Attachment C

Groundwater/Leak Detection and Leachate Monitoring Plan

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Acronyms and Abbreviations

ANOVA	analysis of variance
ARARs	applicable or relevant and appropriate requirements
ASER	Annual Site Environmental Report
ASL	analytical support level
CAWWT	converted advanced wastewater treatment facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cm/sec	centimeters per second
COC	constituent of concern
COD	chemical oxygen demand
CPT	cone penetrometer test
D&D	decontamination and demolition
DOE	U.S. Department of Energy
EPLTS	Enhanced Permanent Leachate Transmission System
EPA	U.S. Environmental Protection Agency
FRL	final remediation level
ft	foot/feet
GEMS	Geospatial Environmental Mapping system
gpad	gallons per acre per day
gpm	gallons per minute
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
HDPE	high-density polyethylene
HTW	horizontal till well
IEMP	Integrated Environmental Monitoring Plan
K_d	distribution coefficient
L	liter
LCS	leachate collection system
LDS	leak detection system
LMICP	Comprehensive Legacy Management and Institutional Controls Plan
LM QAPP	Legacy Management CERCLA Sites Quality Assurance Project Plan
m	meters
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
OU	Operable Unit
PCBs	polychorinated biphenyls
PCCIP	Post-Closure Care and Inspection Plan
PLS	permanent lift station
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SDWA	Safe Drinking Water Act

Acronyms and Abbreviations (continued)

SEEPro	Site Environmental Evaluation for Projects
SNL	Sandia National Laboratories
SWIFT	Sandia Waste Isolation Flow and Transport
UMTRCA	Uranium Mill Tailings Radiation Control Act
VAM3D	Variably Saturated Analysis Model in 3 Dimensions
WAC	Waste Acceptance Criteria
yd^3	cubic yards

1.0 Introduction

This document presents the groundwater/leak detection and leachate management monitoring program (GWMLP) for the on-site disposal facility (OSDF) at the U.S. Department of Energy's (DOE's) Fernald Preserve. This plan is a support plan for the OSDF, and it is required by the *Remedial Action* (RA) *Work Plan for the On-Site Disposal Facility* (DOE 1996a). Revision 0 of the GWMLP was issued in August 1997 (DOE 1997), Revision 1 was issued in April 2005 (DOE 2005a), and draft final Revision 2 was issued in January 2006 (DOE 2006a). As noted in the executive summary, the GWLMP has been integrated into this revision of the *Legacy Management and Institutional Controls Plan* (LMICP). The GWLMP is no longer a stand-alone document with its own review and revision cycle. It will be reviewed and, if necessary, revised each September.

As is discussed in detail in this document, the monitoring program comprises two primary elements: (1) a leak detection component, which provides information to verify the ongoing performance and integrity of the OSDF and its impact on groundwater; and (2) a leachate monitoring component, which satisfies regulatory requirements for leachate collection and management. The leak detection monitoring layers (made up of a leak detection layer inside the facility, and two groundwater zones occurring in the subsurface below the facility) will be used collectively to assess the existence of leakage from the facility and to satisfy OSDF groundwater monitoring requirements. The two groundwater zones in the monitoring plan are the Great Miami Aquifer (a water table found at depths ranging from 40 to 90 feet [ft] in the vicinity of the OSDF) and the perched groundwater residing in the glacial till overlying the Great Miami Aquifer. Note that an additional component of the OSDF is inspections and maintenance activities, which are discussed in Appendix D of this document and in Attachment B (Post-Closure Care and Inspection Plan [PCCIP]).

This OSDF monitoring plan has been developed to meet the regulatory requirements for groundwater detection monitoring in both the Great Miami Aquifer and the perched groundwater system. These detection monitoring requirements constitute the first tier of a three-tiered program consisting of (1) detection, (2) assessment, and (3) corrective action monitoring strategy required for engineered disposal facilities. Consistent with this three-tiered requirement, follow-up groundwater quality assessment and corrective action monitoring plans will be developed and implemented as necessary, if it is determined from detection monitoring that a leachate leak from the OSDF into the underlying natural hydrogeologic environment has occurred. Conversely, if the detection monitoring continues to successfully demonstrate that leachate leaks are not of concern (i.e., the facility is performing as designed), then the monitoring program will remain in the first-tier "detection" mode, and the need for the follow-up groundwater quality assessment and/or corrective action monitoring plans will not be triggered.

The DOE-Office of Legacy Management is responsible for OSDF monitoring, maintenance, and reporting. This plan will be revised, as necessary, to reflect approved updates to monitoring and reporting requirements, and will continue to be used through post-closure.

1.1 Overview of the OSDF

The OSDF is located along the northeast portion of the Fernald Preserve and, as required by the Operable Unit 2 (OU2), OU3, and OU5 records of decision (RODs), is situated over the "best available geology" at the Fernald Preserve to take maximum advantage of the protective hydrogeologic features of the glacial till above the Great Miami Aquifer. The OSDF footprint (including the capped area extending beyond the disposal area) occupies approximately 90 acres of the 1,050-acre Fernald Preserve. This area is dedicated to disposal and will remain under federal ownership and federal administrative control now that the Fernald Preserve's cleanup mission has been completed. The OSDF provides on-site disposal capacity for approximately 2.96 million cubic yards (yd^3) of contaminated soil and debris generated by Fernald Preserve's environmental restoration and building decontamination and demolition (D&D) activities.

The OSDF dimensions are as follows: capacity of 2.96 million yd^3 (2.2 million cubic meters), maximum height of approximately 65 ft (20 meters [m]), and an area coverage of approximately 90 acres (36.423 hectares) of the northeastern area of the Fernald Preserve. The facility was constructed in phases, with eight individual cells. Cells are approximately 700 ft by 400 ft, or 280,000 square ft (ft^2) (6.4 acres). Note that the dimensions of Cell 8 are larger than those of the other cells (approximately 9.4 acres). Each cell was constructed with a leachate collection system (LCS) that collected infiltrating rainwater and stormwater runoff during waste placement and prevented it from entering the underlying environment. Other engineered features include a multilayer composite liner system, a leak detection system (LDS) positioned beneath the primary liner, and a multilayer composite cover placed over each cell following the completion of waste placement activities.

The LCS and LDS layers are designed to convey any leachate/fluid that enters the system through pipes (i.e., the LCS pipes and LDS pipes) to the west side of each cell to the liner penetration box. The liner penetration box is the point where the LCS and LDS pipes penetrate the liner system and therefore represents the lowest elevation of each cell and the most likely point for a leak to occur. From the liner penetration box, the LCS and LDS pipes drain to the EPLTS valve houses where the leachate and LDS fluid are collected in tanks, flow rates/volumes are monitored, and samples are collected. Fluid that collects in the LCS and LDS collection tanks located in each cell's valve house is pumped to the gravity drain portion of the leachate transmission system line, which drains all valve houses to the permanent lift station (PLS). The leachate collected in the PLS is periodically pumped to the converted advanced wastewater treatment facility (CAWWT) backwash basin or directly to CAWWT feed tanks. The EPLTS consists of the valve houses and the equipment contained within them as well as the gravity drain portion of the leachate transmission line that runs from the valve house at Cell 1 to the PLS. Figure 1–1 depicts a cross section of the liner system.

Additionally, it should be noted that there is institutional knowledge regarding the various complexities associated with the regulatory strategy for the OSDF leak detection and data evaluation processes. This information should be considered during future post-closure evaluations. To date, the process continues to evolve and there is much interaction between DOE, the U.S. Environmental Protection Agency (EPA), and the Ohio Environmental Protection Agency (OEPA) regarding the overall process.

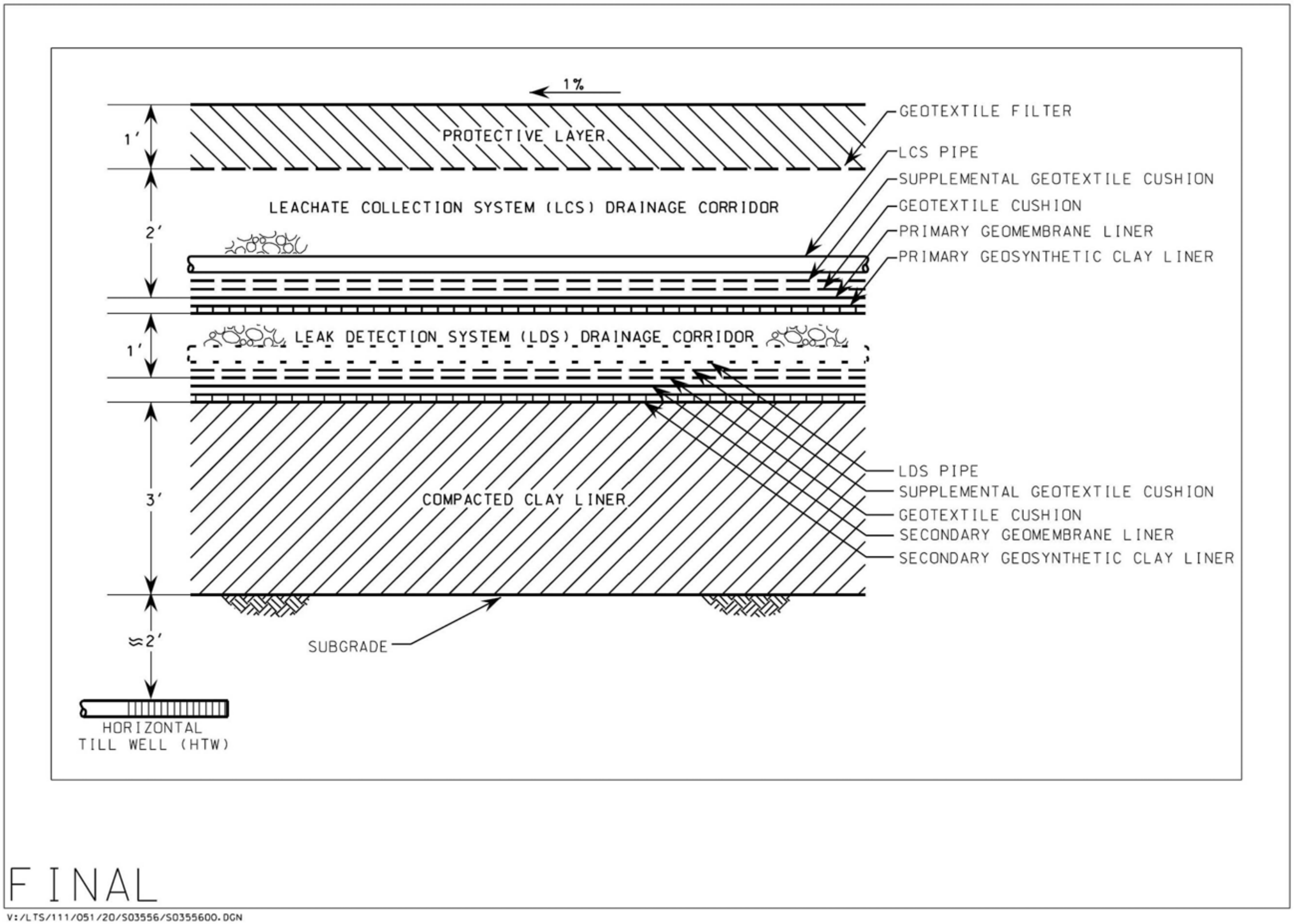

Figure 1–1. On-Site Disposal Facility Liner System with HTW at the Drainage Corridor

1.2 Program Overview

The OSDF monitoring plan was developed by reviewing the pertinent regulatory requirements for detection monitoring and translating those requirements into site-specific monitoring elements (e.g., designation of monitoring zones, monitoring station locations, sampling frequency, and establishment of analytical parameters).

The plan considers current hydrogeologic and contaminant conditions in the glacial till and Great Miami Aquifer beneath the facility. Preexisting contamination in the perched groundwater system and the Great Miami Aquifer, the variable nature of the geology and hydrogeology of the clay-rich glacial deposits, and the influence of aquifer restoration activities in the Great Miami Aquifer add complexity to the development of a groundwater monitoring program. Note that the Great Miami Aquifer was undergoing restoration during the same time period that the OSDF was actively accepting waste for disposal, after the facility was capped and during post-closure. The aquifer restoration is a pump-and-treat operation. The closest pumping wells are approximately 2,000 ft upgradient of the OSDF footprint.

Available site-specific information generated from more than 15 years of detailed site characterization efforts including geology and hydrogeology, results of detailed contaminant fate and transport modeling, OSDF construction activities, and monitoring results from the OSDF program and Attachment D (Integrated Environmental Monitoring Plan [IEMP]) were used to develop the monitoring strategy and to determine monitoring locations. The strategy employs a four layer vertical slice/trend analysis approach to independently monitor the potential for leachate generation and leakage from each of the disposal cells comprising the facility. As part of this strategy, “baseline” conditions for each cell are being established to facilitate trend analysis from data generated for each of the monitoring stations over time. This baseline will help define existing conditions in both the perched groundwater and the Great Miami Aquifer in the immediate vicinity of the facility.

This plan focuses on the monitoring needs associated with detection monitoring during post-closure. Future amendments to the plan will be prepared to address program modifications, if changes to the monitoring program are necessary. An in-depth review of program needs is also envisioned at the completion of Great Miami Aquifer restoration activities. Prior to the completion of the aquifer restoration activities, the data comparisons will focus on shorter term “interim” leakage effects that might occur during the initial years after the cells are capped. The baseline will enhance the ability to conduct the interim comparisons until the facility enters its final long-term, post-closure mode and aquifer restoration activities are complete.

Throughout this process, the analytical results and trend analyses for all three leak detection monitoring layers (the LDS, perched groundwater, and the Great Miami Aquifer) and the LCS will be compared with one another to evaluate the performance of each cell and to determine whether a release from the facility has occurred. In concert with the groundwater monitoring component of the program, the leachate characterization and tracking component will provide for the monitoring of leachate concentrations and flows in the LCS and LDS to support leachate management and treatment decisions.

During the development of this plan, EPA and OEPA identified the need to monitor the potential for leachate leakage from the OSDF at its first point of entry into the natural hydrogeologic environment (rather than relying on Great Miami Aquifer groundwater monitoring alone). This led to the decision to install horizontal monitoring wells in the glacial till directly beneath the liner penetration boxes of the LCS and LDS layers in each cell. The subsurface area beneath the liner penetration boxes provides the best opportunity to monitor for an initial leak into the subsurface environment, should such a leak occur. As a result of the low transmissive properties of the glacial till and the discontinuous nature of the perched groundwater system in the till, it may not always be possible to collect groundwater samples routinely from the horizontal wells. In view of this limitation, DOE, EPA, and OEPA concurred that the placement of the horizontal wells beneath the liner penetration boxes represents the most feasible site-specific approach to monitor for first entry leakage from the facility to the environment, and this approach provides adequate and appropriate early warning detection capabilities for this site-specific setting.

The OSDF groundwater monitoring plan has been implemented as a project-specific plan (refer to Appendix B), with the results presented for EPA and OEPA review as part of the comprehensive IEMP reporting process (i.e., annual site environmental reports [ASERs]). The IEMP (DOE 2006d) provides a consolidated reporting mechanism for all of the environmental regulatory compliance monitoring activities including the data and findings from the OSDF groundwater monitoring plan. Incorporating the OSDF data into the IEMP maintains the commitment to an effective remediation-focused environmental surveillance monitoring program. Once the environmental remediation requirements have been completed and the site is successfully removed from the Superfund National Priorities List, the monitoring activity for the OSDF (which will be the last remaining facility in place at the site) will continue in accordance with applicable regulatory monitoring and reporting requirements.

1.3 Plan Organization

The remainder of this plan is organized as follows:

- A summary of the geology and hydrogeology in the immediate area of the OSDF is provided in Section 2.0.
- A regulatory analysis and strategy for OSDF monitoring is provided in Section 3.0.
- The OSDF leak detection monitoring program is provided in Section 4.0, including a description of program elements, monitoring frequencies, and data evaluation.
- The OSDF leachate management monitoring program, which will be used to support leachate management decisions, is provided in Section 5.0.
- Reporting requirements and notifications are provided in Section 6.0.
- References are provided in Section 7.0.

The appendixes that support this plan are:

- Appendix A—OSDF Applicable or Relevant and Appropriate Requirements (ARARs) and Other Regulatory Requirements.
- Appendix B—Project-Specific Plan for the On-Site Disposal Facility Monitoring Program.
- Appendix C—Fernald Site Data Quality Objectives, Monitoring Program for the On-Site Disposal Facility Program.
- Appendix D—Leachate Management Plan for the On-Site Disposal Facility.
- Appendix E—Selection Process for Site-Specific Leak Detection Indicator Parameters.

1.4 Related Plans

Several other RA plans have been prepared for the OSDF, or for the Fernald Preserve as a whole, containing information relevant to this plan. These other plans are listed below along with a brief statement of their relationship to this plan:

- *Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility* and addendum (DOE 1995a and DOE 1996b): Describe field activities used to assess potential sites for the OSDF, and present the information collected during addendum activities to the *Project-Specific Plan for Installation of the On-Site Disposal Facility Great Miami Aquifer Monitoring Wells* (DOE 2001a).
- OSDF Systems Plan (DOE 2001b): Describes the inspection and maintenance of the LCS and LDS.
- *Enhanced Permanent Leachate Transmission System Operation* (DOE 2005b): Is the operational procedure for management, inspection, and conveyance of leachate and fluid from the LCS and LDS. Note that operational procedures are included in the *Legacy Management Fernald Operating Procedures* (DOE 2006b).
- OSDF Design Packages (GeoSyntec 1996a, GeoSyntec 1996b, GeoSyntec 1997, DOE 2004a) and construction drawing packages: Provide the overall approved design for each cell of the OSDF.
- PCCIP (Attachment B): Summarizes the inspection and maintenance activities (e.g., cap and runoff controls) to ensure continued proper performance of the OSDF and also summarizes at the conceptual level corrective actions/response actions.
- *Borrow Area Management and Restoration Plan, On-Site Disposal Facility* (GeoSyntec 2001a): Describes management of borrow soils used to construct the OSDF, and describes the planning for end state after soils have been excavated.
- *Surface Water Management and Erosion Control Plan, On-Site Disposal Facility* (GeoSyntec 2001b): Describes soil erosion control to minimize sediment loss.
- *Construction Quality Assurance Plan, On-Site Disposal Facility* (GeoSyntec 2002): Describes quality assurance methods and testing to certify the construction of the OSDF.
- *Impacted Materials Placement Plan, On-Site Disposal Facility* (GeoSyntec 2005): Describes the categories of material, prohibited items, and placement methods for impacted material placement in the cells.
- *Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility* (DOE 1998): Defines the OSDF requirements for materials generated by the Fernald site's environmental restoration, and D&D efforts.
- *Project-Specific Plan for Installation of the OSDF Great Miami Aquifer Wells* (DOE 2001a): Describes the installation of Great Miami Aquifer wells.
- *Technical Memorandum for the OSDF Cells 1, 2, and 3 Baseline Groundwater Conditions* (DOE 2002): Describes baseline conditions for Cells 1, 2, and 3.
- IEMP (Attachment D).
- Additionally, ASERs include OSDF reporting requirement updates.

2.0 OSDF Area Geology and Hydrogeology

2.1 Introduction

The OU2, OU3, and OU5 RODs contain requirements that the OSDF be located in an area of the Fernald Preserve that takes maximum advantage of available geologic and hydrogeologic conditions to further reduce the potential for contaminant migration from the facility. To identify the preferred OSDF location, a detailed pre-design geotechnical and hydrogeologic investigation was conducted as a supplement to the sitewide characterization efforts contained in *Remedial Investigation* (RI) *for Operable Unit 5* (DOE 1995b). The detailed findings of the pre-design investigation are documented in the *Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility* (DOE 1995a). As documented in the site selection report, a final location along the eastern margin of the Fernald Preserve was selected to satisfy the RODs and other regulatory-based siting requirements.

The following sections summarize the principal geologic, hydrogeologic, and subsurface contaminant conditions in the OSDF area that have a direct bearing on the development of the leak detection and groundwater monitoring strategy for the facility. For more detailed information, refer to the *Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility* (DOE 1995a) and *Remedial Investigation* (RI) *for Operable Unit 5* (DOE 1995b).

2.2 OSDF Area Geology

The OSDF, inclusive of its final cap configuration, occupies an area of approximately 90 acres along the northeastern area of the Fernald Preserve. The facility is oriented in a north-to-south direction with dimensions of approximately 3,600 ft by 1,000 ft. The east edge of the facility (i.e., the toe of the cap system) is set back from the eastern property line by approximately 100 ft. The subsurface conditions in the immediate area of the selected OSDF location were characterized through the following field and laboratory activities:

Test Borings	Fifty-four borings were drilled in the immediate vicinity of the OSDF to obtain geotechnical soil samples and characterize underlying geology.
Monitoring Wells	Fifty-one groundwater monitoring wells were installed in the general vicinity of the OSDF from which water level data, preexisting groundwater contaminant concentration data, and lithology data have been obtained.
Geotechnical Tests	Key geotechnical tests (i.e., Atterberg limits, water content measurements, and permeability tests) were performed on subsurface geologic samples, including 116 sieve analyses to determine grain size.

Lysimeter Installation	Eight lysimeters were installed in the OSDF site area to determine the nature and concentration of uranium in the vadose zone of the glacial till and the unsaturated Great Miami Aquifer.
Slug Tests	Twenty-four slug tests were performed to assess the hydraulic characteristics of the perched groundwater system.
Water Level Monitoring	Water levels obtained from the perched groundwater and the Great Miami Aquifer wells were used to determine hydraulic gradients and flow directions.
Soil Analyses	Soil samples collected during the RI and the Pre-Design Investigation were characterized for mineralogy and analyzed for uranium and other constituents of concern (COCs) to determine preexisting contaminant levels in the subsurface beneath the OSDF.
Groundwater Flowmeter Study	Twenty-two flowmeter readings were obtained in the perched groundwater in the OSDF site area.
Distribution Coefficient (K_d) Study	A K_d study was performed to determine how uranium will partition itself between groundwater and soil in the OSDF site area.
Cone Penetrometer Tests (CPTs)	Eighty-eight CPTs were conducted in the OSDF site area to aid in making subsurface lithologic interpretations.

The information obtained through these activities, coupled with the sitewide interpretations gained through the OU5 RI, formed the basis for the interpretations of subsurface conditions in the vicinity of the OSDF site.

In general, the OSDF site is situated on glacial till underlain by sand and gravel deposits that comprise the Great Miami Aquifer, which is designated as a sole-source aquifer under the Safe Drinking Water Act (SDWA). The Great Miami Aquifer is a high-yield aquifer (i.e., wells completed in some areas of the aquifer yield greater than 500 gallons per minute [gpm]), and it supplies a significant amount of potable and industrial water to people located in Butler and Hamilton counties.

The glacial till ranges in thickness from approximately 20 to 60 ft in the immediate vicinity of the OSDF and is composed of about equal portions of carbonate (calcite and dolomite) and silicate (quartz, feldspar, and clay minerals) grains. Based on the results of 116 sieve and hydrometer analyses, the glacial till can be characterized as dense, heterogeneous, sandy, lean clay, with occasional discontinuous interbedded sand and gravel lenses. The glacial till can be further divided into an upper brown clay layer and a lower gray clay layer. This division is made on color and physical properties because the mineralogy is similar in both layers. The brown clay layer is more weathered (i.e., it exhibits iron oxidation and contains a greater abundance of desiccation fractures compared with the underlying gray clay layer) and has a higher incidence of interbedded sand and gravel lenses. In the eastern portions of the Fernald Preserve, the gray clay ranges in thickness from approximately 15 to 42 ft, and the brown clay ranges from approximately 8 to 15 ft. As indicated by the OU5 RI, the gray clay is the most uniform and least permeable and, therefore, the most protective geologic layer found above the Great Miami Aquifer across the site.

As a follow-up to the OU5 RI, one of the primary objectives of the *Pre-Design Investigation and Site Selection Report for the On-Site Disposal Facility* (DOE 1995a) was to identify the location where the thickest, laterally persistent gray clay layer is present that contains the least amount of interbedded coarse granular material, and which allows regulatory-based siting requirements (such as the property line and other geographic setbacks) to be met. The selected location for the OSDF has a minimum thickness of gray till of approximately 15 ft and an average thickness of approximately 30 ft. The percentage of interbedded sands and gravels in the gray till in this area is approximately 4 percent.

Beneath the glacial till layer, the sand and gravel deposits comprising the Great Miami Aquifer are approximately 175 ft thick. For RI characterization and monitoring purposes, the Great Miami Aquifer has been divided into three hydrologic zones: the uppermost zone, represented by the Fernald Preserve's Type 2 monitoring wells; the middle zone, represented by the Type 3 monitoring wells; and the lowermost zone, represented by the Type 4 monitoring wells. The sand and gravel deposits comprising the aquifer are extensive and, at the regional scale, occupy a land area of more than 970,000 acres.

Beneath the Great Miami Aquifer deposits, shale and limestone bedrock is encountered at a total depth of approximately 200 ft beneath the OSDF site. Regional studies by the Geological Survey of Ohio indicate the shale and limestone bedrock is approximately 330 ft thick in the Fernald Preserve area (Fenneman 1916).

2.3 Hydrogeologic Conditions

The Fernald Preserve has two distinctive bodies of groundwater that have been extensively characterized through the remedial investigation/feasibility study (RI/FS) process and the Pre-Design Investigation: the Great Miami Aquifer and the perched groundwater found within the overlying glacial till. The discontinuous sand and sand/gravel lenses found within the glacial till can provide water to a pumping well because the deposits are more permeable than the surrounding, clay-rich glacial till. The entire section of glacial till is believed to be saturated or nearly saturated with groundwater. An unsaturated sand and gravel zone approximately 20 ft to 30 ft thick separates the base of the glacial till from the regional water table in the Great Miami Aquifer. Depending on local weather patterns and rainfall, the water table in the Great Miami Aquifer exhibits annual fluctuations of approximately 6 ft within the unsaturated zone below the glacial till in the area of the OSDF.

The Great Miami Aquifer is a classic example of an unconfined buried valley aquifer. The depth to water in the aquifer in the vicinity of the OSDF ranges from 40 to 90 ft below the ground surface. Based on 5 years of water level measurements collected prior to the beginning of the pump-and-treat remedy (1988 through 1993), the groundwater flow direction in the aquifer in this area is from west to east (refer to OU5 RI report, Figure 3–50). Groundwater velocity in the area of the OSDF is approximately 451 ft per year, based on an average hydraulic gradient of approximately 0.0008 (refer to OU5 RI, page 3–61); an average hydraulic conductivity of approximately 463 ft per day (average of three pumping tests); and an effective porosity of 30 percent. Using the representative K_d for uranium of 1.78 liters per kilogram determined through the RI/FS process, the retardation factor for uranium movement in the Great Miami Aquifer is approximately 12. At a retardation factor of 12, the uranium moves approximately one-twelfth as fast as the water or approximately 37.6 ft per year. More recent studies conducted by Sandia National Laboratories (SNL) on uranium-contaminated sediment collected from the vadose zone indicate that the K_d ranges from 2.8 to 8.7 (SNL 2003, SNL 2004). The higher K_d values reported for the SNL study reflect natural variability in the aquifer and stronger bonding of the adsorbed uranium as it ages on the mineral surface, which results in a higher retardation factor and indicates slower migration times.

Perched groundwater is present above the unsaturated zone of the Great Miami Aquifer within the glacial till. Overall the till exhibits between 90 to 100 percent saturation (close to field capacity) and has the general properties of an aquitard. When the till reaches field capacity, it has the capability to release groundwater downward under a unit vertical hydraulic gradient into the underlying unsaturated zone of the Great Miami Aquifer. Eventually, this downward-moving groundwater will enter the saturated portion of the Great Miami Aquifer as recharge. Depths to perched groundwater in the till are generally 6 ft or less in the eastern portion of the Fernald Preserve in the area of the OSDF.

Although the till is generally saturated, there are no identified suitably thick or laterally continuous coarse-grained zones beneath the OSDF that can facilitate implementation of a comprehensive, interlinked (i.e., up- and downgradient monitoring points) perched groundwater monitoring system. The current amount of saturation in the till is expected to be reduced even further in the future, once the cap and underlying liners of the OSDF are in place; they will serve as local hydraulic barriers to further reduce the volume of infiltrating moisture within the OSDF footprint.

Slug test data from 24 perched groundwater wells (Type 1 monitoring wells) indicate that the average horizontal hydraulic conductivity for wells screened across the brown and gray clay layer interface is 6.30×10^{-6} centimeters per second (cm/sec). The gray clay layer beneath the brown clay is the least permeable layer above the Great Miami Aquifer. Laboratory hydraulic conductivities conducted on samples collected from this layer indicate measured values ranging from 9.53×10^{-9} cm/sec to 5.83×10^{-8} cm/sec. Other laboratory and field measurements indicate the till has an effective porosity of 4 to 10 percent, and a representative bulk density of 1.85 grams per cubic centimeter. The discontinuous nature of the perched water in the glacial till does not facilitate the measurement of a continuous water table gradient in the OSDF site area.

Model calibration studies conducted during the OU5 RI/FS indicate average vertical groundwater flow rates through the glacial till (including the gray clay layer) to be approximately 6 inches per year. The time it takes a contaminant to move through the glacial till and break through into the Great Miami Aquifer is controlled by the thickness of gray clay present in the till, the groundwater infiltration rate through the gray clay, and the retardation properties of the gray clay. In the OSDF area, modeled breakthrough travel times for uranium (the Fernald Preserve’s predominant contaminant) range from approximately 210 years (to have a 20-micrograms-per-liter concentration in the aquifer) to 260 years (to have 1 percent of the source concentration). These breakthrough times were calculated using a retardation factor of 165 for the gray clay (refer to OU5 RI report, Appendix F [DOE 1995b]), not considering movement through the brown clay, and not including any retardation in the unsaturated Great Miami Aquifer sand and gravel. The modeled breakthrough travel time for 1 percent of a technetium source, the Fernald Preserve's most mobile contaminant, is approximately 3.6 years. This breakthrough time was calculated using a retardation factor of 2.29 for the gray clay (refer to OU5 RI report, Appendix F [DOE 1995b]), not considering movement through the brown clay, and not including any retardation in the unsaturated Great Miami Aquifer sand and gravel. This modeling strategy was used in the OU5 Feasibility Study (DOE 1995c) to calculate waste acceptance criteria (WAC) for the OSDF.

The extensive presence of low permeability lean sandy clay throughout the till matrix and the discontinuous nature of the coarser grained lenses are the dominant factors controlling the rate at which fluids can migrate through the more permeable portions of till, either vertically or laterally.

Unlike conditions in the Great Miami Aquifer, the up- and downgradient directions of perched groundwater flow are difficult to assign at the local scale. Groundwater flow meter readings from 22 wells taken during the Pre-Design Investigation indicate that the horizontal flow directions vary abruptly from well to well, with no discernable consistent patterns. Consequently, horizontal flow regimes are interpreted to be very localized in nature (perhaps on the order of tens to hundreds of feet in length) and not laterally persistent due to the discontinuous nature of the interbedded coarse-grained lenses. Taken collectively, the water levels obtained during the OU5 RI indicate that if an area gradient were present, it would range from between 0.008 to 0.015.

Model calibration studies conducted during the OU5 RI/FS indicate that vertical flow tends to dominate in the glacial till because of several factors: (1) the steep vertical hydraulic gradients across the till—which are at or near unity—compared to the small localized lateral hydraulic gradients, which collectively indicate a gradient that is much less than unity (0.008 to 0.015); (2) the laterally discontinuous nature of the coarse grained lenses in the till; and (3) the shorter overall flowpath distance in the vertical dimension for the Fernald Preserve (60 ft compared to hundreds or thousands of feet in the horizontal) before a potential discharge point for the glacial till groundwater is reached.

It can be generally interpreted from this information that if a leachate leak were able to exit through the OSDF liner system, it would be expected to migrate vertically towards the Great Miami Aquifer (although some localized "stair step" lateral motion may also be expected to take place in route). The exact pathway that a hypothetical leachate leak from the facility would take is difficult to determine, but it is clear that an effective monitoring program needs to consider both the most likely point of entry of the leak into the subsurface environment beneath the facility (i.e., above the horizontal till well [HTW]) and the ultimate arrival of the leak at the Great Miami Aquifer.

2.4 Existing Contamination

In the immediate vicinity of the OSDF, existing contaminant concentrations are present above background levels in surface and subsurface soil, the perched groundwater, and the Great Miami Aquifer. The nature and extent of contamination in these three media were documented in the OU5 RI report and preliminary remediation levels were developed for the Fernald Preserve's environmental media in the OU5 FS (DOE 1995c). Final remediation levels (FRLs) were documented in the OU5 ROD.

Based on the data presented in the OU5 RI report, only the surface soil (to a depth of approximately 6 inches) was considered contaminated above FRLs within the actual boundaries of the OSDF. The remaining media within the OSDF footprint were contaminated above background but generally below FRLs. An area of deep soil excavation to address deep soil and perched groundwater contamination was completed outside the OSDF footprint at the Fernald Preserve's sewage treatment plant, located immediately east of the OSDF. Additionally, in the spring of 2004, an area due west of Cell 8 was excavated to approximately 6 ft due to contamination just above the soil FRLs. This area was the closest excavation necessary to address soil FRL exceedances that were deeper than 6 inches.

Pre-OSDF aquifer contamination that was proximal to the OSDF footprint was present in the Plant 6 area. The Plant 6 area is located approximately 300 ft west of the OSDF. During the remedial investigation, a uranium plume was detected in this area. Direct-push sampling conducted in 2000 and 2001, in support of the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas, indicated that the uranium plume in the Plant 6 area was no longer present. It is believed that the uranium plume dissipated to concentrations below the FRL as a result of the shutdown of plant operations in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action #1 in the early 1990s. Because a total uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 area at the time of the design, a restoration module for the Plant 6 area became unnecessary and was no longer planned.

In 2004, deep excavation work in the Plant 6 area was completed. As a follow-up to the excavation work, direct-push groundwater sampling was conducted in 2004 in the area to determine if any groundwater FRL exceedances for uranium or technetium-99 were present in the Great Miami Aquifer now that deep excavations were complete. The results of the direct-push groundwater sampling showed no uranium or technetium-99 FRL exceedances.

Since the decision not to install extraction wells in the Plant 6 Area was approved in 2001, uranium FRL exceedances have been measured at one well in the area, Monitoring Well 2389. The uranium FRL exceedances at Monitoring Well 2389 will continue to be monitored as part of the IEMP (DOE 2006d). It appears that a thin layer of contamination is present in the upper 1 ft or so of the aquifer at Monitoring Well 2389; this is not enough contamination to warrant the installation of a groundwater recovery well. It is expected that the concentration of uranium at Monitoring Well 2389 will dissipate on its own over time. The data will continue to be tracked as part of the IEMP sampling activities.

An abandoned steel casing was uncovered during excavation in late 2005 approximately 87 ft west-southwest of Monitoring Well 2389. The casing is believed to have been associated with the hydraulic cylinder of the Plant 5 freight elevator. The abandoned casing was deep enough to breach the aquifer and could have provided a potential contamination pathway to the aquifer. The presence of this abandoned casing could explain the thin layer of uranium contamination that has been detected in the upper 1 ft or so of the aquifer in the location of Monitoring Well 2389.

In accordance with the OU5 ROD, RAs for surface and subsurface soil, the perched groundwater in the glacial till, and the Great Miami Aquifer were implemented in areas where FRLs had been exceeded. However, at the completion of the sitewide RAs, low levels of some contaminants (i.e., above background levels but below FRLs) remained in the various environmental media at the Fernald Preserve, including the area adjacent to and beneath the OSDF. This residual low-level contamination remains after certification of cleanup at the Fernald Preserve has been achieved and it is recognized as a factor that creates a degree of uncertainty in the ability to distinguish small quantities of potential OSDF leakage from the preexisting levels of contamination in the media.

End of current text

3.0 Regulatory Analysis and Strategy

The OSDF groundwater/leak detection and leachate monitoring plan is designed to comply with all regulatory requirements associated with groundwater detection monitoring and leachate monitoring for disposal facilities. The source of these regulatory requirements is the ARARs listed in the RODs for OU2, OU3, and OU5. This section summarizes the regulatory requirements by describing each ARAR and presents the regulatory strategy for compliance with these ARARs.

As indicated in Section 1.1, there is institutional knowledge regarding the various complexities associated with the regulatory strategy for the OSDF leak detection and data evaluation processes. This information should be considered during future post-closure evaluations. To date, the process continues to evolve, and there is much interaction between DOE, EPA, and OEPA regarding the overall process.

3.1 Regulatory Analysis Process and Results

The analysis of the regulatory drivers for groundwater monitoring for the OSDF was conducted by examining the suite of ARARs in the Fernald Preserve's approved OU RODs to identify a subset of specific groundwater monitoring requirements for the OSDF. Three RODs (for OU2, OU3, and OU5) include requirements related to on-site disposal. The RODs for these three OUs were reviewed and the ARARs relevant to the OSDF identified. The results of this review are provided in Appendix A and summarized below.

The following regulations were identified as being ARARs for the OSDF groundwater monitoring program:

- Ohio Solid Waste Disposal Facility Groundwater Monitoring Rules, Ohio Administrative Code (OAC) 3745-27-10, which specify groundwater monitoring program requirements for sanitary landfills (note that the OSDF is not a sanitary landfill). These regulations describe a three-tiered program for detection, assessment, and corrective measures monitoring.
- Resource Conservation and Recovery Act (RCRA)/Ohio Hazardous Waste Groundwater Monitoring Requirements for Regulated Units, title 40 *Code of Federal Regulations* (CFR) 264.90 through .99 (OAC 3745-54-90 through 99), which specify groundwater monitoring program requirements for surface impoundments, landfills, and land treatment units that manage hazardous wastes. Similar to the Ohio Solid Waste regulations, these regulations describe a three-tiered program of detection, compliance, and corrective action monitoring. Because the Ohio regulations mirror or are more stringent than the federal regulations, the Ohio regulations are the controlling requirements and are cited within this document.
- Uranium Mill Tailings Reclamation and Control Act (UMTRCA) Regulations, 40 CFR 192.32(A)(2), which specify standards for uranium byproduct materials in piles or impoundments. This regulation requires conformance with the RCRA groundwater monitoring performance standard in 40 CFR 264.92. Compliance with RCRA/Ohio Hazardous Waste regulations for groundwater monitoring will fulfill the substantive requirements for groundwater monitoring in the UMTRCA regulations.

- DOE Order M 435.1 1, *Environmental Monitoring*, which requires low level radioactive waste disposal facilities to perform environmental monitoring for all media, including groundwater. Compliance with RCRA/Ohio Hazardous Waste and Ohio Solid Waste regulations for groundwater monitoring will fulfill the requirement for groundwater monitoring in this Order, along with incorporating pertinent radiological parameters.

The following drivers necessitated an overall leak detection strategy:

- Ohio Municipal Solid Waste Rules, OAC 3745-27-06(C)(9a) and OAC 3745-27-10, which require that facilities prepare a groundwater monitoring plan that incorporates leachate monitoring and management to ensure compliance with OAC 3745-27-19(M)(4) and OAC 3745-27-19(M)(5).
- Ohio Municipal Solid Waste Rules – Operational Criteria for a Sanitary Landfill Facility, OAC 3745-27-19(M)(4) and (5), which require submittal of an annual operational report including:
    - A summary of the quantity of leachate collected for treatment and disposal on a monthly basis during the year, location of leachate treatment and/or disposal, and verification that the leachate management system is operating in accordance with the rule.
    - Results of analytical testing of an annual grab sample of leachate from the leachate management system.

3.2 OSDF Monitoring Regulatory Compliance Strategy

Of the ARARs presented above, the Ohio Solid Waste and the Ohio Hazardous Waste regulations are the most prescriptive and, therefore, warrant further discussion on how compliance with these two regulatory requirements will be met. The leak detection monitoring requirements of these two sets of regulations are similar, and they dictate the development of detection monitoring plans capable of determining the facility's impact on the quality of water in the uppermost aquifer and any significant zones of saturation above the uppermost aquifer underlying the landfill.

Typically a detection monitoring program consists of the installation of upgradient and downgradient monitoring wells, routine sampling of the wells, and analysis for a prescribed list of parameters, followed by a comparison of water quality upgradient of the landfill to water quality downgradient of the landfill. The detection of a statistically significant difference in downgradient water quality suggests that a release from the landfill may have occurred.

As discussed in Section 2.0, low permeability in the glacial till and preexisting contamination within the glacial till and the Great Miami Aquifer add complexity to the development of a groundwater detection monitoring program consistent with the standard approach of the Solid and Hazardous Waste regulations. Both sets of regulations accommodate such complexities by allowing alternate monitoring programs, which provide flexibility with respect to well placement, statistical evaluation of water quality, facility specific analyte lists, and sampling frequency. The OSDF groundwater/leak detection monitoring program has required the use of an alternate monitoring program, in accordance with the criteria in the Ohio Solid and Hazardous Waste regulations. Compliance with the criteria is discussed below in Section 3.2.1.

The regulatory requirements for the leachate monitoring program are provided by the Ohio Solid Waste regulations. The compliance strategy for the leachate monitoring program is discussed below in Section 3.2.2.

3.2.1 Leak Detection Monitoring Compliance Strategy

The groundwater/leak detection monitoring program for the OSDF includes routine sampling and analysis of water drawn from four zones within and beneath the disposal facility including the LCS, the LDS, perched water within the glacial till, and the Great Miami Aquifer. This four-layered “holistic” approach allows the earliest leak detection from the OSDF given the unique hydrogeologic and preexisting contaminant situation at the site. However, this tailored approach differs from a typical leak detection monitoring program in several ways, and requires a compliance strategy to ensure that the program meets or exceeds the substantive requirements within the Ohio Solid and Hazardous Waste regulations. Below is a detailed discussion of compliance with several elements of the program, including alternate well placement, statistical analysis, monitoring frequency, and parameter selection. The implementation of the OSDF groundwater/leak detection program is presented in Section 4.0 and Appendix B.

3.2.1.1 Alternate Well Placement

The Ohio Solid Waste regulations require that a groundwater monitoring system consist of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from both the uppermost aquifer and any overlying significant zones of saturation (OAC 3745-27-10(B)(1)). Groundwater samples will be obtained through wells installed in the glacial till as well as the Great Miami Aquifer.

The regulations also state that the wells must represent the quality of groundwater passing directly downgradient of the limits of solid waste placement (OAC 3745-27-10(B)(1)(b)). In lieu of installing vertical glacial till monitoring wells along the perimeter of the OSDF, horizontal wells will be installed beneath the OSDF and screened beneath the liner penetration box of the LDS for each disposal cell where the greatest potential for leakage exists. Horizontal wells are preferred to vertical wells due to restrictions on well installation within 200 ft of waste placement so as to avoid interference with the disposal facility cap, and the absence of significant lateral flow within the overburden. The time required for contaminants to migrate laterally in the till toward wells located 200 ft from the limits of waste placement greatly exceeds the vertical travel time through the glacial till; therefore, the aquifer would be impacted by contaminants long before OSDF HTWs could detect the release. Although the existence of the OSDF may result in dewatering of the glacial till such that samples cannot be regularly obtained, horizontal wells installed beneath the liner of the OSDF represent the highest potential for detecting releases to the till. Such an alternate placement for the till wells is allowed in the Ohio Solid Waste regulations.

The performance criteria in OAC 3745-27-10(B)(4) require that the number, spacing, and depth of the wells must be based on site-specific hydrogeologic information and must be capable of detecting a release from the facility to the groundwater at the closest practical location to the limits of solid waste placement. The placement of till wells beneath the facility, as opposed to along its perimeter, meets or exceeds the requirement to be located adjacent to waste placement.

3.2.1.2 Alternate Statistical Analysis

A statistical analysis is required in both the Ohio Solid and Hazardous Waste regulations (OAC 3745-27-10(C)(6) and OAC 3745-54-97(H)). The statistical analysis methods listed in the regulations are: parametric analysis of variance (ANOVA), an ANOVA based on ranks, a tolerance or prediction interval procedure, a control chart approach, or another statistical test method. To date, the control chart approach (combined Shewart CUSUM control charts) has been used as it has been determined the most viable approach; however, problems with control charts are listed below. The method of evaluation for the OSDF groundwater/leak detection monitoring data is an intra-well trend analysis prior to the establishment of background (baseline) conditions in the perched water and Great Miami Aquifer beneath the OSDF. Statistically significant evidence of an upward trend would warrant further technical review, as necessary.

Although vertical monitoring wells are installed in the Great Miami Aquifer upgradient and downgradient of the OSDF, an intra-well comparison is more appropriate than an upgradient versus downgradient comparison until aquifer restoration is complete. Transient flow conditions within the aquifer, as well as the existence and anticipated fluctuation of contaminant concentrations at levels below the FRLs, discourage the use of a statistical comparison of upgradient and downgradient water quality as a reliable indicator of a release from the OSDF.

To date, establishing baseline conditions with statistical analyses has proven to be difficult due mainly to existing trend issues. Steady-state conditions, which are a requirement of control charting, have not been reached. In a letter dated April 19, 2007, DOE requested that control charts be excluded from the 2006 Site Environmental Report because it does not technically make sense to provide them until it has been determined that constituent-specific steady-state conditions have been established. A common ion study is underway that is scheduled to be completed in 2007. When the common ion study is complete, and the data have been compiled, DOE plans on meeting with the EPA/OEPA to go over the data and discuss the OSDF leak detection monitoring program and associated reporting. Once it has been demonstrated that steady-state conditions have been established, control charts could be provided in ASERs. OEPA concurred with this strategy in a letter dated May 21, 2007 (OEPA 2007).

Note: Trend analyses will continue to be performed/prepared annually, and it is anticipated that a statistical approach that includes a comparison to a statistically determined limit based on baseline data (such as control charts) will be the final procedure for evaluating OSDF monitoring data, in accordance with the regulatory citations discussed in Section 2.0. The purpose of the trend analyses currently being conducted is to assist in determining when reliable baseline statistics can be calculated.

3.2.1.3 Alternate Parameter Lists

The process used to select the indicator parameter list, described in detail in Appendix E, used the extensive RI database, and fate and transport modeling to evaluate potential indicator parameters. RIs have been completed for all Fernald Preserve source terms and contaminated environmental media. The RIs included extensive sampling and analysis to characterize wastes and quantify environmental contamination so that health protective remedies, such as the construction of the OSDF, could be selected.

Extensive databases were also used to develop WAC, which consist of concentration and mass-based limitations on the waste entering the OSDF. The WAC for the OSDF were developed with consideration of the types, quantities, and concentration of wastes that would be placed into the OSDF; the leachability, mobility, persistence, and stability of the waste constituents in the environment; and the toxicity of the waste constituents. Of 93 constituents that were evaluated for waste acceptance, 18 were identified as having a relatively higher potential to impact the aquifer within the 1,000-year specified performance period. Maximum allowable concentration limits were established for wastes containing these constituents.

The factors used to establish WAC are similar to the consideration criteria for developing an alternate parameter list specified in the Ohio Solid and Hazardous Waste regulations (OAC 3745-27-10(D)(2) and (3); OAC 3745-54-93(B); OAC 3745-54-98(A)); and OEPA policy and guidance (OEPA 1995, OEPA 1996, OEPA 1997). The methodology for developing an OSDF specific leak detection monitoring parameter list used the WAC methodology and the Ohio Solid and Hazardous Waste regulatory criteria to identify waste constituents that are expected to be derived from wastes placed in the OSDF. It should be noted that this exercise was not completely successful, as waste materials are nearly identical in composition to material outside of the OSDF.

Additionally, review of data collected during OSDF monitoring has indicated that the majority of the constituents, which are sampled initially for baseline, are not detected. It has been agreed upon by DOE, OEPA, and EPA that the list of constituents monitored can be refined to those that were detected more than 25 percent of the time. This is discussed further in Appendix E.

At this time, it is also understood that baseline conditions have not been established for any cell. In order to differentiate the types of monitoring, DOE will refer to baseline monitoring in the following two ways:

- Initial Baseline Monitoring – based on 12 rounds of samples for those initial site-specific leak detection monitoring parameters.
- Refined Baseline Monitoring – based on initial baseline parameters that are detected 25 percent or more of the time.

Specific monitoring parameter information is further discussed in Appendix E.

Note: Fernald Preserve has elected to perform up to 12 rounds of initial baseline sampling for both the perched system and the Great Miami Aquifer for all initial site-specific leak detection monitoring parameters.

Additionally, it should be noted that establishing baseline water chemistry in the perched groundwater and Great Miami Aquifer horizon under each cell is complicated by the construction process used to install the HTWs and the existence of past groundwater contamination in the till and Great Miami Aquifer zones. The installation of the HTWs involved excavation of a trench, placement of a porous filter media composed of sand, and then backfill with the porous media and till material. During this installation, the subsurface chemical properties of the till were altered by the contact of the excavated till material with the atmosphere (oxygen-rich environment). Contact of the subsurface till with the atmosphere may have impacted (1) the oxidation state of metals on the surface of grains and in the pore water and (2) microbial species that mediate oxidation/reduction reactions in the subsurface. Additionally, historical contamination in perched groundwater and Great Miami Aquifer horizons surrounded the cell may be migrating and diffusing into the horizontal and Great Miami monitoring wells.

In the March 2005 technical information exchange meeting, it was agreed between DOE, EPA, and OEPA that, in general, from a statistical standpoint, steady-state conditions in the groundwater (perched water and Great Miami Aquifer) have not been reached regarding OSDF monitoring. Therefore, baseline conditions could not be established at that time. In a letter dated April 19, 2007, DOE requested that control charts be excluded from the 2006 Site Environmental Report because it does not make sense to provide them until it has been determined that constituent-specific steady-state conditions have been established (DOE 2007). A common ion study is underway and is scheduled to be completed in 2007. When the common ion study is complete and the data have been compiled, DOE plans on meeting with EPA and OEPA to go over the study and discuss the OSDF leak detection monitoring program and associated reporting. Once it has been demonstrated that steady-state conditions have been established, control charts could be provided in ASERs. OEPA concurred with this strategy in a letter dated May 21, 2007.

With respect to trend analysis, it is not unexpected that concentrations in any one or a number of horizons might be trending upward. Upward trends are not necessarily indicative of a leak, but they can indicate changes in the environment surrounding the system. For example, the LCS concentrations could reflect more concentrated water as the leachate ages and the capped cells dry up. Also, there is the preexisting contamination in the Great Miami Aquifer, which could cause upward trends in concentrations as well. It is important to look at the overall LCS and LDS flow trends and concentration levels to evaluate the integrity of all components in the system.

The challenges noted above are being met with an extended monitoring period prior to establishing baseline, a significant increase in the number of parameters on the monitoring list, and a common ion study. The intent of the common ion study is to verify the presence of groundwater aging and to help assess when statistically-based leachate monitoring data analysis can be implemented. Observation and trend analysis during the extended monitoring period will determine if the monitored parameters reach a steady-state condition or continue to increase or decrease. Analysis of leachate and groundwater samples for common major and minor ions will allow a better quantitative assessment of the geochemistry in each horizon and identification of potential indicator ions for contaminant migration.

3.2.1.4 Alternate Sampling Frequency

The Ohio Solid Waste regulations require that, for detection monitoring, at least four independent samples from each well will be taken during the first 180 days after implementation of the groundwater detection monitoring program and at least 8 independent samples in the first year to determine the background (i.e., baseline) water quality (OAC 3745-27-10(D)(5)(a)(ii)(a)). The requirement to collect eight independent samples is only applicable to those wells installed after August 15, 2003, because that is the date that the code became effective. The Ohio Hazardous Waste regulations do not specify a frequency for determining a background dataset. The Ohio Hazardous Waste regulations do require a performance standard for establishing background;

OAC 3745-54-97(G) states that the number and kinds of samples taken to establish background be appropriate for the statistical test employed.

Experience and technical knowledge gained from cell monitoring indicated that it was necessary to collect initial baseline samples quarterly. Sampling frequencies were based on the following: HTWs and Great Miami Aquifer wells were sampled bimonthly after waste placement until 12 samples were collected for statistical evaluation. These frequencies were selected to develop an appropriate statistical procedure, to address OSDF construction schedules, and to compensate for the varying temporal conditions and seasonal fluctuations. After sufficient samples were collected for statistical analysis, samples were collected quarterly from the HTWs and Great Miami Aquifer. The Ohio Solid Waste regulations allow for a semiannual sampling frequency for detection monitoring after the first year but also allow for the proposal of an alternate sampling program (OAC 3745-27-10(D)(5)(a)(ii)(b) and (b)(ii)(b), and 3745-27-10(D)(6)). After each cell is capped, the monitoring for each of the four components (i.e., the LCS, LDS, HTW, and Great Miami Aquifer wells) for the site-specific leak detection indicator parameters may be performed semiannually to continue to meet regulatory requirements. However, it is important to note that the frequency of monitoring may be increased again if it is found to be needed to help establish baseline conditions.

3.2.2 Leachate Monitoring Compliance Strategy

The Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. Leachate samples from the LCS have been collected and analyzed for site-specific leak detection indicator parameters to support leachate treatment and discharge, as well as the annual analysis for Appendix I parameters and PCBs. The annual grab sample analysis for Appendix I parameters and PCBs ensures the accuracy of assumptions regarding the nature of wastes within the OSDF, which were used to develop the groundwater/leak detection parameter list.

Although constituents that are not part of the limited indicator parameter list for leak detection may be detected in the annual grab sample, it is not anticipated that the concentrations will be high enough to warrant revision of the leak detection parameter list. However, a review of the data will be conducted (and reported through the ASERs) to determine if any new indicator constituents should be added to the site-specific leak detection indicator parameter list. Constituent concentrations will be reviewed against information gathered during the OU5 RI/FS period and subsequent environmental monitoring data. OSDF annual LCS data will be compared to factors such as Great Miami Aquifer and perched water background values, range of site perched water concentrations, and current laboratory contract required detection limits. Ultimately, a constituent will be added if routine analysis of the constituent can significantly enhance early detection capability. The leak detection/leachate analysis will ensure that the character of the leachate will not adversely impact the treatment facility or the treatment facility effluent receiving stream (the Great Miami River).

Because waste is no longer being placed in the OSDF and an alternate sampling constituent list has been approved for the OSDF, it is envisioned that after completion of the common ion study that collection of an annual grab sample from the LCS of each cell to be tested for Appendix I and PCB parameters listed in OAC 3745-27-10 will no longer be required and this annual sampling/analysis task will stop. Annual sampling from the LCS of each cell will instead focus on site-specific parameters that have been approved for the facility. Annual sampling of the LCS of each cell for Appendix I and PCB listed parameters will not stop until concurrence has been obtained from the EPA/OEPA.

Although not specified in the OU RODs as an ARAR, the federal RCRA (Hazardous Waste) regulations include specific requirements in 40 CFR 264.303 for monitoring the volume of liquid collected from a disposal facility's LDS. Regulation 40 CFR 264.302 includes provisions for determining an "action leakage rate" that, if exceeded, would prompt specific response and notification actions. An action leakage rate of 200 gallons per acre per day (gpad) and an initial response leakage rate of 20 gpad were established during the design of the OSDF. The response and notification process for an exceedance of the both the initial response leakage rate and the "action leakage rate" (40 CFR 264.304) is provided in Section 6.0.

The leachate monitoring strategy, as part of the groundwater monitoring plan and required by OAC 3745-27-06(C)(7), must include provisions for obtaining the monthly volume of leachate collected for subsequent treatment, provide the method of leachate treatment and/or disposal, and include verification that the leachate management system is operating properly (OAC 3745-27-19(M)(4)). Monitoring to verify that the leachate management system is operating properly is identified in the OSDF *Enhanced Permanent Leachate Transmission System Operation* (DOE 2005b) procedure and in Appendix D of this document.

The monthly volume of leachate collected for treatment and subsequent disposal will be obtained based on the program in 40 CFR 264.303(c) to determine the flow rates of leachate collected in the LCS and water in the LDS. Monitoring the flow rates will provide data for determining the volume of leachate collected and will also provide data pertinent to the leak detection monitoring program. The flow rates are part of the leak detection monitoring program and are discussed further in Section 4.0. A separate leachate management monitoring strategy is provided as Section 5.0 to provide information on the method of leachate treatment and disposal, including analysis of parameters useful for leachate treatment. Section 5.0 also includes a discussion on obtaining an annual grab sample to be analyzed for Appendix I parameters and PCBs, in order to comply with the requirement in OAC 3745-27-19(M)(5).

4.0 Leak Detection Monitoring Program

This section presents the technical approach for leak detection monitoring at the OSDF, in light of the regulatory requirements for leak detection monitoring summarized in Section 3.0. This section includes a summary of the objectives of the program, a description of the major program elements, the selection process for analytical parameters (i.e., site-specific leak detection indicator parameters), the monitoring to be employed after cells have been capped, and the strategy for evaluating the data to determine whether a leak has occurred. The subsections are as follows:

- Section 4.1: Introduction.
- Section 4.2: Monitoring Objectives.
- Section 4.3: Leak Detection Monitoring Program Elements.
- Section 4.4: Leak Detection Sample Collection.
- Section 4.5: Leak Detection Data Evaluation Process.

Additionally, Appendixes B and C provide the Project-Specific Plan and Data Quality Objectives for the OSDF Monitoring Program for each cell, with details on specific monitoring lists and frequencies. Appendix E describes the selection process for site-specific leak detection indicator parameters. Section 5.0 describes the overall leak detection strategy including the collection and analysis of an annual leachate grab sample for Appendix I and PCB parameters per OAC 3745-27-10 and 19 to confirm the adequacy and appropriateness of the selected site-specific leak detection indicator parameters. A summary of the notifications and potential follow up response actions that accompany the monitoring program are provided in Section 6.0.

4.1 Introduction

As discussed in Section 1.0, the OSDF leak detection monitoring program constitutes the first tier of a three-tiered detection, assessment, and corrective action monitoring strategy that is required for engineered disposal facilities. Consistent with this three-tiered approach, follow up assessment and corrective action monitoring plans will be developed and implemented as necessary if it is determined that a leachate leak from the OSDF has occurred. Conversely, if the detection monitoring successfully demonstrates that leachate leaks have not occurred, then the monitoring program will remain in the first-tier "detection mode" indefinitely. The follow-up assessment and/or corrective action monitoring plans, if found to be necessary, would be prepared as new, independent plans that would supersede this first-tier detection program.

The leak detection monitoring program employs a multi-component, holistic approach for leak detection, relying on the collective responses obtained from four components: an LCS inside the OSDF; an LDS inside the OSDF and below the LCS; a perched groundwater monitoring component located beneath the compacted clay liner immediately below the LDS and LCS liner penetration boxes (refer to Figure 4–1); and a Great Miami Aquifer monitoring component, found at depths ranging from 40 to 90 ft beneath the OSDF. The data collected from the four components will be evaluated comparatively over time, so that short-term and long-term response relationships between the components can be effectively delineated.

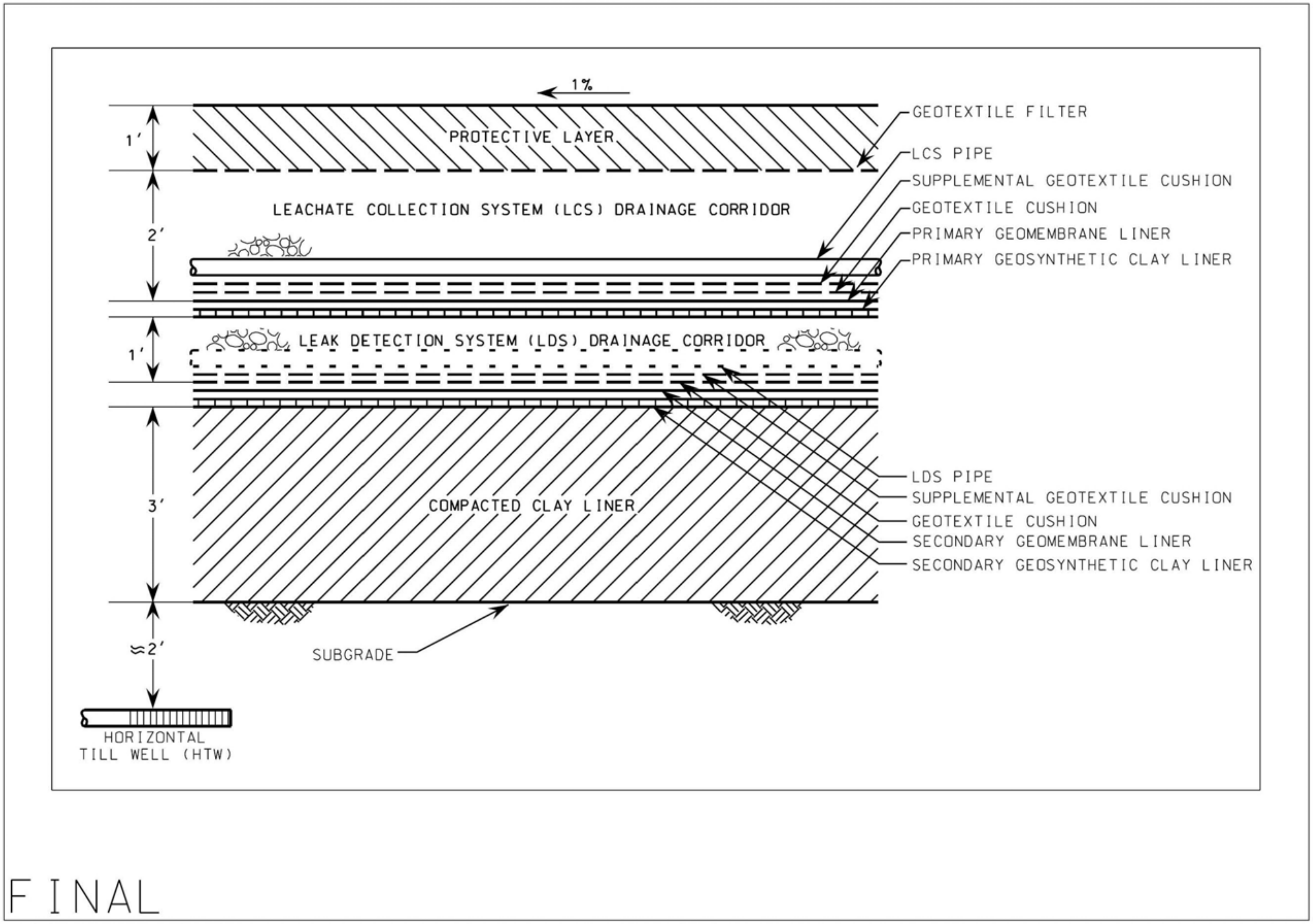

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Figure 4–1. On-Site Disposal Facility Liner System with HTW at the Drainage Corridor

The Great Miami Aquifer is the prime resource of concern that could potentially be affected by the OSDF in the unlikely event that a leachate leak occurred. Therefore, it makes sense to monitor the aquifer at the immediate boundary of the OSDF. However, as discussed in Section 2.0, contaminant travel times to the aquifer through the glacial till beneath the OSDF are of such length that reliance on Great Miami Aquifer monitoring alone would be insufficient to provide effective early warning of a leak from the facility. The overriding intention of the holistic approach, therefore, is to ensure that there is no reliance on any one element alone to determine whether leakage has occurred. As is demonstrated in this section, the groundwater/leak detection monitoring program includes the establishment of baseline conditions in the disturbed and native environment underlying the OSDF (i.e., perched and Great Miami Aquifer groundwater) to be used as a point of comparison during the system wide evaluation of trends. Following the establishment of baseline conditions, the follow-up sampling conducted at each monitoring interval would provide a view of conditions that are present in each of the four components, which can be compared to past results to determine the collective significance of trends or intermittent fluctuations in the data.

To date, establishing baseline conditions based on statistical analyses has proven to be difficult due mainly to existing trend issues. Steady-state conditions, which are a requirement of control charting, have not been reached. In a letter dated April 19, 2007, DOE requested that control charts be excluded from the 2006 Site Environmental Report because it does not technically make sense to provide them until it has been determined that constituent-specific steady-state conditions have been established. A common ion study is underway that is scheduled to be completed in 2007. When the common ion study is complete, and the data have been compiled, DOE plans on meeting with EPA and OEPA to go over the data and discuss the OSDF leak detection monitoring program and associated reporting. Once it has been demonstrated that steady-state conditions have been established, control charts could be provided in ASERs. OEPA concurred with this strategy in a letter dated May 21, 2007.

Additionally, as indicated in Sections 1.1 and 3.0, there is institutional knowledge regarding the various complexities associated with the regulatory strategy for the OSDF leak detection and data evaluation processes. This information should be considered during future post-closure evaluations. To date, the process continues to evolve and there is much interaction between DOE, EPA, and OEPA regarding the overall process.

4.2 Monitoring Objectives

The fundamental objective of the leak detection monitoring program is to provide early detection of a leak from the facility, should one occur. Recognition of this fundamental objective allows the Fernald Preserve to move confidently into the next regulatory-based tiers of the program—assessment and corrective action monitoring—if required. This fundamental objective is the primary driver for all of the key site-specific elements (i.e., monitoring locations, frequencies, analytical parameters, and follow up response actions) of the program.

In addition to this fundamental objective, there are several other objectives that have been considered in the site-specific design of the leak detection program:

- The program should have the ability to distinguish an OSDF leak from the above background preexisting levels of contamination that are found in the subsurface.

- All monitoring wells must be installed at locations and with construction methods that do not interfere with or compromise the integrity of the cap and liner system of the OSDF.
- The program needs to satisfy the site-specific regulatory requirements for leak detection monitoring summarized in Section 3.0.

The leak detection monitoring approach described below meets the intent of providing early detection of a release from the OSDF within the hydrogeologic regime at the Fernald Preserve, and is tailored to accommodate the additional program design objectives summarized above.

4.3 Leak Detection Monitoring Program Elements

4.3.1 Overview

The success of the leak detection monitoring strategy for the OSDF is dependent upon how well the strategy integrates with facility integrity concerns (cap and liner system performance) and how well the groundwater component of the strategy addresses hydrogeologic conditions in the till and aquifer. The trends revealed by groundwater monitoring data need to be effectively integrated with leachate production information within the OSDF in order to provide a comprehensive evaluation of the OSDF performance and integrity.

The approved design for the OSDF is presented in detail in the initial OSDF Design Package and subsequent approved follow up design and construction drawing packages. The OSDF consists of eight individual cells that were constructed in phases. As shown in Figure 4–1, the liner for each cell is a composite liner system, assembled from the following layers (top to bottom): a soil cushion layer, geotextile fabric, LCS drainage layer, primary composite liner, high-density polyethylene (HDPE) (geotextile fabric, HDPE geomembrane, and geosynthetic clay liner), LDS drainage layer, and the underlying secondary composite liner (HDPE geomembrane, geosynthetic clay liner, and compacted clay). Both the LCS and LDS layers drain to the west within each cell. At the western edge of each cell liner, any liquid within the LCS and LDS is collected in pipes that pass through the liner penetration box and flows to the respective cell's valve house. As identified previously, the liner penetration box represents the area with the greatest leak potential for each cell and is considered the primary location where a leak would first enter the environment if a leak were to occur.

Each cell is also constructed with an engineered composite cover. The cover system consists of the following layers (top to bottom): a vegetative cover layer, a topsoil layer, a granular filter layer, a bio-intrusion barrier, a geotextile filter, a cover drainage layer, the primary composite cap (geotextile cushion, HDPE geomembrane, geosynthetic clay liner, and compacted clay), and an underlying contouring layer. The cover system was completed in 2006. Now that the cover system is in place and the cell contents are anticipated to reach equilibrium, leachate production is expected to diminish as a result of the moisture infiltration barrier properties of the cover system. During the time that the cell contents move towards equilibrium, leachate accumulation in the LCS drainage layer is expected to diminish over time.

The leak detection monitoring program involves (1) tracking the quantity of liquid produced within the LCS and LDS over time, and (2) the periodic water quality monitoring of the leachate, the perched groundwater, and the Great Miami Aquifer groundwater. Monitoring activities during post-closure operations consist of initial baseline, refined baseline, and post baseline monitoring, which use components of site-specific analytical parameters, to effectively implement a holistic comparative approach. The performance of each cell is monitored individually, on its own merit; each cell has its own engineered LCS and LDS drainage layers, perched groundwater monitoring component, and upgradient and downgradient Great Miami Aquifer monitoring wells.

4.3.2 Monitoring the Engineered Layers within the OSDF

Water quality samples are collected from individual LCS and LDS drainage layers within each cell during waste placement and after cell closure as described below and in Section 5.0. In addition to water quality monitoring, the quantity of leachate and fluid flowing through the LCS and LDS layers is recorded and reported. This information is used to support a collective qualitative trend analysis for each cell of the OSDF as discussed later in this plan.

4.3.2.1 Leachate Collection System

The LCS drainage layer functions primarily to collect infiltrating water and to keep it from entering the environment. As each cell is capped the volume of leachate decreases, which may, at some time in the future, limit the available sample volume and possibly affect the number of parameters that can be analyzed. The LCS drains to the west through an exit point in the liner to the leachate transmission system located on the west side of the OSDF. From there, the leachate collected is periodically pumped to the CAWWT backwash basin or directly to CAWWT feed tanks. Both flow (quantity/volume) and water quality information are collected from the LCS drainage layer according to Section 4.4, and Appendix B (of the OSDF Project Specific Plan).

4.3.2.2 Leak Detection System

By design, the primary composite liner located underneath the LCS drainage layer should not leak. By design, leachate that accumulates in the LCS drainage layer above the primary liner is drained by gravity out of the cells to further reduce the potential for leakage by minimizing the level of fluid buildup in the primary liner. Notwithstanding this design, a second fluid collection layer, the LDS drainage layer, is positioned beneath the primary composite liner to provide a means to track the integrity and performance of the primary liner. In the event that fluids collect within the LDS layer, by design the fluids gravity drain to the west, out of the cells, where they are routed for treatment.

Similar to the LCS, a greater volume of fluids may initially collect in the LDS as the moisture content of the materials comprising the liner move toward long-term equilibrium levels. This fluid volume is expected to gradually decrease over the long term. Below the LDS drainage layer is a secondary composite liner comprised of an HDPE geomembrane, geosynthetic clay liner, and compacted clay. This secondary liner serves as the lowermost hydraulic barrier in the liner system and inhibits fluids from entering the environment before they are collected and removed through the LDS drainage layer.

Like the LCS drainage layer, both flow (quantity/volume) and water quality information are collected from the LDS drainage layer according to Section 4.4 and Appendix B (the OSDF Project-Specific Plan).

4.3.3 Monitoring the Perched Groundwater

The perched groundwater monitoring component of the program is designed to monitor for the presence of leachate leakage from the OSDF at its first point of entry into the Fernald Preserve's natural hydrogeologic environment. As discussed in Section 1.0, EPA, OEPA, and DOE concur that a horizontally oriented glacial till monitoring well (i.e., HTW), positioned directly beneath the location of the LCS and LDS liner penetration box in each cell, represents the most feasible site-specific approach to monitor for first entry leakage from the OSDF into the Fernald Preserve's environment.

The HTWs have been installed as part of the sub-grade construction activities for each of the cells comprising the OSDF. The individual wells were installed prior to waste placement, therefore eliminating final positioning uncertainties that would be associated with post-construction horizontal drilling techniques. The vertical portion of each of the monitoring wells is located along the western side of the OSDF, while the sample collection interval is positioned beneath the bottom of the secondary composite liner in alignment with the location of the LCS and LDS liner penetration box.

Lithologic and hydraulic characterization of the till in the vicinity of the OSDF indicates that the clay-rich deposits of carbonate and silicate grains may not readily yield fluid to a well. The amount of saturation in the till is further reduced by the barrier properties of the composite cover and liner system of the OSDF, which operate to significantly reduce local infiltration beneath the facility. These conditions may make it difficult or impossible to obtain sufficient sample volume from the till wells to perform detailed water quality analyses. In the event sufficient sample volume cannot be obtained to perform the full list of required analyses, a priority list will be implemented as necessary as identified in Appendix B.

Water quality information is collected from the HTWs according to Section 4.4 and Appendix B (of the OSDF Project Specific Plan).

4.3.4 Monitoring the Great Miami Aquifer

The subsections below describe the Great Miami Aquifer component of the program, including a discussion of the influence of planned aquifer restoration activities on the program, the siting of the monitoring wells, and the use of the groundwater models (i.e., Variably Saturated Analysis Model in 3 Dimensions [VAM3D] and Sandia Waste Isolation Flow and Transport [SWIFT]) to evaluate the adequacy of the planned well locations.

4.3.4.1 Siting of the Great Miami Aquifer Monitoring Wells

The Great Miami Aquifer monitoring wells are located immediately adjacent to the OSDF, just outside the footprint of the final composite cap configuration, so as not to interfere with the integrity of the facility. Each cell has its own set of monitoring wells to assist with the evaluation of conditions associated with that cell. As each new cell has been brought online, its associated monitoring wells have been installed before (or concurrently with) the construction of the cell liners so that the wells have been available for the initiation of baseline sampling prior to waste placement. Thus, the well installations have followed the north-to-south progression of OSDF cell construction. The OSDF is bordered by a network of 18 Great Miami Aquifer monitoring wells that provide upgradient and downgradient monitoring points for each cell (refer to

Figure 4–2). All monitoring wells were constructed in accordance with the *Sitewide CERCLA Quality Assurance Project Plan* (DOE 2003) for Type 2 Great Miami Aquifer wells.

The overall objective of the Great Miami Aquifer component of the leak detection monitoring program is to provide long-term surveillance. Therefore, the current and future (post-remediation) aquifer flow conditions were used to select the 18 monitoring locations. As discussed in the next subsection, groundwater flow and particle tracking using both the VAM3D and the SWIFT groundwater modeling computer codes were used to help select the final monitoring locations identified in this plan.

4.3.4.2 VAM3D Flow Model and SWIFT Transport Model Evaluation of Well Locations

The VAM3D and SWIFT groundwater modeling codes were used to evaluate the adequacy of the density and locations of the monitoring wells planned for the Great Miami Aquifer. The modeling effort examined the fate of a hypothetical release from each cell to the aquifer at a point directly beneath the liner penetration box of the LCS and LDS. The modeling predicted the most likely flow path and plume configuration for particles released from the liner penetration box area over time. The modeling was conducted for post aquifer remediation conditions (when groundwater flow directions would be from west to east). The original modeling was performed using the SWIFT computer and has been updated subsequently using the VAM3D computer code. (Note: Modeling was performed on the assumption that there would be nine cells.)

Particle flow path modeling was conducted using the VAM3D flow model output from two model runs representing seasonal wet and dry conditions within the aquifer. Fifteen particles were seeded in a 125-ft radius around each of nine model nodes located nearest the nine cell liner penetration box locations. These particles were tracked for a 20-year period with no retardation. The velocity flow field data from the post aquifer remediation scenario shows the advective particle path results (refer to Figure 4–3). The particle tracks are generally from west to east beneath the OSDF. As indicated in the figure, the tracks deviate slightly in the north-south direction with seasonal water level fluctuations in the aquifer. Downgradient monitoring wells were located in the area traced out by the modeled flowpaths for each OSDF cell in order to be in the most likely position to detect a leak based on anticipated groundwater flow. These flow model results are similar to the flow modeling results previously obtained with the SWIFT groundwater model, which was used prior to converting to the VAM3D modeling code. Monitoring wells for Cells 1 through 3 were placed based on the results from the SWIFT groundwater flow model and monitoring wells from Cells 4 through 8 were placed based on the results from the VAM3D flow model (DOE 2000).

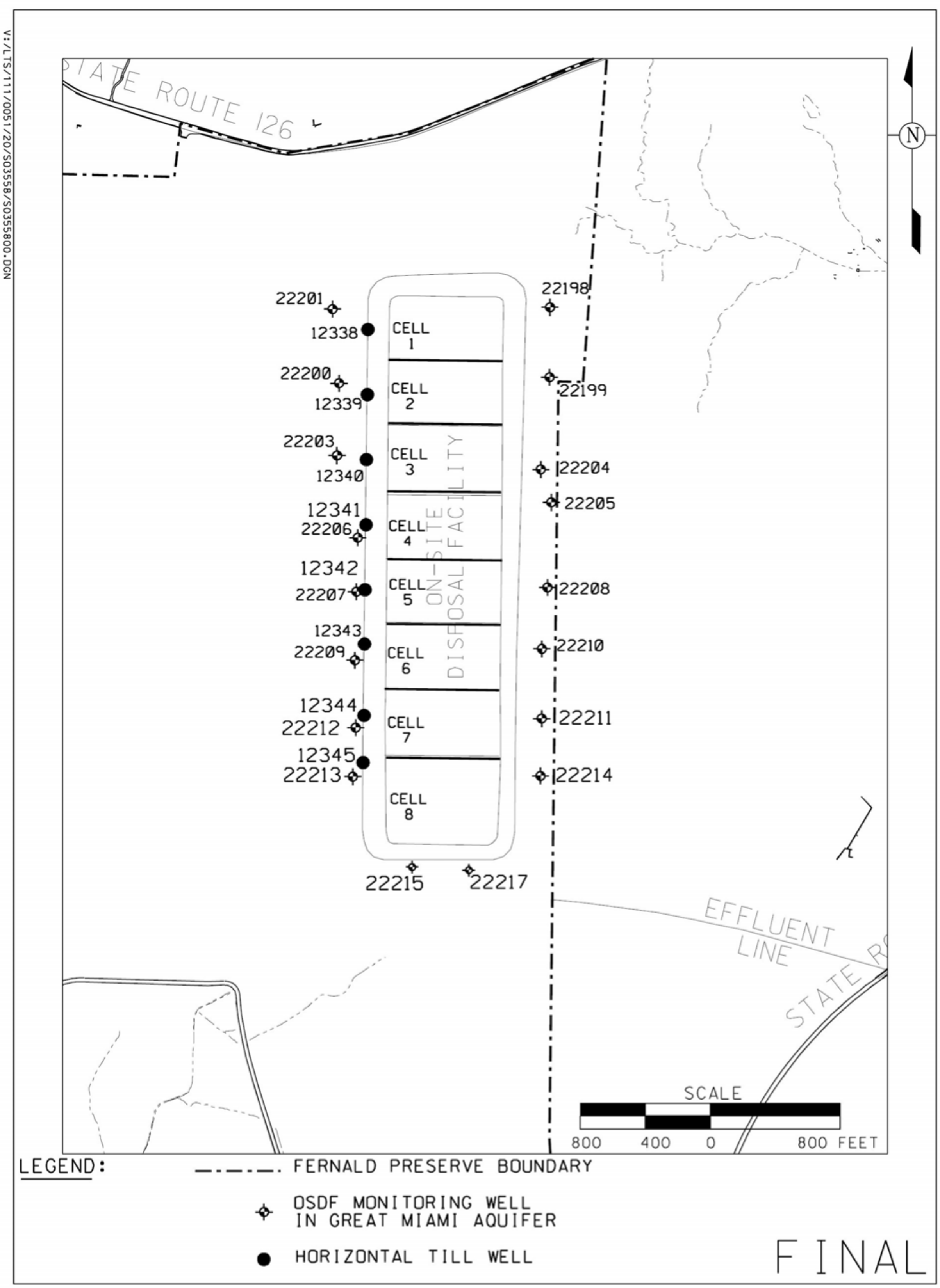

Figure 4–2. OSDF Well Locations

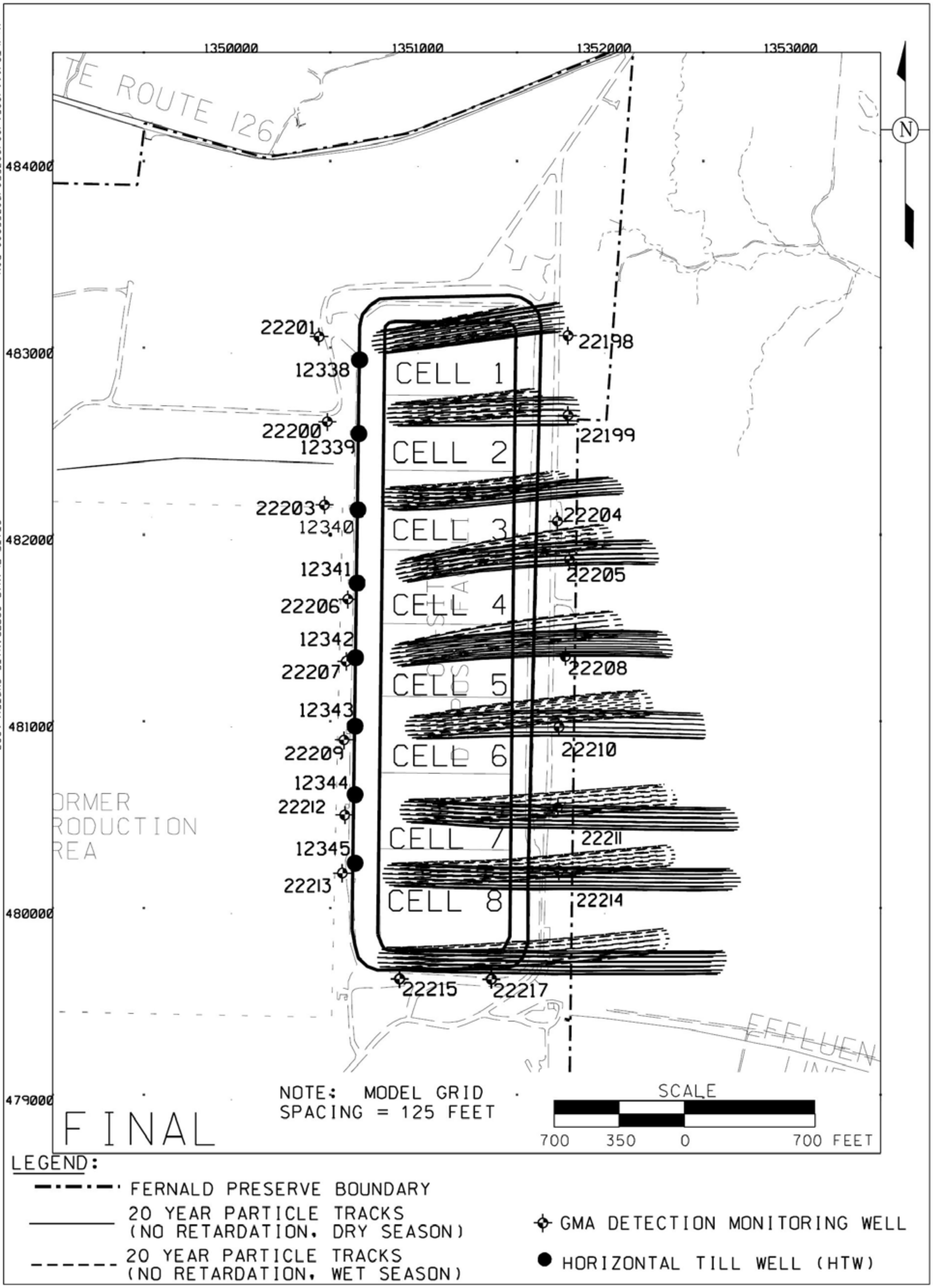

Figure 4–3. Post-Remediation Scenario

An earlier SWIFT model transport simulation was performed for Revision 0 of this plan to determine if the density of the downgradient Great Miami Aquifer monitoring well network is adequate to detect the smallest contaminant plume resulting from a leak in the OSDF that would be of concern. Those SWIFT model results are included here for completeness. The SWIFT model was used to simulate a leak from the cell liner penetration box beneath Cell 3 under natural flow gradients with no on-site pumping. Model simulations for both uranium and technetium 99 were performed. Constant loading from the cell was simulated throughout the model run such that a plume of minimum areal extent (i.e., a plume with maximum concentration equal to the FRL) was maintained in the aquifer. Hypothetical plumes of 20 parts per billion and 94 picocuries per liter were maintained for uranium and technetium 99, respectively. The plumes were loaded from two hypothetical locations. One location was approximated to be beneath the cell liner penetration box at the western edge of Cell 3 in order to represent the most likely leakage point from the cell. The other location was farther east, in order to provide a more conservative scenario where the plume would have less time to expand before the leading edge would reach the downgradient monitoring well network.

The modeling results for uranium at model year 55 (2051) and for technetium 99 at model year 30 (2026) are shown in Figures 4–4 and 4–5, respectively. (Note: Modeling was performed on the assumption that there would be nine cells.) The durations were determined from the modeling, and they represent the period of time under constant loading for the respective plumes to disperse to the width of the spacing distance between monitoring wells (approximately equal to the OSDF cell width). Modeling results indicate that the density of downgradient Great Miami Aquifer monitoring wells is sufficient to detect this minimal plume given the lateral expansion and the plume width under this minimal constant loading.

The width of each plume from horizontal dispersion is approximately the width of an OSDF cell, indicating that one downgradient Great Miami Aquifer monitoring well per cell is sufficient to ensure that a Great Miami Aquifer contaminant plume would be detected. Therefore, the configuration of Great Miami Aquifer wells (shown in Figure 4–2) is sufficient both in terms of well density and location for the OSDF leak detection monitoring program.

4.4 Leak Detection Sample Collection

The following subsections discuss the sample collection for the four components of the leak detection program: the LCS and the LDS drainage layers (flow and water quality), the HTWs in the glacial till (water quality), and the monitoring wells in the Great Miami Aquifer (water quality).

4.4.1 Water Quality Monitoring of the Perched Groundwater and Great Miami Aquifer

Sampling both the perched groundwater and the Great Miami Aquifer groundwater during the same timeframe is desired in order to enhance the comparability of the data; however, the overriding requirement is that enough fluid be present in the individual monitoring point to collect sufficient volume for the analyses.

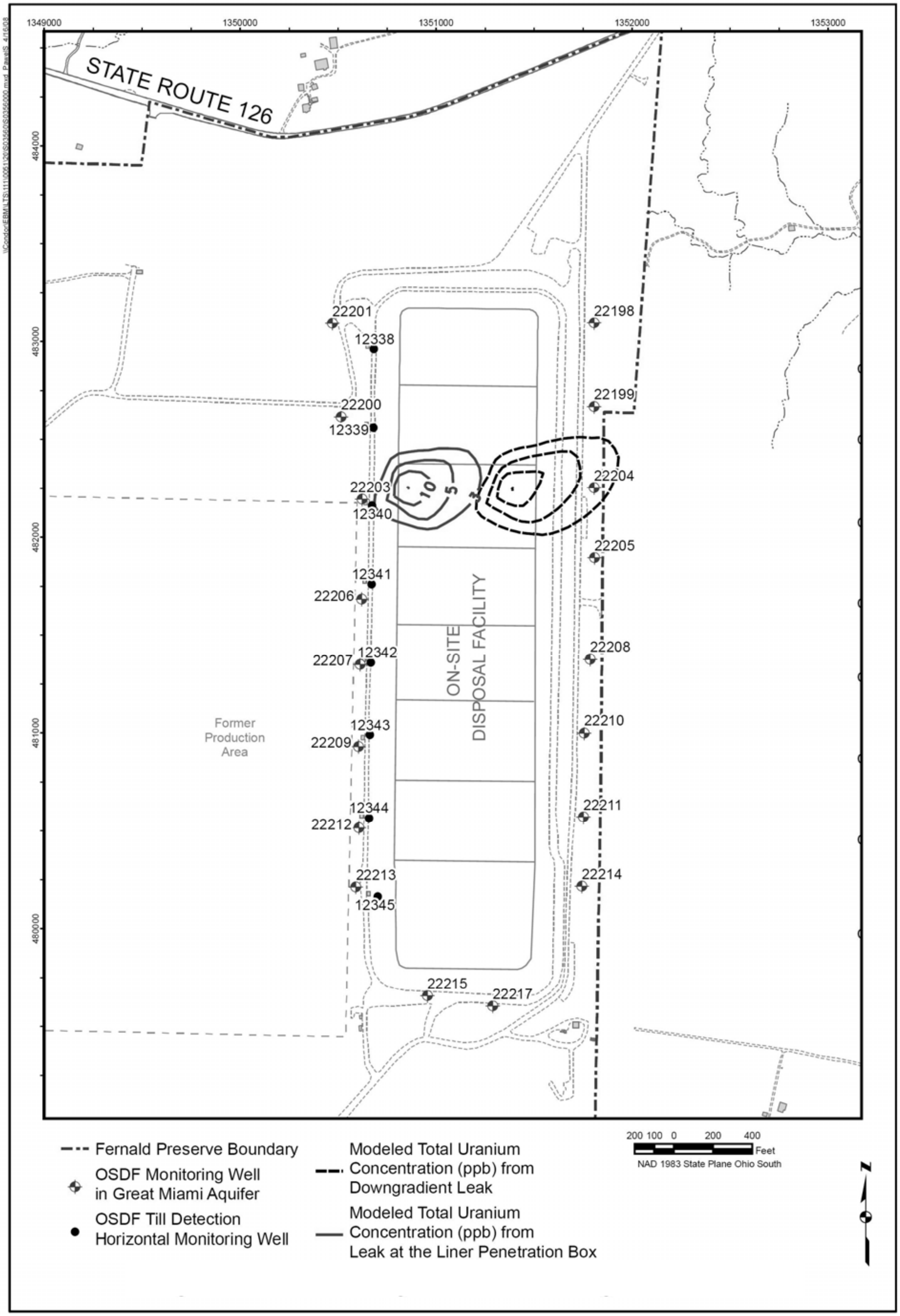

Figure 4–4. SWIFT Modeling with Uranium Loading—55 Years

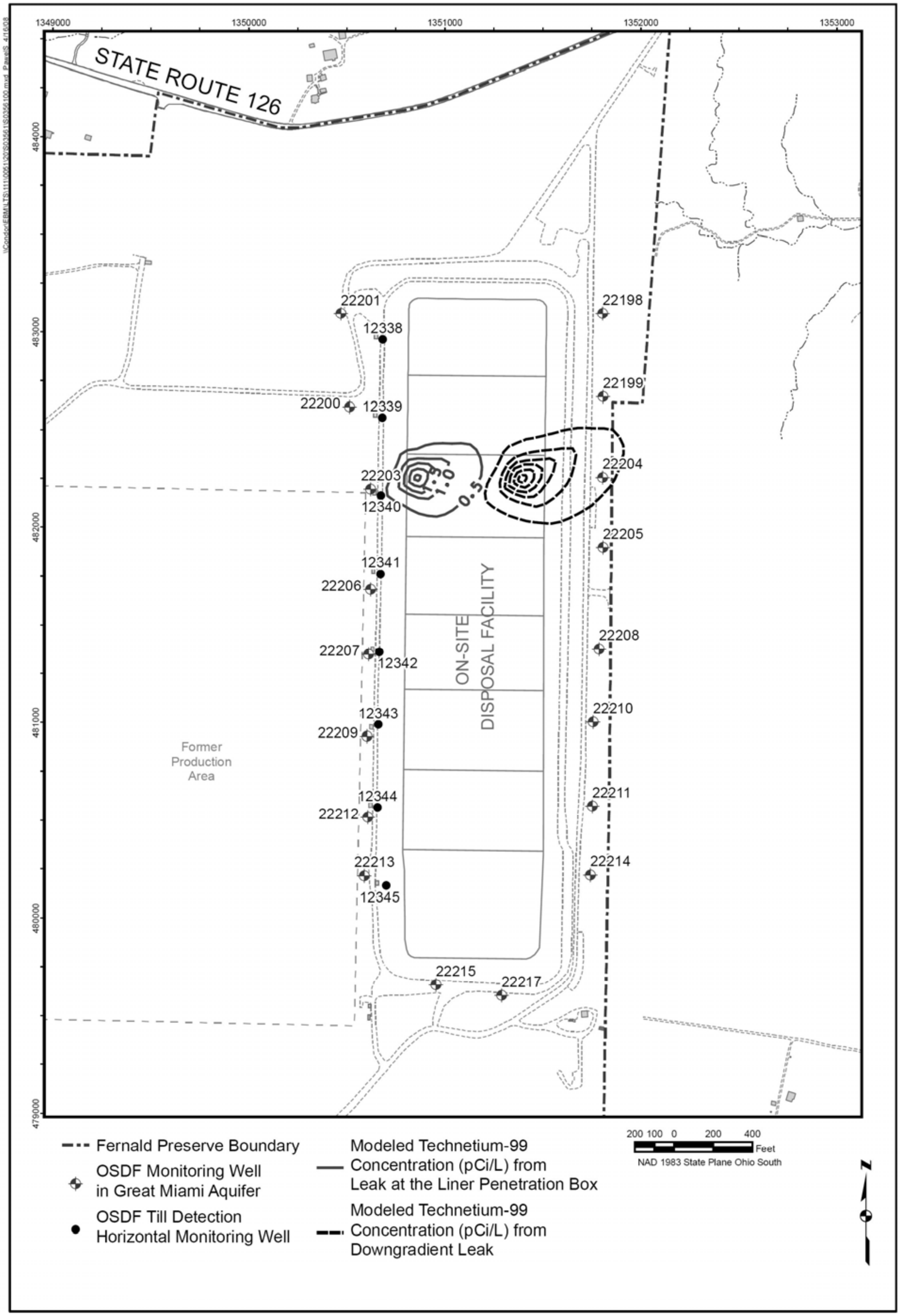

Figure 4–5. SWIFT Modeling with Technetium 99 Loading—30 Years

Prior to collecting the sample, the volume contained in the monitoring point is estimated in order to determine whether sufficient volume is present for the full suite of analytical parameters (refer to Appendix B for a discussion on setting priorities for low sample volume).

4.4.1.1 Establishment of Baseline Conditions in the Perched Groundwater and Great Miami Aquifer

In order to accurately determine whether there has been a leak from the OSDF, it is necessary to establish representative baseline conditions in the disturbed and natural environment underlying the facility, from which to draw future comparisons. As discussed in Section 2.0, both the perched groundwater system (disturbed) and the Great Miami Aquifer in the vicinity of the OSDF contain uranium and other Fernald Preserve related constituents at levels above background. Therefore, it is important to establish baseline conditions (i.e., constituent concentration levels and variability) for all of the OSDF analytical parameters so that accurate assessments of future data trends in the perched system and the Great Miami Aquifer can be made.

The Fernald Preserve’s existing information concerning preexisting contaminant conditions in the subsurface is derived from the OU5 RI (DOE 1995b) and the OSDF Pre-Design Investigation (DOE 1995a). This existing information has been sufficient for the purpose of risk assessment, the development of conceptual and detailed designs for the Fernald Preserve’s RAs, and the formulation of conservative assumptions for fate and transport modeling. The existing information is not of such detail, however, to permit the statistical evaluations, precise spatial and temporal comparisons, and comprehensive data trending that accompanies a leak detection program. More information regarding data variability and seasonal influences is needed in the immediate vicinity of the OSDF for both the perched system and the Great Miami Aquifer.

Based on the current understanding of preexisting levels of contaminants in the OSDF subsurface, DOE is electing to perform up to 12 rounds of initial baseline sampling for both the perched system and Great Miami Aquifer for all site-specific leak detection indicator parameters. Note that baseline monitoring has continued after initiation of waste placement, during active cell operations, and after a cell is capped. Appendix B of the *Project-Specific Plan for Installation of the On-Site Disposal Facility Great Miami Aquifer Monitoring Wells* (DOE 2001a) includes sampling frequencies for each specific cell.

Once the data from the initial sampling events have been received for both the perched groundwater and Great Miami Aquifer wells, DOE will evaluate whether sufficient information is available to establish baseline. At this juncture, an appropriate statistical method and associated statistical measure to establish baseline conditions will be selected. This identification is anticipated to be made on a cell specific basis for both the perched groundwater and Great Miami Aquifer components of the program. If the amount of data is insufficient for establishing baseline conditions, additional samples will be collected.

In the event that one or more monitoring points (e.g., the perched water wells) produce insufficient water volume for sampling the full suite of analytical parameters, the data accumulation period for establishing that monitoring point’s baseline might be extended until sufficient data are obtained for that monitoring point and until such time that steady-state conditions have been established.

This approach and these frequencies (identified in Appendix B) exceed the minimum State of Ohio regulatory requirements and should provide sufficient information to conduct future comparative evaluations.

4.4.1.2 Long-Term Monitoring of the Perched Groundwater and Great Miami Aquifer

Modifications to the baseline sampling list will be based on the rationale identified in Appendix E. After enough samples have been collected to establish baseline conditions for the perched water and Great Miami Aquifer, sample frequency will be semiannual as identified in OAC 3745-27-10(D)(5)(a)(ii)(b) and (b)(ii)(b).

4.4.2 LCS/LDS Monitoring

4.4.2.1 Flow Monitoring in the LCS and LDS

Leachate collected by the LCS from each cell flows by gravity to the tanks located in the valve houses where its volume is measured. The leachate is then pumped into the EPLTS line where it flows by gravity to the PLS then is pumped to CAWWT for treatment. As the cells were capped leachate flow was reduced so that it could be accurately measured from the capped cells. Since Cells 7 and 8 were capped in 2006, beginning in 2007, leachate flow from all eight cells will be compiled and trended to provide an indication of changes in system performance. This data/trend analysis is provided in the ASERs. In 2007, flow in the LCS and LDS was monitored continuously and valve houses were checked daily. In 2008, continuous flow monitoring will remain in effect; however, once the automated flow monitoring system becomes fully functional, the frequency of the valve house checks will be reduced to once every 2 weeks. The continuous monitoring of LCS/LDS flow volumes is above and beyond what is required by the OAC and CFR.

The amount of liquid removed from the OSDF via the LDS system is recorded in accordance with the graded approach depicted below. This graded approach is patterned after federal hazardous waste landfill regulation 40 CFR 264.303(c)(2), and also satisfies Ohio solid waste rule OAC 3745-27-19(M)(4).

If the flow rate in the LDS exceeds the action leakage rate, notifications and response actions are initiated per 40 CFR 264.304(b) and 40 CFR 264.304(c). The required notifications and response actions are discussed in Section 6.0.

“Pump operating level” is that liquid level based on pump activation level, sump dimensions, and the level that avoids backup into the LCS drainage layers in the OSDF cells, and minimizes head in the sump. The LDS flow rate shall be monitored to ensure the maximum design flow rate is not exceeded. The “action leakage rate” is the maximum design flow rate that the LDS can remove without the fluid head on the bottom liner exceeding 1 ft (40 CFR 264.302(a)). Flow rate monitoring for the LDS using the action leakage rate is outlined in the following table:

Tier	LDS Volume Monitoring
Prior to Placement of Final Cover on the Last OSDF Cell:	
0	Record amount of liquids removed from each LDS sump at least weekly.
Post-closure (after placement of final cover on the last OSDF cell)	
1	Record amount of liquids removed from each LDS sump at least **monthly**, except as provided by the following:
2	If the liquid level stays below the "pump operating level" for two consecutive months, record at least **quarterly**, except as provided by the following:
3	If the liquid level stays below the "pump operating level" for at least two consecutive quarters, record at least **semiannually**.

Note: If at any time during the post-closure care period the "pump operating level" is exceeded when on quarterly (Tier 2) or semiannually (Tier 3) recording schedule, the recording schedule will revert to monthly (Tier 1) until the requirement is met to move to the next highest tier.

LDS Average Daily Flow Rate[a] Monitoring
Prior to Placement of Final Cover on Each Cell:
Calculate average daily flow rate for each sump once per **week**[b]
Post-closure:
Calculate average daily flow rate for each sump once per **month**[b]

[a]The average daily flow rate (in gpad) is calculated by converting the weekly or monthly flow rate using the data obtained for LDS volume monitoring.
[b]If the flow rate into the LDS exceeds the action leakage rate, then response and notification action will be as specified in Section 6.2.

4.4.2.2 Water Quality Monitoring in the LCS and LDS

Through calendar year 2007, water quality monitoring for the LCS and LDS drainage layers within each cell (for leak detection monitoring purposes) has been conducted quarterly. It is proposed that beginning in 2008, sampling shift to a semiannual schedule. The samples are analyzed for parameters identified in Appendix E; more specifically, those identified in the Project Specific Plan provided in Appendix B.

Prior to collecting the sample, the volume contained in the LCS and LDS tanks or flowing through the individual LCS and LDS transfer lines is estimated in order to determine whether sufficient volume is present for the full suite of analytes (refer to the discussion in Appendix B for the setting of priorities). In case there is an absence of liquid in the LCS and/or LDS drainage layers such that water quality sampling cannot be conducted, it will be inferred that no leak from the cell has occurred.

While it is desirable that samples be collected from the LCS and LDS during the same time interval to enhance the comparability of the data, the overriding requirement is that enough leachate/fluid be present in the individual system to collect sufficient volume for the analyses.

4.5 Leak Detection Data Evaluation Process

The following components from each OSDF cell will be reviewed as part of the leak evaluation strategy:

- Trend analysis for the LCS, LDS, the glacial till, and the Great Miami Aquifer will help pinpoint potential leak related influences within each leak detection program element.
- The monitoring results from all elements will be correlated and evaluated holistically to determine whether a release has occurred and if a response action is necessary.
- LCS and LDS water volumes will be reviewed in tandem with water quality results to determine potential impacts to the environment from the OSDF.

As indicated previously, there is institutional knowledge regarding the various complexities associated with the regulatory strategy for the OSDF leak detection and data evaluation processes. This information will be considered during post-closure evaluations. To date, the process continues to evolve, and there is much interaction between DOE, EPA, and OEPA regarding the overall process.

4.5.1 Trend Analysis

Establishing an appropriate statistical trend analysis method is part of establishing background (baseline) conditions. Each cell is evaluated independently using intra-well trend analysis.

As identified in Section 3.2.1.2, to date, establishing baseline conditions based on statistical analyses has proven to be difficult due mainly to existing trend issues. Steady-state conditions, which are a requirement of control charting, have not been reached. In a letter dated April 19, 2007, DOE requested that control charts be excluded from the 2006 Site Environmental Report because it does not make sense to provide them until it has been determined that constituent-specific steady-state conditions have been established. A common ion study is underway that is scheduled to be completed in 2007. When the common ion study is complete, and the data have been compiled, DOE plans on meeting with EPA and OEPA to go over the data and discuss the OSDF leak detection monitoring program and associated reporting. Once it has been demonstrated that steady-state conditions have been established, control charts could be provided in ASERs. OEPA concurred with this strategy in a letter dated May 21, 2007.

Additionally, the intra-well trend analysis approach can be applied to data from all the elements—the LCS, LDS, and the groundwater monitoring components. This approach is most advantageous; however, there are issues associated with groundwater given the inherent difficulties in distinguishing potential releases from the OSDF from existing above background levels of monitoring constituents in the area of the OSDF. Regardless, point by point intra-well trending comparisons will be performed for the Great Miami Aquifer wells and HTWs.

4.5.2 Correlation of Monitoring Data

If fluid is collected from the LDS, it does not necessarily mean that the OSDF's leachate is leaking through the primary liner into the LDS. Liquid in the LDS could be from sources other than from within a particular cell. As identified in the USEPA "Report of 1995 Workshop on Geosynthetic Clay Liners," LDS liquids could be sourced from: (i) leakage through the top liner;

(ii) drainage of water (mostly rainwater) that infiltrates the leakage detection layer during construction but does not drain to the LDS sump until after the start of facility operation ("construction water"); (iii) water expelled from the LDS layer as a result of compression under the weight of the waste ("compression water"); (iv) water expelled from any clay component of the top liner as a result of clay consolidation under the weight of the waste ("consolidation water"); and (v) for a waste management unit with its base located below the water table, groundwater infiltration through the bottom liner ("infiltration water").

To determine whether liquid in the LDS is leachate and the primary liner of a cell is leaking, a correlation must exist between the LCS and LDS analyte concentrations. A correlation must also exist between the increases in volume of liquid in the LCS and the LDS ("flow monitoring data"). The expected correlation would be an increase in both flow and analyte concentration for the LCS and LDS. If volume increases and analyte concentrations between the two systems correlate, then a leak through the primary composite liner system will be suspected. The significance of the suspected leak with regard to the protection of the environment depends on the concentrations of the analytes found in the LDS and the volume of liquid present. Analyte concentrations and volume versus time plots of groundwater collected from the HTWs will be correlated with LCS and LDS data to detect a leak in the secondary composite liner system that contains the 3-ft compacted clay liner.

The primary purpose for the data collected in the Great Miami Aquifer is to establish a baseline from which to determine if leakage from the OSDF is detrimentally affecting the Great Miami Aquifer. It is recognized that an exhaustive characterization of the Great Miami Aquifer has already been conducted from which to determine Fernald Preserve impacts (from sources other than the OSDF), and to establish Fernald Preserve-specific COCs and associated FRLs. From this, a protective remedy for the Great Miami Aquifer has been developed, the success of which will be tracked through IEMP monitoring of site-specific indicator constituents. This has been documented in the OU5 RI (DOE 1995b) and FS Reports (DOE 1995c), the OU5 ROD (DOE 1995c), the IEMP (DOE 2006d), and associated IEMP reports. A secondary purpose for the Great Miami Aquifer data collected through the OSDF monitoring plan is to supplement the IEMP remedy performance monitoring data that will be collected for the aquifer. Groundwater data for those OSDF leak detection constituents that are also common to the IEMP groundwater remedy performance constituents are used in the IEMP data interpretations as the data become available. Groundwater data collected for those unique OSDF leak detection constituents that are not being monitored by the IEMP groundwater monitoring program are used only for the establishment of the OSDF baseline and subsequent leak detection monitoring.

End of current text

5.0 Leachate Management Monitoring Program

As discussed in Section 3.0, the Ohio Solid Waste Disposal regulations require an overall leak detection strategy to comply with the leachate management, monitoring, and reporting requirements in OAC 3745-27-19(M)(4) and OAC 3745-27-19(M)(5). To fulfill these requirements, the leachate management monitoring strategy provides:

1. A means to track the quantity of leachate collected for treatment and discharge, reported at least monthly.
2. A means to verify that the engineering components of the leachate management system will operate in accordance with OAC 3745-27-19, Operational Criteria for a Sanitary Landfill Facility.
3. A description of the site-specific leachate treatment and discharge elements to ensure that the leachate collected from the facility is properly managed.
4. Collection and analysis of an annual leachate grab sample for Appendix I and PCB parameters per OAC 3745-27-10 and 19 to confirm, on an ongoing basis, the adequacy and appropriateness of the selected site-specific leak detection indicator parameters.

Item 1 of the strategy above is fulfilled by the flow monitoring component of the leak detection monitoring strategy. Flow measurements are taken at the frequency identified in Section 4.4.2.2. Item 2 of the strategy above is fulfilled by the OSDF Enhanced Permanent Leachate Transmission System Operation procedure, and Appendix D of this plan. Items 3 and 4 are described in Sections 5.1 and 5.2, respectively. Item 4 is discussed in Appendix E.

5.1 Leachate Treatment and Discharge Management

Leachate is treated in the CAWWT and discharged at the National Pollutant Discharge Elimination System (NPDES)–permitted outfall to the Great Miami River. The following is a description of the management approach for leachate treatment, along with a description of the treatment system and the leachate monitoring needs to ensure proper operation of the treatment facility and compliance with the (NPDES) Permit.

Leachate is collected from both the LCS and LDS layers of each cell of the OSDF whenever such fluids are present. Fluid that collects in the LCS and LDS collection tanks located in each cell's valve house is pumped to the gravity drain portion of the leachate transmission system line, which drains all valve houses to the PLS. The leachate collected in the PLS is periodically pumped to the CAWWT backwash basin or directly to CAWWT feed tanks.

The CAWWT facility is a 1,800-gallon-per-minute (gpm) facility divided into a 1,200-gpm treatment train dedicated to groundwater, and a 600-gpm treatment train formerly used for the treatment of storm water and remediation wastewater including leachate. Since site stormwater no longer requires treatment, the CAWWT 600-gpm treatment train treats primarily groundwater but also treats leachate, and water from the backwash basin. All discharges from CAWWT are through the NPDES Outfall PF 4001. OAC 3745-27-19, "Operational Criteria for a Sanitary Landfill Facility," requires treatment of leachate. Leachate is a minimal flow and will likely have no bearing on operational decisions. It is required, however, that leachate be treated through the CAWWT prior to discharge to the Great Miami River until the CAWWT is no longer needed.

Prior to the cessation of CAWWT operations, DOE will have proposed and negotiated the future management of leachate with EPA and OEPA. A passive treatment system for OSDF leachate was evaluated for potential use at the Fernald Preserve post-closure (DOE 2004b). This evaluation used leachate from the OSDF to test the uranium removal effectiveness of several media. Iron filings appeared to perform the best. The evaluation will be revisited in 2009 to determine whether additional testing is warranted prior to selecting the alternative treatment system to be used once CAWWT is no longer available.

5.2 Confirmation of Leak Detection Indicator Parameters

The final leachate management monitoring requirement entails the annual confirmation of the site-specific leak detection indicator parameters. The purpose of this annual sampling is to confirm the appropriateness of the site-specific leak detection indicator parameters in the event that leachate composition changes over time, as described in OAC 3745-27-10(D)(2). An annual leachate grab sample is obtained and analyzed for parameters listed in Ohio Solid Waste regulation OAC 3745-27-10 and 19 (refer to Appendix I and PCBs). This sampling was necessary to fulfill the requirement in OAC 3745-27-19(M)(5) that calls for reporting the data from an annual grab sample of leachate.

Because waste is no longer being placed in the OSDF, and an alternate sampling constituent list has been approved for the OSDF, it is envisioned that after completion of the common ion study that collection of an annual grab sample from the LCS of each cell to be tested for Appendix I and PCB parameters listed in OAC 3745-27-10 will no longer be required, and this annual sampling/analysis task will stop. Annual sampling fro the LCS of each cell will instead focus on site-specific parameters that have been approved for the facility. Annual sampling of the LCS of each cell for Appendix I and PCB listed parameters will not stop until concurrence has been obtained from EPA and OEPA.

While it is anticipated that the results from analysis of the annual grab sample of leachate may indicate the presence of parameters not included in the leak detection indicator parameter list, it is not anticipated that these other parameters will exist in the leachate at concentrations high enough to warrant their addition to the leak detection indicator parameter list. However, a review of the data will be conducted (and reported through the ASERs) to determine if any new indicator constituents should be added to the site-specific leak detection indicator parameter list. Constituent concentrations will be reviewed against information gathered during the OU5 RI/FS period and subsequent environmental monitoring data. OSDF annual LCS data will be compared to factors such as Great Miami Aquifer and perched water background values, range of site perched water concentrations, and current laboratory contract required detection limits. Ultimately, a constituent will be added if routine analysis of the constituent can significantly enhance early detection capability. The leak detection/leachate analysis will ensure that the character of the leachate will not adversely impact the treatment facility or the treatment facility effluent receiving stream (the Great Miami River).

In order to gain pre-waste-placement information, a sample from both the LCS and LDS has been collected and analyzed for the annual leachate monitoring parameter list. This is not a regulatory requirement, but it was added to the monitoring requirements in order to obtain baseline information. This requirement was initiated in 2002.

6.0 Reporting

6.1 Routine Reporting

Information to establish baseline conditions is provided in ASERs as agreed upon in a March 8, 2005, meeting between DOE, EPA, and OEPA. DOE evaluates whether sufficient data are available to ascertain the type of distribution of the data, and from that, select an appropriate statistical method and associated statistical measure. To date, control chart methodology has been used. The determination for statistical analyses is made based on monitoring results from a cell-by-cell basis for each system (i.e., glacial till and Great Miami Aquifer). Once sufficient samples are collected for initial baseline monitoring, it will be recommended that the list of parameters be refined based upon the frequency of detections (i.e., constituents detected 25 percent or more of the time). Cell-specific evaluations will be summarized in ASERs. Initial baseline results for Cells 1 through 7 were presented prior to closure, and Cell 8’s will be presented post-closure. The ASERs will also serve as the mechanism to propose modifications to the initial groundwater/leak detection and leachate monitoring plan in areas such as, but not limited to, the following:

- Modification of leak detection monitoring parameters list for routine monitoring.
- Modification of sampling frequency for LCS, LDS, glacial till, or Great Miami Aquifer monitoring points.
- Modification of leachate management monitoring parameters.
- Establishment of an appropriate statistical method and associated statistical measurements.
- Establishment of a pump operating level for the LCS.
- Temporary suspension or cessation of sampling and attendant statistical analysis for monitoring points (either singly or in combination).

To provide an integrated approach to reporting OSDF monitoring data, LCS and LDS flow data and concentrations, along with groundwater monitoring results, trending results, and interpretation of the data will also be provided in the ASERs. Presenting data in one report will facilitate a qualitative assessment of the impact of the OSDF on the aquifer, as well as the operational characteristics of OSDF caps and liners. Additionally, monitoring data will be made available electronically (i.e., Geospatial Environmental Mapping System [GEMS]).

6.2 Notifications and Response Actions

If the flow rate into any LDS tank exceeds 20 gpad, which is 10 percent of the OSDF design established action leakage rate of 200 gpad, monitoring frequency for the specific cell including both LCS and LDS will be increased to weekly as long as the high flow rate in the LDS remains. Leachate collected will be analyzed to determine concentrations of the indicator constituents. DOE will notify EPA and OEPA when this situation is identified during the routine monitoring. All the monitoring data collected during the subsequent increased monitoring frequency period will be forwarded to EPA and OEPA for review on a weekly basis.

If the flow rate into any LDS tank exceeds 10 percent of the action leakage rate continuously in every weekly monitoring event for more than 3 months, an engineering evaluation of the integrity of the specific cell will be initiated. The cell cap and toe will be inspected for any potential problems. The perched groundwater levels in the surrounding area will also be evaluated. Any significant findings that indicate potential sources of liquid will be reported. Appropriate maintenance actions will be identified and implemented to address any identified problems following consultation with EPA and OEPA.

If the flow rate into any LDS tank exceeds the action leakage rate, the actions presented in Table 6–1 will be implemented. In following the steps required in Table 6–1, both flow volumes and concentration levels of indicator constituents in the leachate collected in the LDS will be evaluated on a cell-by-cell basis together with all the other monitoring data collected from the LCS, till monitoring wells, and Great Miami Aquifer monitoring wells. The previous/historical monitoring data and weather information will be used to compare with the current conditions in order to narrow down the timeframe of potential changes in the system performance.

Preliminary field inspections of the cell caps, toes, run-on/runoff control channel, valve houses, and lift station will be conducted as soon as possible to meet the Step 7 schedule and to identify any visible signs of potential problems or sources of liquids. Pending field conditions, some mowing or snow removal may be required in order to conduct these inspections sufficiently. All necessary efforts will be made to allow sufficient visual inspections. EPA and OEPA will be notified prior to these inspections. Check lists similar to those prepared for the routine quarterly inspections will be submitted as a part of the written report specified in Step 7 to document these inspections.

The Engineer on Record for the OSDF (or other engineering consultants specialize in landfill design and acceptable to EPA and OEPA) will be requested to assist with the data evaluation, field inspections, and preparation of the report.

Preventative maintenance or any necessary repairs of selected OSDF caps or toes will be conducted based on results of routine visual inspections, engineering evaluation triggered by exceeding 10 percent of the action leakage rate continuously for three months, or the Table 6–1 process. If it is determined that both the cap and primary liner have failed following any of the inspections and/or engineering evaluations, then a more intensive OSDF response action will also be required. A response action might include initiating cap repair, investigating whether or not contamination has breached the compacted clay liner component of the secondary composite liner system that lies beneath the LDS, increasing monitoring, or a combination of these actions.

Potential leakage through the clay liner will be assessed by using the HTW installed beneath the liner penetration box area and secondary liner (along with the LCS and LDS flow volumes and water quality data). If it is determined that a leak has adversely impacted groundwater (till and/or Great Miami Aquifer), then a groundwater quality assessment monitoring program will be developed and initiated to determine the nature, rate, and extent of contaminant migration. Groundwater monitoring might also be increased to determine if leakage from the OSDF has entered the Great Miami Aquifer, although given the distances involved it would be unlikely that leakage from the OSDF would be able to migrate to the Great Miami Aquifer in the short timeframe between leak detection and response.

Table 6–1. Notification and Response Actions

Step	Timeframe	Action
1.	Within 7 days of the determination of an exceedance into any LDS at the action leakage rate of 200 gpad.	Notify both of the following in writing: • EPA Region 5 Regional Administrator 77 West Jackson Boulevard Chicago, Illinois 60604-3590 • Director, Ohio Environmental Protection Agency 122 South Front Street Columbus, Ohio 43215
2.	Within 14 days of the determination of an exceedance into any LDS at the action leakage rate of 200 gpad.	Submit to both of the individuals identified in Step 1 a written preliminary assessment as to the: • Amount of liquids. • Likely sources of liquids. • Possible location, size, and cause of any leaks. • Short-term actions taken and planned.
3.	As practicable to meet Step 7.	Determine to the extent practicable the location, size and cause of any leak.
4.	As practicable to meet Step 7.	Determine: • Whether receipt of impacted materials should be ceased or curtailed. • Whether any impacted materials within the OSDF or any individual cell/phase should be removed for inspection, repairs, or controls.
5.	As practicable to meet Step 7.	Determine any other short- or long-term actions to take to stop or mitigate the leaks.
6.	As practicable to meet Step 7.	In order to conduct Steps 3 through 5: • Assess the source of liquids, and amounts of liquids by source; and • In order to identify the source of liquids and the possible location of any leaks, and the hazard and mobility of the liquid, conduct a fingerprint, hazardous constituent, or other analyses of the liquids in the LDS; and • Assess the seriousness of any leaks in terms of potential for escaping into the environment. OR • Document why such assessments are not needed.
7.	Within 30 days of the notification given in Step 1.	Submit to both of the individuals identified in Step 1 a written report of the: • Results of the analyses and determinations made under Steps 3 through 6 (to the extent completed). • Results of action taken. • Actions ongoing (i.e., analyses and determinations under Steps 3 through 6 not yet completed) or planned (refer to Section 9.0 of the OSDF Post-Closure Care and Inspection Plan).
8.	Monthly thereafter, as long as the flow rate in the LDS exceeds the action leakage rate.	Submit to both of the individuals identified in Step 1 a written report summarizing the: • Results of actions taken. • Actions planned.

SOURCE: *Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*, Subpart NC-Landfills, Response Actions, 40 CFR 264.304(b) and 265.303(b).

End of current text

7.0 References

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UMTRCA (Uranium Mill Tailings Reclamation and Control Act Regulations), 1978. United States Congress.

Appendix A

On-Site Disposal Facility Applicable or Relevant and Appropriate Requirements and Other Regulatory Requirements

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Acronyms and Abbreviations

ANOVA	analysis of variance
ARARs	applicable or relevant and appropriate requirements
CFR	*U.S. Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
LDS	leak detection system
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	On-Site Disposal Facility

End of current text

Applicable or relevant and appropriate requirements (ARARs) and to-be-considered criteria —for the On-Site Disposal Facility (OSDF) groundwater detection monitoring, the OSDF leachate monitoring, and the OSDF response action—that should be addressed by this plan are provided in Table A–1, as obtained from the *Final Record of Decision for Remedial Actions at Operable Unit 2* (DOE 1995), the *Record of Decision for Final Remedial Action at Operable Unit 3* (DOE 1996c), the *Final Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996a), or the *Permitting Plan and Substantive Requirements for the On-Site Disposal Facility* (DOE 1996b). Additional regulatory requirements that are appropriate guidance for formulation of this plan have also been identified and included.

Table A–1. OSDF Groundwater/Leak Detection and Leachate Monitoring Plan Compliance Strategy ARARs and Other Regulatory Requirements

Citation	Requirement
PLANS	
Ohio Municipal Solid Waste Rules–Sanitary Landfill Facility Permit to Install Application OAC 3745-27-06(C)(9)(a)	• Prepare a "groundwater detection monitoring plan" as required by OAC 3745-27-10, and if applicable a "groundwater quality assessment plan" and/or "corrective measures plan" required by OAC 3745-27-10.
	• Prepare a "leachate monitoring plan" to ensure compliance with OAC 3745-27-19(M)(4) and (5).
GROUNDWATER/LEAK DETECTION MONITORING	
Ohio Municipal Solid Waste Rules–Groundwater Monitoring Program for a Sanitary Landfill Facility OAC 3745-27-10(A)	(1) The owner or operator of a sanitary landfill facility shall implement a "groundwater monitoring program" capable of determining the quality of groundwater occurring within the uppermost aquifer system and all significant zones of saturation above the uppermost aquifer system underlying the landfill facility, with the following elements: (a) A "groundwater detection monitoring program" which includes: (i) a "groundwater detection monitoring plan" in accordance with OAC 3745-27-10(B) through (D); (ii) a monitoring system in accordance with OAC 3745-27-10(B); (iii) sampling and analysis procedures, including an appropriate statistical method, in accordance with OAC 3745-27-10(C); and (iv) detection monitoring procedures, including monitoring frequency and a parameter list, in accordance with OAC 3745-27-10(D). (2) Schedule for implementation of detection monitoring. (4) For purposes of this rule, the groundwater monitoring program is implemented upon commencement of sampling of groundwater wells.
Ohio Municipal Solid Waste Rules–Groundwater Monitoring System OAC 3745-27-10(B)	(1) The "groundwater detection monitoring program" shall consist of sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from both the uppermost aquifer system and any significant zones of saturation that exist above the uppermost aquifer system that: (a) represent the quality of the background groundwater that has not been affected by past or present operations; and (b) represent the quality of the groundwater passing directly downgradient of the limits of solid waste placement. (4) The number, spacing, and depth of groundwater monitoring wells shall be: (a) based on site-specific hydrogeologic information; and (b) capable of detecting a release from the facility to the groundwater at the closest practicable location to the limits of waste placement.
Ohio Municipal Solid Waste Rules–Groundwater Sampling, Analysis, and Statistical Methods OAC 3745-27-10(C)	(1) The "groundwater monitoring program" shall include consistent sampling and analysis procedures and statistical methods that are protective of human health and the environment and that are designed to ensure monitoring results that provide an accurate presentation of groundwater quality at the background and downgradient well. (a) Sampling and analysis procedures employed must be documented in a written plan. (b) The statistical method selected by the owner or operator must be in accordance with OAC 3745-27-10(C)(6)&(7). (6) After completing collection of the background data, the owner or operator shall specify one of the following statistical methods to be used in evaluating groundwater quality; the statistical method chosen must be conducted separately for each of the parameters required to be statistically evaluated: (a) a parametric analysis of variance (ANOVA); or (b) an ANOVA based on ranks; or (c) a tolerance or prediction interval procedure; or (d) a control chart approach; or (e) another statistical method.

Table A–1. OSDF Groundwater/Leak Detection and Leachate Monitoring Plan Compliance Strategy ARARs and Other Regulatory Requirements (continued)

Citation	Requirement
GROUNDWATER/LEAK DETECTION MONITORING (cont.)	
	(7) Performance standards for statistical methods. (a) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of chemical parameters or leachate and leachate-derived constituents. If shown to be inappropriate, 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. (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 the environment. Any practical quantitation limit 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. (9) The number of samples collected to establish groundwater quality data shall be consistent with the appropriate statistical procedures.
Ohio Municipal Solid Waste Rules–Groundwater Detection Monitoring Program OAC 3745-27-10(D)	(2) Alternate monitoring parameter list. The owner or operator of a sanitary landfill facility may propose to delete any of the Appendix I parameters of this rule. The alternative monitoring parameter list may be approved if the removed parameters are not reasonably expected to be in or derived from the waste contained or deposited in the landfill facility. The following factors should be considered: (a) which of the parameters in Appendix I shall be deleted; (b) types, quantities, and concentrations of constituents in wastes managed at the landfill facility; (c) the concentrations of Appendix I constituents in the leachate from the relevant unit(s) of the landfill facility; (d) any other relevant information. (3) Alternate inorganic parameter list. The owner or operator of a sanitary landfill facility may propose that an alternative list of inorganic indicator parameters to be used in lieu of some or all of the inorganic parameters listed in Appendix I of this rule. The alternative inorganic indicator parameters may be approved if the alternative list will provide a reliable indication of inorganic releases from the facility to the groundwater. The following factors should be considered: (a) the types, quantities, and concentrations of constituents in wastes managed at the facility; (b) the mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the facility; (c) the detectability of the indicator parameters, waste constituents, and their reaction products in the ground water; and (d) the concentrations or values and coefficients of variation of monitoring parameters or constituents in the background groundwater quality. (5) Monitoring parameters, frequency, location. The owner or operator shall monitor the groundwater monitoring well system (a) and (b) during the active life of the facility (including final closure and the post-closure care period, (ii) at least semiannually by collecting: (*a*) during the initial one hundred and eighty days after implementing the groundwater detection monitoring program (the first semiannual sampling event), a minimum of four independent samples from each monitoring well. Collect and analyze a minimum of eight independent samples during the first year of sampling. *(b)* After the first year during subsequent semiannual sampling events, at least one sample for each monitoring well. (iii) beginning with receiving the results from the first monitoring event under (D)(5)(a)(ii)(b) of this rule and semiannually thereafter, by statistically analyzing the results. (6) Alternative sampling and statistical analysis frequency. The owner or operator of a sanitary landfill facility may propose an alternative frequency for groundwater sampling and/or statistical analysis. The alternative frequency may be approved provided it is not less than annual. The following factors should be considered: (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) groundwater 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; and (e) resource value of the uppermost aquifer system. NOTE: Table B-3 on page B.3-25 of the *Record of Decision for Operable Unit 5* states, “an alternate list of monitoring parameters will be required.”

Table A–1. OSDF Groundwater/Leak Detection and Leachate Monitoring Plan Compliance Strategy ARARs and Other Regulatory Requirements (continued)

Citation	Requirement
GROUNDWATER/LEAK DETECTION MONITORING (Cont.)	
Ohio Hazardous Waste General Facility Standard–New Facilities Rules–Required Programs OAC 3745-54-91; 40 CFR 264.91	Owners or operators subject to the groundwater protection rules must conduct a monitoring and response program as follows: (1) whenever hazardous constituents from a regulated unit are detected at the compliance point, the owner or operator must institute a compliance monitoring program. “Detected” is defined as statistically significant evidence of contamination. (2) whenever the groundwater protection standard is exceeded, the owner or operator must institute a corrective action program. “Exceeded” is defined as statistically significant evidence of increased contamination. (3) whenever hazardous constituents from a regulated unit exceed concentration limits in groundwater between the compliance point and the downgradient facility property boundary, the owner or operator must institute a corrective action program. (4) in all other cases, the owner or operator must institute a detection monitoring program.
Ohio Hazardous Waste General Facility Standards–New Facilities Rules–Groundwater Protection Standard OAC 3745-54-92; 40 CFR 264.92	The owner or operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents detected in the groundwater from a regulated unit do not exceed the specified concentration limits (specified in the permit) in the uppermost aquifer underlying the waste management area beyond the point of compliance. The groundwater protection standard will be established when hazardous constituents have been detected in the groundwater.
Ohio Hazardous Waste General Facility Standards–New Facilities Rules–Hazardous Constituents OAC 3745-54-93; 40 CFR 264.93	(A) The permit will specify the hazardous constituents to which the groundwater protection standard applies. Hazardous constituents are those that have been detected in the groundwater in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless excluded under paragraph B of this rule. (B) A constituent will be excluded from the list of hazardous constituents specified in the facility permit if it is found that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. The following will be considered: (1) Potential adverse effects on groundwater quality, considering: (a) the physical and chemical characteristics of the waste in the regulated unit, included its potential for migration; (b) the hydrogeological characteristics of the facility and surrounding land; (c) the quantity of groundwater and the direction of groundwater flow; (d) the proximity and withdrawal rates of groundwater users; (e) the current and future use of groundwater in the area; (f) the existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality; (g) the potential for health risks caused by human exposure to waste constituents; (h) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; (i) the persistence and permanence of the potential adverse effects.

Table A–1. OSDF Groundwater/Leak Detection and Leachate Monitoring Plan Compliance Strategy ARARs and Other Regulatory Requirements (continued)

Citation	Requirement
Ohio Hazardous Waste General Facility Standards–New Facilities Rules–General Groundwater Monitoring Requirements OAC 3745-54-97; 40 CFR 264.97	(G) In detection monitoring or where appropriate in compliance monitoring, data on each constituent specified in the permit [or in the monitoring plan] is to be collected from background wells and wells at compliance point(s). The number and kinds of samples collected to establish background shall be appropriate for the form of statistical test employed. The sample size should be as large as necessary to ensure with reasonable confidence that a contaminant release to the groundwater from a facility will be detected. The owner or operator will determine an appropriate sampling procedure and interval for each constituent. (H) The owner or operator is to specify one of the following statistical methods to be used in evaluating groundwater monitoring data for each constituent to be specified. Use of any of the following statistical methods must be protective of human health and the environment: (1) a parametric ANOVA; (2) an ANOVA based on ranks; (3) a tolerance or prediction interval procedure; (4) a control chart approach; or (5) another statistical method.
GROUNDWATER/LEAK DETECTION MONITORING (Cont.)	
Ohio Hazardous Waste General Facility Standards–New Facilities Rules–Detection Monitoring Program OAC 3745-54-98; 40 CFR 264.98	(A) The owner or operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogens, waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. The director (of the Ohio Environmental Protection Agency [OEPA]) will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors: (1) types, quantities, and concentrations of constituents to be managed at the regulated unit; (2) mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the waste management area; (3) detectability of the indicator parameters, waste constituents, and their reaction products in the ground water; and (4) concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in the ground water background. (D) The permit will specify the frequencies for collecting samples and conducting statistical tests to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent specified in the permit. (F) The owner or operator must determine whether there is statistically significant evidence of contamination for any chemical parameter or hazardous constituent specified in the permit at the frequency specified in the permit.
Federal Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings: Subpart D–Standards for Management of Uranium Byproduct Material Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended 40 CFR 192.30 through .34	Uranium byproduct materials shall be managed to conform to the ground water protection standard in 40 CFR 264.92, which includes detection monitoring. Alternate concentration limits for uranium can be established, as described in 40 CFR 264.95 and 264.94(b).
Environmental Monitoring DOE M 435.1-1	I.1.E.(7) Environmental Monitoring. Radioactive waste management facilities, operations, and activities shall meet the environmental monitoring requirements of DOE 5400.1, General Environmental Protection Program; and DOE 5400.5, Radiation Protection of the Public and the Environment. IV.R.(3)(a) The site-specific performance assessment and composite analysis shall be used to determine the media, locations, radionuclides, and other substances to be monitored. IV.R.(3) Disposal Facilities. (C) The environmental monitoring programs shall be capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the performance objectives in this Chapter.
LEACHATE MANAGEMENT AND MONITORING	
Ohio Municipal Solid Waste Rules–Operational Criteria for a Sanitary Landfill Facility OAC 3745-27-19(M)(4)&(5)	The owner annually shall report: • a summary of the quantity of leachate collected for treatment and disposal on a monthly basis during the year; location of leachate treatment and/or disposal; and verification that the leachate management system is operating in accordance with this rule; • results of analytical testing of an annual grab sample of leachate.
OTHER REQUIREMENTS	

Table A–1. OSDF Groundwater/Leak Detection and Leachate Monitoring Plan Compliance Strategy ARARs and Other Regulatory Requirements (continued)

Citation	Requirement
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N–Landfills, Monitoring and Inspection 40 CFR 264.302	Action Leakage Rate: (a) The action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without the fluid head on the bottom liner exceeding 1 ft. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions (e.g., the action leakage rate must consider decreases in the flow capacity of the system over time resulting from siltation and clogging, rib layover and creep of synthetic components of the system overburden pressures, etc.). (b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under 40 CFR 264.303(c), to an average daily flow rate (gallons per acre per day) for each sump (i.e., liner penetration box). Unless the U.S. Environmental Protection Agency (EPA) approves a different calculation, the average daily flow rate for each sump must be calculated weekly during the active life and closure period, and monthly during the post-closure care period when monthly monitoring is required under 40 CFR 264.303(c).
OTHER REQUIREMENTS (Cont.)	
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N–Landfills, Monitoring and Inspection 40 CFR 264.303(c)	An owner or operator required to have a LDS must record the amount of liquids removed from each LDS sump as follows: (1) During the active life and closure period, at least once each week. (2) After the final cover is installed, in accordance with the following graded approach: • at least monthly; or • if the liquid level in the sump stays below the pump operating level for two consecutive months, at least quarterly; or • if the liquid level in the sump stays below the pump operating level for two consecutive quarters, at least semiannually; but • if at any time during the post-closure care period the pump operating level is exceeded at units on quarterly or semiannual recording schedules, the owner or operator must return to monthly recording of amounts of liquids removed from each sump until the liquid level again stays below the pump operating level for two consecutive months. NOTE: There are no requirements in Ohio hazardous waste or Ohio solid waste rules regarding LDS flow monitoring.
Federal Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart N–Landfills, Response Actions 40 CFR 264.304	(a) The owner or operator of landfill units subject to 264.301(c) or (d) must have an approved response action plan before receipt of waste. The response action plan must set forth the action to be taken if the "action leakage rate" has been exceeded [in any LDS sump]. (b) At a minimum, the response action plan [see entry 2 above] must describe the following actions to be taken: (1) Notify the Regional Administrator in writing of the exceedance within 7 days of the determination; (2) Submit a preliminary written assessment to the Regional Administrator within 14 days of the determination, as to the amount of liquids, likely sources of liquids, possible location, size, and cause of any leaks, and short-term actions taken and planned; (3) Determine to the extent practicable the location, size, and cause of any leak; (4) Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed; (5) Determine any other short-term or longer-term actions to be taken to mitigate or stop any leaks; and (6) Within 30 days of the notification that the action leakage rate has been exceeded, submit to the Regional Administrator the results of the analysis specified in (3), (4), and (5) [above], the results of action taken, and actions planned. Monthly thereafter, as long as the flow rate in the LDS exceeds the action leakage rate, the owner or operator must submit to the Regional Administrator a report summarizing the results of any RAs taken and actions planned. (c) To make the leak and/or RA determinations in paragraphs (b)(3), (4) and (5) [above], the owner or operator must: • Asses the source of liquids, and amount of liquids by source; • Conduct a fingerprint, hazardous constituent, or other analyses of the liquids in the LDS to identify the source of liquids and possible location of any leaks, and the hazard and mobility of the liquid; and • Assess the seriousness of any leaks in terms of potential for escape to the environment; or • Document why such assessments are not needed.

References

DOE (U.S. Department of Energy), 1995. *Final Record of Decision for Remedial Actions at Operable Unit 2*, EPA/ROD/R05-95/289, Final, Fernald Environmental Management Project, Cincinnati, Ohio, June 8.

DOE (U.S. Department of Energy), 1996a. *Record of Decision for Remedial Actions at Operable Unit 5*, EPA/ROD/R05-96/312 (7478 U-007-501.4), Fernald Environmental Management Project, Cincinnati, Ohio, January 31.

DOE (U.S. Department of Energy), 1996b. *The Permitting Plan and Substantive Requirements for the On-Site Disposal Facility*, Fernald Environmental Management Project, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1996c. *Operable Unit 3 Record of Decision for Final Remedial Actions*, EPA/ROD/R05-96-311, Final, Fernald Environmental Management Project, Cincinnati, Ohio, September 24.

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Appendix B

Project-Specific Plan for the
On-Site Disposal Facility Monitoring Program

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Contents

Figure

Tables

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Acronyms and Abbreviations

APHA	American Public Health Association
ASER	Annual Site Environmental Report
CAWWT	Converted Advanced Wastewater Treatment facility
CLP	Contract Laboratory Program
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	Environmental Protection Agency
GMA	Great Miami Aquifer
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
HTW	horizontal till well
IEMP	Integrated Environmental Monitoring Plan
L	liter
LCS	leachate collection system
LDS	leak detection system
LM QAPP	*Legacy Management CERCLA Sites Quality Assurance Project Plan*
LM SAP	*Sampling and Analysis Plan for United States Department of Energy Office of Legacy Management Sites*
mL	milliliter
OAC	Ohio Administrative Code
OSDF	On-Site Disposal Facility
SE	southeast
SEEPro	Site Environmental Evaluation for Projects database
SW	southwest
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TOX	Total Organic Halogens

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1.0 Introduction

1.1 Purpose

This plan was developed in support of the Groundwater/Leak Detection and Leachate Monitoring Plan (GWLMP) for the On-Site Disposal Facility (OSDF). Specifically, the purpose of this plan is to provide detailed information for samplers to collect data to support the analytical and reporting requirements described in the OSDF GWLMP. The GWLMP divides the OSDF monitoring program into two primary elements: (1) a leak detection component, which will provide information to verify the OSDF's ongoing performance, its integrity, and its impact on groundwater; and (2) a leachate monitoring component, which will satisfy requirements for leachate collection and management. This plan discusses requirements for sampling the groundwater monitoring system (i.e., horizontal till wells [HTWs] and Great Miami Aquifer [GMA] wells), leachate collection system (LCS), and leak detection system (LDS). All sampling and analysis activities will be consistent with the data quality objective (DQO) (DOE 2006b) provided in Appendix C of the GWLMP.

1.2 Scope

The leak detection monitoring strategy recognizes the various operating phases of the OSDF, including periods before, during, and after waste placement. Each cell has been constructed with an LCS to collect infiltrating rainwater and an LDS to provide early detection of leakage within the individual cells. Additionally, groundwater within the glacial till will be monitored using a series of HTWs constructed beneath each cell, and the GMA will be monitored by conventional monitoring wells located upgradient and downgradient of each OSDF cell. Monitoring locations for the eight cells are identified in Figure 1–1.

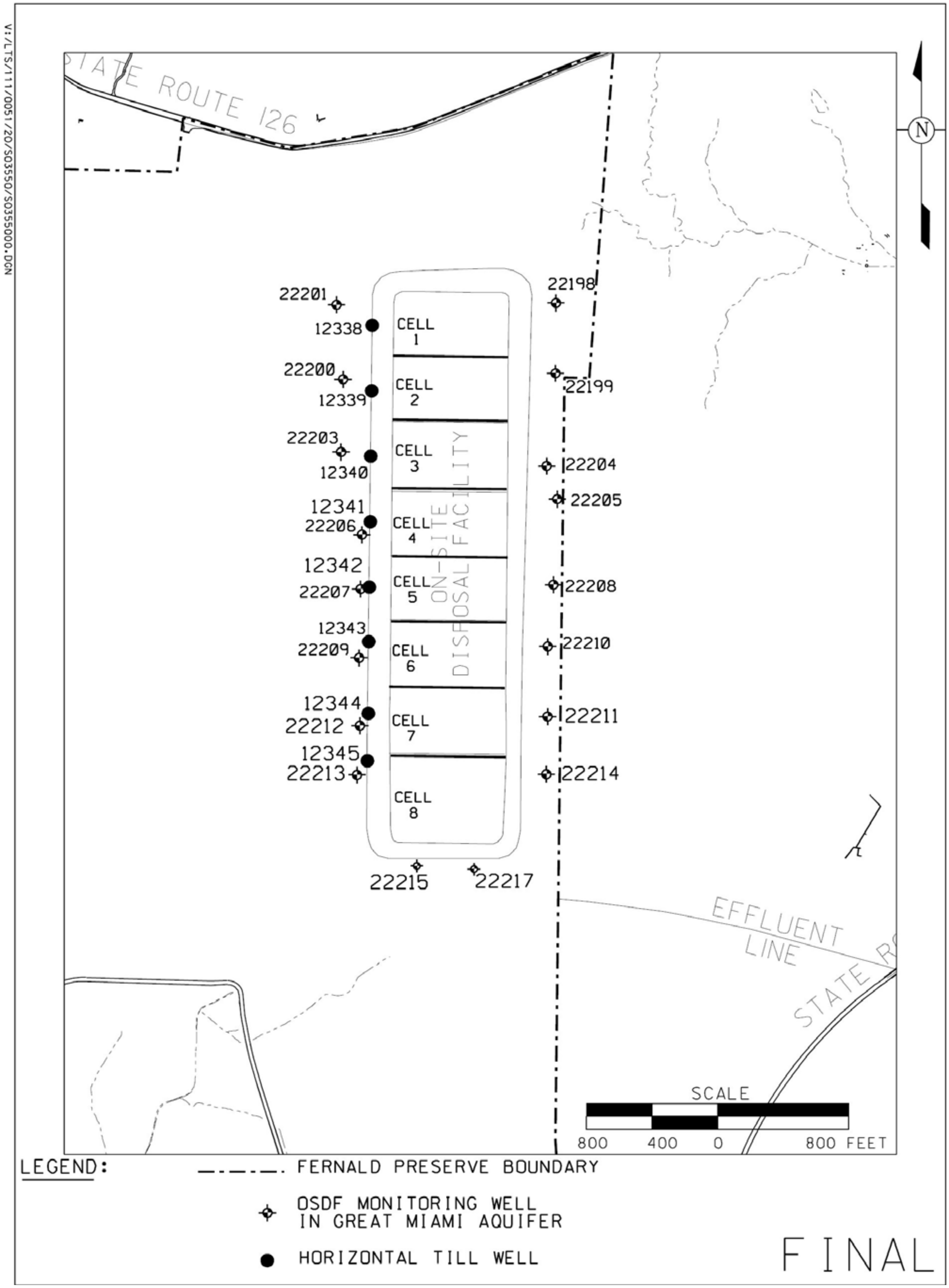

Figure 1–1. OSDF Well Locations

2.0 Sampling Program

As noted in Section 3.0 of the GWLMP, the Ohio Solid Waste regulations require that, for detection monitoring, at least four independent samples from each well will be taken during the first 180 days after implementation of the groundwater detection monitoring program and at least eight independent samples in the first year to determine the background (baseline) water quality (Ohio Administrative Code [OAC] 3745-27-10(D)(5)(a)(ii)(a)). The requirement to collect eight independent samples is only applicable to those wells installed after August 15, 2003, because that is the date that the code became effective. Current sampling frequencies are based on the following: HTWs and GMA wells are sampled bimonthly after waste placement until 12 samples are collected for statistical evaluation. These frequencies were selected to address OSDF construction schedules while the OSDF was under construction, to develop an appropriate statistical procedure, and to compensate for varying temporal conditions and seasonal fluctuations. After sufficient samples are collected for statistical analysis, samples are collected quarterly from the HTWs and the GMA.

Specific monitoring requirements for each cell are provided in Sections 2.1, 2.2, and 2.3, with the specific analytical parameters listed in Tables 2–1, 2–2, and 2–3. Analytical detection limits, at a minimum, will meet the applicable final remediation levels identified in the *Integrated Environmental Monitoring Plan* (IEMP) (DOE 2006c and DOE 2006d). A summary of sampling requirements for each OSDF cell is presented in Table 2–4.

2.1 Sampling at Cells 1 through 7

Sampling will be as follows:

- Annual samples will be collected from the LCS for the parameters listed in Table 2–2.
- Annual samples will be collected from the LDS for the parameters listed in Table 2–1.
- Quarterly samples will be collected from the LCS, LDS, HTW, and GMA for the parameters listed in Table 2–3.

If an analyte is detected in the annual samples from either the LDS or LCS, then confirmatory sampling will be conducted for that constituent for three quarterly consecutive events from the horizon in which it was detected. Depending on the magnitude and persistence of the constituent detected, sampling of the next lower horizon may be considered. The requirements for this confirmatory sampling will be documented and approved through the established variance process.

Table 2–1. Initial Baseline Monitoring Requirements for the Cell 8 LDS, LCS, Glacial Till, and GMA

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
Radionuclides:	LM QAPP[c]		D	6 months	HNO_3 to pH<2			Plastic or Glass
Technetium-99		2				1 L	500 mL	
Uranium, Total		1				100 mL	10 mL	
Inorganics:	CLP[d]/SW-846[e]	7	C		HNO_3 to pH<2	1 L	600 mL	Plastic or Glass
Boron				6 months				
Mercury				28 days				
Volatile Organics:	CLP[d]/SW-846[e]	3	C	14 days	Cool to 4°C	4 × 40 mL	1 × 40 mL	Glass vial with Teflon-lined
Bromodichloromethane					With H_2SO_4, HCL, or solid			septum cap[f]
1,1-Dichloroethene					$NaHSO_4$ to pH<2			
1,2-Dichloroethene (Total)								
Tetrachloroethene								
Trichloroethene								
Vinyl Chloride								
Semi-Volatile Organics:	CLP[d]/SW-846[e]	6	C	7 days to extraction/	Cool to 4°C	1 L	1L	Amber glass bottle with
Carbazole				40 days from				Teflon-lined cap
4-Nitroaniline				extraction to analysis				
Bis (2-Chloroisopropyl) ether								
Pesticides:	CLP[d]/SW-846[e]	8	C	7 days to extraction/	Cool to 4°C	1 L	1 L	Amber glass bottle with
alpha-Chlordane				40 days from				Teflon-lined cap
				extraction to analysis				

Table 2–1(continued). Initial Baseline Monitoring Requirements for the Cell 8 LDS, LCS, Glacial Till, and Great Miami Aquifer

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
General Chemistry:								
Total Organic Halogens (TOX)	9020B[e]	4	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	500 mL	20 mL	Amber glass with Teflon-lined cap[g]
Total Organic Carbon (TOC)	9060[e]	5	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	250 mL	125 mL	Amber glass with Teflon-lined cap
Sulfate	375.2[h], 300.0[h], 4500E[i]	9	B	28 days	Cool to 4°C	250 mL	100 mL	Plastic

Note: The LDS for Cells 1 through 7 will be monitored annually for these parameters per requirements in Section 2.1.

Note: Field parameters are performed at each sampling location prior to sample collection and include dissolved oxygen, pH, specific conductance, temperature, and turbidity at ASL A, Priority 1.

[a]If sufficient volume is not available for collection of a full suite at standard volume, then the minimum volume is to be collected for all analytical groups. If sufficient volume is still not available for collection of the full suite, then a partial sample is to be collected in accordance with the indicated priority rating.
[b]Analytical support level. The ASL may become more conservative, if necessary to meet detection limits or data quality objectives.
[c]Radiological analyses do not have standard methods; however, the performance-based analytical specifications for these parameters are provided in the LM QAPP.
[d]EPA Contract Laboratory Program (CLP) Statement of Work: Multi-Media, Multi-Concentration, most recent revision (EPA 2003, EPA 2004). Per the LM QAPP, where CLP is listed, SW-846 (EPA 1998) can now be used for ASL C or D.
[e]Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA 1998)
[f]No head space
[g]Minimal head space – as close to zero as possible
[h]Methods for Chemical Analysis of Water and Wastes (EPA 1983)
[i]Standard Methods for Analysis of Water and Wastewater, 17th edition (APHA 1989)

Table 2–2. Annual Monitoring Requirements for the OSDF Leachate Collection System

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
Radionuclides:	LM QAPP[c]		D	6 months	HNO_3 to pH<2			Plastic or Glass
Technetium-99		2				1 L	500 mL	
Uranium, Total		1				100 mL	10 mL	
Inorganics:	CLP[d]/SW-846[e]	7	C	6 months	HNO_3 to pH<2	1 L	300 mL	Plastic or Glass
Antimony								
Arsenic								
Barium								
Beryllium								
Boron								
Cadmium								
Calcium								
Chromium								
Cobalt								
Copper								
Iron								
Lead								
Magnesium								
Manganese								
Nickel								
Potassium								
Selenium								
Silver								
Sodium								
Thallium								
Vanadium								
Zinc								
Mercury				28 days				
General Chemistry:								
Ammonia	350.1[f], 350.3[f], 4500C[g], 4500F[g]	13	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	500 mL	200 mL	Plastic
Total Organic Halogens (TOX)	9020B[e]	4	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	500 mL	20 mL	Amber glass with Teflon-lined cap[h]
Total Organic Carbon (TOC)	9060[e]	5	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	250 mL	125 mL	Amber glass with Teflon-lined cap
Chloride	325.2[f], 300(all)[f]	11	B	28 days	None	250 mL	100 mL	Plastic
Nitrate/Nitrite	353.1[f], 353.2[f], 4500D[g],4500E[h]	9	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	100 mL	20 mL	Plastic or Glass
Sulfate	375.2[f], 300.0[f], 4500E[g]	12	B	28 days	Cool to 4°C	250 mL	100 mL	Plastic
Total Dissolved Solids (TDS)	160.1[f], 2540C[g]	10	B	7 days	None, Cool to 4°C	500 mL	250 mL	Plastic or Glass
Total Alkalinity	310.1[f], 2320B[g]	14	B	14 days	Cool to 4°C	500 mL	250 mL	Plastic

Table 2–2 (continued). Annual Monitoring Requirements for the OSDF Leachate Collection System

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
Volatiles: Acetone Acrylonitrile Benzene Bromochloromethane Bromodichloromethane Bromoform Bromomethane 2-Butanone Carbon disulfide Carbon tetrachloride Chlorobenzene Chloroethane Chloroform Chloromethane Dibromochloromethane 1,2-Dibromo-3-chloropropane Ethylene dibromide[i] 1,2-Dichlorobenzene 1,4-Dichlorobenzene trans-1,4-Dichloro-2-butene 1,1-Dichloroethane 1,2-Dichloroethane 1,1-Dichloroethene 1,2-Dichloroethene (Total) 1,2-Dichloropropane cis-1,3-Dichloropropene trans-1,3-dichloropropene Ethylbenzene 2-Hexanone Methylene Bromide Methylene Chloride Methyl iodide 4-Methyl-2-pentanone Styrene 1,1,1,2-Tetrachloroethane 1,1,2,2-Tetrachloroethane Tetrachloroethene Toluene 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trichloroethene Trichlorofluormethane 1,2,3-Trichloropropane Vinyl Acetate Vinyl Chloride Xylenes (Total)	CLP [d]/SW-846[e]	3	C	14 days	Cool to 4°C, H_2SO_4 to pH<2	4 × 40 mL	40 mL	Glass with Teflon-lined septum cap[h]

Table 2–2. Annual Monitoring Requirements for the OSDF Leachate Collection System (continued)

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
Semi-Volatile Organics: Carbazole 4-Nitroaniline bis(2 Chloroisopropyl)ether	CLP[d]/SW-846[e]	6	C	7 days to extraction/ 40 days from extraction to analysis	Cool to 4°C	1 L	1 L	Amber glass bottle with Teflon-lined cap
Pesticides: alpha Chlordane	CLP[d]/SW-846[e]	8	C	7 days to extraction/ 40 days from extraction to analysis	Cool to 4°C	1 L	1 L	Amber glass bottle with Teflon-lined cap
Polychlorinated Biphenyls: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260	CLP[d]/SW-846[e]	15	C	7 days to extraction/ 40 days from extraction to analysis	Cool to 4°C	2 L	1 L	Amber glass bottle with Teflon-lined cap

Note: Field parameters are performed at each sampling location prior to sample collection and include dissolved oxygen, pH, specific conductance, temperature, and turbidity at ASL A, Priority 1.

[a]If sufficient volume is not available for collection of a full suite at standard volume, then the minimum volume is to be collected for all analytical groups. If sufficient volume is still not available for collection of the full suite, then a partial sample is to be collected in accordance with the indicated priority rating.
[b]Analytical support level. The ASL may become more conservative, if necessary to meet detection limits or data quality objectives.
[c]Radiological analyses do not have standard methods; however, the performance-based analytical specifications for these parameters are provided in the LM QAPP.
[d]EPA Contract Laboratory Program Statement of Work: Multi-Media, Multi-Concentration, most recent revision. Per the LM QAPP, where CLP is listed, SW-846 can now be used for ASL C or D.
[e]Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
[f]Methods for Chemical Analysis of Water and Wastes
[g]Standard Methods for the Analysis of Water and Wastewater, 17th edition
[h]No head space
[i]Also referred to as 1,2-dibromoethane.

Table 2–3. Refined Baseline Monitoring Requirements for Cells 1 Through 7

Parameter	Method	Priority[a]	ASL[b]	Holding Time	Preservation	Standard Volume	Minimum Volume	Container
Radionuclides: Uranium, Total	LM QAPP[c]	1	D	6 months	HNO_3 to pH<2	100 mL	10 mL	Plastic or Glass
Inorganics: Boron	CLP[d]/SW-846[e]	4	C	6 months	HNO_3 to pH<2	1 L	600 mL	Plastic or Glass
General Chemistry:								
Total Organic Halogens (TOX)	9020B[e]	2	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	500 mL	20 mL	Amber glass with Teflon-lined cap[f]
Total Organic Carbon (TOC)	9060[e]	3	B	28 days	Cool to 4°C, H_2SO_4 to pH<2	250 mL	125 mL	Amber glass with Teflon-lined cap
Sulfate	375.2[g], 300.0[g], and 4500E[h]	5	B	28 days	Cool to 4°C	250 mL	100 mL	Plastic

Note: Field parameters are performed at each sampling location prior to sample collection and include dissolved oxygen, pH, specific conductance, temperature, and turbidity at ASL A, Priority 1.

[a]If sufficient volume is not available for collection of a full suite at standard volume, then the minimum volume is to be collected for all analytical groups. If sufficient volume is still not available for collection of the full suite, then a partial sample is to be collected in accordance with the indicated priority rating.
[b]Analytical support level. The ASL may become more conservative, if necessary to meet detection limits or data quality objectives.
[c]Radiological analyses do not have standard methods; however, the performance-based analytical specifications for these parameters are provided in the LM QAPP.
[d]EPA Contract Laboratory Program Statement of Work: Multi-Media, Multi-Concentration, most recent revision. Per the LM QAPP, where CLP is listed, SW-846 can now be used for ASL C or D.
[e]Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.
[f]Minimal head space (as close to zero as possible).
[g]Methods for Chemical Analysis of Water and Wastes.
[h]Standard Methods for the Analysis of Water and Wastewater, 17th edition.

Table 2–4. Summary of Sampling Requirements for the OSDF

Cell(s)	Monitoring Horizons[a]	Quarterly	Annually[b]
1 through 7	LCS	Table 2-3	Table 2-2
	LDS	Table 2-3	Table 2-1
	HTW	Table 2-3	NA
	GMA	Table 2–3	NA
8	LCS	Table 2–1	Table 2–2
	LDS	Table 2–1	NA
	HTW	Table 2–1	NA
	GMA (Up and Down)	Table 2–1	NA
	GMA (SE & SW)	Table 2–1	NA

Note: For Cell 8 a statistical analysis of the data for Refined Baseline Monitoring is scheduled to be conducted for the 2007 Annual Site environmental Report (ASER) due June 2008.

[a]LCS = leachate collection system
LDS = lead detection system
HTW = horizontal till will
GMA = Great Miami Aquifer
[b]NA = not applicable

Note: Confirmatory sampling for 1,1-dichloroethene is taking place in 2008 in the Cell 3 LCS. As indicated in the IEMP Mid-Year Data Summary Report for 2005 (DOE 2005a), 1,1-dichloroethene was detected in the annual Cell 3 LCS sample collected in May 2005, which triggered the confirmatory sampling. In 2006 sampling for 1,1-dichloroethene was also conducted in the Cell 3 LDS. As explained in the *2006 Annual Site Environmental Report* (ASER), confirmatory sampling at the Cell 3 LCS for 1,1-dichloroethene will continue in 2007 until the constituent is further evaluated using a site specific parameter selection approach that is presented in the 2006 ASER. Sampling for 1,1-dichloroethene in the Cell 3 LDS was discontinued in 2006. Continued sampling in the Cell 3 LCS is also documented in Appendix E, Table 4–1 of the GWLMP.

In addition, as indicated in the 2007 ASER, technetium-99 was detected in the annual Cell 1 LCS and annual Cell 7 LCS in May 2007. Confirmatory sampling for technetium-99 in the Cells 1 and 7 LCS will be initiated in the third quarter of 2008 (August) and will continue in 2008 and 2009 (November and February). (Note: The February 2009 sampling event will cover the routine annual LCS sampling event.)

2.2 Sampling at Cell 8

Sampling will be as follows:

- Annual samples will be collected from the LCS for the parameters listed in Table 2–2.
- Quarterly samples will be collected from the LCS, LDS, HTW, and GMA (upgradient, downgradient, SE, and SW) for all parameters listed in Table 2–1.

Note: Based on the understanding of preexisting levels of contaminants in the OSDF subsurface, the Fernald Preserve elected to perform up to 12 rounds of initial baseline sampling for both the perched system and the GMA for all initial site-specific leak detection monitoring parameters. At the close of 2007, at least 12 rounds of initial baseline sampling had occurred. It is anticipated that a proposal will be made, via the 2007 ASER to be issued in June 2008, for a refined baseline sampling at Cell 8.

2.3 Common Ion Monitoring

Common ion monitoring was completed in the first half of 2007. For the study, common ions were monitored from each cell's LCS, LDS, and HTW for eight sampling rounds. Constituents that were monitored included calcium, iron, magnesium, manganese, phosphorus, potassium, silicon, sodium, alkalinity, chloride, fluoride, nitrate/nitrite, and oxidation reduction potential. Future action regarding the common ion study is pending review of the final report on the study.

2.4 Additional Sampling Requirements

All horizons for a particular cell will be sampled during the same timeframe to enhance the comparability of the data. In the event insufficient volume is available for collection of the entire analytical suite, the sample sets shall be collected in accordance with the priorities listed in Tables 2–1, 2–2, and 2–3. Samples will be collected from the HTWs, GMA wells, LCS, and LDS in accordance with the *Sampling and Analysis Plan for United States Department of Energy Office of Legacy Management Sites* (LM SAP) (DOE 2006f) and the *Legacy Management CERCLA Sites Quality Assurance Project Plan* (LM QAPP) (DOE 2006e), which references the *Sitewide CERCLA Quality Assurance Project Plan* as the primary document that describes procedures and protocols for monitoring the Fernald Preserve (DOE 2003).

2.5 LCS and LDS Sample Collection

Samples from the LCS and LDS shall be collected by entering the valve houses located on the western side of each cell. Samples will be collected directly from the sample ports on the bottom of the LCS and LDS as the lines enter the eastern side of the valve house. The LCS is located on the northern side of the valve house, and the LDS is located on the southern end of the valve house. No purging of the line is required prior to sample collection. If the discharge line is dry or does not yield enough water for the entire sample suite, the sample will be collected from the LCS and LDS tanks located within the valve house. The samples from the tanks will be collected using a dedicated Teflon bailer.

2.6 HTW Sample Collection

The glacial till is monitored under each cell using horizontal wells installed during construction of each cell. Prior to sample collection, the HTWs shall be purged of three well volumes or purged to dry, whichever occurs first. Sample collection from the horizontal well shall be accomplished using a Teflon bailer in accordance with the LM SAP.

2.7 Great Miami Aquifer Sample Collection

Each cell is monitored by two GMA wells, located east and west of each individual cell. Two additional GMA wells are located on the south side of Cell 8. These wells are sampled using dedicated sampling equipment in accordance with the LM SAP.

Filtering of groundwater samples at monitoring wells may take place on a case-by-case basis if deemed appropriate. If filtering is conducted, the reasons for filtering will be presented to EPA and OEPA as soon as possible through the monthly conference call update and annually through the ASER.

3.0 Additional Sampling Program Requirements

3.1 Quality Assurance Requirements

Quality assurance requirements are consistent with those identified in the LM QAPP. Self-assessment and independent assessments of work processes and operations will be conducted to ensure quality of performance. Self-assessments will evaluate sampling procedures and/or paperwork associated with the sampling effort. Independent assessments will be performed by a quality assurance representative by conducting surveillances. Surveillances will be performed at least once per year at any time during the project and will consist of monitoring/observing ongoing project activity and work areas to verify conformance to specified requirements.

3.2 Changes to the Project-Specific Plan

Prior to the implementation of field changes, the project manager and field sampling lead shall be informed of the proposed changes. Once the field sampling lead has approved, and obtained approval from the project manager, data management lead, and quality assurance contact for, the field changes to the plan, the field changes may be implemented. Field changes to the plan shall be noted on a Variance/Field Change Notice. The Variance/Field Change Notice shall be approved by the project manager, field sampling lead, data management lead, and quality assurance contact prior to implementation of the changes.

3.3 Quality Control Samples

Quality control sample analyses are required as part of the GWLMP for the OSDF. A minimum of one set of field quality control samples is required for each sampling round. A “sampling round” refers to collection of samples from one or more locations for a specific project during a specified time period for a similar purpose. Duplicate and rinsate samples will be collected at a rate of one per sampling round or one per 20 samples, whichever is more frequent. Trip blanks will be collected one per day per team when samples are collected for volatile organic analysis. A rinsate sample will not be required for those locations with dedicated sample collection equipment. One matrix spike/matrix spike duplicate will be analyzed at a frequency of one per sampling event or one per 20 samples, whichever is more frequent. Quality control samples will be analyzed for the same analytes as the normal samples.

3.4 Equipment Decontamination

All non-dedicated sampling equipment shall be decontaminated per the LM SAP, prior to sample collection at each sample location. Sampling equipment shall also be decontaminated per the LM SAP upon completion of sampling activities, unless equipment has been dedicated to the sample location.

3.5 Disposition of Wastes

During sampling activities, waste will be generated in various forms; disposition of all waste will be in accordance with site requirements and procedures. The various forms of waste expected to be encountered during this program are contact waste, purge water, and decontamination wastewater.

Contact waste will be minimized by limiting contact with the sample media and by using disposable materials whenever possible. Contact waste shall be placed into plastic garbage bags and disposed of in a dumpster on site. If contact waste is determined to be radiologically contaminated, the assigned radiological control technician/engineer shall survey, contain, label, and disposition the waste according to radiological control requirements.

All decontamination wastewater and purge water will be containerized and disposed through the converted advanced wastewater treatment (CAWWT) facility for treatment. The point of entry into the CAWWT will either be via the CAWWT backwash basin or the OSDF permanent lift station.

3.6 Health and Safety

Health and Safety requirements are addressed in the *Fernald Project Health and Safety Plan* (DOE 2006g). Fernald Preserve–specific requirements are identified in this plan.

3.7 Data Management

Information collected as a part of this monitoring program will be managed according to the guidelines below to ensure availability of documentation for verification and reference and to ensure regulatory compliance.

Field documentation, as required by the LM SAP for this sampling program (e.g., Chain of Custody forms), will be carefully maintained in the field. To ensure appropriate documentation was completed during field activities and that documentation was completed correctly, required documentation shall be verified by Environmental Monitoring personnel. One hundred percent of the analytical data shall be validated in accordance to the ASL specified in Tables 2–1, 2–2, and 2–3. Information is stored in the Site Environmental Evaluation for Projects database, and the hard-copy original field documentation packages shall be stored in controlled file storage cabinets, and eventually a long-term archive environment. Per regulatory guidance, these records must be maintained for a minimum of 30 years.

4.0 References

Note: Tasks associated with this plan are performed under the most current revision of plans, procedures, and documents.

APHA (American Public Health Association), 1989. *Standard Methods for Analysis of Water and Wastewater*, 17th Edition.

DOE (U.S. Department of Energy), 2003. *Sitewide CERCLA Quality Assurance Project* FD-1000, Revision 3, Final, Fernald Closure Project, Cincinnati, Ohio, November.

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DOE (U.S. Department of Energy), 2006c. *Integrated Environmental Monitoring Plan*, 2505-WP-0022, Revision 4B, Final, Fluor Fernald, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2006d. Integrated Environmental Monitoring Plan, 2505-WP-0022, Revision 5A, Draft Final, Fluor Fernald, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2006e. *Legacy Management CERCLA Sites Quality Assurance Project Plan*, DOE-LM/GJ1232-2006, Revision 1, S.M. Stoller Corporation, Grand Junction, Colorado, July.

DOE (U.S. Department of Energy), 2006f. *Sampling and Analysis Plan for the U.S. Department of Energy Office of Legacy Management Site*, DOE-LM/GJ1197-2006, Revision 1, S.M. Stoller Corporation, Grand Junction, Colorado, October.

DOE (U.S. Department of Energy), 2006g. *Fernald Project Safety Plan*, DOE-LM/1324-2006, Revision 1, S.M. Stoller Corporation, Grand Junction, Colorado, September.

EPA (U.S. Environmental Protection Agency), 1983. *Methods for Chemical Analysis of Water and Wastes*, EPA600/4-79-020, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March.

EPA (U.S. Environmental Protection Agency), 1998. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, 3rd edition, Office of Solid Waste, Washington, DC, April.

EPA (U.S. Environmental Protection Agency), 2003. S*uperfund Analytical Services Contract Laboratory Program/Statement of Work: Multi-Media, Multi-Concentration Organics Analysis*, OLM04.3, March.

EPA (U.S. Environmental Protection Agency), 2004. *Superfund Analytical Services Contract Laboratory Program/Statement of Work: Multi-Media, Multi-Concentration Inorganic Analysis*, ILM05.3, March.

Appendix C

Fernald Preserve Data Quality Objectives
Monitoring Program for the On-Site Disposal Facility

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Acronyms and Abbreviations

ASL	Analytical Support Level
BNA	base neutral acid
BTX	benzene, toluene, and xylene
CEC	cation exchange capacity
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	Environmental Protection Agency
FRLs	final remediation levels
FS	feasibility study
GMA	Great Miami Aquifer
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
HTW	horizontal till well
IEMP	Integrated Environmental Monitoring Plan
L	liter
LCS	leachate collection system
LDS	leak detection system
LM QAPP	*Legacy Management CERCLA Sites Quality Assurance Project Plan*
LM SAP	*Sampling and Analysis Plan for United States Department of Energy Office of Legacy Management Sites*
OAC	Ohio Administrative Code
ORP	oxidation reduction potential
OSDF	On-Site Disposal Facility
PCBs	polychlorinated biphenyls
PSP	*Project-Specific Plan for the On-Site Disposal Facility Monitoring Program*
QC	quality control
RA	remedial action
RI	remedial investigation
RD	remedial design
RvA	removal action
SDWA	Safe Drinking Water Act
SEEPro	Site Environmental Evaluation for Projects database
SWIFT	Sandia Waste Isolation Flow and Transport
TDS	Total Dissolved Solids
TCLP	toxicity characteristic leaching procedure
TSD	treatment, storage, and disposal
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TPH	total petroleum hydrocarbons
VAM3D	Variably Saturated Analysis Model in 3 Dimensions
VOA	volatile organic analysis
WAC	Waste Acceptance Criteria

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1.0 Statement of Problem

Problem Statement: Analytical data, obtained from a multi-component monitoring system, is necessary to support the leak detection element of the on-site disposal facility (OSDF) monitoring strategy.

The construction of the OSDF for long-term storage and containment of low-level radioactive waste was completed in phases with eight individual cells. Each cell is monitored on an individual basis for leak detection and possible environmental impact.

A major concern regarding the storage of waste at the Fernald Preserve is the prevention of any additional environmental impact to the Great Miami Aquifer (GMA). To address this concern, site-specific monitoring requirements that integrate state and federal regulatory requirements were developed to provide a comprehensive program for monitoring the ongoing performance and integrity of the OSDF.

In consideration of unique hydrogeologic conditions and preexisting contamination on site, a baseline data set (Ohio Administrative Code (OAC) 3745-27-10(D)(5)(a)(ii)(a); OAC 3745-27-10(A)(2)(b) and OAC 3745-54-97(G)) will be established. In addition, an alternate sampling program (OAC 3745-2-10(D)(5)(a)(ii)(b) and (b)(ii)(b); 3745-27-10(D)(6)) will be initiated to address site-specific complexities and provide an effective monitoring program for the OSDF that meets and exceeds federal and state regulations for treatment, storage, and disposal (TSD) facilities.

The OSDF monitoring program strategy uses OSDF system design in combination with a monitoring well network to provide data for a collective assessment of OSDF performance. Each individual OSDF cell is constructed with a leachate collection system (LCS) and a leak detection system (LDS); these systems are separate and contain sample collection points within the valve house. The LCS is designed to collect infiltrating rainwater (and stormwater runoff during waste placement) and prevent it from entering the underlying environment; the leachate drainage layer drains to the west through an exit point in the liner to a leachate transmission system located on the west side of the OSDF and routed for treatment. The LDS is a drainage layer positioned beneath the primary composite liner; any collected fluids from that layer drain to the west where they are removed and routed for treatment as in the LCS. Flow monitoring measurements of the LCS and LDS will be conducted on a scheduled basis. Monitoring the flow and sampling of the LCS and LDS liquids will provide an assessment of migratory dynamics within each cell and determine primary liner performance.

The monitoring well network consists of two separate systems. A horizontal till well (HTW) is placed in the subsurface beneath the LCS and LDS liner penetration box within each cell. Each liner penetration box represents the lowest elevational area of each cell, by definition the most likely location for a potential leak to migrate. GMA monitoring wells are placed at the immediate boundaries of each cell, at upgradient and downgradient locations, to monitor the water quality of the aquifer and verify presence/absence of environmental impact. Sampling of the four components mentioned above (LCS, LDS, HTW, and GMA monitoring wells) will provide a four-layered holistic approach to provide early leak detection from the OSDF.

2.0 Identify the Decision

Analytical data provided by a monitoring program will provide the information necessary for management of the OSDF. Information derived from flow volume assessment and sample analyses will constitute the first tier of a three-tier strategy: detection, assessment, and corrective action; if it is determined from detection monitoring that a leachate leak from the OSDF has occurred, additional groundwater quality assessment studies will be initiated, and corrective action monitoring plans will be developed and implemented as necessary. If the detection monitoring continues to successfully demonstrate that the performance of the OSDF is as designed, then the monitoring program will remain in the first-tier detection mode, and a follow-up groundwater quality assessment or corrective action monitoring plans will not be necessary.

The OSDF monitoring strategy includes the establishment of baseline conditions in the hydrogeological environment beneath each individual cell prior to waste placement. Both perched groundwater and the GMA contain uranium and other Fernald Preserve–related constituents at levels above background in the vicinity of the OSDF; therefore, it is necessary to establish preexisting conditions (constituent concentration levels and variability) for applicable OSDF monitoring parameters.

3.0 Inputs that Affect the Decision

An extensive characterization of wastes, to quantify environmental contamination in the area of the Fernald Preserve, provided the information to develop the Waste Acceptance Criteria (WAC) for waste entering the OSDF. The leachability, mobility, persistence, toxicity, and stability of identified waste constituents were evaluated, and of 93 constituents, less than 20 constituents were identified as having the potential to impact the aquifer within a 1,000-year performance period. These site-specific leak detection indicator parameters chosen as monitoring parameters will be supplemented with additional water chemistry indicator parameters.

Additionally, waste TSD facilities must analyze collected leachate on an annual basis to fulfill a reporting requirement per Ohio Solid Waste regulation, OAC 3745-27-19(M)(5). OSDF monitoring has been complying by collecting a grab sample yearly and performing analysis for the parameters listed in Appendix I of OAC 3745-27-10 and polychlorinated biphenyls (PCBs). Because waste is no longer being placed in the OSDF, and an alternate sampling constituent list has been approved for the OSDF, it is envisioned that after completion of the Common Ion Study that collection of an annual grab sample for the LCS of each cell to be tested for Appendix I and PCB parameters listed in OAC 3745-27-10 will no longer be required, and this annual sampling/analysis task will stop. Annual sampling from the LCS of each cell will instead focus on site-specific parameters that have been approved for the facility. Annual sampling of the LCS of each cell for Appendix I and PCB listed parameters will not stop until concurrence has been obtained from the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA).

Although the site-specific leak detection indicator parameter list was initially created for the purpose of establishing baseline, it will probably provide sufficient and reliable data for the monitoring throughout the active operation of the OSDF; however, future considerations for potential modifications of the parameter list may occur during subsequent reevaluations of the monitoring program.

Monitoring of the liquid flow within the LCS and LDS drainage layers will be performed to provide a trend analysis that can be used as an indicator of containment system performance; changes in the trend of flow will initiate follow-up inspection and corrective action measures as necessary. A graded approach, patterned after federal hazardous waste landfill regulations title 40 *Code of Federal Regulations* (CFR) 264.303(c)(2) and Ohio solid waste rule OAC 3745-27-19(M)(4), will be used to provide a quantitative monitoring control for drainage within the OSDF.

4.0 Define the Boundaries of the Study

Subsurface conditions in the immediate area of the OSDF location are typical of glacial deposition; the subsurface formation comprises a glacial till underlain by sand and gravel deposits that are characterized as the GMA. The GMA is a high-yield aquifer and a designated sole-source aquifer under the Safe Drinking Water Act (SDWA). It supplies a significant amount of potable water for private and industrial use in Butler and Hamilton counties (Ohio); therefore, a leakage of contaminants from the OSDF could affect water quality for a large population.

Typically, a detection monitoring program consists of upgradient and downgradient monitoring well installations with routine sampling for a prescribed list of parameters. Consequently, detection of a statistically significant difference in downgradient water quality will indicate that release from a facility may have occurred. However, at the Fernald Preserve, low permeability and preexisting contamination within the overburden formation, and implementation of a site-wide groundwater remedial action (RA) for the subsurface aquifer formation, add complexity to the development of a groundwater detection monitoring program that is consistent with the standard approach in solid and hazardous waste regulations. To accommodate such complexities, federal and state regulations do allow alternative monitoring strategies, which provide flexibility with respect to well placement, statistical evaluation of data, parameter lists, and sampling frequency. The OSDF monitoring program does incorporate an appropriate alternative monitoring strategy to ensure integrity and provide effective early warning of a leak from the facility. The program includes alternate well placement, statistical analysis, parameter lists, and sampling frequencies.

An OSDF leak would migrate vertically towards the GMA beneath it; therefore, a horizontally positioned well placed within the glacial till shall have its screen interval beneath the LCS and LDS liner penetration box of each cell as a site-specific approach to monitor a first-entry leakage from the OSDF. The GMA wells are installed immediately adjacent to the OSDF, just outside the boundary of the final composite cap configuration. Each cell will be monitored with a set of GMA monitoring wells, placed upgradient and downgradient of each cell. The OSDF will be bordered by a network of GMA monitoring wells that provide upgradient and downgradient monitoring points for the entire facility.

The parameters are limited to those indicated as having a potential to migrate from the OSDF and impact the GMA. The concentration levels of concern are those required to determine fluctuations in GMA concentrations and provide a sensitivity great enough to indicate potential impacts.

Sampling frequencies for the OSDF monitoring program meet federal and state requirements. The additional data will be used to develop an appropriate statistical procedure and to compensate for the varying temporal conditions in the groundwater flow direction and chemistry due to seasonal fluctuations.

5.0 Decision Rule

The initial flow and water quality data obtained from the LCS, the LDS, and the groundwater monitoring components will be used to begin a statistical trend analysis of the volume of leachate produced by each cell and the corresponding concentrations of analytes in each individual monitoring component. Each cell will be evaluated independently; therefore, the preferred method of statistical evaluation for the OSDF will be an intra-well trend analysis following establishment of baseline conditions in the glacial till and GMA. The intra-well trend analysis approach will be applied to data from all of the components—the LCS, the LDS, and the groundwater monitoring wells. The data received from each component will be compared for evidence of consistent trend values that verify OSDF integrity status.

Note: Trend analyses will be performed/prepared annually, and it is anticipated that a statistical approach that includes a comparison to a statistically determined limit based on baseline data (such as control charts) will be the final procedure for evaluating OSDF monitoring data, in accordance with the regulatory citations discussed in Section 2.0 of the OSDF Groundwater/Leak Detection and Leachate Monitoring Plan (GWLMP). The purpose of the trend analyses currently being conducted is to assist in determining when reliable baseline statistics can be calculated. Additionally, data shall also be compared between all of the monitoring components within the multi-component monitoring system of each cell. This strategy is the four-layer vertical slice/trend analysis approach.

Data collected from the OSDF monitoring program will also be used to supplement the compilation of data for the *Integrated Environmental Monitoring Plan* (IEMP) reports. Groundwater data for those OSDF leak detection constituents that are also common to the IEMP groundwater remedy performance constituents will be used in the IEMP data interpretations as the data become available. Groundwater data collected for those unique OSDF leak detection constituents, which are not being monitored by the IEMP groundwater monitoring program will be used only for the establishment of the OSDF baseline and subsequent leak detection monitoring. To provide an integrated approach to reporting OSDF monitoring data, the annual site environmental report will serve as the mechanism by which LCS and LDS volumes and concentrations will be reported, along with groundwater monitoring results, trending results, and interpretation of the data. Presenting data in one report will facilitate a qualitative assessment of the impact of the OSDF on the aquifer, as well as the operational characteristics of OSDF caps and liners.

6.0 Limits on Uncertainty

In baseline establishment, the sensitivity and precision must be sufficient to define the GMA concentrations of the parameters of concern such that fluctuations will be observable and effects impacting the final remediation levels (FRLs) are observed. A false-positive error would indicate that either certain parameters are present when in fact they are not, or that baseline parameters are present at higher concentrations than are actually present in the GMA. This type of error would give a false indication that the cell is leaking. A false-negative error would indicate that certain parameters are not present when in fact they are. This may lead to a mistaken indication that the cell is not leaking. It is necessary to define the concentrations of the parameters of concern such that fluctuations in concentration and effects impacting the GMA will be observable.

Following baseline establishment, a false-positive result in OSDF monitoring may suggest that a leak from the OSDF has occurred when, in fact, it has not. Additional monitoring assessments would be initiated in response and added costs would be incurred unnecessarily. The greater concern would be a false-negative error, verifying that integrity of the OSDF was intact when in fact some component of the structure may have failed. No corrective action would be initiated and contaminants could migrate into the GMA undetected, possibly posing a threat to human health and the environment.

7.0 Optimize Design

An aquifer simulation model (i.e., SWIFT [Sandia Waste Isolation Flow and Transport] and, more recently, VAM3D [Variably Saturated Analysis Model in 3 Dimensions]) was used to select monitoring well locations, typically one upgradient and one downgradient of each cell. These wells are used in the detection monitoring program, as well as for baseline establishment.

Standard statistical modeling studies indicate that data from a minimum of four independent sampling events are necessary to establish baseline values; however, for an improved comparative statistical analysis, more sampling events were chosen to ensure sufficient available data for baseline establishment for each GMA monitoring well location.

To ensure consistency of method and an auditable sampling process, each sample will be collected per the following:

- *Sampling and Analysis Plan for United States Department of Energy Office of Legacy Management Sites* (LM SAP) (DOE 2006a).
- *Legacy Management CERCLA Sites Quality Assurance Project Plan* (LM QAPP) (DOE 2006b).
- *Project-Specific Plan for the On-Site Disposal Facility Monitoring Program* (PSP) (Appendix B of the OSDF GWLMP).

Laboratory quality control (QC) requirements will be as specified in the LM QAPP and PSP. One hundred percent of the data will undergo field and laboratory validation.

All chemical sample analyses will be performed at Analytical Support Level (ASL) C, except general water chemistry analyses, which will always be ASL B, and field water quality analyses, which will always be performed at ASL A. Radiological constituents will be analyzed at ASL D, unless ASL E is required to meet detection limits.

All samples require field QC and will include trip blanks as specified in the LM QAPP. Duplicates will be collected for each sampling round (a "sampling round" is defined as one round of sample collection from various locations occurring within a short period of time [i.e., several days]). Equipment rinsates will be performed when dedicated equipment is not available. One laboratory QC sample set shall be collected per each release of samples.

Laboratory QC will include a method blank and a matrix spike for each analysis, as well as all other QC required per the method and LM QAPP.

If a well does not recharge sufficiently to collect specified volumes for all analytes or the LCS/LDS systems do not contain sufficient volume for a full suite of samples, parameters will be collected in the order of priority stated in the PSP. Sampling parameter requirements and frequencies are defined in the PSP and meet applicable federal and state requirements.

8.0 Data Quality Objectives

Baseline Establishment for GMA Groundwater Monitoring of the OSDF

1a. Task/Description. Baseline Establishment for GMA Groundwater Monitoring of the OSDF. This sampling program will determine a baseline characterization of the GMA in the immediate vicinity of the OSDF.

1b. Project Phase. Put an *X* in the appropriate box:

RI ☐ FS ☐ RD ☒ RA ☐ R_VA ☐ Other ☐ Specify:____________________

1c. DQO No.: GW-024____ DQO Reference No.: not applicable

---

2. Media Characterization. Put an *X* in the appropriate box:

Air ☐ Biological ☐ Groundwater ☒ Sediment ☐ Soil ☐

Waste ☐ Wastewater ☐ Surface water ☐ Other ☐ Specify: Leachate______________

---

3. Data Use with ASLs A−E. Put an *X* in the appropriate ASL boxes beside each applicable data use:

Site Characterization
A ☒ B ☒ C ☒ D ☒ E☒

Risk Assessment
A ☐ B ☐ C ☐ D ☐ E☐

Evaluation of Alternatives
A ☐ B ☐ C ☐ D ☐ E☐

Engineering Design
A ☐ B ☐ C ☐ D ☐ E☐

Monitoring during remediation activities
A ☒ B ☒ C ☒ D ☒ E☒

Other (specify):______________________
A ☐ B ☐ C ☐ D ☐ E☐

4a. Drivers. OSDF GWLMP, the OAC for the containment of solid and hazardous waste, and the CFR TSD Facility Standards.

4b. Objective. To provide information by which verification of the ongoing performance and integrity of the OSDF and its impact on groundwater can be evaluated.

5. Site Information (description). The OSDF will consist of eight individual cells, and each cell will be monitored on an individual basis. The monitoring system developed to detect any potential leaks originating from the cells consists of four components: an LDS, an LCS, a till monitoring system, and a Great Miami Aquifer monitoring system. This DQO addresses baseline characterization, facility, and groundwater detection monitoring for the OSDF.

6a. Data Types with Appropriate ASL. Put an *X* to the right of the appropriate boxes for required analyses:

A. pH	☒	B. Uranium	☐	C. BTX	☐
Temperature	☒	Full Radiologic	☒*	TPH	☐
Specific Conductance	☒	Metals	☒*	Oil/Grease	☐
Dissolved Oxygen	☒	Cyanide	☐		
Turbidity	☒	Silica	☐		

D. Cations	☐	E. VOA	☒*	F. Other (specify): Total Alkalinity, Ammonia, Chloride, TDS, Sulfate, Nitrate/Nitrite, Fluoride, ORP
Anions	☐	BNA	☒*	
TOC	☒	Pesticides	☒*	
TCLP	☐	PCB	☒	
CEC	☐	TOX	☒	
COD	☐			

*See specific parameters listed in PSP.

7a. Sampling Methods. Put an *X* in the appropriate box:

Biased ☐ Composite ☐ Environmental ☐ Grab ☒ Grid ☐

Intrusive ☐ Non-Intrusive ☐ Phased ☐ Source ☐

Other (specify): ____________ DQO Number: DQO #GW-024

7b. Sample Work Plan Reference. List the samples required, and reference the work plan or sampling plan guiding the sampling activity, as appropriate. Baseline/background samples and routine monitoring samples: PSP for on-site disposal monitoring program.

7c. Sample Collection Reference. Provide a specific reference to the SCQ section and subsection guiding sampling collection procedures. A PSP will detail sampling methodology; unless otherwise indicated in the PSP, sampling will follow requirement guidelines outlined in the LM QAPP and LM SAP.

Sample Collection Reference: LM QAPP and LM SAP.

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8. Quality Control Samples. Put an *X* in the appropriate box:

Field Quality Control Samples

Trip Blanks	☒	Container Blanks	☐
Field Blanks	☐	Duplicate Samples	☒
Equipment Rinsate Samples	☒	Split Samples	☐
Preservative Blanks	☐	Performance Evaluation Samples	☐

Other (specify): none required

Laboratory Quality Control Samples

Method Blank	☒	Matrix Duplicate/Replicate	☒
Matrix Spike	☒	Surrogate Spikes	☒

Other (specify) none required

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9. Other. Provide any other germane information that may impact the data quality or gathering of this particular objective, task, or data use.

9.0 References

DOE (U.S. Department of Energy), 2006a. *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Site*, DOE-LM/GJ1197-2006, Revision 0, S.M. Stoller Corporation, Grand Junction, Colorado, May.

DOE (U.S. Department of Energy), 2006b. *Legacy Management CERCLA Sites Quality Assurance Project Plan*, DOE-LM/GJ1189-2006, S.M. Stoller Corporation, Grand Junction, Colorado, June.

Appendix D

Leachate Management System for the On-Site Disposal Facility

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Acronyms and Abbreviations

CAWWT	converted advanced wastewater treatment
CFR	*Code of Federal Regulations*
cm	centimeter
DOE	U.S. Department of Energy
EPLTS	enhanced permanent leachate transmission system
ft	foot/feet
HDPE	high-density polyethylene
LCS	leachate collection system
LDS	leak detection system
LTS	leachate transmission system
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
PLS	permanent lift station
PS	pipe segment
RLCS	redundant leachate collection system

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1.0 Overview

The double liner system of each on-site disposal facility (OSDF) cell contains a leachate collection system (LCS) and a leak detection system (LDS). These systems are designed to convey any leachate/fluid that enters the system through pipes (i.e., the LCS pipes and LDS pipes) to valve houses located outside each cell. After closure of the OSDF, fluids that enter the LCS have infiltrated through the emplaced impacted material. Fluid that collects in the LCS and LDS collection tanks located in the valve house for each cell will be pumped to the enhanced permanent leachate transmission system (EPLTS). The EPLTS conveys leachate from each of the valve houses, via gravity flow, to a permanent lift station (PLS). The location of the LCS, LDS, and EPLTS pipes and gravity lines are shown in the as-built construction drawings.

The *Systems Plan, On-site Disposal Facility* (DOE 2000), *Collection and Management of Leachate for the On-site Disposal Facility* procedure (DOE 2001a), and *Enhanced Permanent Leachate Transmission System Operation* procedure (DOE 2007) provide specifics on activities during post-closure. Note that operational procedures are included in the *Legacy Management Fernald Operating Procedures* (DOE 2006). Equipment will be maintained, operated, and serviced per manufacturer instructions and the *Enhanced Permanent Leachate Transmission System Operation* procedure (DOE 2007).

2.0 Basic System Operation

What follows is a description of the basic operation of the OSDF leachate management system.

- The LCS and LDS pipes from the liner system to the valve houses for each cell consist of double-wall, high-density polyethylene (HDPE) pipes (i.e., inner carrier pipes and outer containment pipes). Each pipe drains by gravity from below the OSDF cell and terminates in a valve house for each cell.
- The LDS line in each valve house allows for direct discharge of flow from the LDS carrier pipe into a collection tank located inside the valve house. The lined valve house foundation wall serves as a secondary containment structure for the collection tank. The valve house has provisions to monitor liquid in the collection tank. The tank is equipped with a level-sensing element and a pump to discharge the contents of the tank. The level instrument is used to track the tank level so that pump-outs can be scheduled and the volume yield can be tracked. The discharge pipe from the tank pump is connected to the EPLTS gravity line. The LDS containment pipe has a monitoring port and a fixed end seal within the valve house to verify the absence of fluid in the annular space between the carrier pipe and containment pipe.
- Each LDS line has a cleanout within the valve house for maintaining the LDS carrier pipe.
- The LCS allows direct discharge of flow from the LCS carrier pipe into the EPLTS gravity line that passes through each valve house. The LCS line can also be directed to a tank in the valve house so that flow can be quantified once it has dropped to a point below the flow meter's ability to quantify flow. LCS flow has diminished to the point that flow from all 8 cells is currently directed through the collection tanks in each valve house. The leachate collected in the tanks is pumped to the EPLTS line as necessary to prevent overflow of the tanks. The LCS carrier pipe in each valve house also has a sampling port for obtaining leachate samples. Each valve house has an inlet for a redundant LCS (RLCS)

carrier pipe. The redundant carrier pipe has a valve (secured in a closed position) and a monitoring port (for periodically confirming the absence of leachate in the pipe). The redundant carrier pipe valve is configured so that it can be opened to allow flow to the EPLTS gravity line in the event of a failure due to clogging of the primary LCS carrier pipe. Both the primary and RLCS containment pipes have monitoring ports and fixed end seals within the LCS to verify the absence of leachate in the annular space between the carrier pipe and the containment pipe.

- Each valve house is equipped with liquid level alarms, consisting of a submersible liquid level sensor (located in a small sump in the corner of each valve house) and alarm light. Alarm signals are transmitted to the permanent lift station and a general alarm is subsequently sent to the CAWWT control room. The liquid level sensor is calibrated so that the alarm is activated when the fluid level in the valve house sump reaches approximately 11 inches.
- The EPLTS gravity line consists of a double-wall HDPE pipe with a 6-inch-diameter (15.2-centimeter [cm]) inner carrier pipe, and a 10-inch-diameter (25-cm) outer containment pipe.
- The EPLTS gravity line is equipped with a vent at its northern end. The purpose of the vent is to prevent pressure buildup in the systems. The EPLTS gravity line has cleanouts in each valve house that provide access to the EPLTS line in both directions for maintenance.
- The PLS has secondary containment designed so that it can be monitored for the presence of leakage.
- The PLS was designed to be capable of storing the anticipated quantity of leachate generated during a 1-week period using design assumptions simulating final closure of the OSDF.
- Prior to the discharge of fluid into the PLS, the fluid passes through a motor-operated inflow valve located in the control valve house just upstream of the PLS. This valve closes automatically in the event of a power failure, or if fluid levels in the lift station rise above the high-level alarm set point (or any level that would cause an electrical short or damage to equipment in the lift station). In the event of a power failure or high-level alarm, the motor-operated valve for the leachate transmission system (LTS) will close automatically. The lift station also has a means for manually closing the motor-operated inflow valve. Therefore, this valve can be closed if needed until appropriate maintenance activities can be implemented.
- The PLS is equipped with a pumping system to transfer liquids in the lift station to the converted advanced wastewater treatment (CAWWT) facility for treatment.

2.1 LDS and LCS

The LDS and LCS of each OSDF cell shall be operated in conformance with the requirements of this section and the Enhanced Permanent Leachate Transmission System Operation procedure.

The valve on the RLCS carrier pipe shall be maintained closed at all times, unless overridden by conditions dictated by Section 1.3.

In order to allow discharge to the EPLTS gravity line, the valve on the LCS carrier pipe shall be maintained open at all times during the post-closure period of the OSDF, except for those periods when the valve needs to be closed for system maintenance and repair, or in the event of an operational emergency.

The LCS valve houses are designed as a closed system; leachate should not accumulate in these valve houses. If the alarms are activated, personnel shall respond to assess the problem and to take appropriate corrective actions. If the alarm occurs during day shift operations (6 a.m. to 4:30 p.m.) the response will be within 1 hour. If the alarm occurs during the night when operations personnel are not on site, the response will occur the next morning at the start of the day shift.

3.0 Inspection and Maintenance Activities

The Enhanced Permanent Leachate Transmission System Operation procedure provides the current details associated with inspection and maintenance activities for the leachate management system. The following subsection and Table 3–1 provide guidelines for the activities to continue during post-closure.

3.1 LCS and LDS

The LCS and LDS shall be inspected and maintained according to the schedule and activity requirements outlined in Table 3–1, or until leachate is no longer generated and an alternative activity schedule has been approved.

According to appropriate regulations—Ohio Administrative Code ([OAC] 3745-27-19[k][3])—the routine inspection of the pipe network shall be annual until final closure to ensure clogging has not occurred. Clogging could occur from deposition of sediments or from biological growth inside the pipe. Since the facility closed in 2006, the annual inspection requirement is no longer applicable; however, DOE will inspect the pipe network in 2010 and report the findings of this inspection in the site 5-year CERCLA review. This pipe network shall be inspected between the valve house and the first 100 feet (ft) of the subdrain pipe inside the cell (at minimum). The portion of the pipe beyond this point inside the cell is considered redundant because gradation for the LCS granular drainage material is designed to limit the level of leachate on the geomembrane liner to less than 1 ft (0.3 meters) without need for a subdrain pipe.

Access to the network pipes for inspection shall be through cleanouts located in each cell's valve house. Inspections shall be performed using a video camera, or any other appropriate inspection equipment. The inspection equipment shall have the ability to monitor its location (e.g., distance counter), be sized to fit within the LCS and LDS inner carrier pipes indicated on construction drawings, and be capable of being pushed the length to be inspected.

If an inspection indicates that a pipe in the pipe network is obstructed, the pipe shall be flushed by pumping water from a water truck through a hose inserted in the pipe cleanout. If flushing does not remove the obstruction, other methods shall be used to clean the pipe. These other methods may include blowing the obstruction out with air; vacuuming; jet rodding; or inserting a

Table 3–1. Post-closure OSDF Leachate Management System Inspection and Maintenance Activities

Component	Inspection Frequency	Conditions to Check	Remedy (and/or Actions)
Routine inspection and maintenance of LDS	Various	• Check general condition of valve house for each cell annually. • Inspect the primary containment vessel for leakage quarterly. • Check for fluid in LDS containment pipe monthly.	• Check level transmitter operations (e.g., operating temperature range, accuracy), electrical connections, and alarm light. • Check for source of leak; if source identified, then take appropriate corrective measures (e.g., spot-seal vessel, replace vessel, etc.). • Keep monitoring port drained; if above the action level in the *Leachate Management Contingency Plan* (DOE 2001b), perform video inspection of pipe and attempt to identify source of leakage; develop plan to mitigate effects.
Routine inspection and maintenance of LCS	Various	• Check general condition of valve house for each cell annually. • Check condition of shutoff valve quarterly. • Check for leachate in LCS containment pipe monthly. • Check for leachate in RLCS carrier pipe annually.	• Check level transmitter operations (e.g., operating temperature range, accuracy), electrical connections, strobe light, and radio transmission. • Check valve operability; correct any deficiencies. • Keep monitoring port drained; if above the action level specified in the *Leachate Management Contingency Plan* (DOE 2001b), perform video inspection of pipe and attempt to identify source of leakage; develop plan to mitigate effects. • Drain pipe into EPLTS gravity line.
Routine inspection and maintenance of pipe networks	Once every 5 years if needed. Note: Monitoring is anticipated to remain in effect until it is demonstrated that leachate no longer poses a threat to human health or the environment. Temporary suspension of leachate requirements may also be considered.	Video inspect for: • Cracking/crushing of pipe • Clogging of pipe	• Flush clogged pipe with water or mechanically clean. • Insert small diameter pipe in crushed pipe, if possible. • Replace cracked/crushed pipe if cracked/crushed portion is outside of the cell. • Use RLCS.

Table 3–1 (continued). OSDF Leachate Management System Inspection and Maintenance Activities—Post-Closure

Component	Inspection Frequency	Conditions to Check	Remedy (and/or Actions)
OSDF Cell Valve Houses	Annually	• Confirm all required signage is visible. • Check general structural condition of valve house components. • Check for odors, bacterial growth (containment vessel).	• Repair and/or replace as necessary. • Check for structural integrity; if problems are found, take appropriate measures (e.g., spot seal vessel, replace vessel) and implement permanent solution. • Flush and/or spray sodium hypochlorite into containment vessel.
EPLTS Gravity Line	Various	• Check for fluid in EPLTS gravity line containment pipe monthly. • Inspect pipe for clogging or crushing once every 5 years if needed.	• Keep containment pipe drained; if above the action level specified in the *Leachate Management Contingency Plan* (DOE 2001b), perform video inspection of pipe and attempt to identify source of leakage; if leakage is minor, continue to operate; if leakage is significant, evaluate repair options. • Flush clogged pipe with water, or mechanically clean; repair as necessary.

snake, fish tape, or other suitable device. If air or water pressure is used, the working pressure inside the pipe shall not exceed the rated pressure for the pipe.

The specific pipe maintenance procedures (other than flushing) to be used to remove a pipe obstruction will be selected by the U.S. Department of Energy (DOE) on a case-by-case basis. In the event that LCS or LDS pipe obstruction cannot be dislodged, or in the very unlikely event that a pipe has undergone partial or total cracking, the following procedures will be considered:

- For the LCS, activate the RLCS pipe.
- For the LCS or LDS, insert a new small diameter pipe within the obstructed/collapsed pipe or replace the broken piece, as necessary.
- For the LCS or LDS pipe, if the obstruction or collapse is outside of the disposal facility containment systems, replace the pipe.
- All equipment inserted into the LCS or LDS line for inspection and/or maintenance shall be decontaminated prior to its removal from the OSDF.

In addition to the aforementioned requirements, all mechanical and electrical equipment shall be calibrated, operated, maintained, and serviced according to the manufacturer’s instructions and site procedures.

3.2 EPLTS Inspection and Maintenance Activities

The EPLTS shall be inspected and maintained in accordance with the schedule and activity requirements outlined in Table 3–1, or until leachate is no longer generated and an alternative activity schedule has been approved.

The LTS, valves, connections, sampling ports, monitoring ports, pumps, and the like shall be routinely inspected and maintained to provide for proper OSDF operation. All mechanical and electrical equipment shall be calibrated, operated, maintained, and serviced according to the manufacturer’s instructions and site procedures.

In addition, the inspection and maintenance activities for the EPLTS shall include the following:

- Confirm that appropriate warning signs are visible (e.g., for confined spaced).
- Check instruments and valves (e.g., note sticking or jammed devices, corrosion, leaks, and misalignments).
- Note any temperature extremes that may exist inside the valve houses.
- Verify instrument systems status (e.g., elevation and location of automatic level switch in the lift station).
- Monitor flow for pulsating, over pressure, or under pressure.
- Check for the presence of fluids in all secondary containment system.
- Confirm pump operation/priming.
- Check hoses for physical wear and poor connections prior to each use.

4.0 Leachate Management

Treatment of fluids collected from the LCS and LDS will be through the CAWWT as long as it is operating. Long-term treatment of the fluids collected from the LCS and LDS will be evaluated prior to discontinuation of operations of the CAWWT. In accordance with Ohio solid waste rule OAC 3745-27-19(K)(5), some of those alternatives are expected to consist of the following:

- On-site pretreatment of collected fluids with off-site disposal.
- Off-site treatment and disposal of collected fluids.
- Various options that may exist for the off-site portion of either of these alternatives.

It is anticipated that off-site treatment and/or disposal would likely require collection of leachate in the sump or another accumulation tank while awaiting periodic removal. Any modification involving such accumulation in a tank would need to estimate the quantity of leachate per time period, in order to specify the frequency of removal and how it will be disposed of or treated.

The processes presented above are anticipated to remain in effect until leachate is no longer detected (refer to federal hazardous waste regulation 40 *Code of Federal Regulations* [CFR] 264.310[b][2]), or until it is demonstrated that leachate no longer poses a threat to human health or the environment. If leachate volumes decrease below anticipated levels and the leachate toxicity decreases, the DOE may choose to petition the director of the Ohio Environmental Protection Agency (OEPA) to modify or temporarily suspend some of the leachate management requirements. OAC 3745-66-18(G) gives the director of OEPA authority to extend or reduce the post-closure care period based on cause. Eventually the leachate management system will be placed into its final, long-term configuration with the valve houses and contents being removed and replaced with straight lengths of pipes connecting the LDS and LCS to the EPLTS line. The decision regarding when the long-term configuration can be implemented will be made in conjunction with EPA and OEPA. This decision will be based on criteria developed in conjunction with EPA and OEPA. The criteria will include factors such as asymptotic leachate flows, a past history of no problems with plugging of the LCS or LDS lines, no recent activity to repair or revegetate the cap and the absence of similar conditions which argue for maintaining the ability to inspect and repair the LCS and LDS lines.

Information associated with leachate monitoring will be reported through the annual site environmental reports as identified in the front sections of Attachment C (OSDF Groundwater/Leak Detection and Leachate Monitoring Plan).

5.0 Leachate Contingency Plan

By the summer of 2006, the flows from the OSDF LCS and LDS systems had decreased significantly due to the filling and capping of cells. The previous *Leachate Management Contingency Plan for the On-Site Disposal Facility* (DOE 2001b) was written in January 2001 for failure of the LDS, LCS, or EPLTS lines. The plan contained detailed operating modes for each line failure, including failure of the line downstream of the PLS that required using a tanker to transport water from the PLS to the treatment system. A review of the plan indicated that most of the actions detailed in the plan are no longer applicable. For a failure of the EPLTS or the line downstream of the PLS, the preferred option is to close the valves from the LDS and LCS for each cell, allow the water to accumulate in the cells and repair the line as necessary.

To determine if this option was feasible, calculations were performed for each cell to determine how much water could be allowed to accumulate in each cell without exceeding 1 ft of head on the primary liner (DOE 1997). Information from Geosyntec indicated that the 1-ft level would be reached in each cell when 8,623 gallons had accumulated (GeoSyntec 2006). Daily flow from the cells was compared to that volume to determine the number of days required for each cell to accumulate 8,623 gallons. Table 5–1 shows the data used to determine the number of days. The table has been updated to reflect LCS flow data as of September 2007.

Table 5–1. Determination of the Number of Days Required to Reach the 1-ft Level (8,623 Gallons)

Tank	Dates	Water Vol. (gallons)	Change in Time (days)	Gallons per Day	Gallons per Acre per Day	# Days to Accumulate 8,623 Gallons
LCS 1	9/12–9/19	411	7.00	58.7	9.17	146
LCS 2	9/13–9/15	157.45	1.96	80.4	12.56	107
LCS 3	9/13–9/15	136.84	1.92	71.4	11.16	120
LCS 4	9/13–9/15	216.04	1.96	110.3	17.24	78
LCS 5	9/14–9/16	224.04	1.92	116.9	18.26	73
LCS 6	9/14–9/16	159.41	1.96	81.4	12.72	105
LCS 7	9/14–9/17	192.77	3.00	64.3	10.04	134
LCS 8	9/13–9/15	208.82	1.92	108.9	11.71	79

Since the minimum number of days required to reach the accumulation limit is 73 days and the number of days will increase as the flow from the individual cells decrease, it was determined that transporting leachate water by tanker to the treatment system in the event of a line failure will not be necessary. If any of the lines in the leachate system fail, the valves from the affected cell's LDS and LCS will be closed, and water will be allowed to accumulate in the cells while repairs are performed. The new contingency leachate plan for the EPLTS or the line downstream of the PLS is to develop a repair plan and repair the line(s) before any of the affected cells accumulate 8,623 gallons. If repairs are anticipated to take longer than the time it would take to accumulate 1 ft of head on the primary liner, leachate would be transferred to the CAWWT via a rental tanker truck or other portable tank.

Monitoring of the LDS, LCS, RLCS, and LTS containment pipes will continue as specified in Table 3–1. Refer to Figure 5–1 for a schematic of the Leachate Management System. The actions levels listed in Table 5–2 were derived from the *Leachate Management Contingency Plan for the On-Site Disposal Facility* (DOE 2001b) and apply on a weekly basis. As the period between monitoring events is extended, the weekly action levels will be multiplied by the number of weeks between monitoring events to yield the applicable periodic action levels.

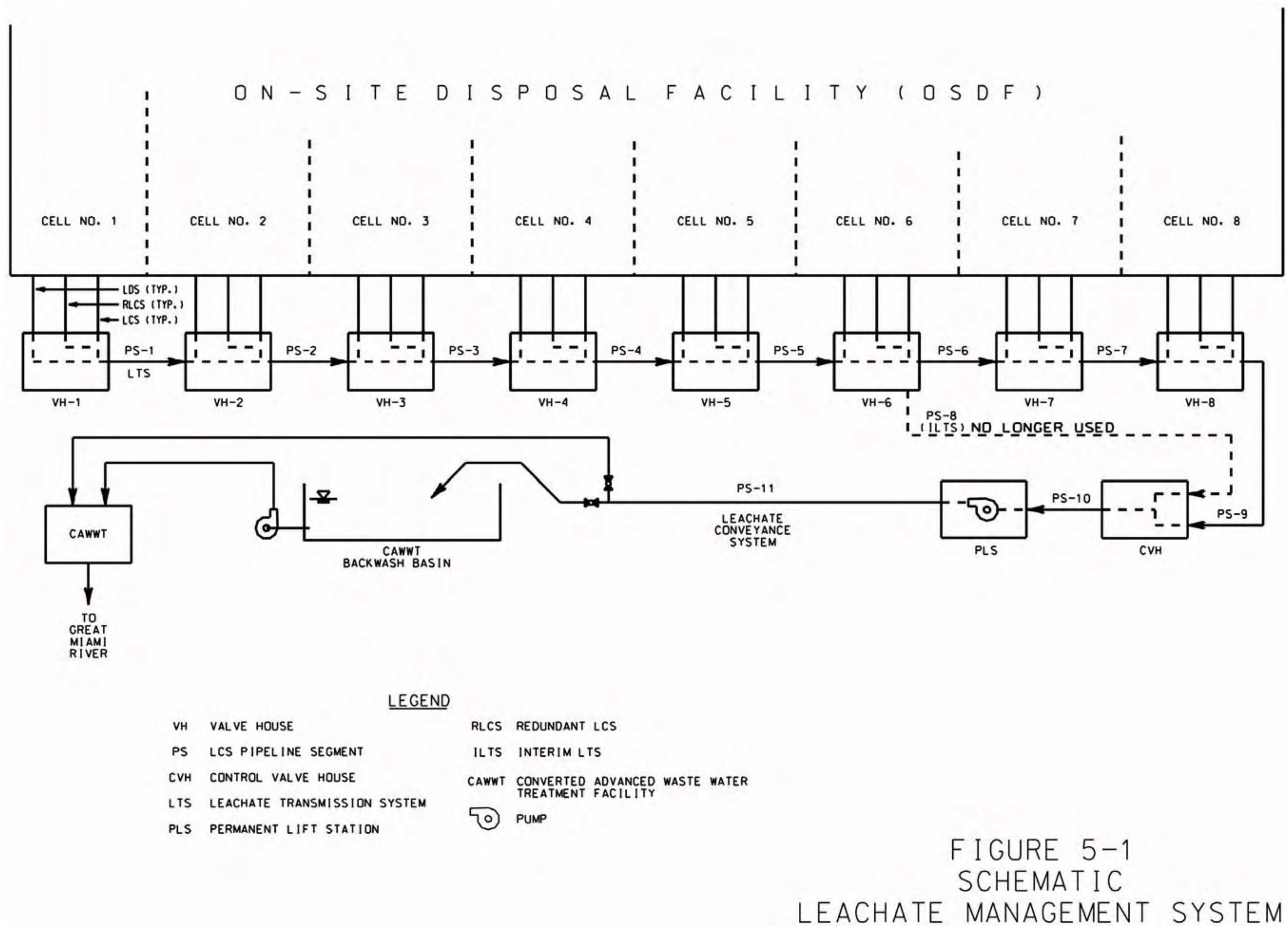

Figure 5–1. Leachate Management System

Table 5–2. Action Levels for Containment Pipe Monitoring

	LDS	LCS	RLCS	LTS in Each Valve House (PS-1 through 7)	LTS at Port V1007 (PS-9)	LTS at Port V1006 (PS-10)	LTS at Port V1008 (PS-8)
Weekly Maximum (milliliters)	2,270	2,650	2,650	5,300	18,900	370	No Maximum

If the water collected from any monitoring port exceeds the action level for the period, the port will be checked again in 1 week. If the amount of water collected again exceeds the action level, an investigation of the pipe segment (PS) in question will be performed and corrective actions taken as needed. Note that PS-8 on Figure 5–1 is no longer monitored because the interim LTS is no longer used as a contingency pipeline.

6.0 References

40 CFR 264.302. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities—Action Leakage Rate," *Code of Federal Regulations*, 57 FR, January 29, 1992, as amended at 71 FR 40273, July 14, 2006.

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Appendix E

Selection Process for Site-Specific Leak Detection Indicator Parameters

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Acronyms and Abbreviations

ASER	Annual Site Environmental Report
COCs	constituents of concern
COD	chemical oxygen demand
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FRL	final remediation level
FS	feasibility study
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
LCS	leachate collection system
LDS	leak detection system
mg/kg	milligrams per kilogram
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
OU	Operable Unit
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
TDS	total dissolved solids
TOC	Total Organic Carbon
TOX	Total Organic Halogens
WAC	waste acceptance criteria

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1.0 Introduction

A successful leak detection monitoring program must focus on the best indicators of potential releases, as opposed to analyzing for every possible constituent that may be present in a disposal facility (which would not be manageable and would add unnecessary complexity to the data analysis process). This section presents the criteria and process used to identify the site-specific indicator parameters for the on-site disposal facility (OSDF) groundwater leak detection monitoring program.

2.0 Guidelines for Site-Specific Monitoring Parameter Selection

At the Fernald Preserve, residual contamination in soil may move through the glacial till and impact the aquifer at concentrations below the groundwater final remediation levels (FRLs) but statistically elevated above current background conditions. It is important to recognize that all of the inorganic constituents and all but nine organic constituents included in the regulatory default monitoring parameters list (i.e., Appendix I of Ohio Administrative Code [OAC] 3745-27-10) have been detected in perched groundwater samples collected at various locations under the Fernald Preserve. Such preexisting contamination in the environment beneath the site, along with aquifer remediation activities, add complexity to the development of a successful leak detection parameter list capable of indicating the presence of a leak from the OSDF. Therefore, a tailored leak detection parameter list has been developed that provides adequate leak detection and is in compliance with the standard requirements of the Ohio Solid Waste Rules and the Ohio Hazardous Waste Rules. As discussed in Section 3.0 of the Groundwater/Leak Detection and Leachate Monitoring Plan (GWLMP), both sets of rules allow the use of an alternate monitoring parameter list based on site-specific conditions.

Ohio Solid Waste regulations OAC 3745-27-10(D)(2) and (3) allow six considerations in proposing an alternate monitoring parameter list in lieu of some or all of the parameters listed in Appendix I of OAC 3745-27-10. Also, the Ohio Hazardous Waste regulations for new facilities, OAC 3745-54-98(A), recognize four considerations in formulating the facility-specific monitoring parameter list. Table 2–1 summarizes the important considerations and approval criteria related to monitoring parameter selection under the Ohio Solid Waste and Ohio Hazardous Waste regulations.

It is important to point out that the chemical constituents listed in Appendix I of OAC 3745-27-10 are typical contaminants found in sanitary landfills. Appendix I does not include any radionuclides, which are the primary constituents of concern (COCs) at the Fernald Preserve. Therefore, any site-specific constituents that are not included in Appendix I of OAC 3745-27-10, but that are good indicators of potential leaks from the OSDF, also need to be evaluated in the parameter selection process. However, the general considerations summarized in Table 2–1 can apply to any constituent when selecting the leak detection indicator parameters.

Table 2–1. Regulatory Criteria for Alternate Parameter List

Ohio Solid Waste Regulation	Ohio Hazardous Waste Regulation
Requirements:	
• For all parameters, the removed parameters are not reasonably expected to be in or derived from the waste contained or deposited in the landfill facility; and • [OAC 3745-27-10 (D)(2)]	-
• For inorganic parameters, the approved alternative monitoring parameter list will provide a reliable indication of inorganic releases from the landfill facility to the groundwater. • [OAC 3745-27-10 (D)(3)]	Indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. [OAC 3745-54-98 (A)]
Considerations:	
• Types, quantities, and concentrations of constituents to be managed at the facility; • [OAC 3745-27-10 (D)(2)(b) and (D)(3)(a)]	Types, quantities, and concentrations of constituents to be managed at the regulated unit; [OAC 3745-54-98 (A)(1)]
• Mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the facility; • [OAC 3745-27-10 (D)(3)(b)]	Mobility, stability, and persistence of the waste constituents or their reaction products in the unsaturated zone beneath the waste management area; [OAC 3745-54-98 (A)(2)]
• Concentrations in the leachate from the relevant unit(s) of the facility; • [OAC 3745-27-10 (D)(2)(c)]	-
• Detectability of the parameters, waste constituents, and their reaction products in the groundwater; • [OAC 3745-27-10 (D)(3)(c)]	Detectability of the indicator parameters, waste constituents, and their reaction products in the groundwater; and [OAC 3745-54-98 (A)(3)]
• Concentrations or values and coefficients of variation of monitoring parameters or constituents in the background [baseline] groundwater quality, and • [OAC 3745-27-10 (D)(3)(d)]	Concentrations or values and coefficients of variation of monitoring parameters or constituents in the background [baseline] groundwater quality. [OAC 3745-54-98 (A)(4)]
• Any other relevant information. • [OAC 3745-27-10 (D)(2)(d)]	-

Parameter selection focuses on establishing baseline conditions for the individual cells of the OSDF. Parameters selected for the baseline sampling and analysis approach of the OSDF groundwater monitoring program were selected using site-specific contamination data generated during the previous remedial investigation/feasibility study (RI/FS) processes in accordance with the regulatory considerations presented above.

The remainder of this section presents the site-specific monitoring parameters. These lists correspond to an alternate monitoring program parameters list as defined in the regulations. It is thought that these indicator parameters will provide sufficient and reliable indication of potential releases throughout the operation of the OSDF. However, future considerations for potential modifications of the parameter list are discussed in Section 4.0 of this appendix.

3.0 Initial Leak Detection Monitoring Parameter List

An alternate leak detection monitoring parameters list should include both primary (i.e., chemical-specific) parameters and supplemental indicator parameters. As suggested by the regulatory considerations summarized in Table 2–1, primary parameters should consist of selected site-specific chemical constituents that are expected to be of significant amounts in the monitored facility, and that are persistent, mobile, and differentiable from existing background conditions when released. The supplemental indicator parameters may include general groundwater quality parameters, which will have rapid and detectable changes in response to variations in chemical compositions in groundwater under the monitored facility, potentially as a result of a leak.

Fourteen primary parameters and four supplemental indicator parameters are proposed for the initial groundwater leak detection monitoring for the OSDF (i.e., initial baseline monitoring). Samples collected in the perched groundwater and Great Miami Aquifer monitoring wells for the initial baseline analyses, as well as samples collected in all four monitoring components during and after waste placement, will be analyzed for these 18 parameters. Following is the rationale for the selection of the primary and supplemental indicator parameters.

3.1 Primary Parameters

In general, organic constituents are more mobile but less persistent than most inorganic constituents and radionuclides. Because inorganic constituents and most radionuclides are present in natural soil, if the OSDF were constructed in a pristine site, organic constituents may be the preferred primary monitoring parameters for early leak detection purposes. However, because all three types of constituents have been detected in the media (i.e., perched groundwater and the Great Miami Aquifer), and in order to be differentiable from background conditions in case of a release, a good leak detection monitoring parameter must also be present in significant abundance or at relatively high source strengths in the OSDF.

Constituent-specific quantity, persistence, and mobility data were considered during the development of the waste acceptance criteria (WAC) for the OSDF. Therefore, information from the OSDF WAC development process was first reviewed to select the primary parameters for leak detection monitoring purposes. The WAC for the OSDF were developed for 42 constituents during the Operable Unit 5 (OU5) feasibility study (FS); 41 of the WAC are included in the final OU5 record of decision (ROD). (As discussed later, one compound—magnesium—was eliminated following completion of the FS.) As discussed in this section, 18 of the 41 WAC are numerical limits and 23 are non-numerical limits that were established to satisfy regulatory screening criteria for constituents regulated under the Resource Conservation and Recovery Act (RCRA).

The maximum acceptable leachate concentrations for constituents that will be present in the OSDF were determined by fate and transport modeling. The constituent-specific leaching potential, solubility, mobility, and benefits of the engineering controls in the OSDF were considered in the modeling process. These maximum acceptable leachate concentrations were converted into solid-phase WAC at the end of the process. These solid-phase WAC represent the maximum concentrations for soil and debris that can be disposed of in the OSDF.

To assist in selecting the primary parameters, the actual soil concentrations for each of the 18 COCs for which numerical WAC were developed were also reviewed in order to provide a clear perspective regarding which COCs may approach their corresponding WAC concentrations and, therefore, are more likely to be detectable when released from the OSDF.

During the OU5 FS, two categories of COCs were evaluated in the WAC development process. The first category includes all site-specific groundwater pathway COCs that were identified in the OU5 Remedial Investigation (RI). As a result of the process, 12 numerical WAC were developed for the groundwater pathway COCs. The second category includes those Fernald Preserve constituents that need to be managed and accounted for under RCRA regulations. Six additional numerical WAC were developed for the RCRA-regulated constituents, bringing the total numerical WAC for the OSDF to 18. The following subsections summarize the WAC development process for these two categories of constituents, as derived from the site-wide WAC development process described in the OU5 FS. Figure 3–1 summarizes the process in a flowchart.

3.1.1 Groundwater Pathway COCs

Initially, only the WAC for groundwater pathway COCs were developed. WAC were determined necessary for 15 groundwater pathway COCs selected from Table F.2–2 of Appendix F of the OU5 FS. Among all the detected soil and groundwater constituents at the Fernald Preserve, these 15 COCs have potential to reach and impact the Great Miami Aquifer through the glacial till within 1,000 years under natural conditions (i.e., if they are not disposed of in the OSDF). Table F.2–2 of Appendix F of the OU5 FS also lists all the other constituents screened for potential cross-media impacts. Overall, 53 organics, 25 inorganics, and 15 radionuclides were evaluated in the groundwater COC selection process, including all the RCRA constituents that have been detected in soil and groundwater at the Fernald Preserve.

After considering the engineering controls provided by the OSDF in the modeling procedures, 12 of the original 15 groundwater pathway COCs were found to require numerical WAC. When determining what materials can be disposed of in the OSDF, compliance with the 12 numerical WAC will be required for the long-term protection of the Great Miami Aquifer. Table 3–1 lists the 15 COCs considered and the WAC that were developed. The technical approach of fate and transport modeling conducted to develop the COC-specific WAC has been summarized in Section F.5 in the OU5 FS.

Upon further review of the initial WAC development process contained in the OU5 FS, the U.S. Environmental Protection Agency (EPA), the Ohio Environmental Protection Agency (OEPA), and the U.S. Department of Energy (DOE) concurred that magnesium does not present a significant threat to human health. Therefore, magnesium was eliminated from further consideration, and a WAC for magnesium was not presented in Table 9–6 of the OU5 ROD.

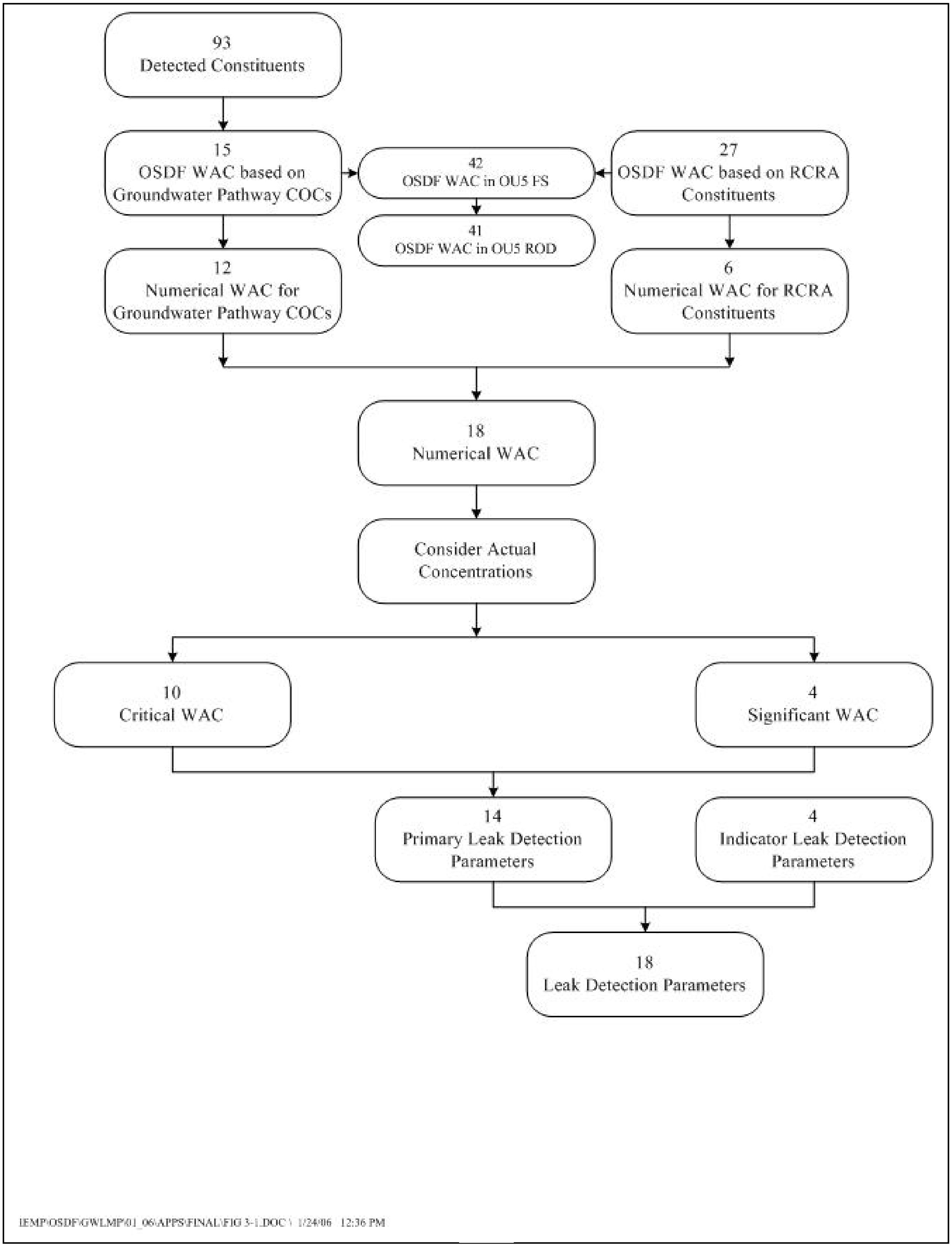

Figure 3–1. Groundwater/Leak Detection Parameter Selection Process

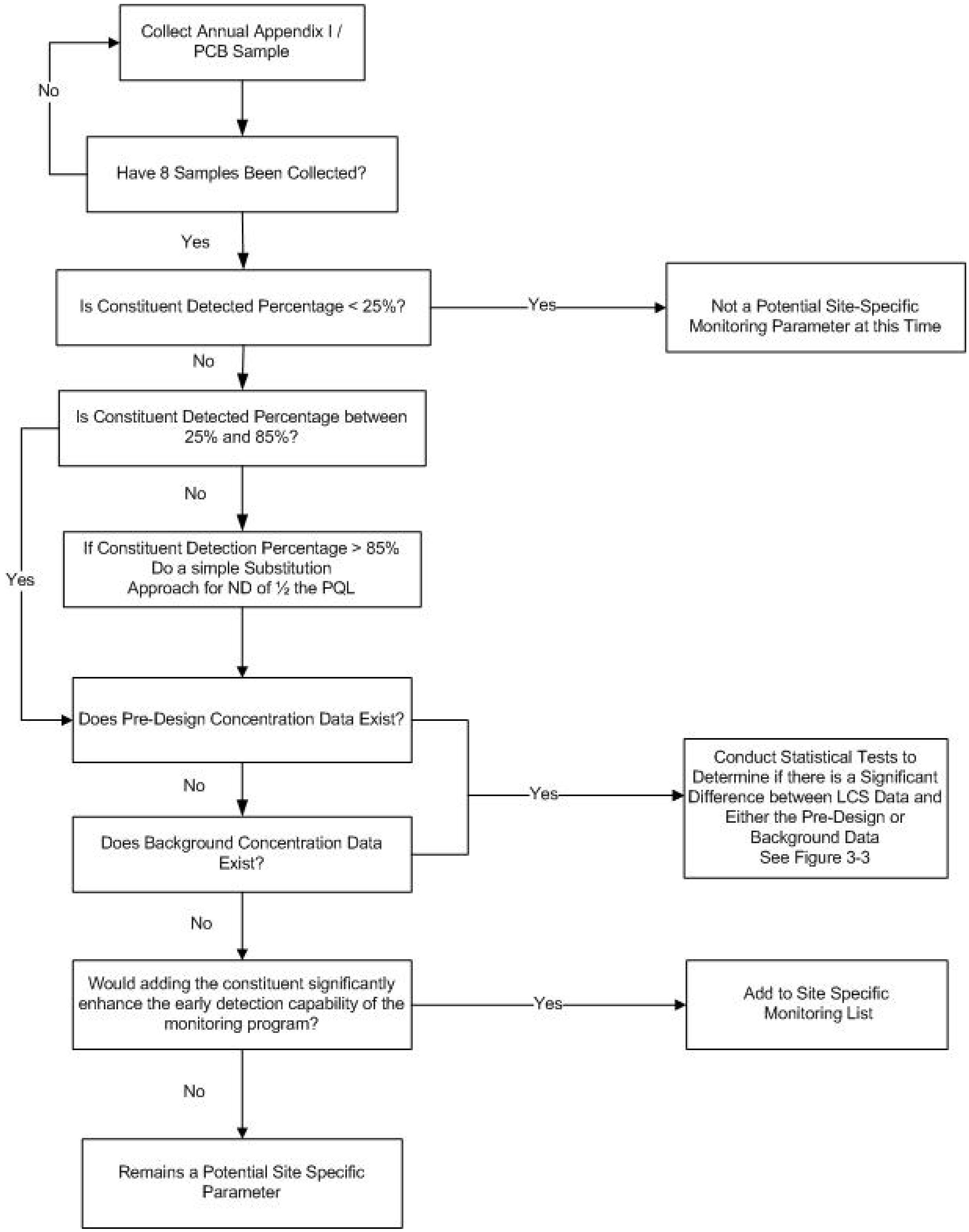

Figure 3–2. OSDF Site-Specific Leachate Monitoring Parameter Selection Approach

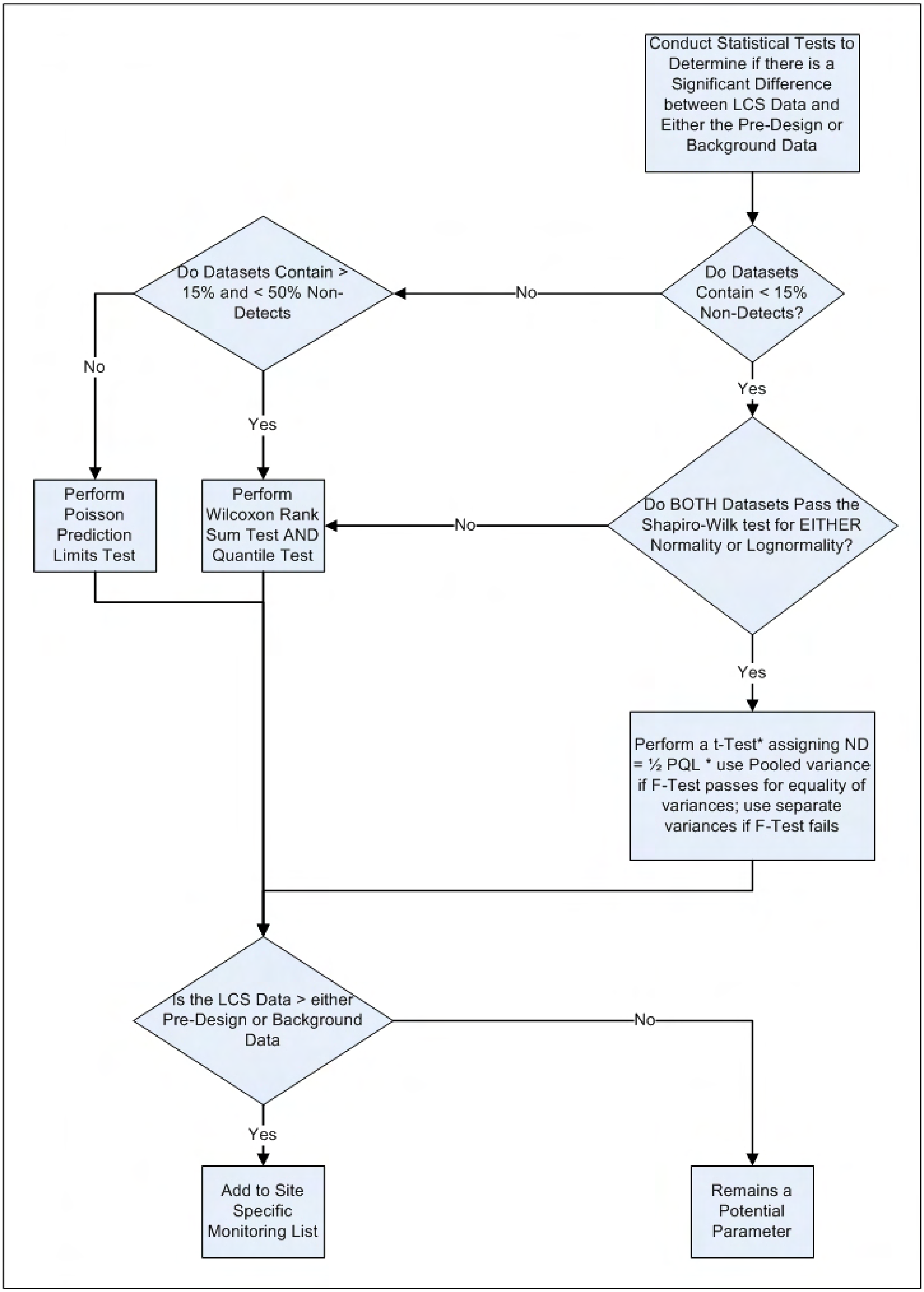

Figure 3–3. OSDF Site-Specific Leachate Monitoring Parameter Selection Statistical Testing Approach

The numerical WAC for the 12 groundwater pathway COCs were the main controlling factors for the disposal of contaminated soil in the OSDF. The 12 groundwater pathway COCs, which have numerical WAC, have significantly higher mobility and persistence and, therefore, should be considered prime candidates when selecting the indicator parameters for the detection monitoring program for the OSDF.

The numerical WAC for the 12 groundwater pathway COCs in Table 3–1 only define the maximum allowable soil concentrations that can be safely disposed of in the OSDF; they do not indicate what level of soil concentrations will actually be encountered during soil remediation. In order to frame the relative significance of these 12 WAC, the maximum soil concentrations for the 12 constituents that are expected in the OSDF following soil placement are provided in Table 3–2.

Table 3–1. WAC for Groundwater Pathway COCs

COC	WAC
Radionuclides (pCi/g):	
Neptunium-237	3.12×10^{9}
Strontium-90	5.67×10^{10}
Technetium-99	2.91×10^{1}
Total Uranium (mg/kg)	1.03×10^{3}
Organics (mg/kg):	
alpha-Chlordane	2.89×10^{0}
bis(2-Chloroisopropyl)ether	2.44×10^{-2}
Bromodichloromethane	9.03×10^{-1}
Carbazole	7.27×10^{4}
1,2-Dichloroethane	*
4-Nitroaniline	4.42×10^{-2}
Vinyl Chloride[1]	1.51×10^{0}
Inorganics (mg/kg):	
Boron	1.04×10^{3}
Chromium VI[1]	*
Magnesium	*
Mercury[1]	5.66×10^{4}

*Denotes constituents that will not exceed designated Great Miami Aquifer action level within 1,000-year performance period, regardless of starting concentration in the disposal facility.
[1]RCRA constituent.

As shown in Table 3–2, the expected maximum soil concentrations in the OSDF reveal that only five of the 12 groundwater pathway COCs with numerical WAC (technetium-99, total uranium, vinyl chloride, bis (2-chloroisopropyl) ether, and 4-nitroaniline) are expected to approach their respective WAC concentrations. The other seven COCs will have maximum soil concentrations in the OSDF that are much less than the corresponding WAC. This information regarding overall abundance is also an important consideration for selecting indicator parameters for the leak detection monitoring program.

Table 3–2. Expected Maximum COC Concentrations in the OSDF

COC	Maximum Concentration[1]	WAC	MAX/WAC
Radionuclides (pCi/g):			
Neptunium-237	2.63×10^{0}	3.12×10^{9}	8.43×10^{-10}
Strontium-90	6.49×10^{0}	5.67×10^{10}	1.14×10^{-10}
Technetium-99	2.91×10^{1}	2.91×10^{1}	1.00×10^{0}
Total Uranium (mg/kg)	1.03×10^{3}	1.03×10^{3}	1.00×10^{0}
Organics (mg/kg):			
alpha-Chlordane	5.10×10^{-3}	2.89×10^{0}	1.76×10^{-3}
bis(2-Chloroisopropyl)ether	2.44×10^{-2}	2.44×10^{-2}	1.00×10^{0}
Bromodichloromethane	7.00×10^{-3}	9.03×10^{-1}	7.75×10^{-3}
Carbazole	2.50×10^{-1}	7.27×10^{4}	3.44×10^{-6}
4-Nitroaniline	4.42×10^{-2}	4.42×10^{-2}	1.00×10^{0}
Vinyl Chloride[2]	1.51×10^{0}	1.51×10^{0}	1.00×10^{0}
Inorganics (mg/kg):			
Boron	1.43×10^{1}	1.04×10^{3}	1.38×10^{-2}
Mercury	1.30×10^{0}	5.66×10^{4}	2.30×10^{-4}

[1]Lower value between the WAC and the maximum soil concentration presented in Table F.3.4–3 of OU 5 RI.
[2]Also consider tetrachloroethene and trichloroethene in soil.

3.1.2 RCRA Constituents

After the WAC for the groundwater pathway COCs were developed, WAC for 27 additional RCRA-regulated constituents (termed the RCRA COCs) were evaluated. The development of WAC for these specific constituents was considered necessary from a regulatory standpoint to address a requirement that the RCRA COCs not be eliminated in any COC screening step during the RI/FS process. The intention was to demonstrate compliance with RCRA regulations by providing a mechanism for keeping track of the fate of materials contaminated with RCRA constituents during the remediation.

Most of the RCRA COCs are not groundwater pathway COCs; thus, the calculated WAC for the majority of these constituents are relatively high (i.e., essentially pure product concentration). Only six of the additional constituents were determined to need a numerical WAC. The details of the RCRA constituent WAC development process are provided in Attachment F.5.I of the OU5 FS. Table 3–3 summarizes the results.

The six additional numerical WAC in Table 3–3 are actually not expected to affect any disposal decisions for contaminated waste, soil, and debris from OU2, OU3, and OU5. As shown in Table 3–3, the WAC for chloroethane and toxaphene are close to pure product concentration (i.e., 1.00 × 106 milligrams per kilogram [mg/kg]). The WAC for tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene are higher than the highest detected soil concentrations, which were used in the previous screening process summarized in Table F.2–2 of the OU5 FS. The maximum detected soil concentrations presented in Table F.3.4–3 of the OU5 RI for tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene are 1.6 × 100, 8.90 × 101, 3.90×10^{-2}, and 3.4×10^{-1} mg/kg, respectively.

In general, the 15 groundwater pathway COCs listed in Table 3–1 already include all the constituents detected in soil and groundwater at the Fernald Preserve which may have potential to impact the Great Miami Aquifer and, therefore, are more likely to be detectable in the monitoring system in case of a leak from the OSDF.

3.1.3 Selected Primary Parameters

Based on information presented in Tables 3–1 through 3–3, 14 constituents are considered to be the initial primary parameters list for OSDF leak detection monitoring purposes. Table 3–4 summarizes these constituents and the rationale for their selection. Table 3–4 also indicates whether each of the 14 constituents is listed in OAC 3745-27-10 Appendix I as a regulatory default parameter.

Four of the 18 constituents that have numerical WAC listed in Tables 3–1 or 3–3 (chloroethane, toxaphene, neptunium-237, and strontium-90) were not selected because of their expected actual maximum concentrations in the OSDF and their comparatively high WAC values that indicate less likely potential impacts and detectability in case of a leak from the OSDF. However, four RCRA constituents that are not groundwater pathway COCs (tetrachloroethene, trichloroethene, 1,1-dichloroethene, and 1,2-dichloroethene) were selected because their expected maximum soil concentrations are reasonably close to the WAC.

The 14 constituents identified in Table 3–4 that were selected as the primary leak detection monitoring parameters have a potential to enter the environment in measurable quantities and are likely to be more differentiable from background conditions. These 14 constituents will provide a reliable indication of potential releases from the OSDF to the groundwater. A possible exception may be boron because it is present in the crushed carbonate stone used for the leachate collection system (LCS), leak detection system (LDS), and cap drainage layers.

Table 3–3. WAC for Additional RCRA Constituents

RCRA Constituents	Detected and Previously Screened	WAC	OAC 3745-27-10 Appendix I
Organics (mg/kg):			
Acetone	Yes	*	Yes
Benzene	Yes	*	Yes
Carbon tetrachloride	Yes	*	Yes
Chloroethane	No	3.92×10^5	Yes
Chloroform	Yes	*	Yes
Chloromethane	No	*	Yes
1,1-Dichloroethane	Yes	*	Yes
1,1-Dichloroethene	Yes	1.14×10^1	Yes
1,2-Dichloroethene	No	1.14×10^1	Yes
Endrin	No	*	No
Ethylbenzene	Yes	*	Yes
Heptachlor	No	*	No
Heptachlor epoxide	No	*	No
Hexachlorobutadiene	No	*	No
Methoxychlor	No	*	No
Methylene chloride	Yes	*	Yes
Methyl ethyl ketone	Yes	*	Yes
Methyl isobutyl ketone	No	*	Yes
Tetrachloroethene	Yes	1.28×10^2	Yes
1,1,1-Trichloroethane	Yes	*	Yes
Trichloroethene	Yes	1.28×10^2	Yes
Toluene	Yes	*	Yes
Toxaphene	No	1.06×10^5	No
Xylenes	Yes	*	Yes
Inorganics (mg/kg):			
Barium	Yes	*	Yes
Lead	Yes	*	Yes
Silver	Yes	*	Yes

*Denotes constituents that will not exceed designated Great Miami Aquifer action level within 1,000-year performance period, regardless of starting concentration in the disposal facility.

Table 3–4. Proposed Primary Parameters List

Constituents of Concern	Rationale	Appendix I
Radionuclides (pCi/g):		
Technetium-99	likely detectable when released	No
Total uranium (mg/kg)	likely detectable when released	No
Organics (mg/kg):		
alpha-Chlordane	likely detectable when released	No
bis(2-Chloroisopropyl)ether	likely detectable when released	No
Bromodichloromethane	likely detectable when released	Yes
Carbazole	likely detectable when released	No
1,1-Dichloroethene	significant RCRA constituent	Yes
1,2-Dichloroethene	significant RCRA constituent	Yes
4-Nitroaniline	likely detectable when released	No
Tetrachloroethene	significant RCRA constituent	Yes
Trichloroethene	significant RCRA constituent	Yes
Vinyl Chloride	likely detectable when released and significant RCRA constituent	Yes
Inorganics (mg/kg):		
Boron	likely detectable when released	No
Mercury	likely detectable when released and significant RCRA constituent	No

3.2 Supplemental Indicator Parameters

In addition to the primary parameters discussed in the preceding subsection, four general groundwater contamination indicator parameters were also proposed to supplement the selected chemical constituents in the initial leak detection monitoring parameters list. These supplemental indicator parameters comprise the following:

- pH.
- Specific Conductance.
- Total Organic Halogens (TOX).
- Total Organic Carbon (TOC).

These general groundwater contamination indicator parameters are typically used to aid in the detection of releases from disposal facilities. However, given that the largest volume of material placed in the cell is contaminated glacial till (made up of approximately 50 percent carbonate grains by volume), the pH of leachate will not be appreciably different from the pH of perched water or groundwater in the Great Miami Aquifer. Therefore, the remaining three supplemental indicator parameters provide an added means to detect contaminant migration and will be useful as indicators for general groundwater quality degradation.

Although the initial indicator parameters should provide indications of potential releases throughout the operational life of the OSDF, efficiency of the parameters list may still be improved based on the collected data obtained over the course of the program. Any proposed modifications based on the accumulated database will involve EPA and OEPA review and approval before adoption, as discussed below.

4.0 Parameter List Modifications

The sections above identify the process for selecting parameters for initial baseline sampling and analysis (i.e., site-specific leak detection indicator parameters, which are the proposed primary parameters in Table 3–4, and the supplemental indicator parameters listed in Section 3.2 of this appendix). It is anticipated that during the data collection process for OSDF, recommended refinements to the monitoring lists will be made periodically. The following subsections describe some of the considerations of future additions and deletions to the parameter lists and Table 4–1 identifies modifications that have been made through 2006. As explained below no additional modifications will be made until results of the Common Ion Study have been shared with the EPA/OEPA. Also, a new evaluation process that was presented in the 2006 SER (and is presented below) will be utilized for any future evaluation of existing data. All modifications have been and will be identified to EPA and OEPA and approved prior to implementation. Variances and revisions will be made as necessary. Currently, recommendations for parameter list modifications have been made through the Cells 1, 2, and 3 Technical Memorandum, the annual review process (which is documented in the annual site environmental reports), and through DOE, OEPA, and EPA agreements.

4.1 Eliminating Monitoring Parameters

An indicator parameter will be considered for elimination from the long-term leak detection monitoring parameters list if it is not detected in the LCS leachate samples collected during active waste placement. Any constituents not detected in the LCS leachate samples after waste placement are likely to be absent, insoluble, or of insignificant abundance in the OSDF.

An indicator parameter will be eliminated from the long-term leak detection monitoring program if not detected more than 25 percent of the time during the initial baseline period. This approach will be implemented on a cell-by-cell basis. Another reason parameters will be eliminated for monitoring is through agreements between DOE, OEPA, and EPA.

4.2 Adding Monitoring Parameters

Until the Common Ion Study is completed and cell monitoring becomes refined, analytical results of the annual grab sample of leachate collected in the LCS for the Appendix I and polychlorinated biphenyl (PCB) parameters specified in OAC 3745-27-10 and 19, detected constituents will be evaluated to determine whether the original indicator parameters list is sufficient for leak detection purposes. As mentioned before, most of the Appendix I constituents have already been detected in perched groundwater under the Fernald Preserve and were considered when selecting the initial leak detection indicator parameters. It is expected that these constituents will also be detected in future OSDF leachate samples. However, they will not

Table 4–1. OSDF GWLMP Parameters List Modifications through 2006

	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	CELL 7	CELL 8
LCS (Initial Baseline)	(02/1998)	(11/1998)	(10/1999)	(11/2002)	(11/2002)	(10/2003)	(09/2004)	(10/2004)
Parameter	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**
Reason[a]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
Sampling Period	02/2003–indefinitely	02/2003–indefinitely	02/2003–indefinitely	09/2003–indefinitely	02/2003–indefinitely	10/2003–indefinitely	09/2004–indefinitely	10/2004–indefinitely
Parameter	**PCBs**	**PCBs**	**Technetium-99**	**PCBs**	**PCBs**	**PCBs**	**PCBs**	**PCBs**
Reason[a]	3[c]	3[c]	2	3[c]	3[c]	3[c]	3[c]	3[c]
Sampling Period	05/2004–indefinitely	05/2004–indefinitely	02/2004–08/2004	05/2004–indefinitely	05/2004–indefinitely	05/2004–indefinitely	09/2004–indefinitely	10/2004–indefinitely
Parameter	**COD**	**COD**	**PCBs**	**COD**	**COD**	**COD**	**COD**	**COD**
Reason[a]	6[c]	6[c]	3[c]	6[c]	6[c]	6[c]	6[c]	6[c]
Sampling Period	05/2004–indefinitely	05/2004–indefinitely	05/2004–indefinitely	05/2004–indefinitely	05/2004–indefinitely	05/2004–indefinitely	09/2004–indefinitely	10/2004–indefinitely
Parameter	**Common Ions**	**Common Ions**	**COD**	**TDS & NO_3/NO_2**	**TDS & NO_3/NO_2**	**TDS & NO_3/NO_2**	**TDS & NO_3/NO_2**	**TDS & NO_3/NO_2**
Reason[a]	3	3	6[c]	7[d]	7[d]	7[d]	7[d]	7[d]
Sampling Period	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	05/2004–indefinitely	02/2005-indefinitely	02/2005-indefinitely	02/2005-indefinitely	02/2005-indefinitely	02/2005-indefinitely
Parameter	**Toxaphene**	**Toxaphene**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**
Reason[a]	3[e]	5[e]	3	3	3	3	3	3
Sampling Period	08/2005	08/2005	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)
Parameter			**Toxaphene**	**Toxaphene**	**Toxaphene**	**Toxaphene**	**Toxaphene**	**Toxaphene**
Reason[a]	--	--	5[e]	5[e]	5[e]	5[e]	5[e]	5[e]
Sampling Period			08/2005	08/2005	08/2005	08/2005	08/2005	08/2005
Parameter			**1,1-Dichloroethene**					
Reason[a]	--	--	2	--	--	--	--	--
Sampling Period			11/2005–indefinitely					
LDS (Initial Baseline)	(02/1998)	(02/1998)	(08/2002)	(11/2002)	(11/2002)	(10/2003)	(09/2004)	(10/2004)
Parameter	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**
Reason[a]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
Sampling Period	02/2003–indefinitely	02/2003–indefinitely	05/2003–indefinitely	05/2003–indefinitely	05/2003–indefinitely	10/2003–indefinitely	09/2004–indefinitely	10/2004–indefinitely
Parameter	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**PCBs**	**PCBs**
Reason[a]	3	3	3	3	3	3	3[c]	3[c]
Sampling Period	Initiated 05/2005 (8 rounds)	Initiated 11/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	09/2004-indefinitely	10/2004-indefinitely
Parameter			**1,1-Dichloroethene**				**Common Ions**	**Common Ions**
Reason[a]	--	--	2	--	--	--	3	3
Sampling Period			08/2006-02/2007				Initiated 05/2005 (8 rounds)	Initiated 08/2005 (8 rounds)

Table 4–1 (continued). OSDF GWLMP Parameters List Modifications through 2006

	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	CELL 7	CELL 8
HTW (Initial Baseline)	(10/1997)	(06/1998)	(07/1998)	(02/2002)	(02/2002)	(03/2003)	(02/2004)	(05/2004)
Parameter	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**
Reason[a]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
Sampling Period	02/2003–indefinitely	02/2003–indefinitely	02/2003–indefinitely	01/2003–indefinitely	01/2003–indefinitely	03/2003–indefinitely	02/2004–indefinitely	05/2004–indefinitely
Parameter	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**	**Common Ions**
Reason[a]	3	3	3	3	3	3	3	3
Sampling Period	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 05/2005 (8 rounds)	Initiated 08/2005 (8 rounds)	Initiated 08/2005 (8 rounds)	Initiated 08/2005 (8 rounds)
GMA (Initial Baseline)	**U-GMA & D-GMA** (03/1997)	**U-GMA &D-MA** (06/1997)	**U-GMA & D-GMA** (08/1998)	**U-GMA & D-GMA** (11/2001)	**U-GMA & D-GMA** (11/2001)	**U-GMA & D-GMA** (12/2002)	**U-GMA & D-GMA** (01/2004)	**U-GMA, D-GMA, SW-GMA, & SE-GMA[f]** (03/2004)
Parameter	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**	**Sulfate**
Reason[a]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]
Sampling Period	02/2003-indefinitely	02/2003-indefinitely	02/2003-indefinitely	01/2003-indefinitely	01/2003-indefinitely	01/2003-indefinitely	01/2004-indefinitely	03/2004-indefinitely
Refined Baseline								
Reason	4	4	4	4	4	4	4	--
Initiated	08/2002	08/2002	08/2002	08/2005	08/2005	08/2005	Post-closure	

[a]The reasons for sampling program modifications are identified in Section 4.2 of this appendix and are as follows:
1. Addition was based on annual LCS concentration, because it could significantly enhance the early detection capability of the monitoring program.
2. Addition was based on constituent being detected in either the annual LCS or LDS during refined baseline sampling. Confirmatory sampling for the constituent will consist of three quarterly consecutive sample events from the horizon in which it was detected.
3. Addition was based on EPA/OEPA agreement beyond what is included in 1 or 2 above.
4. Deletion was based on constituent not being detected more than 25 percent of the time during initial baseline sampling.
5. Deletion was based on constituent not being detected in LCS during active waste placement.
6. Deletion was based on EPA/OEPA agreement beyond what is included in 4 or 5 above.
7. Frequency modification based on EPA/OEPA approval.

[b]In 2002, there were relatively high concentrations of sulfate in the Cells 4 and 5 LCS indicating a sulfate source in the gravel. Due to sulfate's high mobility and the presence of an ongoing source in the LCS/LDS layers, sulfate was added to the monitoring requirements at all locations.
[c]OAC 3745-27-19(M)(5) indicates PCB analysis and no required COD analysis.
[d]TDS and NO_3/NO_2 were originally sampled quarterly, based on potential treatment system impacts. Frequency was reduced to annual, based on 7+ years of data collected (DOE 2004). Implemented after approval on 01/2005. For Cells 1 through 3, frequency modification occurred when refined baseline was initiated.
[e]Constituent was added as a result of Comment #138 from EPA/OEPA (DOE 2005).
[f]For the SW-GMA and SE-GMA, the initial baseline sampling date was 08/2005.

necessarily be adequate indicators of a release. Therefore, constituents detected in the annual OSDF LCS samples will not be automatically added to the leak detection indicator parameters list, unless they meet the criteria discussed below.

Because waste is no longer being placed in the OSDF, and an alternate sampling constituent list has been approved for the OSDF, it is envisioned that after completion of the Common Ion Study that collection of an annual grab sample from the LCS of each cell to be tested for Appendix I and PCB parameters listed in OAC 3745-27-10 will no longer be required, and this annual sampling/analysis task will stop. Annual sampling from the LCS of each cell will instead focus on refined site-specific list of parameters that has been approved for the facility. Annual sampling of the LCS of each cell for Appendix I and PCB listed parameters will not stop until concurrence has been obtained from EPA/OEPA.

Until monitoring is refined, an indicator parameter will be added when it can be demonstrated that routine analysis of the constituent in the leak detection monitoring system can significantly enhance the early detection capability of the monitoring program. Evaluations of the annual leachate grab sampling data will be conducted to determine the need for adjustments to the current parameter list; the results of the evaluations will be reported in accordance with the OAC 3745-27-19(M) reporting requirement. The evaluation process is presented in Figure 3–2 and Figure 3–3.

Although constituents that are not part of the limited indicator parameter list for leak detection may be detected in the annual grab sample, it is not anticipated that the concentrations will be high enough to warrant revision of the leak detection parameter list. However, a review of the data will be conducted (and reported through the annual site environmental reports) to determine if any new indicator constituents should be added to the site-specific leak detection indicator parameter list. Constituent concentrations will be reviewed against information gathered during the OU5 RI/FS period and subsequent environmental monitoring data. OSDF annual LCS data will be compared to factors such as Great Miami Aquifer and perched water background values, range of site perched water concentrations, and current laboratory contract-required detection limits. Ultimately, a constituent will be added if routine analysis of the constituent can significantly enhance early detection capability. The leak detection/leachate analysis will ensure that the character of the leachate will not adversely impact the treatment facility or the treatment facility effluent receiving stream (the Great Miami River). Evaluations will be documented through tables provided in the annual site environmental reports. Sample results will be compared to groundwater FRLs, groundwater (perched water and Great Miami Aquifer) background concentrations, and site perched water concentrations.

Additionally, as recommended in the Cells 1, 2, and 3 Technical Memorandum, even when cell monitoring becomes refined (i.e., based on those constituents detected more than 25 percent of the time during initial baseline sampling), annual samples collected from LCS and LDS will be analyzed for all site-specific leak detection indicator constituents. If a constituent is detected in either the LCS or LDS, then confirmatory sampling for that constituent will consist of three quarterly consecutive sample events from the horizon in which it was detected. Depending on the magnitude and/or persistence of the constituent detected in the LCS or LDS, sampling for the detected constituent in the next lower horizon may occur. If the constituent is detected in the next lower horizon, then confirmatory sampling will again be conducted for three quarterly consecutive events. This strategy, performed as necessary, is based on detected constituents to ensure that a thorough evaluation of all detected constituents is completed.

Another reason parameters will be added for monitoring is through agreements between DOE, OEPA, and EPA.

5.0 References

DOE (U.S. Department of Energy), 2005. *Response to EPA and OEPA Technical Review Comments on the Revised Comprehensive Legacy Management and Institutional Controls Plan, Volumes I and II, Draft Final, April*, Fernald Closure Project, Cincinnati, Ohio, August.

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End of current text