii) Consistent with the overall objective of the remediation procedure.

(13) All solid wastes that are managed pursuant to a remediation procedure required under paragraph (F)(8) of this rule, or an interim measure required under paragraph (F)(5) of this rule, shall be managed in the following manner:

(a) That is protective of human health and safety and the environment.

(b) That complies with applicable laws and regulations.

(14) Remediation procedures selected pursuant to paragraphs (F)(1) and (F)(2) of this rule shall be considered complete when compliance with the ground-water concentration levels established under paragraph (F)(6) of this rule have been achieved, and all actions required to complete the remediation procedure have been satisfied.

(15) Upon completion of the remediation procedure, the owner or operator shall submit to the director certification that the remediation procedure has been completed. The certification must be signed by the owner or operator and by an independent professional(s) skilled in the appropriate technical discipline(s).

(16) When, upon receipt of the certification and in consideration of any other relevant information, the director determines that the remediation procedure has been completed in accordance with paragraph (F)(14) of this rule, the director shall release the owner or operator from continuing performance of the approved remediation procedure. This approval shall not exempt the owner or operator from meeting the requirements of paragraphs (F)(9) and (F)(10) of this rule.

(17) The owner or operator shall submit, upon implementation of the remediation procedure chosen under paragraph (F)(7) of this rule, a report of the activities being conducted at the facility as part of implementation of the chosen

remediation procedure. This report shall be submitted semiannually and contain the following:

(a) A narrative description of all remedial activities that have occurred since the previous report.

(b) All data generated as part of the remedial activities at the facility.

R.C. 119.032 review dates: 02/01/2008 and 02/01/2013

CERTIFIED ELECTRONICALLY

Certification

02/01/2008

Date

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Appendix I

Parameter	CAS Registry Number
1) Acetone.	67-64-1
2) Acrylonitrile.	107-13-1
3) Benzene.	71-43-2
4) Bromocholoromethane.	74-97-5
5) Bromodicholoromethane.	75-27-4
6) Bromoform; Tribromomethane	75-25-2
7) Carbon disulfide	75-15-0
8) Carbon tetrachloride	56-23-5
9) Chlorobenzene.	108-90-7
10) Chloroethane; Ethyl chloride.	75-00-3
11) Chloroform; Trichloromethane	67-66-3
12) Dibromochloromethane; Chlorodibromomethane	124-48-1
13) 1,2-Dibromo-3-chloropropane; DBCP.	96-12-8
14) 1,2-Dibromomethane; Ethylene dibromide; EDB.	106-93-4
15) o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1
16) p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7
17) trans-1,4-Dichloro-2-butene.	110-57-6
18) 1,1-Dichloroethane; Ethylidene chloride.	75-34-3
19) 1,2-Dichloroethane; Ethylidene dichloride.	107-06-2
20) 1,1-Dichloroethylene; 1,1-Dichloroethene; Vinylidene chloride	75-35-4
21) cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2
22) trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene.	156-60-5
23) 1,2-Dichloropropane; Propylene dichloride.	78-87-5
24) cis-1,3-Dichloropropene.	10061-01-5
25) trans-1,3-Dichloropropene.	10061-02-6
26) Ethylbenzene	100-41-4
27) 2-Hexanone; Methyl butyl ketone.	591-78-6
28) Methyl bromide; Bromomethane	74-83-9
29) Methyl chloride; Chloromethane	74-87-3
30) Methylene bromide; Dibromomethane.	74-95-3
31) Methylene chloride; Dichloromethane.	75-09-2
32) Methyl ethyl ketone; MEK; 2-Butanone	78-93-3
33) Methyl iodide; iodomethane	74-88-4
34) 4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1
35) Styrene.	100-42-5
36) 1,1,1,2-Tetrachloroethane.	630-20-6
37) 1,1,2,2-Tetrachloroethane.	79-34-5

38) Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	127-18-4
39) Toluene.	108-88-3
40) 1,1,1-Trichloroethane; Methylchloroform.	71-55-8
41) 1,1,2-Trichloroethane.	79-00-5
42) Trichloroethylene; Trichloroethene	79-01-6
43) Trichloroflouromethane; CFC-11	75-69-4
44) 1,2,3-Trichloropropane	96-18-4
45) Vinyl acetate.	108-05-4
46) Vinyl chloride	75-01-4
47) Xylene (total).	includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

Appendix II

	Compound	CAS RN2
1)	Acenaphthene; 1,2-Dihydroacenaphthylene	83-32-9
2)	Acenaphthylene	208-96-8
3)	Acetone;2-Propanone	67-64-1
4)	Acetonitrile; Methyl cyanide	75-05-8
5)	Acetophenone; 1-Phenylethanone	98-86-2
6)	2-Acetylaminoflourene; 2-AAF; N-9H-flouren-2-yl-acetamide	53-96-3
7)	Acrolein; 2-Propenal	107-02-8
8)	Acrylonitrile; 2-Propenenitrile	107-13-1
9)	Aldrin; 1,2,3,4,10,10-hexachlora-1,4,4a,5,8,8a-hexahydro(1a,4a,4ab,5a,8a,8ab)-1,4:5,8-Dimethanonaphthalene	309-00-23
10)	Allyl chloride; 3-Chloro-1-propene	107-05-1
11)	4-Aminobiphenyl; [1,1'-Biphenyl]-4-amine	92-67-1
12)	Anthracene	120-12-7
13)	Antimony	See note 4
14)	Arsenic	See note 4
15)	Barium	See note 4
16)	Benzene	71-43-2
17)	Benzo[a]anthracene; Benzanthracene	56-55-3
18)	Benzo[b]flouranthene; Benz[e]acephenanthylene	205-99-2
19)	Benzo[k]flouranthene	207-08-9
20)	Benzo[ghi]perylene	191-24-2
21)	Benzo[a]pyrene	50-32-8
22)	Benzyl alcohol; Benzenemethanol	100-51-6
23)	Beryllium	See note 4
24)	alpha-BHC; 1,2,3,4,5,6-Hexachlorocyclohexane, (1a,2a,3b,4a,5b,6b)	319-84-63
25)	beta-BHC; 1,2,3,4,5,6-Hexachlorocyclohexane, (1a,2b,3a,4b,5a,6b)	319-85-73
26)	delta-BHC; 1,2,3,4,5,6-Hexachlorocyclohexane, (1a,2a,3a,4b,5a,6b)	319-86-83
27)	gamma-BHC; Lindane; 1,2,3,4,5,6-Hexachlorocyclo hexane,(1a,2a,3b,4a,5a,6b)	58-89-93
28)	bis(2-Chloroethoxy)methane; 1,1'-[methylenebis(oxy)] bis[2-chloroethane]	111-91-1
29)	bis(2-Chloroethyl) ether; Dichloroethyl ether; 1,1'-oxybis[2-Chloroethane]	111-44-4
30)	bis-(2-Chloro-1-methylethyl) Ether; 2,2'-Dichloro-diisopropyl ether; DCIP; 2,2'-oxybis[1-Chloropropane]	108-60-15
31)	bis(2-Ethylhexyl) Phthalate; 1,2-Benzenedicarboxylic acid, bis(2-Ethylhexyl) ester	117-81-7
32)	Bromochloromethane; Chlorobromomethane	74-97-5
33)	Bromodichloromethane; Dibromochloromethane	75-27-4
34)	Bromoform; Tribromomethane	75-25-2
35)	4-Bromophenyl phenyl ether; 1-Bromo-4-phenoxy-benzene	101-55-3
36)	Butyl benzyl phthalate; Benzyl butyl phthalate; 1,2-Benzenedicarboxylic acid, Butyl phenylmethyl ester	85-68-7
37)	Cadmium	See note 4

38) Carbon disulfide 75-15-0
39) Carbon tetrachloride; Tetrachloromethane 56-23-5
40) Chlordane; 1,2,4,5,6,8,8-octochloro-2,3,3a,4,7,7a-
hexahydro-4,7-methano-1H-indene. . . . . See note 6
41) p-Chloroaniline; 4-Chlorobenzenamine 106-47-8
42) Chlorobenzene 108-90-7
43) Chlorobenzilate; 4-Chloro-a-(4-Chlorophenyl)-a-
Hydroxybenzeneacetic acid, Ethyl ester 510-15-6
44) p-Chloro-m-Cresol; 4-Chloro-3-Methylphenol 59-50-7
45) Chloroethane; Ethyl chloride 75-00-3
46) Chloroform; Trichloromethane 67-66-3
47) 2-Chloronaphthalene 91-58-7
48) 2-Chlorophenol 95-57-8
49) 4-Chlorophenyl phenyl ether; 1-Chloro-4-phenoxy benzene...7005-72-3
50) Chloroprene; 2-Chloro-1,3-butadiene 126-99-8
51) Chromium .... See note 4
52) Chrysene 218-01-9
53) Cobalt .... See note 4
54) Copper .... See note 4
55) m-Cresol; 3-Methylphenol 108-39-4
56) o-Cresol; 2-Methylphenol 95-48-7
57) p-Cresol; 4-Methylphenol 106-44-5
58) Cyanide 57-12-5
59) 2,4-D; 2,4-Dichlorophenoxyacetic acid 94-75-7
60) 4,4'-DDD; 1,1'-(2,2-Dichloroethylidene)bis
[4-chlorobenzene] 72-54-8
61) 4,4'-DDE; 1,1'-(2,2-Dichloroethyenylidene)bis
[4-chlorobenzene] 72-55-9
62) 4,4'-DDT; 1,1'-(2,2,2-Trichloroethylidene)bis
[4-chlorobenzene] 50-29-3
63) Diallate; bis(1-Methylethyl)-carbamothoic acid
S-(2,3-Dichloro-2-propenyl) ester 2303-16-4
64) Dibenz[a,h]anthracene 53-70-3
65) Dibenzofuran 132-64-9
66) Dibromocholormethane; Chlorodibromomethane 124-48-1
67) 1,2-Dibromo-3-chloropropane; DBCP 96-12-8
68) 1,2-Dibromoethane; Ethylene dribromide; EDB 106-93-4
69) Di-n-butyl phthalate; 1,2-Benzenedicarboxylic
acid dibutyl ester 84-74-2
70) o-Dichlorobenzene; 1,2-Dichlorobenzene 95-50-1
71) m-Dichlorobenzene; 1,3-Dichlorobenzene 541-73-1
72) p-Dichlorobenzene; 1,4-Dichlorobenzene 106-46-7
73) 3,3'-Dichlorobenzidine; 3,3'-Dichloro-[1,1'-bi
phenyl]-4,4'-diamine 91-94-1
74) trans-1,4-Dichloro-2-butene 110-57-6
75) Dichlorodifluoromethane; CFC 12 75-71-8
76) 1,1-Dichloroethane; Ethylidene chloride 75-34-3
77) 1,2-Dichloroethane; Ethylene dichloride 107-06-2
78) 1,1-Dichloroethylene; 1,1-Dichloroethene;
Vinylidene chloride 75-35-4
79) cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene 156-59-2
80) trans-1,2-Dichloroethylene; trans-1,2-Dichloro ethene 156-60-5

81) 2,4-Dichlorophenol 120-83-2
82) 2,6-Dichlorophenol 87-65-0
83) 1,2-Dichloropropane; Propylene dichloride 78-87-5
84) 1,3-Dichloropropane; Trimethylene dichloride 142-28-9
85) 2,2-Dichloropropane; Isopropylidene chloride 594-20-7
86) 1,1-Dichloropropene; 1,1-Dichloro-1-propene 563-58-6
87) cis-1,3-Dichloropropene; 10061-01-5
88) trans-1,3-Dichloropropene. 10061-02-6
89) Dieldrin; 3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,
7,7a-octahydro-2,7:3,6-dimethanonaphthalene
[2,3-b]oxirene, (1aa,2b,2aa,3b,6b,6aa,7b,7aa). 60-57-13
90) Diethyl phthalate; 1,2-Benzenedicarboxylic
acid, Diethyl ester. 84-66-2
91) O,O-Diethyl O-2-Pyrazinyl phosphorothioate; Thionazin. . . 297-97-2
92) Dimethoate; Phosphorodithoic acid O,O-Dimethyl-S-
[2-(methylamino)-2-oxoethyl] ester 60-51-5
93) p-(Dimethylamino)azobenzene; N,N-Dimethyl-4-
(phenylazo)benzenamine 60-11-7
94) 7,12-Dimethylbenz[a]anthracene 57-97-6
95) 3,3'-Dimethylbenzidene; 3,3'-Dimethyl[1,1'bi
phenyl]-4,4'-diamine 119-93-7
96) 2,4-Dimethylphenol; m-Xylenol 105-67-9
97) Dimethyl phthalate; 1,2-Benzenedicarboxylic
acid, dimethyl ester 131-11-3
98) m-Dinitrobenzene 99-65-0
99) 4,6-Dinitro-o-cresol; 4,6-Dinitro-2-methylphenol;
2-Methyl-4,6-dinitrophenol 534-52-1
100) 2,4-Dinitrophenol. 51-28-5
101) 2,4-Dinitrotoluene; 1-Methyl-2,4-dinitrobenzene. 121-14-2
102) 2,6-Dinitrotoluene; 2-Methyl-1,3-dinitrobenzene. 606-20-2
103) Dinoseb; DMBP; 2-sec-Butyl-4,6-dinitrophenol;
2-(1-Methylpropyl)-4,5-dinitrophenol 88-85-7
104) Di-n-octyl phthalate; 1,2-Benzenedicarboxylic
acid, Dioctyl ester. 117-84-0
105) Diphenylamine; N-phenylbenzenamine 122-39-4
106) Disulfoton; Phosphorodithioic acid O,O-diethyl
S-[2-(ethylthio)ethyl] ester 298-04-4
107) Endosulfan I; 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,
9a-hexahydro-6,9-methano-2,4,3-benzodioxa thiepin,
3-oxide 959-98-8
108) Endosulfan II; 6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,
9a-hexahydro-6,9-methano-2,4,3-benzodioxa
thiepin, 3-oxide (3a,5aa,6b,9b,9aa). 33213-65-93
109) Endosulfan sulfate; 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,
9a-hexahydro-6,9-methano-2,4,3-benzodioxa
thiepin, 3-3-dioxide 1031-07-8
110) Endrin; 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-
octahydro-2,7:3,6-dimethanonaphth[2,3-
b]oxirene, (1aa,2b,2ab,3a,6a,6ab,7b,7aa) 72-20-83
111) Endrin aldehyde; 2,2a,3,3,4,7-hexachlorodecahydro-
1,2,4-methenocyclopenta[cd]pentalene-5-carboxaldehyde,
(1a,2b,2ab,4b,4ab,5b,6ab,6bb,7r*). 7421-93-43

112) Ethylbenzene 100-41-4
113) Ethyl methacrylate; 2-Methyl-2-propenoic acid, ehtyl
ester 97-63-2
114) Ethyl methanesulfonate; Methanesulfonic acid, ethyl
ester. 62-50-0

115) Famphur; Phosphorothioic acid, O-[4-[(dimethylamino)
sulfonyl]phenyl]0,0-dimethyl ester 52-85-7
116) Flouranthene 206-44-0
117) Flourene; 9H-flourene 86-73-7
118) Heptachlor; 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-
tetrahydro-4,7-methano-1H-indene 76-44-8
119) Heptachlor epoxide; 2,3,4,5,6,7,7-Heptachloro-1a,1b,
5,5a,6,6a-hexahydro-2,5-methano-2h-indeno
[1,2-b]oxirene, (1aa,1bb,2a,5a,5ab,6b,6aa) 1024-57-33
120) Hexachorobenzene 118-74-1
121) Hexachlorobutadiene; 1,1,2,3,4,4-Hexachloro-1,3-butadiene. 87-68-3
122) Hexachlorocyclopentadiene; 1,2,3,4,5,5-Hexachloro-
1,3-cyclopentadiene 77-47-4
123) Hexachloroethane 67-72-1
124) Hexachloropropene; 1,1,2,3,3,3-Hexachloro-1-propene. . . 1888-71-7
125) 2-Hexanone; Methyl butyl ketone 591-78-6
126) Indeno(1,2,3-cd)pyrene 193-39-5
127) Isobutyl alcohol;2-Methyl-1-propanol 78-83-1
128) Isodrin; 1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-
hexahydro-1,4,5,8-dimethanonaphthalene,
(1a,4a,4ab,5b,8b,8ab). 465-73-63
129) Isophorone; 3,5,5-Trimethyl-2-cyclohexen-1-one 78-59-1
130) Isosafrole; 5-(1-Propenyl)-1,3-benzodioxole 120-58-1
131) Kepone; 1,1a,3,3a,4,5,5a,5b,6-decachlorocta
hydro-1,3,4-methano-2H-cyclobuta[cd9]pentalen-2-one. . . . 143-50-0
132) Lead . . . . See note 4
133) Mercury . . . . See note 4
134) Methacrylonitrile; 2-Methyl-2-propenenitrile 126-98-7
135) Methapyrilene; N,N-dimethyl-N'-2-pyridinyl-N'-
(1/2-thienylmethyl)-1,2-ethanediamine. 91-80-5
136) Methoxychlor; 1,1'-(2,2,2-Trichloroethylidene)bis
[4-Methoxybenzene] 72-43-5
137) Methyl bromide; Bromomethane 74-83-9
138) Methyl chloride; Chloromethane 74-87-3
139) 3-Methylcholanthrene; 1,2-Dihydro-3-methyl-
benze[j]aceanthrylene. 56-49-5
140) Methyl ethyl ketone; MEK; 2-Butanone 78-93-3
141) Methyl iodide; Iodomethane 74-88-4
142) Methyl methacrylate; 2-Methyl-2-propenoic acid, methyl
ester 80-62-6
143) Methyl methanesulfonate; Methanesulfonic acid, methyl
ester. 66-27-3
144) 2-Methylnaphthalene 91-57-6
145) Methyl parathion; Parathion methyl; Phosphorothioic
acid, 0,0-dimethyl 0-(4-nitrophenyl) ester 298-00-0
146) 4-Methyl-2-pentanone; Methyl isobutyl ketone 108-10-1

147) Methylene bromide; Dibromomethane 74-95-3
148) Methylene chloride; Dichloromethane 75-09-2
149) Naphthalene 91-20-3
150) 1,4-Naphthoquinone; 1,4-Naphthalenedione 130-15-4
151) 1-Naphthylamine; 1-Naphthalenamine 134-32-7
152) 2-Naphthylamine; 2-Naphthalenamine 91-59-8
153) Nickel . . . . See note 4
154) o-Nitroaniline; 2-Nitroaniline; 2-Nitrobenzenamine 88-74-4
155) m-Nitroaniline; 3-Nitroaniline; 3-Nitrobenzenamine 99-09-2
156) p-Nitroaniline; 4-Nitroaniline; 4-Nitrobenzenamine . . . 100-01-6
157) Nitrobenzene 98-95-3
158) o-Nitrophenol; 2-Nitrophenol 88-75-5
159) p-Nitrophenol; 4-Nitrophenol 100-02-7
160) N-Nitrosodi-n-butylamine; N-Butyl-N-Nitroso-1-butanamine. .924-16-3
161) N-Nitrosodiethylamine; N-Ethyl-N-nitroso ethanamine 55-18-5
162) N-Nitrosodimethylamine; N-Methyl-N-nitroso methananmine . 62-75-9
163) N-Nitrosodiphenylamine; N-Nitroso-N-phenyl benzenamine..... 86-30-6
164) N-Nitrosodipropylamine; N-Nitroso-N-dipropylamine;
di-n-propylnitrosamine; N-Nitroso-N-propyl- 1-propanamine..621-64-7
165) N-Nitrosomethylethalamine; N-Methyl-N-nitroso
ethanamine. 10595-95-6
166) N-Nitrsopiperidine; 1-Nitrosopiperidine 100-75-4
167) N-Nitrosopyrrolidine; 1-Nitrosopyrrolidine 930-55-2
168) 5-Nitro-o-toluidine; 2-Methyl-5-nitrobenzenamine 99-55-8
169) Parathion; Phosphorothioic acid, O,O-diethyl O-
(4-nitrophenyl) ester 56-38-2
170) Pentachlorobenzene 608-93-5
171) Pentachloronitrobenzene 82-68-8
172) Pentachlorophenol 87-86-5
173) Phenacetin; N-(4-Ethoxyphenyl)acetamide 62-44-2
174) Phenanthrene 85-01-8
175) Phenol 108-95-2
176) p-Phenylenediamine; 1,4-Benzenediamine 106-50-3
177) Phorate; Phosphorodithioic acid, O,O-Diethyl S-
[(ethylthio]methyl] ester 298-02-2
178) Polychlorinated biphenyls; PCBs; aroclors;
1,1'-Biphenyl, chloro derivatives .... See note 7
179) Pronamide; 3,5-Dichloro-N-(1,1-dimethyl-2-
propynyl)benzamide 23950-58-5
180) Propionitrile; Ethyl cyanide 107-12-0
181) Pyrene 129-00-0
182) Safrole; 5-(2-Propenyl)-1,3-benzodioxole 94-59-1
183) Selenium .... See note 4
184) Silver .... See note 4
185) Silvex; 2,4,5-TP; 2-(2,4,5-Trichlorophenoxy)propanoic
acid 93-72-1
186) Styrene; Ethenylbenzene 100-42-5
187) Sulfide 18496-25-8
188) 2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid 93-76-5
189) 1,2,4,5-Tetrachlorobenzene 95-94-3
190) 1,1,1,2-Tetrachloroethane 630-20-6
191) 1,1,2,2-Tetrachloroethane 79-34-5

192) Tetrachloroethylene; Tetrachloroethene;
Perchloroethylene 127-18-4
193) 2,3,4,6-Tetrachlorophenol 58-90-2
194) Thallium .... See note 4
195) Tin .... See note 4
196) Toluene; Methylbenzene 108-88-3
197) o-Toluidine; 2-Methylbenzenamine 95-53-4
198) Toxaphene .... See note 8
199) 1,2,4-Trichlorobenzene 120-82-1
200) 1,1,1-Trichloroethane; Methylchloroform 71-55-6
201) 1,1,2-Trichloroethane 79-00-5
202) Trichloroethylene; Trichloroethene 79-01-6
203) Trichlorofluoromethane; CFC-11 75-69-4
204) 2,4,5-Trichlorophenol 95-95-4
205) 2,4,6-Trichlorophenol 88-06-2
206) 1,2,3-Trichloropropane 96-18-4
207) o,o,o-Triethyl phosphorothioate; Phosphorothioic acid,
o,o,o-triethyl ester 126-68-1
208) sym-Trinitrobenzene; 1,3,5-Trinitrobenzene 99-35-4
209) Vanadium . . . . See note 4
210) Vinyl acetate; Acetic acid, ethenyl ester 108-05-4
211) Vinyl chloride; Chloroethene 75-01-4
212) Xylene (total); Dimethylbenzene . . . . See note 9
213) Zinc . . . . See note 4

Note 1: Common names are those widely used in government regulation, scientific publications, and commerce; synonyms exist for many chemicals.

Note 2: Chemical Abstract Service registry number. Where "total" is entered, all species in ground water that contain this element are included.

Note 3: When numbers and letters appear in this form at the end of a chemical name, i.E. (1a,4a,4aB,5a,8a,8aB), the following applies: "a" = small case "a"; "a" (italic) = alpha; "b" = small case "b"; and "B" (italic) = beta.

Note 4: Analysis for these compounds shall be representative of the quality background ground water that has not been affected by past or present operations at the sanitary landfill facility and representative of the quality of ground water passing directly downgradient of the limits of solid waste placement.

Note 5: CAS No. 108-60-1. This substance is often called bis(2-Chloroisopropyl) ether, the name Chemical Abstracts Service applies to its commercial isomer, propane, 2,2"-oxybis[2-Chloro-(CAS RN 39638-32-9).

Note 6: Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-Chlordane (CAS RN 5103-74-2), gamma-Chlordane (CAS RN 5566-34-7), and constituents of Chlordane (CAS RN 54-74-9 and CAS RN 12789-03-06).

Note 7: Polychlorinated biphenols (CAS RN 1336-36-3); This category contains congener chemicals, including constituents of Aroclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Aroclor 1232 (CAS RN 11141-16-5), Aroclor 1242 (CAS RN 53469-21-9), Aroclor 1248 (CAS RN 12672-29-6), Aroclor 1254 (CAS RN 11097-69-1), and Aroclor 1260 (CAS RN 11096-82-5).

Note 8: Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2, i.e., chlorinated camphene.

Note 9: Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m-xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7).

Appendix III
Ground water monitoring parameters

A. Wastes Generated From Fuel Burning Operations Using Primarily Coal as Fuel [OAC 3745-30-01(B)(1)]

1. Annual Monitoring Parameters
   - Temperature*
   - Specific conductance*
   - pH*
   - Calcium**
   - Chloride**
   - Potassium**
   - Sodium**
   - Sulfate**
   - Arsenic
   - Barium
   - Cadmium
   - Chromium
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Selenium
   - Total Dissolved Solids
   - Gross Beta
   - Gross Alpha

2. Background Water Quality Parameters #
   - Temperature*
   - Specific Conductance*
   - pH*
   - Calcium**
   - Chloride**
   - Potassium**
   - Sodium**
   - Sulfate**
   - Arsenic
   - Barium
   - Cadmium
   - Chromium
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Mercury
   - Selenium
   - Silver
   - Total Organic Carbon
   - Chemical Oxygen Demand
   - Total Dissolved Solids
   - Gross Beta
   - Gross Alpha
   - Turbidity
   - Total Alkalinity
   - Phenols***
   - Cyanide***
   - The Volatile Organic Compounds listed in Appendix I of this rule***

Parameters determined at least quarterly for initial year of ground water monitoring
* Parameters determined each time a monitoring well is sampled.
** Indicator parameters to be determined at least semi-annually.
*** Only need to sample for initial quarter unless Director determines otherwise.

B. Waste Generated From Foundry Operations [OAC 3745-30-01(B)(2)]

1. Annual Monitoring Parameters
   - Temperature*
   - Specific conductance*
   - pH*
   - Copper**
   - Fluoride**
   - Iron**
   - Lead**
   - Phenols** *(including cresols)*
   - Sulfate**
   - Zinc**
   - Total dissolved solids**
   - Ammonia
   - Arsenic
   - Barium
   - Cadmium
   - Chloride
   - Chromium
   - Lead
   - Manganese
   - Magnesium
   - Sodium
   - Turbidity
   - Formaldehyde
   - The volatile organic compounds (VOCs) detected in background sampling.

2. Background Water Quality Parameters #
   - Temperature*
   - Specific conductance*
   - pH*
   - Copper**
   - Fluoride**
   - Iron**
   - Lead**
   - Phenols** *(including cresols)*
   - Sulfate**
   - Zinc**
   - Total dissolved solids**
   - Ammonia
   - Arsenic
   - Barium
   - Cadmium
   - Chloride
   - Chromium
   - Lead
   - Manganese
   - Magnesium
   - Sodium
   - Turbidity
   - Formaldehyde
   - The volatile organic compounds (VOCs) listed in appendix I of this rule***

Parameters determined at least quarterly for initial year of ground water monitoring

* Parameters determined each time a monitoring well is sampled.

** Based on waste characterization, the owner or operator shall select four (or more) of the double asterisked parameters as indicator parameters to be determined at least semi-annually. The other double-asterisked parameters remain on the annual list.

*** Only need to sample for initial quarter unless Director determines otherwise.

C. Wastes Generated from Pulp and Papermaking Operations
[OAC 3745-30-01(B)(3)]

1. Annual Monitoring Parameters

- Temperature*
- Specific conductance*
- pH*
- Chemical Oxygen Demand**
- Total Alkalinity**
- Sodium**
- Sulfate**
- Ammonia
- Arsenic
- Barium
- Cadmium
- Calcium
- Chloride
- Chromium
- Iron
- Lead
- Magnesium
- Manganese
- Nitrate-nitrite
- Potassium
- Total Dissolved Solids
- Turbidity

2. Background Water Quality Parameters #

- Temperature*
- Specific conductance*
- pH*
- Chemical Oxygen Demand**
- Total Alkalinity**
- Sodium**
- Sulfate**
- Ammonia
- Arsenic
- Barium
- Cadmium
- Calcium
- Chloride
- Chromium
- Iron
- Lead
- Magnesium
- Manganese
- Nitrate-nitrite
- Potassium
- Total Dissolved Solids
- Turbidity
- Phenols***
- Cyanide***
- The Volatile Organic Compounds listed in Appendix I of this rule***

Parameters determined at least quarterly for initial year of ground water monitoring
* Parameters determined each time a monitoring well is sampled.
** Indicator parameters to be determined at least semi-annually.
*** Only need to sample for initial quarter unless Director determines otherwise.

D.Wastes Generated from Steelmaking Operations[OAC 3745-30-01(B)(4)]

1. Annual Monitoring Parameters

Temperature*
Specific conductance*
pH*
Total Dissolved Solids**
Iron**
Sodium**
Sulfate**
Ammonia
Antimony
Arsenic
Barium
Cadmium
Calcium
Chloride
Chromium
Copper
Lead
Magnesium
Manganese
Mercury
Nickel
Selenium
Sodium
Sulfate
Zinc
Turbidity
Total Organic Carbon
Gross Beta
Gross Alpha

2. Background Water Quality Parameters
#

Temperature*
Specific conductance*
pH*
Total Dissolved Solids**
Iron**
Sodium**
Sulfate**
Ammonia
Antimony
Arsenic
Barium
Cadmium
Calcium
Chloride
Chromium
Copper
Lead
Magnesium
Manganese
Mercury
Nitrate-Nitrite
Nickel
Selenium
Sodium
Sulfate
Zinc
Turbidity
Total Organic Carbon
Gross Beta
Gross Alpha
Chemical Oxygen Demand
Total Alkalinity
Phenols***
Cyanide***
The Volatile Organic Compounds listed in Appendix I of this rule***

#	Parameters determined at least quarterly for initial year of ground water monitoring
*	Parameters determined each time a monitoring well is sampled.
**	Indicator parameters to be determined at least semi-annually.
***	Only need to sample for initial quarter unless Director determines otherwise.

E. Wastes Generated from Gypsum Processing Plant Operations
[OAC 3745-30-01(B)(5)]

1. Annual Monitoring Parameters
   - Temperature*
   - Specific Conductance* **
   - pH* **
   - Calcium**
   - Sulfate**
   - Arsenic
   - Barium
   - Cadmium
   - Chromium
   - Chloride
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Mercury
   - Selenium
   - Sodium
   - Chemical Oxygen Demand
   - Total Alkalinity
   - Total Dissolved Solids

2. Background Water Quality Parameters
   #
   - Temperature*
   - Specific Conductance* **
   - pH* **
   - Calcium**
   - Sulfate**
   - Arsenic
   - Barium
   - Cadmium
   - Chromium
   - Chloride
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Mercury
   - Nitrate-Nitrite
   - Selenium
   - Sodium
   - Chemical Oxygen Demand
   - Total Alkalinity
   - Total Dissolved Solids
   - Total Organic Carbon
   - Turbidity
   - Phenols***
   - Cyanide***
   - The Volatile Organic Compounds listed in Appendix I of this rule***

Parameters determined at least quarterly for initial year of ground water monitoring

* Parameters determined each time a monitoring well is sampled.

** Indicator parameters to be determined at least semi-annually.

*** Only need to sample for initial quarter unless Director determines otherwise.

F. Wastes Generated from Lime Processing Operations [OAC 3745-30-01(B)(6)]

1. Annual Monitoring Parameters
   - Temperature*
   - Specific conductance*
   - pH* **
   - Chloride**
   - Potassium**
   - Sodium**
   - Sulfate**
   - Total Dissolved Solids**
   - Barium
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Selenium
   - Turbidity
   - Chemical Oxygen Demand
   - Total Alkalinity
   - Gross Beta
   - Gross Alpha

2. Background Water Quality Parameters #
   - Temperature*
   - Specific conductance*
   - pH* **
   - Chloride**
   - Potassium**
   - Sodium**
   - Sulfate**
   - Total Dissolved Solids**
   - Arsenic
   - Barium
   - Calcium
   - Iron
   - Lead
   - Magnesium
   - Manganese
   - Selenium
   - Turbidity
   - Chemical Oxygen Demand
   - Total Alkalinity
   - Gross Beta
   - Gross Alpha
   - Phenols***
   - Cyanide***
   - The Volatile Organic Compounds listed in Appendix I of this rule***

#	Parameters determined at least quarterly for initial year of ground water monitoring
*	Parameters determined each time a monitoring well is sampled.
**	Indicator parameters to be determined at least semi-annually.
***	Only need to sample for initial quarter unless Director determines otherwise.

G. Wastes Generated from Portland Cement Operations
[OAC 3745-30-01(B)(7)]

1. Annual Monitoring Parameters

Temperature*
Specific conductance*
pH* **
Chloride**
Potassium**
Sodium**
Sulfate**
Total Dissolved Solids**
Barium
Chloride
Chromium
Iron
Lead
Magnesium
Manganese
Mercury
Selenium
Turbidity
Chemical Oxygen Demand
Total Alkalinity
Gross Beta
Gross Alpha

2. Background Water Quality Parameters #

Temperature*
Specific Conductance*
pH* **
Chloride**
Potassium**
Sodium**
Sulfate**
Total Dissolved Solids**
Arsenic
Barium
Calcium
Chloride
Chromium
Iron
Lead
Magnesium
Manganese
Mercury
Selenium
Turbidity
Chemical Oxygen Demand
Total Alkalinity
Gross Beta
Gross Alpha
Phenols***
Cyanide***
The Volatile Organic Compounds listed in Appendix I of this rule***

Parameters determined at least quarterly for initial year of ground water monitoring
* Parameters determined each time a monitoring well is sampled.
** Indicator parameters determined at least semi-annually.
*** Only need to sample for initial quarter unless Director determines otherwise.

H. Industrial solid waste facilities permitted and operating under Chapter 3745-29 of the Administrative Code.

1. Annual Monitoring Parameters

Temperature*
Specific conductance*
pH*
Ammonia**
Calcium**
Chloride**
Iron**
Nitrate-nitrite**
Potassium**
Sodium**
Sulfate**
Total alkalinity**
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Copper
Lead
Magnesium
Manganese
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc
Turbidity
Chemical oxygen demand
Total dissolved solids
The volatile organic compounds (VOCS) listed in appendix I of this rule

2. Background Water Quality Parameters #

Background Water Quality Parameters are the same as Annual Monitoring Parameters.

Parameters determined at least quarterly for initial year of ground water monitoring.

Analysis for these parameters shall be representative of the quality background ground water that has not been affected by past or present operations at the landfill facility and representative of the quality of ground water passing directly downgradient of the limits of solid waste placement.

* Parameters field analyzed each time a monitoring well is sampled.

** Indicator parameters determined at least semi-annually.

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