LMS/MND/S07963

Five-Year Review Report

Third Five-Year Review for the Mound, Ohio, Site Miamisburg, Ohio

September 2011

U.S. DEPARTMENT OF ENERGY | Legacy Management

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September 2011

Approved by:

Jane Powell
Site Manager

Date: 9/15/11

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Abbreviations

ARAR	applicable or relevant and appropriate requirement
ATD	Authorization to Discharge
BVA	Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
Cr	chromium
DCE	dichloroethylene
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ft	feet
gpm	gallon per minute
GPS	global positioning system
HEAST	Health Effects Assessment Summary Tables
IC	institutional control
IRIS	Integrated Risk Information System
JGMS	J.G. Management Systems, Inc.
LM	Office of Legacy Management
LOC	level of concern
LTS&M	Long-Term Surveillance and Maintenance
MCL	maximum contaminant level
MDC	Mound Development Corporation (formerly MMCIC)
MDL	method detection limit
µg/L	micrograms per liter
µg/L/year	micrograms per liter per year
mg/L	milligrams per liter
MMCIC	Miamisburg Mound Community Improvement Corporation (see MDC)
MNA	monitored natural attenuation
mV	millivolts
nCi/L	nanocurie per liter
NCP	National Oil and Hazardous Substance Pollution Contingency Plan

NFA	No Further Action
Ni	nickel
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operations and Maintenance
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OU	Operable Unit
P&T	pump and treatment
PCE	perchloroethene
pCi/L	picocuries per liter
pCi/L/yr	picocuries per liter per year
PRS	potential release site
Ra	radium
RAO	remedial action objective
RBGV	risk-based guideline value
ROD	Record of Decision
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
SARA	Superfund Amendments and Reauthorization Act
Sr	strontium
SSTP	site sanitary treatment package
Stoller	S.M. Stoller Corporation
SVE	soil vapor extraction
TCE	trichloroethylene
VC	vinyl chloride
VOC	volatile organic compound

Executive Summary

The Mound Site in Miamisburg, Ohio, was remediated by the U.S. Department of Energy (DOE) in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

This third five-year review includes the operable units and parcels that were part of the remedial action at the Mound Site. These include:

- Operable Unit 1 (Former Waste Disposal Sites)
- Operable Unit 4 (Miami-Erie Canal; no action or restrictions required)
- Release Block D
- Release Block H
- Phase I (Areas A, B, and C)
- Parcel 3 (GP-1 and GH)
- Parcel 4 (South Property)
- Parcels 6, 7, and 8

The CERCLA five-year review is required by statute. CERCLA Section 121(c) requires that remedial actions resulting in any hazardous substances, pollutants, or contaminants remaining at a site above levels that allow for unlimited use and unrestricted exposure be reviewed every 5 years to ensure protection of human health and the environment.

This is the third five-year review conducted for the Mound Site. Since the second five-year review, soil remediation at the Mound Site was completed in 2009. Institutional controls (ICs) have been implemented for Parcels 6, 7, and 8, and a monitored natural attenuation (MNA) remedy has been implemented for trichloroethylene (TCE) and tritium contaminated groundwater in Parcels 6, 7, and 8. Operation of the pump and treatment system, which controls the migration of TCE-contaminated groundwater in the Operable Unit 1 (OU-1) area, was stopped in June 2011 to support a rebound study. The ownership of one land parcel has been transferred to the Mound Development Corporation (MDC), which was formerly known as Miamisburg Mound Community Involvement Corporation. Additional soil removal work was completed in the OU-1 area to support economic redevelopment. The OU-1 Record of Decision (ROD) is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9.

A no-action ROD has been approved for the Miami-Erie Canal, and the canal was not evaluated under this review. The ROD found that the soil was remediated to risk levels acceptable for unrestricted residential use.

The ICs implemented at the Mound Site are protective of human health and the environment because they are functioning as intended. The groundwater remedies for Phase I and Parcels 6, 7, and 8 are expected to be protective of human health and the environment upon attainment of cleanup goals. In the interim, exposure pathways are being controlled through ICs. The remedy for OU-1 is protective of human health and the environment as exposure pathways are being controlled through plume containment and Federal ownership of the land. Controlled access to the landfill is no longer necessary since excavation was completed; however, for the remedy to be protective in the long-term, ICs to restrict soil removal and groundwater use need to be implemented.

This is the third statutory five-year review for this site. The next five-year review will be conducted in 2016.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Mound Plant (DOE)		
EPA ID *(from WasteLAN)*: OH6890008984		
Region: 5	**State: OH**	**City/County: Miamisburg / Montgomery**
SITE STATUS		
NPL status: [X] Final [ ] Deleted [ ] Other (specify)		
Remediation status (choose all that apply): [ ] Under Construction [X] Operating [X] Complete		
Multiple OUs?* [X] YES [ ] NO	**Construction completion date:** Not Applicable	
Has site been put into reuse? [X] YES [ ] NO		
REVIEW STATUS		
Lead agency: [ ] EPA [ ] State [ ] Tribe [X] Other Federal Agency -- U.S. Department of Energy		
Author name: Jane Powell		
Author title: Site Manager	**Author affiliation: DOE**	
Review period:** 09 / 29 / 2006 to 09 / 28 / 2011		
Date(s) of site inspection: 04 / 12 / 2011		
Type of review: [X] Post-SARA [ ] Pre-SARA [ ] NPL-Removal only [ ] Non-NPL Remedial Action Site [ ] NPL State/Tribe-lead [ ] Regional Discretion		
Review number: [ ] 1 (first) [ ] 2 (second) [X] 3 (third) [ ] Other (specify) __________		
Triggering action: [ ] Actual RA Onsite Construction at OU #____ [ ] Actual RA Start at OU#____ [ ] Construction Completion [X] Previous Five-Year Review Report [ ] Other (specify)		
Triggering action date *(from WasteLAN)*: 09 / 28 / 2006		
Due date *(five years after triggering action date)*: 09 / 28 / 2011		

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the five-year review in WasteLAN.]

Five-Year Review Summary Form (continued)

Issues:
No issues were identified from this review.

Recommendations and Follow-up Actions:
The following three recommendations were identified as the result of this five-year review and associated actions are outlined in Table 44.

- Verify that the quitclaim deed for Parcels 6, 7, and 8 is appropriately recorded and is free and clear of all liens and encumbrances.
- Finalize the sitewide IC Management/Land Use Control Plan (with CERCLA Summary).
- Finalize the sitewide O&M Plan for groundwater remedies.

Protectiveness Statement(s):

Institutional Controls: The remedy for Parcels D, H, 3, and 4 and ICs associated with Phase I and Parcels 6, 7, and 8 are protective of human health and the environment because controls are functioning as intended.

Operable Unit 1: The remedy at OU-1 currently protects human health and the environment because containment of the plume is functioning as intended. Exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and Federal ownership of the land. However, in order for the remedy to be protective in the long-term, ICs to restrict soil removal and groundwater use need to be implemented. The OU-1 ROD is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. As stated in the OU-1 ROD, the ICs for OU-1 would be developed prior to transfer and therefore, will be outlined in future documentation for Parcel 9.

Phase I Groundwater (MNA) Remedy: The remedy for Phase I is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent the groundwater from being used in the restricted area.

Parcels 6, 7, and 8 Groundwater (MNA) Remedy: The remedy for Parcels 6, 7, and 8 is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent the groundwater from being used in the restricted area.

Other Comments:
There are no other comments to make at this time.

1.0 Introduction

The U.S. Department of Energy (DOE) has conducted a third five-year review of the remedial actions implemented at the Mound Site in Miamisburg, Ohio. The review was conducted from December 2010 through September 2011 in accordance with the *Comprehensive Five-year Review Guidance* (EPA 2001). This report documents the results of the review.

This third five-year review is a statutory review to ensure that the remedial actions established in the records of decision (RODs) have been followed. The RODs cover the following areas:

- Operable Unit 1 (Former Waste Disposal Sites)—(DOE 1995)
- Parcel (formerly Release Block) D—(DOE 1999a)
- Parcel (formerly Release Block) H—(DOE1999b)
- Parcel 3 (GP-1 and GH)—(DOE 2001a)
- Parcel 4 (South Property)—(DOE 2001b)
- Phase I (Areas A, B, and C)—(DOE 2003a)
- Operable Unit 4 (Miami-Erie Canal; no action or review required)—(DOE 2004a)
- Parcels 6, 7, and 8—(DOE 2009a)

Parcels 6, 7, and 8 is included in this review even though the remedial actions have not been in place for 5 years. The U.S. Environmental Protection Agency (EPA) guidance states that "five-year reviews should address all operable units and remedial actions that have been initiated at the time of the review."

1.1 Purpose

A five-year review determines whether the remedies at a site are protective of human health and the environment by evaluating the implementation and performance of the selected remedies. It does not reconsider past remedy decisions. A five-year review report documents the review methods, findings, and conclusions; identifies deficiencies found during the review; and recommends actions to address them.

The review was conducted in accordance with the *Comprehensive Five-year Review Guidance* (EPA 2001), which states that Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), "requires that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site be subject to a five-year review. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) further provides that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment."

Five-year reviews are required by statute. Their implementation must be consistent with CERCLA and NCP. CERCLA Section 121(c), as amended, states:

"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than five years after the initiation of such remedial action to ensure that human health and the environment are being protected by the remedial action being implemented."

Title 40, *Code of Federal Regulations* (CFR), Part 300, NCP, states:

"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action" [40 CFR 300.430(f)(4)(ii)].

1.2 Site Status

As of August 2006, DOE had completed all soil and building remediation at the Mound Site, except for potential release sites (PRSs) 7 and 441, and had transferred five land parcels to the Miamisburg Mound Community Improvement Corporation (MMCIC), which is now called the Mound Development Corporation (MDC). PRS 441, which was the staging area for loading waste into rail cars, was remediated and verified to meet the clean-up objectives and closed on December 1, 2009 (DOE 2009b). PRS 7 conveyed treated sanitary effluent from the site's western boundary to the Great Miami River. The PRS was removed and verified to meet the clean-up objectives, and the PRS was closed on March 1, 2010. (DOE 2010a) The completion of these two PRSs completed the CERCLA remediation at Mound Site.

DOE transferred Phase I (Areas A, B, and C) to MDC on February 19, 2009. Parcels 6, 7, and 8 have completed the CERCLA process and were offered to MDC in 2010, but they have not been transferred.

DOE received additional funding from Congress to perform two non-CERCLA removal actions at OU-1 to excavate the site sanitary landfill. The overflow pond adjacent to the landfill was removed, and underground storm water drainage systems were installed north and south of the landfill. This work occurred intermittently from 2006 through 2010 (DOE 2009b and DOE 2010b).

OU-1 is undergoing a ROD amendment to expand the area to include PRS 441 and to document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9.

Operation of the pump and treatment system, which controls the migration of trichloroethylene (TCE) contaminated groundwater in the Operable Unit 1 (OU-1) area, was stopped in June 2011 to support a rebound study.

Since the last five-year review, the site sanitary sewer lines were connected to the Miamisburg Publicly Owned Treatment Works. After the tie-in was completed on July 16, 2009, the site sanitary treatment package (SSTP) plant was drained, cleaned, and free-released for complete reuse and recycle. All of the SSTP plant removal work was completed by March 5, 2010.

On November 1, 2007, the Ohio Environmental Protection Agency (OEPA) granted a request from DOE to redesignate the National Pollutant Discharge Elimination System (NPDES) 1IO00005001 discharge from the sanitary package sewage treatment plant to the 1IO00005002 discharge point, which goes to the same body of water, the Great Miami River. This was done so that the pipe that contained the discharge (PRS 7) could be removed as required under CERCLA. On November 4, 2009, OEPA granted DOE's request to terminate NPDES Permit number 1IO00005*JD. This permit covers two outfalls at the U.S. DOE Mound Closure Project. Outfall 001 was the former sanitary effluent and outfall 002 was the storm water discharge. The final reporting period for these two outfalls was November 2009.

The DOE Office of Legacy Management (LM) follows several Operations and Maintenance (O&M) Plans (DOE 2004b, DOE 2004c, and DOE 2006b) and the Long-Term Surveillance and Maintenance (LTS&M) Plan (DOE 2005), and will maintain the necessary facilities and administrative procedures to implement the selected CERCLA remedies. These remedies include the following:

- The OU-1 pump and treatment (P&T) system, including three extraction wells, a treatment plant, and a discharge point will remain after completion of site activities. A groundwater monitoring system has been designated for monitoring in order to evaluate the capture of contaminated groundwater in this area.
- Sampling associated with the Phase I and Parcels 6, 7, and 8 groundwater remedies.
- Institutional controls (ICs) associated with (1) Parcels D, H, 3; (2) Parcels 4, 6, 7, and 8; and (3) Phase I. These ICs are documented in the appropriate ROD and the quitclaim deed for each parcel. Parcels 6, 7, and 8 have not been transferred to MDC, but the remedial actions have been completed and a ROD has been finalized.

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2.0 Site Chronology

1946: Construction of the Mound facility was started to support the early atomic weapons programs. The original footprint of the facility was 182 acres.

1948–1995: The plant grew into an integrated research, development, and production facility performing work in support of the nation's weapons and energy programs, with emphasis on explosives and nuclear technology.

1981: DOE purchased an additional 124 acres of land south of the original property. The property remained undeveloped.

1984: DOE established the Environmental Restoration Program at the Mound Site to collect and assess environmental data in order to evaluate both the nature and extent of contamination and to identify potential exposure pathways and potential human and environmental receptors. This was done to develop a conceptual site model.

1989: EPA placed the Mound Site on the National Priorities List (NPL) in November because of chemical contamination present in the site groundwater and the site's proximity to a sole source aquifer.

1990: DOE and EPA signed a Federal Facility Agreement (FFA) in October.

1993: OEPA added to FFA making it a tripartite agreement.

1995:

- Regulators approved the *Operable Unit 1 Record of Decision*. The selected remedy of controlling contamination from the soils and groundwater is (1) collection, treatment, and disposal of groundwater and (2) ICs.
- DOE and its regulators developed an approach to making decisions about the environmental restoration of the Mound Site and its facilities. This approach is known as the Mound 2000 Process, which meets the requirements of CERCLA Section 120(h), "Property Transferred by Federal Agencies." DOE and its regulators used the Mound 2000 Process to address the environmental issues associated with the restoration of the site, completion of work at the site, and deletion of the site from the NPL.

1997: Operation of the OU-1 P&T system.

1998:

- The Miami-Erie Canal included in OU-4 underwent a soil cleanup, primarily for plutonium. The canal, lying outside the Mound property boundary, was included on the NPL due to the impacts of operational and accidental releases from the facility.
- DOE and MDC signed a sales contract establishing how DOE would convey the entire Mound Site by discrete parcels, subject to the CERCLA Section 120(h), *"Property Transferred by Federal Agencies."*

1999:

- Regulators approved the *Record of Decision for Release Block D*. The selected remedy for Release Block D is ICs.
- Regulators approved the *Record of Decision for Release Block H*. The selected remedy for Release Block H is ICs.
- The deed for Release Block H was filed with Montgomery County, Ohio, on August 8.
- The deed for Release Block D was filed with Montgomery County, Ohio, on November 19.

2001:

- Regulators approved the *Parcel 4 Record of Decision*. The selected remedy for Parcel 4 is ICs.
- EPA deleted Release Blocks D and H from the NPL on April 16.
- The deed for Parcel 4 was filed with Montgomery County, Ohio on April 19.
- Regulators approved the *Parcel 3 Record of Decision*. The selected remedy for Parcel 3 is ICs.

2002:

- The deed for Parcel 3 was filed with Montgomery County, Ohio, on August 2.
- EPA deleted Parcel 4 from the NPL on December 2.

2003: Regulators approved the Phase I Record of Decision. The selected remedy for TCE contamination in Phase I is monitored natural attenuation (MNA) with ICs.

2004: Regulators approved the no-action ROD for OU-4 regarding the soil/sediment in the Miami-Erie Canal.

2006:

- Site contractor completed the CERCLA remediation (except for PRSs 7 and 441) in July.
- Congressional funding obtained to remove priority areas of OU-1. This was referred to as the first phase of OU-1 excavation.

2008:

- DOE and MDC updated the site sales contract, "SALES CONTRACT by and between the UNITED STATES DEPARTMENT OF ENERGY and the MIAMISBURG MOUND COMMUNITY IMPROVEMENT CORPORATION," on August 28.

2009:

- Competed removal of PRS 7.
- Competed removal of PRS 441.
- Completed Phase I of non-CERCLA excavation of OU-1.

2010:

- Regulators approved the Record of Decision for Parcels 6, 7, and 8.
- Completed Phase II final non-CERCLA excavation of OU-1.

2011:

- Rebound study was started for the OU-1 P&T system.

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3.0 Background

3.1 Site Description

The Mound Site is located in Miamisburg, Ohio, approximately 10 miles southwest of Dayton (Figure 1). In 1995, the DOE Mound Plant, named after the Miamisburg Indian Mound that is adjacent to the site, was comprised of 120 buildings on 306 acres. The Great Miami River located west of the site flows from northeast to southwest through Miamisburg and dominates the geography of the region surrounding the Mound Site.

The Mound Site sits atop an elevated area overlooking the city of Miamisburg, the Great Miami River, and the river plain area to the west. To the west of the plant is an abandoned section of the Miami-Erie Canal that parallels the river. An intermittent stream runs through the plant valley and drains to the river.

Site elevations vary from 700 feet (ft) to 900 ft above sea level; most of the site is above 800 ft. No building in which radioactive material was processed was located below an elevation of 790 ft. The typical non-flood stage of the Great Miami River is 682 ft. The highest floodwater levels that can be reasonably postulated for the Great Miami River basin (100-year storm event) would result in flooding to 700 ft. Parcels H and 4 of the Mound Site lie within the 100-year floodplain of the Great Miami River.

3.2 Land and Resource Use

The river valley is highly industrialized, while the rest of the region is a mix of farmland, residential area, small communities, and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and six of the city's 17 parks are located within 1 mile of the Mound Site.

Population information extracted from the 2010 Census shows that within a 10-mile radius of the Mound Site there are 336,956 residents, and within a 50-mile radius of the site there are 3,183,953 residents. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10 percent of the agricultural land is devoted to livestock.

3.3 Site History and Enforcement Activities

3.3.1 History

The Mound Site was established by the U.S. Atomic Energy Commission, a predecessor to DOE, as an integrated research, development, and production facility that supported the nation's weapons and energy programs. To reconfigure and consolidate the nuclear complex, DOE decided to phase out the defense mission at the Mound Site. As a result, the Mound Site was designated an environmental management site and the plant is in the process of being transferred and converted into a research and industrial/commercial site.

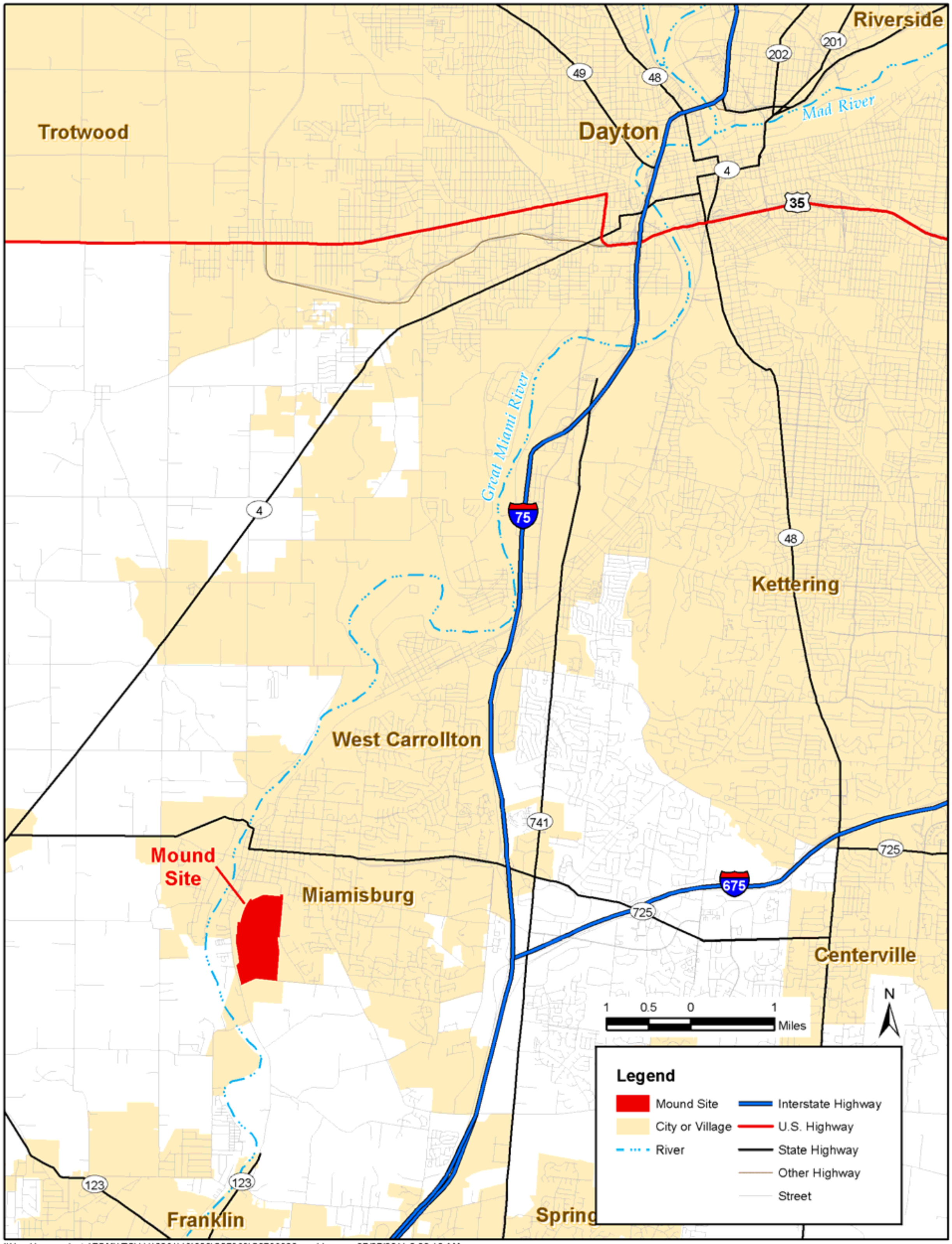

Figure 1. Mound, Ohio, Site Location Map

Early programs at the Mound Site investigated the chemical and metallurgical properties of polonium-210 and its applications; particularly, the fabrication of neutron and alpha sources for weapon and non-weapon use. Investigations involving uranium, protactinium-231, and plutonium-239 were performed from 1950 to 1963 as part of the national civilian power reactor program. In 1954, Mound began the separation of stable isotopes.

In the mid-1950s, Mound initiated efforts to develop a large-scale process for the recovery of thorium from a variety of thorium-bearing ores. Even though this project was canceled prior to full-scale operation, approximately 1,650 tons of thorium-containing sludge was received at the Mound Site. Due to its corrosivity, the thorium sludge was continually repackaged and relocated. This resulted in a number of thorium-contaminated areas around the site.

Plutonium-238 research and development activity began at the Mound Site in the mid-1950s. From the early 1960s to the late 1970s, the Mound facility processed plutonium-238 for use in heat sources within radioisotopic thermal generators. The fabrication of heat sources from plutonium metal was terminated in the mid-1960s. Plutonium oxide processes continued into the late 1970s. After early 1979, Mound did not handle un-encapsulated plutonium-238.

As a result of discovery of volatile organic compounds (VOCs) in groundwater, the Mound Site was placed on the NPL on November 21, 1989. DOE signed a CERCLA Section 120 FFA with EPA, effective in October 1990. In 1993, this agreement was modified and expanded to include OEPA.

3.3.2 Enforcement and Agreements—Mound 2000 Process

DOE, EPA, and OEPA had originally planned to address the environmental restoration issues under a set of OUs, each of which would include a number of PRSs. For each OU, the site would follow the traditional CERCLA process: a remedial investigation/feasibility study followed by a ROD, followed by remedial design/remedial action. After initiating remedial investigations for several OUs, DOE and its regulators concluded during a strategic review in 1995 that the OU approach was inefficient for Mound. DOE and its regulators agreed that it would be more appropriate to evaluate each PRS or building separately, use removal action authority to remediate them as needed, and establish a goal for no additional remediation other than ICs for the final remedy documented in the ROD. To evaluate any residual risk after all removals have been completed, a residual risk evaluation (RRE) was to be conducted to ensure the conditions would not pose an unacceptable risk to human health when the parcel is used for industrial/commercial purposes. This process was named the Mound 2000 Process. DOE and its regulators pursued this approach with the understanding that (1) EPA and OEPA reserve all rights to enforce all provisions of the FFA and (2) participation in the Mound 2000 Process does not constitute a waiver of EPA and OEPA rights to enforce the FFA.

The Mound 2000 Process established a Mound Core Team consisting of representatives of the DOE Miamisburg Closure Project, EPA, and OEPA. The Mound Core Team evaluated each of the PRSs and recommended the appropriate response. The Mound Core Team used process knowledge, site visits, and existing data to determine whether or not any action was warranted concerning each PRS. The PRSs at Mound were identified based on knowledge of historical land use that was considered potentially detrimental and/or an actual sampling result showing elevated concentrations of contaminants. If a decision could not be made, the Mound Core Team identified specific information needed to make a decision (e.g., data collection, investigations). The Mound Core Team also received input from technical experts as well as the general public and/or public interest groups. Thus, all stakeholders had the opportunity to express their opinions or suggestions involving each PRS. The details of this process are explained in the *Work Plan for Environmental Restoration at the Mound Plant, The Mound 2000 Approach* (DOE 1999c).

Originally, the Mound property was divided into nineteen "release blocks," which were contiguous tracts of property designated for transfer of ownership. Release Blocks D and H were transferred to MDC in 1999. The remaining release blocks were reconfigured and renamed parcels. Parcel 4 was transferred to MDC in 2001. Parcel 3 was transferred to MDC in 2002.

The *Mound 2000 Residual Risk Evaluation Methodology* (RREM) (DOE 1997a) was developed as a framework for evaluating human health risks associated with residual levels of contamination. The RREM was applied to a parcel after remediation, and the remaining PRSs or buildings in the parcel were designated as No Further Action (NFA). An RRE was performed after the identified environmental concerns were adequately addressed by the Mound Core Team. The RRE documented that the parcel was acceptable for industrial/commercial redevelopment.

The ROD for a given parcel documented the most appropriate remedy that met statutory requirements and ensured protection of human health and the environment.

After the ROD for a given parcel was final, DOE submitted documentation to EPA and OEPA that showed the property met CERCLA 120(h)(3) requirements. After concurrence was obtained, the title of the property was formally transferred. Prior to acceptance of the deed for any discrete parcel, the Buyer acknowledged that it had reviewed the Mound environmental reports provided by DOE. Acceptance of the deed thereby acknowledged and committed the Buyer to abiding by ICs specified in the ROD.

3.4 Geology and Hydrogeology

The geologic record preserved in the rocks underlying the site indicates that the area has been relatively stable since the beginning of the Paleozoic era more than 500 million years ago. There is no evidence indicating subsurface structural folding, significant stratigraphic thinning, or subsurface faulting in the underlying bedrock. Limestone, which is interbedded with shale layers, is the uppermost bedrock units at the site. No evidence of solution cavities or cavern development has been observed in any borings or outcrops in the Miamisburg area.

The aquifer system at the Mound Site consists of two different hydrogeologic environments: groundwater flow through the bedrock beneath the hills, and groundwater flow within the unconsolidated glacial deposits and alluvium associated within the Buried Valley Aquifer (BVA) in the Great Miami River valley. The bedrock flow system is dominated by fracture flow and is not considered a highly productive aquifer. The Buried Valley Aquifer is dominated by porous flow with interbedded gravel deposits providing the major pathway for water movement. The unconsolidated deposits are Quaternary Age sediments consisting of both glacial and fluvial deposits. The BVA is a highly productive aquifer capable of yielding a significant quantity of water and is designated a sole-source aquifer.

4.0 Remedial Actions

DOE remediated the former DOE Mound Site Property (Figure 2) to EPA's risk-based standards for industrial/commercial use only. Mound Site remedial actions consist of groundwater remedies and ICs to control land and groundwater use. An additional IC for the OU-1 area controls site access. The Phase I and Parcels 6, 7, and 8 remedies include monitored natural attenuation for those contaminants that exceed maximum contaminant levels (MCLs). OU-1 contains a P&T system to control groundwater contamination and to minimize exposure to potential receptors by minimizing migration of contaminated groundwater.
The primary remedial action objective (RAO) for residual contaminated soil at the site is to ensure that exposures to soil do not result in an aggregate excess cancer risk of greater than the upper end of EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} or a hazard index greater than 1. This is accomplished primarily through the use of ICs at the site which:

- Limit land use to industrial/commercial only.
- Prohibit the removal of soil from the property boundaries unless prior written approval from OEPA and the Ohio Department of Health (ODH) is obtained;

The long-term RAO for groundwater is to meet MCLs through MNA in the Phase I and Parcels 6, 7, and 8 areas or through hydraulic containment in the OU-1 area. Until these goals are achieved, the near-term RAO is to prohibit the extraction and use of groundwater underlying the premises unless prior written approval is obtained from OEPA and ODH.

The following sections contain general information about remedial actions at the Mound Site and specific remedies for OU-1, Phase I, and Parcels 6, 7, and 8, which have additional groundwater monitoring requirements. The overall O&M costs are presented for the Mound Site as a whole and are discussed at the end of this section.

4.1 Regulatory Actions at Mound Site

The following RODs apply to the Mound Site:

- *Operable Unit 1 Record of Decision* (DOE 1995)—(currently being amended into the Parcel 9 ROD)
- *Record of Decision, Release Block D* (DOE 1999a)
- *Record of Decision, Release Block H* (DOE 1999b)
- *Parcel 3 Record of Decision* (DOE 2001a)
- *Parcel 4 Record of Decision* (DOE 2001b)
- *OU-4 Canal Record of Decision* (DOE 2004a)—(no action or restrictions required)
- *Parcels 6, 7, and 8 Record of Decision* (DOE 2009a)

The OU-1 ROD is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9.

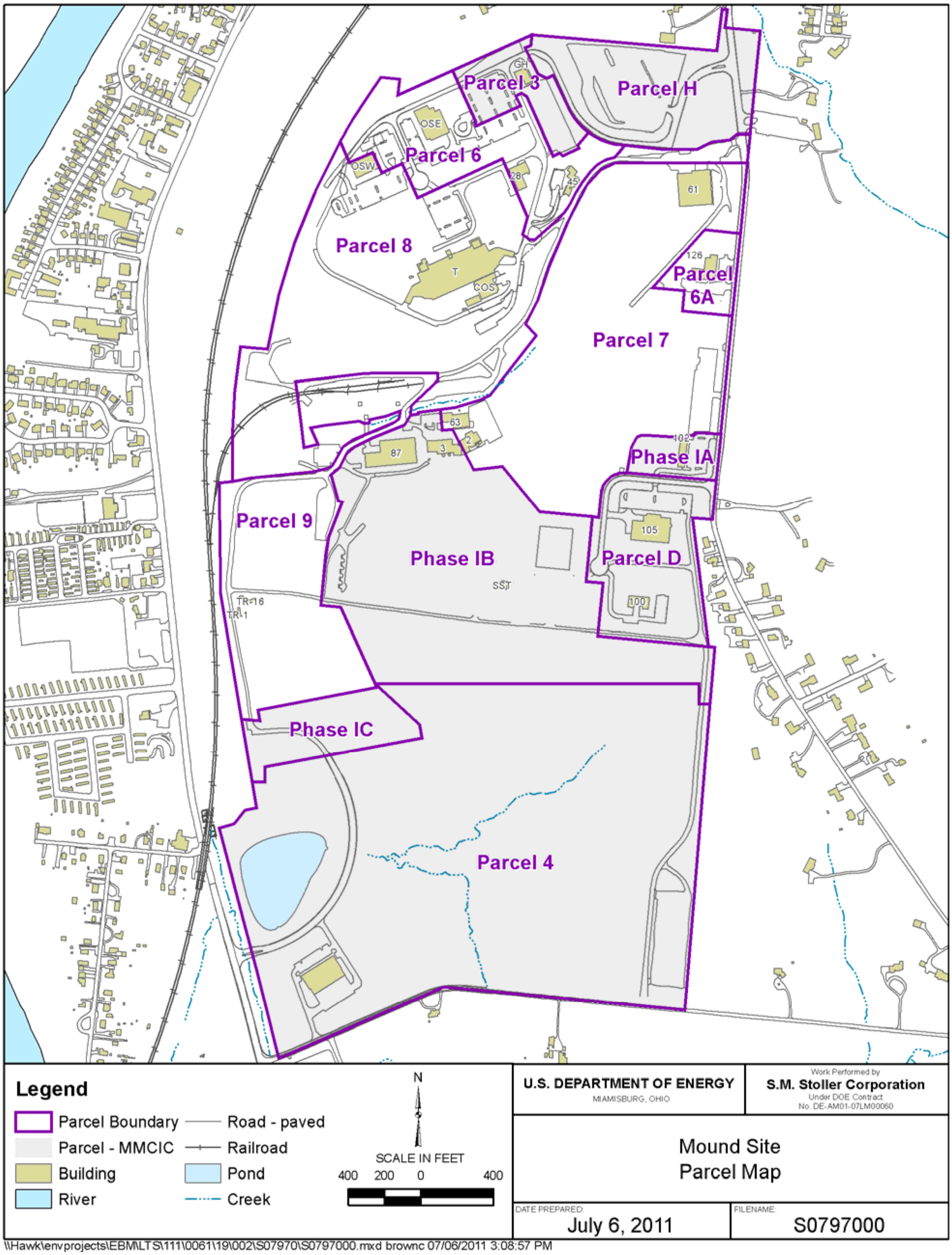

Figure 2. Land Parcels at the Mound Plant Site

4.1.1 Remedy Selection at Mound Site

The primary remediation objective was to ensure that any residual risk associated with each parcel was acceptable based on the agreed-upon industrial/commercial end-use as the only use. Remedies for each parcel were developed in accordance with that agreement. Evaluation of residual soil and groundwater contaminants within each land parcel determined that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks as long as compliance with the deed restrictions is maintained. The soil within each land parcel was not evaluated for any use other than on-site industrial and/or commercial use. Any off-site disposition of the soil from a land parcel without proper handling, sampling, and management could create an unacceptable risk to off-site receptors. Additional groundwater monitoring was imposed for OU-1, Phase I, and Parcels 6, 7, and 8, where groundwater contamination had not reached acceptable levels. The selected remedy for each parcel (except OU-1) includes the ICs described in Section 4.1.3. DOE is amending the OU-1 ROD into Parcel 9 and will add the ICs not currently included.

4.1.2 Remedy Implementation at Mound Site

The sales contract between DOE and MDC, dated January 23, 1998, and revised in 2008, establishes that DOE will convey the entire Mound Site by discrete parcels, subject to the CERCLA Section 120(h), "Property Transferred by Federal Agencies." After regulatory approval is received via approval of the Environmental Summary, each parcel of land is transferred via a quitclaim deed. The quitclaim deed contained or referred to restrictions required under CERCLA to ensure that the parcel being transferred is protective of human health and the environment (i.e., as stipulated in the ROD). Copies of the recorded deeds for Parcels D, H, 3, 4, and Phase I are included in Appendix D. However, in the future, ICs will be implemented through environmental covenants in accordance with Ohio Revised Code. This method will be used to establish the ICs for Parcel 9 (OU-1 ROD Amendment).

The preparation of the quitclaim deed and environmental covenant requires input from the CERCLA process. A copy of the Environmental Summary is also recorded with the deed. The quitclaim deed transfers ownership of the land and establishes that MDC will take the land "as is" and "where is." Although the deed does not contain a warranty for the land, DOE maintains responsibility for cleanup if contamination resulting from previous DOE activities (that pose a risk to human health and the environment) is discovered in the future (DOE 2008a).

DOE, the regulators, and MDC agreed that the future land used for the site is industrial. The risk assessments evaluated two scenarios: commercial worker and construction worker. At closure, the deed restrictions described in Section 4.4 will apply to the entire site.

4.1.3 Institutional Controls at the Mound Site

ICs were selected as part of each remedy to protect future occupants or workers and were imposed through deed restrictions on future land use. DOE or its successors, as the lead agency for the RODs, has the responsibility to monitor, maintain, and enforce ICs.

ICs are non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. The Mound Site ICs are in the form of deed restrictions that were developed with input from the public, the City of Miamisburg, the regulators, and MDC. ICs are implemented through deed restrictions on future land use as outlined in the RODs for Parcels D, H, 3, 4, 6, 7, and 8, and Phase I. However, ICs for Parcel 9 (OU-1) will be implemented through environmental covenants in accordance with Ohio Revised Code.

When ICs are part of the remedy, the ROD contains (1) the deed-restriction language to be embedded in the quitclaim deed or environmental covenant and (2) the summary notice of hazardous substances (i.e., the CERCLA Summary Notice) required by CERCLA 120(h) for the parcel it covers. The quitclaim deed and the CERCLA Summary Notice are recorded with Montgomery County, Ohio, so that all future property owners will know about the deed restrictions. Copies of the quitclaim deeds are included in Appendix D.

The following deed restriction or environmental covenant language is a summary only. The RODs contain the parcel-specific restriction language and a summary of the ICs for each parcel is presented in Table 1. RODs and other CERCLA administrative record documents are available in the CERCLA Public Reading Room and electronically on the LM Mound website: http://www.lm.doe.gov/mound/Sites.aspx.

The restrictions are designed to:

- Prohibit the removal of soil from the original DOE Mound Site property boundaries, unless prior written approval from OEPA and ODH has been obtained.
- Prohibit the extraction or consumption of, exposure to, or the use in any way of the groundwater underlying the premises, unless prior written approval from EPA and OEPA has been obtained.
- Limit land use to industrial/commercial only. Each parcel ROD identifies land uses that will not be permitted, but the list is not all-inclusive. Parcels may not be used for any residential or farming activities, or any activities that could result in the chronic exposure of children less than 18 years of age to soil or groundwater from the premises. Restricted uses include:
    - Single or multi-family dwellings or rental units.
    - Daycare facilities.
    - Schools or other educational facilities for children under 18 years of age.
    - Community centers, playgrounds, or other recreational or religious facilities for children less than 18 years of age.
- Prohibit the removal of concrete floor material in specified rooms of T Building to off-site locations without prior approval from EPA, OEPA, and ODH.
- Prohibit the penetration of concrete floors in specified rooms of T Building without prior approval from EPA, OEPA, and ODH.
- Allow site access for federal and state agencies for sampling and monitoring.

Table 1. Mound Site IC Summary

Parcel	Former ID or other names	ROD Date	Remedy	Objectives of ICs	Instrument
D	Release Block D	1999	ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Quitclaim deed for Parcel D Appendix D
H	Release Block H	1999	ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Quitclaim deed for Parcel H Appendix D
3	None	2001	ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Quitclaim deed for Parcel 3 Appendix D
4	South property	2001	ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Quitclaim deed for Parcel 4 Appendix D
Phase I	A	2003	MNA ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Quitclaim deed for Phase I (A, B, and C) Appendix D
	B				
	C				
6	Parcels 6, 7, and 8	2010	MNA ICs	Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only. Prohibit the removal of concrete floor material in specified rooms of T building. Prohibit the penetration of concrete floor material in specified rooms of T building.	Draft Quitclaim deed for Parcels 6, 7, and 8 Appendix D Property still controlled by DOE
7					
8					
9	OU-1	1995	Hydraulic containment ICs Surface water controls Long-term GW monitoring	OU-1 existing ROD. Limit site access. Parcel 9 ROD amendment in progress. Prohibit the removal of soil. Prohibit the use of groundwater. Restrict land-use to industrial only.	Property still controlled by DOE
6A	Within Parcel 7	2010	ICs	Prohibit the removal of soil Prohibit the use of groundwater Restrict land-use to industrial only	Draft Quitclaim deed for Parcels 6, 7, and 8 Appendix D Property still controlled by DOE
OU-4	Miami Erie Canal	2004	No action	None	None

4.1.3.1 Prohibit Removal of Soils

The first restriction applied to land parcels transferred to date pertains to the removal of soil from the Mound Site without prior written approval from EPA, OEPA, and ODH. The protocol for obtaining approval is contained in the *Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* (2004b) As OEPA is structured today, the decision authority for removal of soil from the Mound Site resides with the Southwest District Office, located in Dayton, Ohio. Information outlined in Attachment 7 should be provided in writing to OEPA and ODH/Bureau of Radiation Protection for each instance of proposed soil volume transport. Information about the cleanup process, background levels, and toxicology data is contained in or referenced in the *Mound 2000 Residual Risk Evaluation Methodology* (DOE 1997a).

4.1.3.2 Prohibit Use of Groundwater

The second restriction prohibits the extraction, consumption, exposure, or use in any way of the groundwater underlying the premises, without prior written approval. The protocol for obtaining approval to install a groundwater well is contained in the *Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property*. The protocol was developed to assist and inform the public, and future property owners, of the actions needed to request the permission from DOE to use groundwater on the Mound Site. Permission will be based upon a written request to EPA and OEPA.

4.1.3.3 Restrict Land Use to Industrial Only

The third restriction prohibits the land use to be anything other than industrial and/or commercial. The Proposed Plan and ROD for each land parcel state that land use will be for industrial and/or commercial use only. The RODs further detail specific land uses that will not be permitted onsite, but the list in the ROD is not meant to be all inclusive. Land parcels may not be used for any residential or farming activities, or for any other activities that could result in the chronic exposure of children under 18 years of age to soil or groundwater from the Mound Site.

To date, restricted land uses listed in the RODs include, but are not limited to:

- Single- or multi-family dwellings or rental units
- Day care facilities
- Schools or other educational facilities for children under 18 years of age
- Community centers, playgrounds, or other recreational or religious facilities for children less than 18 years of age

4.1.3.4 Special ICs for T Building

Two additional ICs were added to the Parcels 6, 7, and 8 ROD that prohibit the removal of concrete floor material in specified rooms of T Building (Figure 3) to off-site locations and prohibit the penetration of concrete floors in specified rooms of T Building without prior approval from EPA, OEPA, and ODH.

The protocol for obtaining approval to remove or penetrate flooring in certain rooms in T Building is contained in the *T Building Special ICs Core Team Agreement and Position Paper June 29, 2009*, which will be added to the *Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plan Property*. The protocol was developed to assist future property owners of the actions needed to request the permission to remove or penetrate flooring in certain rooms of T Building on the Mound Site. Permission will be based upon a written request to EPA and OEPA.

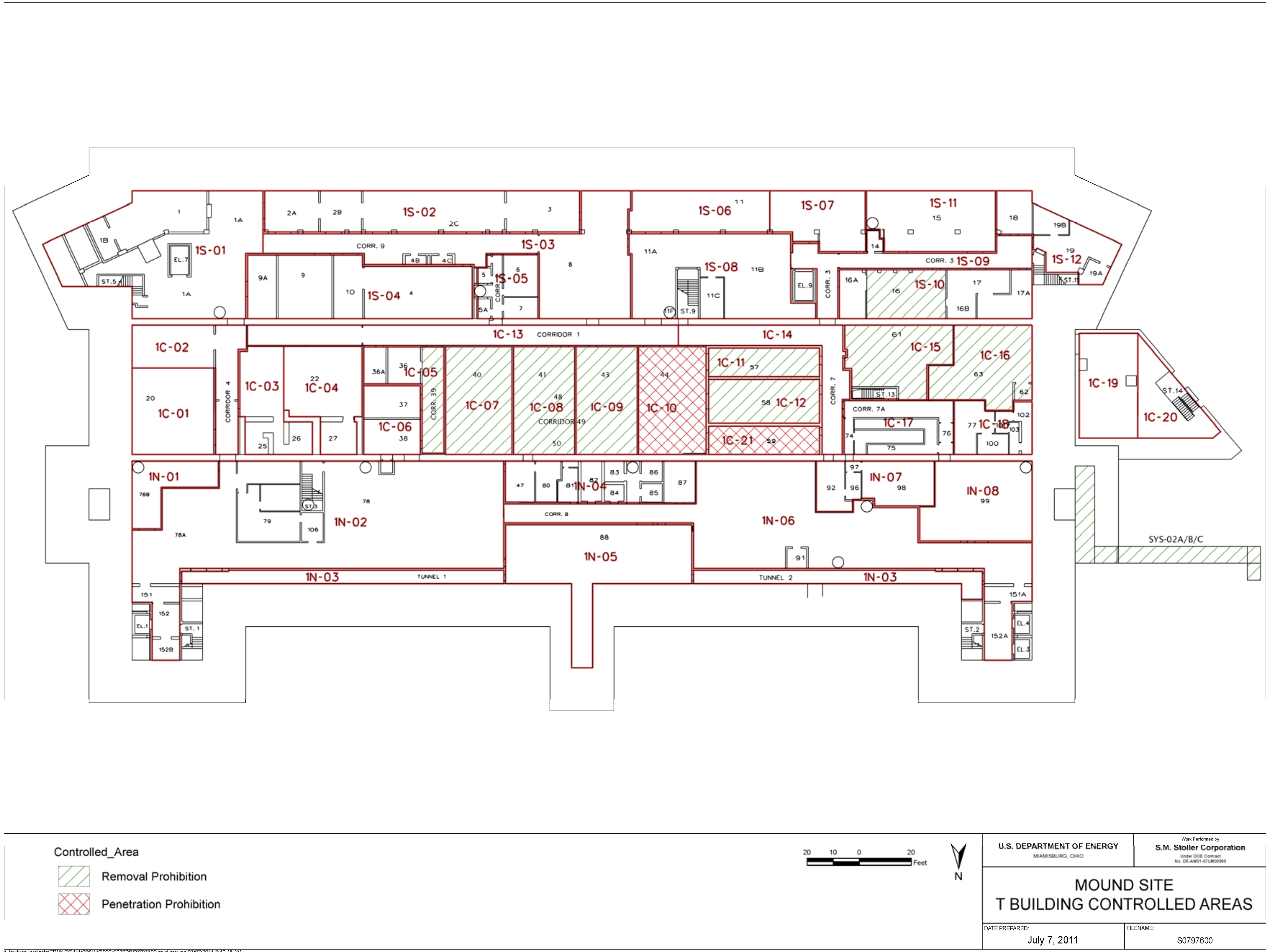

Figure 3. Mound Site T Building Controlled Areas

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4.1.3.5 Operations and Maintenance

ICs comprise all, or part of, the remedy for land parcels at the Mound Site that have completed the CERCLA Section 120(h) process for property transfer. In general, DOE will assess the effectiveness of ICs applied to the Mound Site on an annual basis. DOE may also, at any time, conduct a review of ICs if there is reason to believe a degradation of any control has occurred. However, the RODs for each parcel state that DOE can petition the regulators to decrease the assessment frequency (e.g., to every 5 years). DOE presents the annual assessment of ICs in an annual report.

The assessment of ICs includes a visual inspection of the site supported with review of any recent aerial photography. A complete description of the assessment of ICs, including a checklist, is contained in the *Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property*. This document was prepared in 1998 and was updated in 2004 to include Phase I. A new document titled the "Site-Wide IC Management/Land Use Control Plan (with CERCLA Summary)" is being prepared as a stand alone manual for implementing and maintaining the ICs and land use controls at the DOE Mound site in the future.

4.2 Operable Unit 1

In June 1995, DOE finalized the *Operable Unit 1 Record of Decision* (DOE 1995) to address contaminated groundwater in this discrete portion of the Mound Plant Site. OU-1 is located in the southwestern portion of the Mound Site (Figure 4). It encompasses a historical waste disposal area (landfill) and the plant production wells. The OU-1 remedial action was designed to control groundwater contamination (primarily low-level volatile organic compounds) to prevent migration of contamination toward the plant production wells, and to minimize exposure to potential receptors. The pathway of concern consists of leaching of contaminants from site soils or disposed wastes; entrainment in the groundwater flow; and withdrawal by the Mound Plant production wells or by other future wells. The plant production wells were abandoned in October 2005, when the facility was connected to the municipal water supply. The OU-1 landfill was excavated in two phases from 2007 through 2010 to support future redevelopment of the property by MDC.

4.2.1 Remedy Selection

The selected remedy for controlling contamination from the soils and groundwater at OU-1 is the collection, treatment, and disposal of groundwater. Surface water controls, ICs to limit site access, and long-term groundwater monitoring are also part of the remedy (DOE 1995). This action is being implemented through the collection and treatment of contaminated groundwater and discharge of the treated water. The chemical properties and hydraulic behavior of the groundwater system are monitored to verify the adequacy of the remedy. The major components of this remedy include:

- Extraction of groundwater using three conventional wells
- Treatment of the extracted groundwater to remove the VOCs using air stripping
- Discharge of the treated groundwater to the Great Miami River
- Monitoring of the chemical properties of the groundwater system

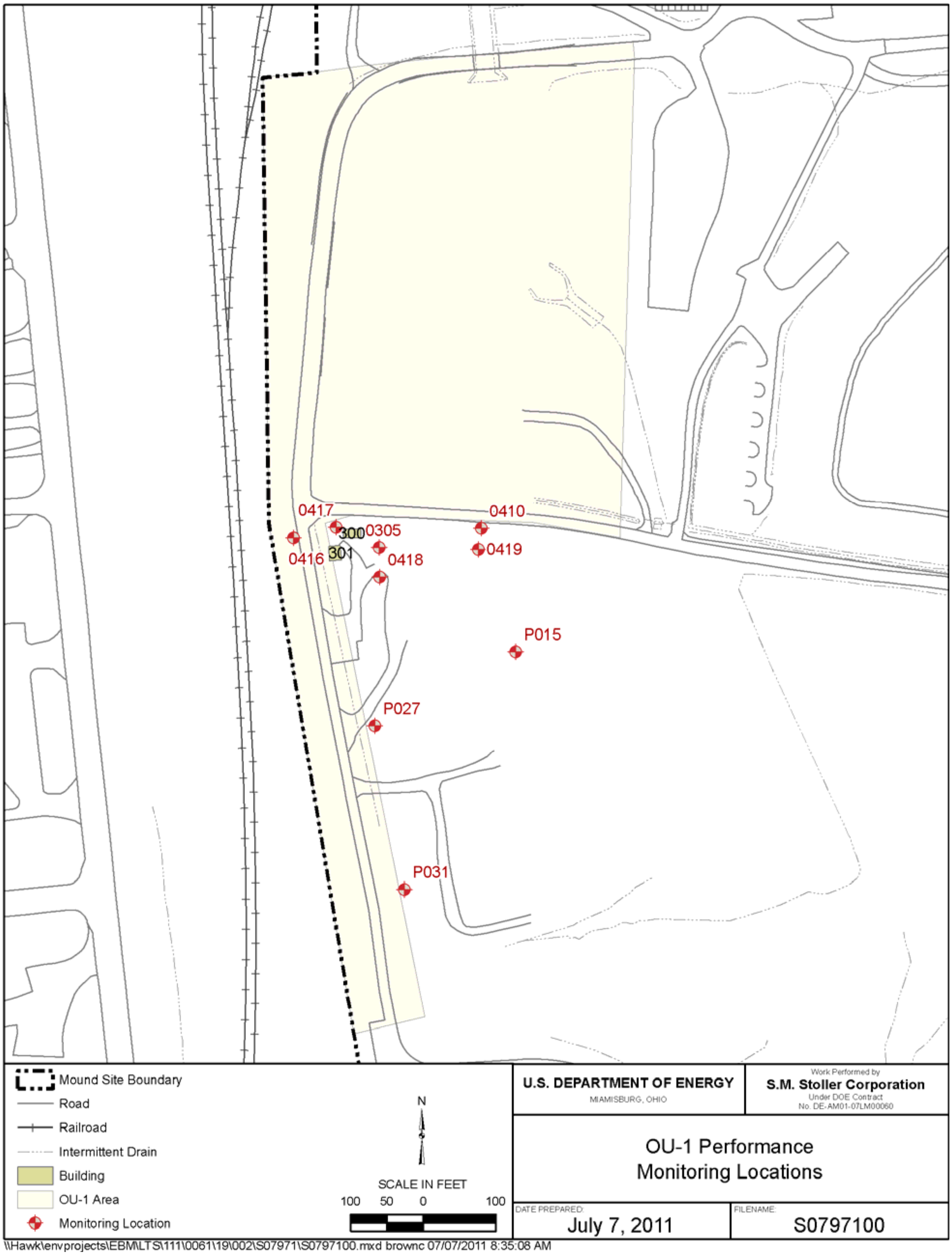

Figure 4. Operable Unit 1 Site Map

- Monitoring of the hydraulic behavior of the groundwater system
- Monitoring of the discharge effluent
- Periodic testing of the OU-1 extraction system (rebound testing)

The remedy also included surface water controls, the implementation of ICs to limit access to the site, and long-term groundwater monitoring. Surface water controls were installed to manage the surface water run-on and run-off and to reduce infiltration into the wastes in the landfill. Access restrictions and fencing were implemented to minimize contact with the soils until such time as the property is transferred.

In 2007, the three original extraction wells were removed to allow for excavation of the OU-1 landfill. Two extraction wells were installed south of the landfill to provide hydraulic containment of the impacted groundwater. A more frequent groundwater monitoring program has been implemented since 2007. Surface water controls were modified during that time to direct water away from the excavation area. Also, the pond on the north end of the OU-1 landfill area was removed to allow for excavation below the footprint of the pond. The OU-1 landfill, including the pond area, was backfilled to allow for future reuse. Since the landfill has been removed, access restriction and fencing have been removed. ICs will be implemented that control land and groundwater use, and those ICs will be incorporated into deed restrictions developed when ownership of OU-1 is transferred.

A rebound test was performed in 2003 and the system was restarted by increases in TCE above trigger levels in downgradient wells. The 2003 test was performed prior to the removal of the landfill; therefore, materials will still present that could provide a VOC source to groundwater. Starting in June 2011, another rebound test was initiated after the completion of the landfill excavation. It is expected that study will continue for 18 to 24 months. After that period, a passive groundwater remedy will be proposed, if supported by data from the rebound study.

4.2.2 Remedy Implementation

The components of the remedy that have been ongoing since the first five-year review (DOE 2001a) are groundwater extraction, treatment, and discharge; groundwater monitoring for chemical and hydraulic behavior; and monitoring of the discharge effluent.

During 2006, sampling of selected groundwater monitoring wells for volatile organic compounds was performed quarterly as specified in Section 8 of the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000). The monitoring network is summarized in Table 2. Data were analyzed to determine sustained downward trends as proof of successful capture of the plume. In accordance with the *OU-1 Pump and Treatment Operation and Maintenance Plan*, OEPA was notified prior to collection of groundwater samples and measuring water levels in the selected well.

Table 2. Groundwater and Hydraulic Monitoring for OU-1 During 2006

Location	VOC Analysis	Groundwater Hydraulic Measurement	Location	VOC Analysis	Groundwater Hydraulic Measurement
0305	X	X	0422		X
0410	X	X	0423		X
0416	X		P003		X
0417	X	X	P015	X	
0418	X		P027	X	
0419	X		P031	X	

In support of the OU-1 landfill excavation project (which was performed to support future reuse of the OU-1 area), a more frequent monitoring program was implemented. Starting in January 2007, sampling was performed in wells downgradient of the landfill to assess the groundwater quality in the BVA and the distribution of TCE closer to the landfill area and extraction wells. Sampling was performed according to the requirements in the *Work Plan for the Replacement of the OU-1 Extraction Wells*, which was developed to address the removal of the remaining two extraction wells (0413 and 0414) to accommodate additional source removal (i.e., the excavation of contaminated soil and debris from the landfill area). The sampling program changed over time to address changing conditions as excavation activities progressed. The most recent sampling program is presented in Table 3.

Table 3. Sampling Frequencies for OU-1 Wells in 2010

Well ID	Sampling Frequency
0305	Monthly
0410	
0416	
0417	
0418	
0419	
0449 – extraction well	
0450 – extraction well	
P053	
P054	
P056	
0424	Bimonthly
0425	
P015	
P027	
0422	Quarterly
0423	
P031	

Closely related to the operation of the system is the measurement of groundwater elevations in the OU-1 area, which are used to verify the satisfactory function of the pumping system. Water level measurements were made within the treatment area as specified in Section 8 of the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000). Section 8 describes how head measurements are made using a network of 16 wells. It was later determined that hydraulic capture could be determined through the use of a small network of wells located on the compliance boundaries (Table 2). Starting in 2008, a new set of wells along the southern side of the OU-1 landfill were selected to determine the inward gradients maintained by the new extraction wells 0449 and 0450; (several of the wells used previously were removed during excavation activities).

4.2.3 Operations and Maintenance

O&M requirements are documented in the *OU-1 Pump and Treatment Operational and Maintenance Plan* (DOE 2000). In January 2007, excavation of the OU-1 landfill was started to support future reuse of the property. Operation of the P&T system was modified to address the changing conditions as excavation activities progressed. Focus was placed on maintaining hydraulic capture and assessing downgradient groundwater quality. Sampling was performed according to the requirements in the *Work Plan for the Replacement of the OU-1 Extraction Wells*. Starting in June 2011, monitoring in OU-1 has been modified to support a rebound study. The monitoring requirements will be incorporated into a site-wide groundwater monitoring plan that will be developed to compile all of the O&M monitoring requirements into one document.

4.3 Phase I Groundwater (MNA) Remedy

The *Phase I Record of Decision* (DOE 2003a) was finalized in July 2003 to address groundwater contaminated with TCE in this discrete area through MNA and ICs. Phase I is an approximately 52-acre area. It lies on the southern border of the plant and is made up of three distinct sections of the site property (Figure 5). This area contains monitoring wells that are screened in both the BVA and the bedrock aquifer system. MNA is being utilized as a remedy for a small section of the bedrock groundwater system contaminated with TCE to ensure the concentration of TCE within the bedrock groundwater is decreasing to levels below the MCL and does not impact the downgradient BVA.

Several wells in this area also exhibit levels of barium, radium (Ra), chromium, and/or nickel that exceed MCLs established under the Safe Drinking Water Act. The elevated levels of barium and radium were evaluated and determined to be naturally occurring with the local bedrock matrix serving as the mineral source. The elevated chromium and nickel were determined to be the result of corrosion of the stainless steel well casings. DOE committed to monitor select wells to confirm the results of the previous investigations where these conclusions were reached.

ICs associated with Phase I are discussed in Section 4.1.3.

4.3.1 Remedy Selection

Groundwater in Phase I is monitored for TCE and its degradation products to verify that the concentration of TCE is decreasing due to natural attenuation and is not impacting the BVA. A groundwater monitoring program was established to ensure that the BVA is not negatively impacted by TCE-contaminated groundwater within the Phase I bedrock aquifer system. The objective of this monitoring is to protect the BVA by verifying that the concentration of TCE in the vicinity of well 0411, well 0443, and seep 0617 are decreasing and that TCE is not impacting the BVA. This program may be decreased or terminated with the TCE concentrations observed in well 0411, well 0443, and seep 0617 meet the MCL for four consecutive sampling events.

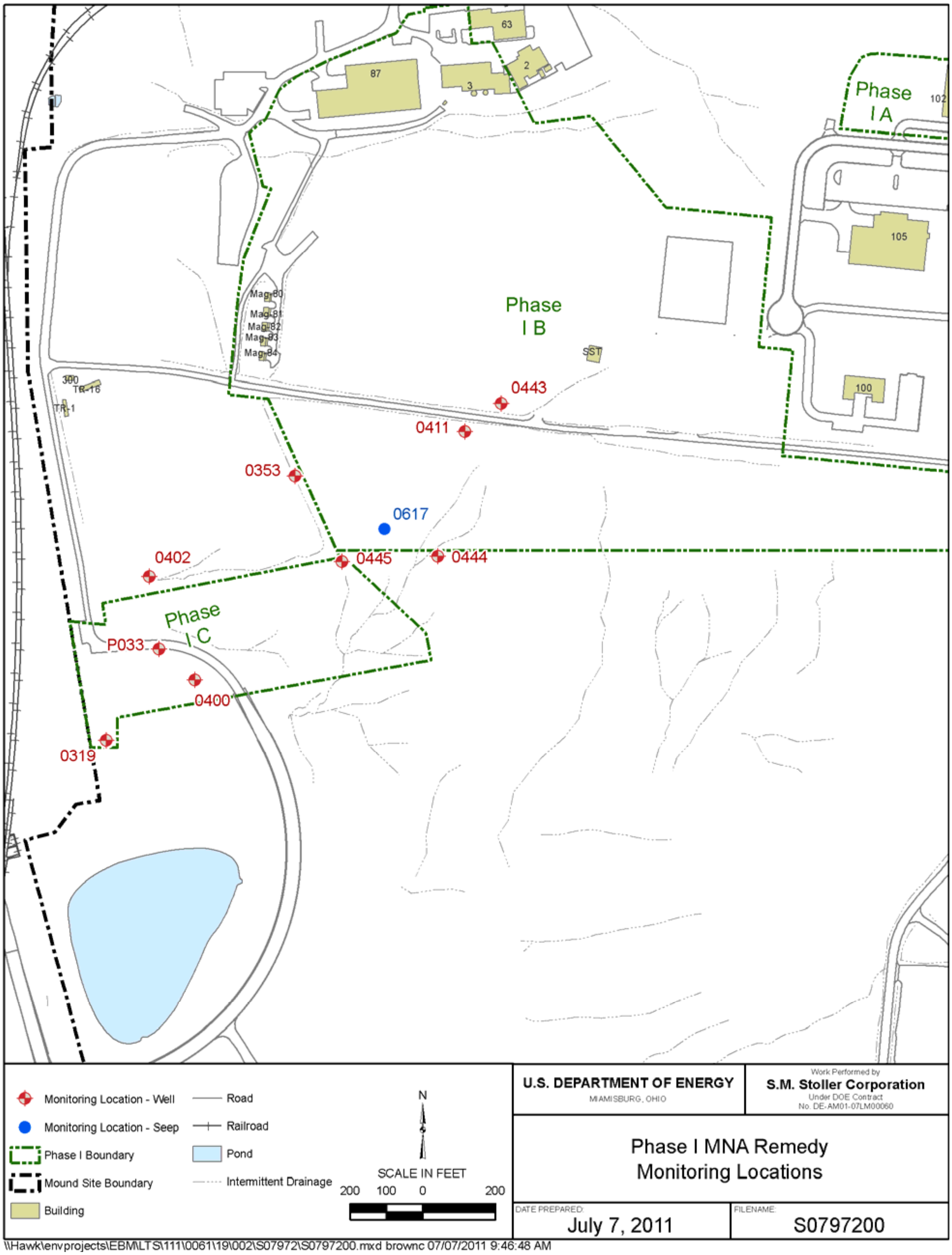

Figure 5. Monitoring Network for Phase I Groundwater (MNA) Remedy

Although not part of the selected remedy, monitoring was performed to evaluate barium, radium, chromium, and nickel impact in the Phase I groundwater. Based on investigations, none of these parameters were considered to be a contaminant of concern in Phase I.

Monitoring of groundwater for barium, Ra-226, and Ra-228 continues to provide assurance that the understanding of the barium and radium in groundwater is correct. If monitoring indicates that the concentrations are not decreasing below the MCL within a reasonable timeframe, the need for an active remediation for these contaminants or additional characterization will be considered. It was concluded from investigations in this area that a salt source located on the surface leached into the bedrock formation dissolving naturally occurring barium and radium in a low flow area of the bedrock aquifer. The salt storage shed was taken out of use.

Nickel and chromium concentrations observed in wells 0319, 0399, 0400, and 0411 are the result of corrosion of the stainless steel well casings and not the result of plant operations. Monitoring was performed to obtain a more comprehensive set of data to support this conclusion. Monitoring for nickel and chromium was discontinued in 2010.

4.3.2 Remedy Implementation

Under the MNA monitoring program, samples are collected from selected wells and seeps and analyzed as outlined in Section 4.3 of the *Phase I Groundwater Monitoring Plan* (DOE 2004b). In 2007, the sampling frequency for the MNA program was reduced to semiannually with the approval of the Mound Core Team. The present monitoring program is presented Table 4.

Table 4. Remedy (MNA) Monitoring for Phase I

Monitoring Location	Area	Parameters
Well 0411	Well 0411 Area	Trichloroethylene (TCE) Dichloroethylene (DCE) Vinyl Chloride (VC)
Well 0443		
Well 0353	Downgradient Bedrock Monitoring	
Well 0444		
Well 0445		
Seep 0617		
Well 0400	Downgradient Buried Valley Aquifer Monitoring	
Well 0402		
Well P033		

The confirmatory sampling program was modified with approval from the Mound Core Team in 2007 and 2009 (DOE 2008c and DOE 2010d). The confirmatory monitoring program is summarized in Table 5.

Table 5. Confirmatory Monitoring for Phase I

Location	Chromium	Nickel	Ra-226/228	Barium	Sodium	Chloride	Notes
Well 0319	X	X					Chromium/nickel (Cr/Ni) sampling discontinued in 2007.
Well 0400	X	X	X	X	X	X	Cr/Ni sampling discontinued in 2007. Sampling frequency reduced to semiannual in 2007.
Well 0402			X	X	X	X	Sampling frequency reduced to semiannual in 2007.
Well 0442	X	X					Cr/Ni sampling discontinued in 2007.
Well 0443	X	X					Cr/Ni sampling discontinued in 2009.
Well 0445			X	X	X	X	Sampling frequency reduced to semiannual in 2007.
Well P033			X	X	X	X	Sampling frequency reduced to semiannual in 2007.

The contaminant data is evaluated against previous data collected at each location to determine if MNA is adequately addressing groundwater impact and to monitor the geochemical conditions in the aquifer. Trigger levels and response actions have been established for each contaminant as presented in the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. The objective of the trigger level is to provide a threshold level that is indicative of a definitive change in the groundwater quality that would result in a response action. The levels of concern are designed to indicate that a change has occurred in the current bedrock groundwater system relative to the elevated barium and radium levels and could indicate the potential for increased mobility and mass transfer away from the source area (well 0445). The triggers and levels of concern are summarized in Table 6.

Table 6. Trigger Levels and Levels of Concern for Phase I MNA Remedy

Location	Trigger Levels			Levels of Concern			
	TCE (µg/L)	DCE (µg/L)	VC (µg/L)	Ra-226/228 (pCi/L)	Barium (mg/L)	Chromium (µg/L)	Nickel (µg/L)
0319	---	---	---	---	---	100	100
0353	5	70	2	---	---		
0400	5	70	2	5	1	100	100
0402	5	70	2	5	1	---	---
0411	30	70	2	---	---	---	---
0442	---	---	---	---	---	100	100
0443	30	70	2	---	---	100	100
0444	5	70	2	---	---	---	---
0445	5	70	2	75	---	---	---
P033	5	70	2	5	1	---	---
0617 (seep)	16	70	2	---	---	---	---

EPA and OEPA must be notified if these trigger levels or levels of concern are exceeded. After notification, the Mound Core Team (EPA, OEPA, and DOE) will determine an appropriate course of action.

4.3.3 Operations and Maintenance

The program to support MNA for the groundwater in Phase I is documented in the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2004b). ICs are evaluated in accordance with the *Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* (DOE 2004b). A new document titled the "Site-Wide IC Management/Land Use Control Plan (with CERCLA Summary)" is being prepared as a stand alone manual for implementing and maintaining the ICs and land use controls at the DOE Mound site in the future. The groundwater and seep monitoring requirements will be incorporated into a site-wide groundwater monitoring plan that will be developed to compile all of the O&M monitoring requirements into one document.

4.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

The *Parcels 6, 7, and 8 Record of Decision* (DOE 2009a) was finalized in September 2010 to address groundwater and seeps associated with the Main Hill contaminated with TCE and its breakdown products, tritium, and radionuclides through MNA and ICs. Parcels 6, 7, and 8 occupy approximately 101 acres of the northern portion of the Mound Plant site. The main production facilities were located within Parcels 6 and 8, and this area is called the Main Hill area (Figure 6).This area contains monitoring wells that are screened in the BVA and seeps. Groundwater within the fractured bedrock beneath the Main Hill area flows along horizontal bedding planes and fractures and ultimately discharges to seeps or to the downgradient BVA.

MNA is being utilized as a remedy for the bedrock groundwater system and BVA contaminated with TCE and its breakdown products, tritium, and radionuclides to ensure the concentrations of these constituents within the groundwater are decreasing to levels below the MCL and do not impact the downgradient BVA off-site.

ICs associated with Parcels 6, 7, and 8 are discussed in Section 4.1.3.

4.4.1 Remedy Selection

Groundwater in the Parcels 6, 7, and 8 area is monitored for TCE and its degradation products to verify that the downgradient BVA is not affected and that concentrations are decreasing. In addition, groundwater discharging from seeps is monitored for TCE and its degradation products, tritium, and radioisotopes (strontium-90 [Sr-90], Ra-226, and Ra-228) to verify that source removal will result in decreasing concentrations over time.

The sampling is separated into two programs that relate to the areas of impact. These areas are:

- **Wells 0315/0347 Area:** Wells at the edge of the BVA on the southwestern corner of Parcel 8 that have elevated concentrations of VOCs. The program consists of wells that have TCE greater than the MCL and downgradient wells to the west.
- **Main Hill Seeps:** Seeps on the northern and southern sides of the Main Hill that have elevated concentrations of VOCs and tritium. The program consists of seeps and downgradient wells to the west.

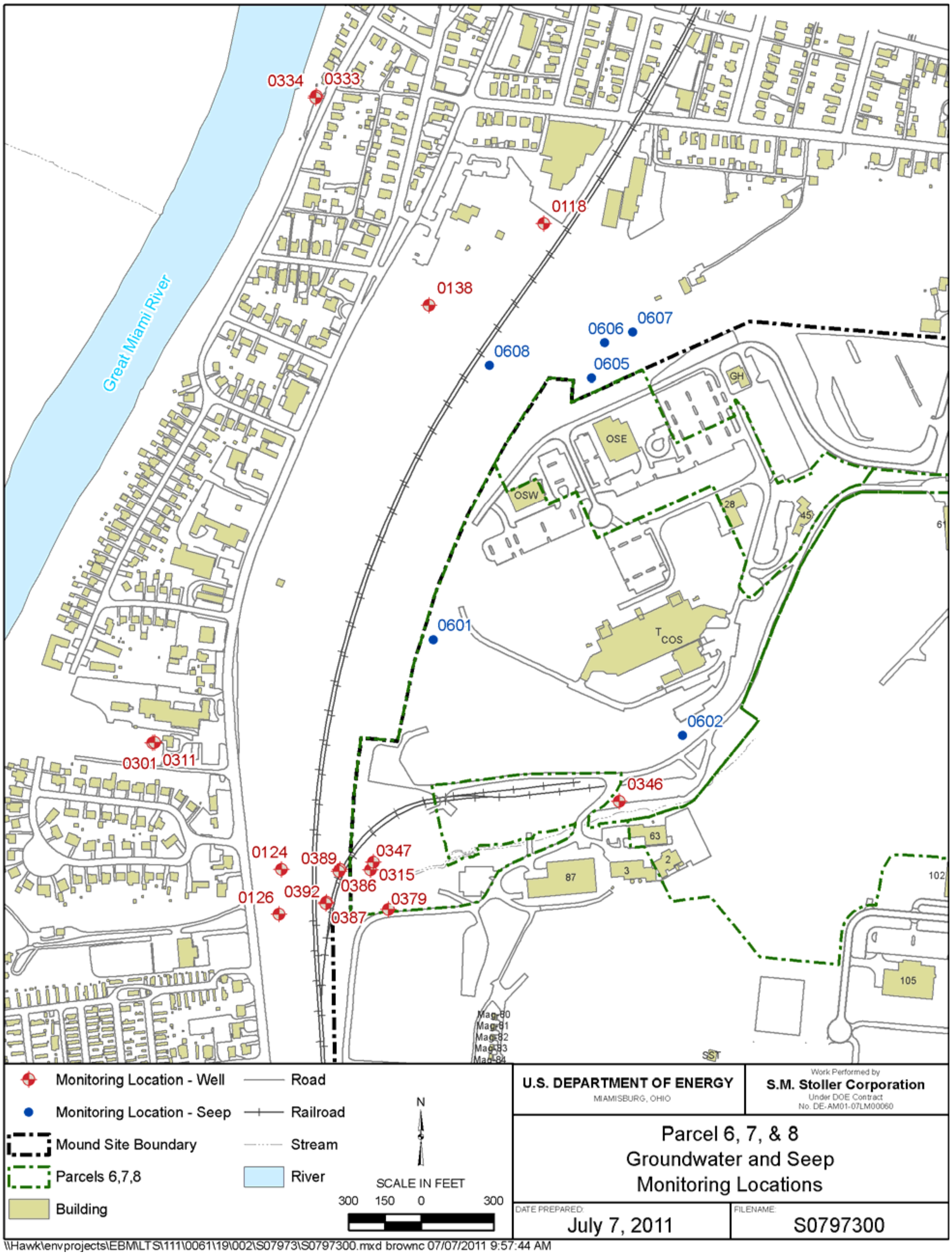

Figure 6. Parcels 6, 7, and 8 Groundwater and Seep Monitoring Locations

4.4.2 Remedy Implementation

Under the Parcels 6, 7, and 8 MNA monitoring program, samples are collected quarterly for selected wells and seeps (Figure 6) and analyzed as outlined in Sections 4.1 and 4.2 of the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Final Draft) (DOE 2006).

The two source wells and other selected downgradient BVA wells are monitored for VOCs—namely, tetrachloroethylene (PCE), dichloroethylene (DCE), TCE, and vinyl chloride (VC). A summary of the monitoring locations is provided in Table 7.

Table 7. Monitoring for the Wells 0315/0347 Area

<table>
<tr><th>Monitoring Location</th><th>Area</th><th>VOC</th></tr>
<tr><td>Well 0315</td><td rowspan="2">Source Wells</td><td rowspan="8">TCE
PCE
DCE
Vinyl Chloride</td></tr>
<tr><td>Well 0347</td></tr>
<tr><td>Well 0124</td><td rowspan="6">Downgradient BVA Monitoring</td></tr>
<tr><td>Well 0126</td></tr>
<tr><td>Well 0386</td></tr>
<tr><td>Well 0387</td></tr>
<tr><td>Well 0389</td></tr>
<tr><td>Well 0392</td></tr>
</table>

Water from seeps 0601, 0602, 0605, 0606, 0607, and 0608 is collected and analyzed for VOCs and the radiological constituents shown in Table 8. Wells within the BVA that are downgradient of the bedrock groundwater discharge area of the Main Hill will also be sampled to monitor the levels of tritium and VOC contamination.

Table 8. Monitoring for the Main Hill Seeps and Groundwater

<table>
<tr><th>Monitoring Location</th><th>Area</th><th>Parameters</th></tr>
<tr><td>Seep 0601</td><td rowspan="6">Main Hill Seeps</td><td>TCE
PCE
DCE
Vinyl Chloride
Ra-226 and Ra-228
Tritium
Sr-90</td></tr>
<tr><td>Seep 0602</td><td rowspan="5">TCE
PCE
DCE
Vinyl Chloride
Tritium</td></tr>
<tr><td>Seep 0605</td></tr>
<tr><td>Seep 0606</td></tr>
<tr><td>Seep 0607</td></tr>
<tr><td>Seep 0608</td></tr>
<tr><td>Well 0118</td><td rowspan="5">Downgradient BVA Monitoring Wells</td><td rowspan="5">TCE
PCE
DCE
Vinyl Chloride
Tritium</td></tr>
<tr><td>Well 0138</td></tr>
<tr><td>Well 0301</td></tr>
<tr><td>Well 0346</td></tr>
<tr><td>Well 0379</td></tr>
</table>

The contaminant data are evaluated against previous data collected at each location to determine if downward trends are occurring. Trigger levels and response actions have been established for each contaminant as presented in the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Draft Final) (DOE 2006). The objective of the trigger level is to provide a threshold level that is indicative of a definitive change in the groundwater quality that would result in a response action. The triggers are summarized in Table 9.

EPA and OEPA must be notified if these trigger levels are exceeded. After notification, the Mound Core Team (EPA, OEPA, and DOE) will determine an appropriate course of action.

Table 9. Trigger Levels for Parcels 6, 7, and 8 Monitoring Locations

Location	TCE (µg/L)	PCE (µg/L)	Tritium (nCi/L)	Ra-226/228 (pCi/L)	Sr-90 (pCi/L)
0315	30				
0347	30				
0124	5				
0126	5				
0386	5				
0387	5				
0389	5				
0392	5				
0601 (seep)		75	1,500	20	20
0605 (seep)	150				

nCi/L = nanocuries per liter

4.4.3 Operations and Maintenance

The program to support MNA for the groundwater in Parcels 6, 7, and 8 is documented in the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Draft Final) (DOE 2006b). ICs are evaluated in accordance with the *Operations and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* (DOE 2004b). A new document titled the "Sitewide IC Management/Land Use Control Plan (with CERCLA Summary)" is being prepared as a stand alone manual for implementing and maintaining the ICs and land use controls at the DOE Mound site in the future. The groundwater and seep monitoring requirements will be incorporated into a site-wide groundwater monitoring plan that will be developed to compile all of the O&M monitoring requirements into one document.

4.5 O&M Costs for the Mound Site

Costs associated for each remedy are not tracked separately. The total O&M costs for groundwater monitoring, sample analysis, data management, reporting, and operation of the OU-1 P&T system are included in the costs shown in Table 10.

Table 10. General O&M Costs for the Mound Site

Year	O&M Cost
2006	$ 563,529
2007	$ 1,148,190
2008	$ 1,180,741
2009	$ 708,363
2010	$ 566,411
Total	$ 4,167,234

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5.0 Progress Since Last Review

5.1 Institutional Controls

Since the last five-year review, the Parcels 6, 7, and 8 ROD was signed in 2010 and contained two additional ICs relating to T Building. These are:

- Prohibit the removal of concrete floor material in specified rooms of T Building to off-site locations without prior approval from EPA, OEPA, and ODH.
- Prohibit the penetration of concrete floors in specified rooms of T Building without prior approval from EPA, OEPA, and ODH.

The OU-1 ROD is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. As stated in the OU-1 ROD, the ICs for this area would be developed prior to transfer and therefore, will be outlined in future documentation for Parcel 9.

5.1.1 Protectiveness Statement from Last Review

The remedy for parcels D, H, 3, and 4 and the ICs associated with Phase I are protective of human health and the environmental because controls are functioning as intended. However, in order to ensure the long-term protectiveness of the remedy, adequate signage should be installed to inform visitors that fishing, swimming, and wading is prohibited in the Parcel 4 retention basin.

5.1.2 Status of Recommendations from Last Review

Recommendations regarding ICs from the last review were:

- Ineffective signage at the Parcel 4 retention basin has resulted in violation of the ICs in the past (land-use inconsistent with industrial/commercial land-use).

After reconsidering the exposure assumptions that were used to develop the industrial/ commercial cleanup standards for the Mound Site, DOE, EPA, and OEPA reached the conclusion that occasional visits to the retention pond by area residents will not result in an unacceptable risk to the visitors. Even so, DOE and MDC will continue to monitor and discourage these unauthorized uses of the Parcel 4 retention basin area. No further action is required to assure protectiveness of human health or the environment.

5.1.3 Status of Other Prior Issues

No other issues related to the ICs have been identified.

5.2 Operable Unit 1

Since the last five-year review, the OU-1 landfill was excavated in two phases under a Congressionally funded non-CERCLA activity during period from 2007 to 2010. As a result of this excavation, access to the former landfill area is not longer required and the source materials

for groundwater impact have been removed. In addition to the removal of the site sanitary landfill the Soil Vapor Extraction (SVE) was removed.
The OU-1 Record of Decision is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. This amendment will include removal of ICs specifying fencing controls around the OU-1 landfill area and access controls to minimize contact with those soils. The ICs will be adjusted to match those for the rest of the site as described in Section 4.1.3.

Operation of the P&T system, which controls the migration of TCE-contaminated groundwater in the OU-1 area, was stopped in June 2011 to support a rebound study. Since the source has been removed, the feasibility of moving away from containment to a more passive remedy, namely monitored natural attenuation (MNA), is being considered.

5.2.1 Protectiveness Statement from Last Review

The remedy for OU-1 is protective of human health and the environment and, in the interim, exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and control of access to the landfill. However, in order to ensure the long-term protectiveness of the remedy, adequate documentation and interpretation of the operational and monitoring data associated with the P&T system should be maintained. Also, long-term monitoring locations should be adequately maintained to ensure that representative samples are obtained and to prevent possible impact to the aquifer via surface water infiltration.

5.2.2 Status of Recommendations from Last Review

Recommendations regarding OU-1 from the last review were:

- Excessive vegetation is present around the OU-1 facility and structures and on the landfill surface.
- Inadequate storm water control is maintained on the southwestern corner of the landfill.
- Inadequate documentation and interpretation of operational and monitoring data for the OU-1 remedy is maintained. Permanent ID markers are not installed on all long-term groundwater monitoring wells.
- Protective casings of the long-term groundwater monitoring locations are in general disrepair.
- Adequate protection from vehicular traffic is not present for long-term groundwater monitoring wells.
- Excessive vegetation is present around the long-term groundwater monitoring locations.

A routine maintenance program to address vegetation and general housekeeping needed to be established for the OU-1 area. During the inspection, excessive vegetation was noted around the treatment buildings, extraction wells, SVE wells, fence line, and drainage areas. Routine cutting of the vegetation would facilitate periodic inspection of the facility and appurtenances, reduce degradation of the concrete drainage channels, facilitate flow in the drainage channels, and reduce the likelihood of vermin in the buildings.

A corrective action needed to be developed to address the inadequate storm water controls on the southwestern corner of the OU-1 landfill. Ponding of water should be prevented in order to reduce the infiltration of water into the landfill that will ultimately lead to migration of contaminants from the soil into the groundwater.

An annual report summarizing the hydraulic gradient determinations, groundwater monitoring data, and performance evaluations of the OU-1 P&T and SVE systems should be prepared. Previous reporting was accomplished using the monthly reports prepared by the environmental restoration contractor. While monthly summaries of the data are beneficial, an annual summary would aid in the interpretation of the performance of the system and provide valuable information for future five-year reviews.

A routine maintenance program needs to be established for the long-term groundwater monitoring locations at the Mound Site. This program should include periodic inspections of the integrity of the wells and the condition of the protective casing and surface pad as well as the surrounding area and access. Neglect of these wells could lead to failure of the surface seals, which could lead to migration of contamination from surface sources into the subsurface. Also, protection of these locations should be maintained as construction activities increase in the transitioned parcels. In the long-term this could impact the monitoring results that are used to evaluate the effectiveness of the remedies.

These deficiencies were addressed during 2007 (DOE 2007a). Issues regarding the general condition of the OU-1 landfill (i.e., housekeeping, surface water ponding) were no longer an issue as excavation of the landfill was started in January 2007. It was decided that monthly documentation of the performance of the OU-1 P&T system was adequate; however, the data was made more readily available and additional information was included in the reports.

A well rehabilitation program was initiated in 2007 that included repainting of all the long-term wells and bollards and installing permanent well identification markers. Broken surface pads were repaired and vegetation was removed. Protection from vehicular traffic was installed for those wells that were determined to be at greater risk. The monitoring network is inspected during each sampling event to ensure the integrity of the monitoring well network is maintained. Vegetation around the wells and seeps is removed at least once a year, and access is better maintained. The wells are repainted as necessary.

5.2.3 Status of Other Prior Issues

No other issues related to the remedy for OU-1 have been identified.

5.3 Phase I Groundwater (MNA) Remedy

Since the previous five-year review, monitoring has been ongoing. The sampling frequency for the Phase I MNA remedy has been reduced from quarterly to semiannually. No changes were made to the monitoring network.

5.3.1 Protectiveness Statement from Last Review

The remedy for Phase I is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent the groundwater from being used in the restricted area. However, in order to ensure the long-term protectiveness of the remedy, long-term monitoring locations should be adequately maintained to ensure that representative samples are obtained and to prevent possible impact to the aquifer via surface water infiltration.

5.3.2 Status of Recommendations from Last Review

Recommendations regarding Phase I from the last review were:

- Permanent ID markers are not installed on all long-term groundwater monitoring wells.
- Protective casings of the long-term groundwater monitoring locations are in general disrepair.
- Adequate protection from vehicular traffic is not present for long-term groundwater monitoring wells.
- Excessive vegetation is present around the long-term groundwater monitoring locations.

A routine maintenance program needed to be established for the long-term groundwater monitoring locations at the Mound Site. This program should include periodic inspections of the integrity of the wells and the condition of the protective casing and surface pad as well as the surrounding area and access. Neglect of these wells could lead to failure of the surface seals and lead to the potential for migration of contamination from surface sources into the subsurface. Also, protection of these locations should be maintained as construction activities increase in the transitioned parcels. In the long-term this could impact the monitoring results that are used to evaluate the effectiveness of the remedies.

This issue was resolved in 2007 (DOE 2007a). A well rehabilitation program was initiated in 2007 that included repainting of all the long-term wells and bollards and installing permanent well identification markers. Broken surface pads were repaired and vegetation was removed. Protection from vehicular traffic was installed for those wells that were determined to be at greater risk. The monitoring network is inspected during each sampling event to ensure the integrity of the monitoring well network is maintained. Vegetation around the wells and seeps is removed at least once a year and access is better maintained. The wells are repainted as necessary.

5.3.3 Status of Other Prior Issues

No other issues related to the Phase I MNA remedy have been identified.

5.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

The remedy for groundwater in Parcels 6, 7, and 8 was approved in 2010. Groundwater monitoring in support of the remedy has been performed since 2006.

This is the first five-year review of the Parcels 6, 7, and 8 Remedy. Annual reports have been prepared since 2006 summarizing the data for the MNA remedy. These reports were reviewed as part of this five-year review.

5.5 Operable Unit 4—Miami-Erie Canal

A no action ROD was approved for the soil in the Miami-Erie Canal in 2004. The Miami-Erie Canal was never owned by DOE; however, the canal was included on the NPL due to impact from operational and accidental releases from the facility. Remediation of the canal soil attained risk levels that were acceptable for residential use. No property transfer was necessary. As this was a no-action ROD, further evaluation of the canal was not performed for this five-year review report.

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6.0 Five-Year Review Process

6.1 Administrative Components of the 2011 Five-Year Review

LM began the Mound Site five-year review process in December 2010 and continued it through August. This included notifying regulatory agencies, the community, and other interested parties; establishing the review team in consultation with EPA and OEPA; reviewing relevant documents and data; conducting site inspections; analyzing monitoring data; and developing and reviewing this third five-year review report.

LM discussed the five-year review process with the EPA and OEPA at the FFA and Mound Core Team meeting on December 14, 2010. During the February 15, 2011, FFA meeting, the regulators agreed to combine the physical walkarounds for the annual IC assessment and the five-year review.

The annual IC assessment walkaround with the regulators and stakeholders occurred on April 12, 2011. The physical inspection for the CERCLA five-year review was held concurrently. Art Kleinrath, LM Mound Site Manager, began the walkaround with a presentation that defined the scope of the annual assessment, reviewed the 2010 assessment recommendations, and presented the results of the 2011 preliminary inspections. Participants were given a safety briefing, a copy of the presentation, and the IC checklist for the walkaround.

The annual walkaround consisted of a driving tour of the site and a walkaround inside T Building. Participants in the annual walkaround included:

- Frank Bullock, MDC
- Becky Cato, S.M. Stoller Corporation (Stoller)
- Joe Crombie, ODH
- Tim Fisher, EPA
- Chuck Friedman, Stoller
- Ken Karp, Stoller
- Art Kleinrath, LM
- Joyce Massie, J.G. Management Systems, Inc. (JGMS)
- Anthony Campbell, OEPA
- Jane Powell, LM
- Bob Ransbottom, Stoller
- Karen Reed, LM
- Jeff Smith, OEPA
- Ellen Stanifer, City of Miamisburg
- Gary Weidenbach, Stoller

The CERCLA five-year review team included: Art Kleinrath, LM; Rebecca Cato, Laura Cummins, Chuck Friedman, and Bob Ransbottom, Stoller; Joyce Massie, JGMS; Tim Fischer, EPA-Region 5; and Brian Nickel, OEPA.

6.2 Community Notification and Involvement

LM placed public notices of the five-year review in the *Dayton Daily News* and Miamisburg West Carrollton newspapers. The notices described the review process including the ICs. DOE also created a CERCLA five-year review page, including a survey form for the public, on the LM Mound website. LM also e-mailed many local stakeholders, directing them to the website and inviting them to complete the survey. As of the end of the review period, no surveys were submitted via the website. Copies of the public notices and survey are contained in Appendix C.

Representatives of the City of Miamisburg and MDC accompanied the review team during every annual physical inspection for the assessment of ICs at the Mound Site, including the inspection performed on April 12, 2011. Also, personnel from both organizations were interviewed during the records review portion of the IC assessment during each annual review.

6.3 Interviews and Record Review

During each annual assessment of ICs at the Mound Site, DOE conducted interviews with representatives of the City of Miamisburg Engineering and Planning Departments. Review of permits with these departments indicated that all work performed by MDC or other parties during the reporting period appeared to be covered by permits submitted to the City.

In general, the City of Miamisburg permit review process maintains an adequate record-keeping system. The City queried the electronic permit database and provided a printout to LM. All reported work performed by MDC or other parties on the Mound Site during each 12-month reporting period was covered by permits submitted to the City.

Interviews were also conducted with O&M managers from both DOE and its oversight contractor, S.M. Stoller Corporation. These interviews are included with the Site Inspection Checklist (Appendix B).

6.4 Site Inspections

The annual IC assessments include a physical walkover inspection, discussions with property owners, and a review of records maintained by DOE, the property owner, and the City of Miamisburg Engineering and Planning Departments. During the visual inspection, DOE determines if new facilities have been constructed, if obvious improvements have been made to the property, and/or if property usage has changed. These visual inspections are typically performed by a group comprised of representatives of DOE, EPA, OEPA, the City of Miamisburg, and MDC.

Discussions with local government offices and records review will include, at a minimum, contacting the City of Miamisburg Engineering and Planning Departments to obtain information regarding construction or building permits, or exemptions from zoning ordinances, issued for the former DOE Mound Site. The following is a general discussion of each annual inspection. A more detailed discussion can be found in the appropriate report submitted for each inspection.

6.4.1 2007 Annual IC Assessment

The 2007 annual IC assessment covered Parcels 3, 4, D, and H, and Phase I (Areas A, B, and C). There were no observations of noncompliance. MDC owned all of these parcels except Phase I.

Wells that were present in each parcel were also inspected to document their condition. All of the monitoring wells were in operable condition. The annual assessment report documented the effectiveness of the ICs' remedy applied to the Parcels D, H, 4, 3 and the Phase I land parcel. This did not include a determination of the effectiveness of the various groundwater remedies, including the MNA remedy associated with the Phase I land parcel.

The 2007 report recommended adding the City Planning Commission requests to the list of documents examined for annual assessments to capture work not covered by the permit process such as parking lot installations. It also recommended adding the Ohio Department of Natural Resources (ODNR) well logs to the list of documents examined for annual assessments.

It was concluded in the *Annual Assessment of the Effectiveness of Institutional Controls Applied to the Former Mound Site Property, June 2007* (DOE 2007a) that ICs for Parcels 3, 4, D, H, and Phase I (Areas A, B, and C) continued to function as designed, adequate oversight mechanisms appeared to be in place to identify possible violations of ICs, and adequate resources were available to correct or mitigate any problems if a violation were to have occurred.

6.4.2 2008 Annual IC Assessment

The 2008 annual IC assessment covered Parcels 3, 4, D, H, and Phase I (Areas A, B, and C). There were no observations of noncompliance. MDC owned all of these parcels except Phase I.

Wells that were present in each parcel were also inspected to document their condition. All of the monitoring wells shown were in operable condition. The annual assessment report documented the effectiveness of the ICs' remedy applied to the Parcels D, H, 4, 3 and the Phase I land parcel. This did not include a determination of the effectiveness of the various groundwater remedies, including the MNA remedy associated with the Phase I land parcel.

The 2008 report recommended that the landowner or management organization must notify LM when address or street names change on site, since building permits are filed by street address. It also recommended adding the landowner or management organization contracts and easement documents to those reviewed for the annual IC assessment.

It was concluded in the *Annual Assessment of the Effectiveness of Institutional Controls Applied to the Former Mound Site Property, June 2008* (DOE 2008b) that ICs for Parcels D, H, 3, and 4 continued to function as designed, adequate oversight mechanisms appeared to be in place to identify possible violations of ICs, and adequate resources were available to correct or mitigate any problems if a violation were to have occurred.

6.4.3 2009 Annual IC Assessment

The 2009 annual IC assessment covered Parcels 3, 4, D, H, and Phase I (Areas A, B, and C). There were no observations of noncompliance. MDC owned all of these parcels.

Monitoring wells were also inspected to document their condition, and all were in operable condition. The annual assessment report documented the effectiveness of the ICs' remedy applied to the Parcels D, H, 4, 3 and the Phase I land parcel. This did not include a determination of the effectiveness of the various groundwater remedies, including the MNA remedy associated with the Phase I land parcel.

The 2009 report recommended confirming that a well was correctly abandoned and removed from the ODNR website, and improving drainage around well 0353.

It was concluded in the *Annual Assessment of the Effectiveness of Institutional Controls Applied to the Former Mound Site Property, July 2009* (DOE 2009c) that ICs for Parcels D, H, 3, and 4 and Phase I continued to function as designed, adequate oversight mechanisms appeared to be in place to identify possible violations of ICs, and adequate resources were available to correct or mitigate any problems if a violation were to have occurred.

6.4.4 2010 Annual Inspection

This annual assessment covered Parcels D, H, 3, 4, 6, 7, and 8 and the Phase I (Areas A, B, and C) parcel of the Mound Site. MDC owned all of these parcels except Parcels 6, 7, and 8.

There were no observations of noncompliance with the ICs. In particular, there was no evidence of unauthorized well installation or soil removal within the original boundaries of the DOE Mound Site property.

Although not an IC, groundwater monitoring is required by CERCLA remedies for some parcels. The inspection included the physical conditions of wells and seeps associated with these remedies.

The 2010 annual assessment recommended improving the marking labels at seeps; removing the water sampling station, fencing over seep 0607, and returning the area to its original condition; ensuring that the signs by the pond in Parcel 4 are present at all times; and painting well 0124 in the old canal area.

It was concluded in the *Annual Assessment of the Effectiveness of Institutional Controls Applied to the Former Mound Site Property, July 2010* (DOE 2010c) that the ICs for Parcels D, H, 3, 4, 6, 7, and 8 and the Phase I land parcel continued to function as designed. Adequate oversight mechanisms appeared to be in place to identify possible violations of ICs, and adequate resources were available to correct or mitigate any problems if a violation were to have occurred.

6.4.5 2011 Inspections—Annual IC and Five-Year Review

The 2011 physical inspections, which combined the annual IC inspection and the CERCLA five-year review inspection, are summarized in the following sections. The five-year review Site Inspection Checklist is contained in Appendix B. Photographs from the walkaround performed for this review are contained in Appendix A.

6.4.5.1 Institutional Controls Inspection

The annual assessment of the effectiveness of the institutional controls for the Mound Site, in accordance with the *Operations and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property,* was conducted in March and April of 2011. This assessment covered the entire Mound Site.

The physical walkaround was held on April 12, with representatives of EPA, OEPA, MDC, and the City of Miamisburg participating in the inspection. This inspection also served as part of the five-year review inspection to support the CERCLA five-year review report. The physical inspection included the areas within T Building to which special ICs—which prohibit the penetration of concrete in some areas, and the removal of concrete in others, without prior approval—apply.

The solar array was installed west of COS Building. This work was covered by City of Miamisburg permits and was overseen by MDC.

The recommendations from the 2010 annual IC assessment report were corrected. One issue that was noted during each annual inspection was wording on signs at the MDC retention basin near the bike path in Parcel 4. The second five-year review for the Mound Site recommended that the issue of adequate signage around the Parcel 4 retention basin be addressed by DOE, EPA, and OEPA. Signs placed around the basin to inform area visitors that recreational use around the basin is prohibited have been damaged and removed on several occasions by members of the public.

After reconsidering the exposure assumptions that were used to develop the industrial/commercial cleanup standards for the Mound Site, DOE, EPA, and OEPA have reached the conclusion that occasional visits to the retention pond by area residents will not result in an unacceptable risk to the visitors. Even so, DOE and the MDC will continue to monitor and discourage these unauthorized uses of the Parcel 4 retention basin area. No further action is required to assure protectiveness of human health or the environment.

No recommendations significant to the protectiveness of the remedies were made as a result of this 2011 inspection.

It was concluded in the *Annual Assessment of the Effectiveness of Institutional Controls Applied to the Former Mound Site Property, June 2011* (DOE 2011a) that there were no observations of noncompliance with the ICs. In particular, there was no evidence of unauthorized well installation, soil removal, or site activities inconsistent with industrial/commercial use. The ICs continue to function as designed. Adequate oversight mechanisms appear to be in place to identify possible violations of ICs, and adequate resources are available to correct or mitigate any problems if violations occur.

6.4.5.2 Phase I and Parcels 6, 7, 8 Groundwater Monitoring Wells and Seeps

Because the groundwater monitoring is not an IC, the annual IC assessment only verifies the conditions of the wells and seeps, and it does not determine the effectiveness of the MNA remedies.

All Phase I wells were locked, had permanent markers, and were in good condition. One outstanding recommendation from the 2009 annual assessment was to improve the drainage around well 0353. Drainage was corrected after the excavation at OU-1 was completed in 2010.

All of the Parcels 6, 7, and 8 wells were locked and in good condition, with the exception of well 0124. Well 0124, which was rusty and needed painting, was painted in 2011.

The 2010 inspection report recommended that the seeps be marked with sturdier markers. However, it was decided that adding more visible markers would call unwanted attention to the seep locations. Since the samplers use the global positioning system (GPS) locations and sample the seeps often, it was decided that no further marking would be added at this time.

It was observed in 2010 that the old tritium sampler over seep 0607 was no longer required or functional. This sampler and the surrounding fence were removed, and the area was returned to its original state before the 2011 inspection.

6.4.5.3 OU-1 Landfill

The site sanitary landfill has been removed, and the pond immediately adjacent to its northern edge has been filled. The land area has been graded and contoured to direct the storm flow to the northwest corner of the former pond where a catch basin has been installed. The northern edge of the former pond area has been graded and contoured to promote storm water flow to the catch basin in the northeast corner of the former pond.

This walkaround consisted of a visual survey of the physical aspects of the OU-1 remedy and included the landfill area, storm water controls, and the OU-1 P&T system.

The general condition of the OU-1 area is adequate. Access roads are in minor disrepair, but they provide adequate access for inspection of the OU-1 area and operation of the treatment system and storm water controls.

ICs associated with OU-1 consisted of land-use controls to restrict access to the area to minimize contact with soils. Fencing around the landfill proper was removed during the excavation of OU-1 and was not replaced.

Storm water from this area was monitored in accordance with NPDES permit 1IO00005*ID. On November 1, 2007, OEPA granted DOE's request to redesignate the NPDES 1IO00005001 discharge from the sanitary package sewage treatment plant to the 1IO00005002 discharge point, which goes to the same body of water, the Great Miami River. This was done so that the pipe that contained the discharge at that time could be removed as required under CERCLA. On November 4, 2009, OEPA granted DOE's request to terminate NPDES Permit number 1IO00005*JD. This permit covers the two outfalls at the U.S. DOE Mound Closure Project. Outfall 001 was the former sanitary effluent and outfall 002 was the storm water discharge. The final reporting period for these two outfalls was November 2009.

During the walkover of the OU-1 area, the groundwater monitoring wells that are included in the *OU-1 Pump and Treatment Operations and Maintenance Plan* were also inspected. The wells were locked and in good condition.

6.4.5.4 OU-1 Pump and Treatment System

The OU-1 P&T system is composed of two extraction wells (0449 and 0450) located along the southern edge of the former landfill area. These create a hydraulic barrier to prevent the migration of VOC-impacted groundwater. Water extracted from the two extraction wells is directed to Building 300, where VOC contamination is removed. The effluent from this system is monitored and discharged in accordance with the CERCLA Authorization to Discharge (ATD) under NPDES (Authorization Number 1 IN90010*BD). Visual inspection of the components of the treatment system indicated that the building and system is in good condition.

The original extraction wells (0412, 0412, and 0414) were removed in 2007 during the excavation of the landfill. In addition to the removal of the site sanitary landfill, the SVE system was removed.

6.5 Document Review

The following sections use categories to list the documents that were reviewed as part of this five-year review.

6.5.1 Basis for Response Action

The documents listed in Table 11 identify the background and goals of the remedies and any changes in laws and regulations that could affect the response action. These documents also (1) address community concerns and preferences and (2) provide background information on the remedial actions, basis for action, cleanup levels, and applicable or relevant and appropriate requirements (ARARs).

Table 11. Documents Supporting Basis for Response Action at the Mound Site

Document	Purpose	Use for Review
Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio, June 1995	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns Cleanup Levels Operational Criteria ICs ARARs
Record of Decision for Release Block D, Mound Plant, Miamisburg, Ohio, February 1999	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio, June 1999	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Parcel 4 Record of Decision, Mound Plant, Miamisburg, Ohio, February 2001	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Parcel 3 Record of Decision, Mound Plant, Miamisburg, Ohio, August 2001	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Phase I Record of Decision, Miamisburg Closure Project, July 2003	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns Cleanup Levels ICs ARARs
Miami-Erie Canal Record of Decision, Miamisburg Closure Project, September 2004	Record selected remedial decision	Background Basis for Action Community Concerns ARARs
Parcels 6, 7, 8 Record of Decision, Mound Plant, Miamisburg, Ohio, September 2009	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs

Table 12. Documents Supporting Implementation of the Response at the Mound Site

Document	Purpose	Use for Review
Final Report on the Implementation of Operable Unit 1 Record of Decision	Documents the approach used to evaluate hydraulic capture for OU-1 pump and treatment	Data evaluation

6.5.2 Operations and Maintenance

O&M documents listed in Table 13 describe the ongoing measures at the Mound Site to ensure the remedy remains protective. They provide the structure for O&M at the site and confirm that O&M is proceeding as planned.

Table 13. Documents Supporting Operations and Maintenance at the Mound Site

Document	Purpose	Use for Review
OU-1 Pump and Treatment Operation and Maintenance Plan, March 2000	Provides the general guidelines for effective operation of the P&T system.	O&M Requirements Monitoring Requirements Reporting
Operation and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property, 2004	Provides details about the implementation of ICs for all parcels/phases at the Mound Site and the process for evaluation of the effectiveness of ICs.	O&M Requirements Reporting
Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan, September 2004	Provides the groundwater monitoring approach for the MNA remedy in Phase I.	Monitoring Requirements Reporting
Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Miamisburg Closure Project, Mound Site, Miamisburg, Ohio, Vol. 1 (Draft), September 2005	Provides a summary of activities and operations that are required to maintain the selected CERCLA remedial actions and ensure the effectiveness of the remedies.	O&M Requirements Commitments Reporting
Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan, December 2006	Describes the groundwater monitoring approach for the MNA remedy in Parcels 6, 7, and 8.	Monitoring Requirements Reporting

6.5.3 Remedy Performance

Monitoring data, progress reports, and performance evaluation reports listed in Table 14 provide information that can be used to determine whether the remedial actions continue to operate and function as designed and have achieved, or are expected to achieve, cleanup levels.

Table 14. Documents Supporting Remedy Performance at the Mound Site

Document	Purpose	Use for Review
CERCLA Five-Year Review Report for the Operable Unit 1 Remedy at the U.S. Department of Energy Miamisburg Environmental management Project, September 2001	Records status and protectiveness of remedy.	History Update Status
Second Five-Year Review for the Mound, Ohio, Site, Miamisburg, Ohio, September 2006	Records status and protectiveness of remedy.	History Update Status
Annual Assessment of the Effectiveness of Site-Wide Institutional Controls Applied to the Former Mound Site Property, multiple annual documents, June 2007–June 2011	Documents results of annual inspection and IC status.	IC status
Phase I Groundwater Monitoring Report, multiple annual documents, 2006–2010	Documents sampling results and conclusions regarding the effectiveness of the MNA remedy.	Site status Monitoring results
Parcel 6, 7, and 8 Groundwater Monitoring Report, multiple annual documents, 2007–2010	Documents sampling results and conclusions regarding the effectiveness of the MNA remedy.	Site status Monitoring results
OU-1 Monthly Summaries, entries in the ER Monthly report, October 2006–June 2011	Documents the monthly operation and performance of the OU-1 system.	System Performance
OU-1 Pump and Treatment System Performance Evaluation, March 2010	Documents the groundwater capture of the OU-1 P&T system.	System Performance
OU-1 Pump and Treatment System—Groundwater Capture Demonstration Using Rhodamine WT Dye, Mound, Ohio, February 2011	Documents the groundwater capture of the OU-1 P&T system.	System Performance

6.5.4 Legal Standard Regarding Remedial Action

The legal documentation listed in Table 15 includes information about specified responsibilities for conducting remedial action, implementing institutional and access controls, and O&M activities at the Mound Site.

6.6 Risk Information Review

A risk information review was conducted to determine if the site residual contamination could present unacceptable risks. The documents surveyed included residual risk evaluation documentation (general and parcel-specific), groundwater monitoring reports, and ICs monitoring reports, among others. Toxicity information sources (e.g., Integrated Risk Information System [IRIS], Health Effects Assessment Summary Tables [HEAST]) were consulted for main site constituents to determine whether there have been significant changes in the understanding of health-related effects since the last five-year review. The review of site-specific risk information included an evaluation of ARARs, exposure assumptions, and RAOs used at the time of remedy selection.

Table 15. Documents Supporting Legal Standards Regarding Remedial Action at the Mound Site

Document	Purpose	Use for Review
FFA under CERCLA Section 120; In the Matter of the U.S. DOE's Mound Plant (1993)	Documents the commitments and agreements regarding the implementation and operation of remedies. Also documents the responsibilities of other agencies.	Required Actions Roles of Other Agencies
Work Plan for Environmental Restoration of the DOE Mound Site, The Mound 2000 Approach, 1999	Documents the process for evaluating PRSs.	Site conditions
Mound 2000 Residual Risk Evaluation Methodology, Mound Plant, 1997	Documents the methodology for evaluating the residual risk remaining for each parcel.	Site conditions
Site Sales Agreement (updated 2008)	Documents (1) how DOE will convey the Mound Plant Property to MMCIC by discrete parcels, subject to CERCLA Section 120(h) and (2) the condition the property will be left in upon completion of remedial actions.	Required Actions

6.6.1 Applicable or Relevant and Appropriate Requirements

The chemical-specific ARARs identified in the RODs at the site are maximum contaminant levels specified in the Safe Drinking Water Act and MCLs identified in State of Ohio regulations (OAC-3745-81-11, -12, -13, -15, and -16). Numerical standards for the primary constituents of concern at the site are listed in Table 16. There have been no changes in these numerical values for the constituents that are the main drivers for remediation at the site since the time of the RODs that would call into question the protectiveness of the remedies selected for groundwater at the Mound Site.

Table 16. Applicable Groundwater Standards for the Mound Site

Constituent	Standard	ARAR
Tritium	20,000 pCi/L 4 mrem/yr	OAC-3745-81-16 40 CFR 141
Radium 226 + 228	5 pCi/L	OAC-3745-81-15 40 CFR 141
PCE	5 μg/L	OAC-3745-81-12 40 CFR 141
TCE	5 μg/L	OAC-3745-81-12 40 CFR 141
cis-1,2,-DCE	70 μg/L	OAC-3745-81-12 40 CFR 141
trans-1,2-DCE	100 μg/L	OAC-3745-81-12 40 CFR 141
Vinyl chloride (VC)	2 μg/L	OAC-3745-81-12 40 CFR 141

6.6.2 Exposure Pathways

The first ROD for the site was completed for OU-1. The risk assessment completed in support of that ROD considered a variety of exposure pathways and assumed exposures to both contaminated soils and groundwater. Risks were largely dominated by the use of groundwater as a source of drinking water.

As discussed in Section 3.3.2 the "traditional" CERCLA remediation approach was replaced with the Mound 2000 Process (DOE 1999c), which includes the preparation of an RRE to support a ROD for a given parcel. The site conceptual model for Mound was defined in the *Residual Risk Evaluation Methodology* (DOE 1997a) and includes assumptions regarding relevant exposure pathways at the Mound Site. A commercial/industrial land-use scenario was assumed with future construction workers and office workers as the primary receptors. Exposure pathways for both types of receptors included ingestion and inhalation of fugitive dust and external radiation from surface soil and ingestion of groundwater. Additionally, the construction worker was also assumed to experience inhalation of vapors from groundwater during showering with water from a well on the property. A RRE is completed for a parcel to demonstrate that remedial action goals are met and that a parcel is suitable for industrial/commercial purposes.

Total risks calculated in some RREs (e.g., Release Blocks D and H, Parcels 3 and 4) exceeded the acceptable risk range; as with OU-1, these were due primarily to the inclusion of the groundwater ingestion pathway. Subsequently, production wells were removed and prohibitions were placed on groundwater use. As a result, the more recent RRE prepared for Parcels 6, 7, and 8 (DOE 2007b) did not include the groundwater pathway. For purposes of this five-year review, the groundwater pathway is currently considered incomplete across the site. The other exposure pathways for construction and office workers from the original RRE methodology are still considered valid.

The original RRE methodology did not include the dermal pathway for soils. This pathway was subsequently added in the Parcels 6, 7, and 8 RRE. Results of this analysis indicate that risks associated with dermal exposure are typically less than those associated with ingestion, though in some instances they are roughly equivalent to ingestion risks. Therefore it appears that the inclusion of dermal exposures can increase total risks in some cases, though oral and external exposure pathways tend to dominate. Exclusion of the dermal pathway in the assessment of residual risks for some portions of the Mound Site may have slightly underestimated potential risks for site construction workers. However, the use of conservative exposure assumptions reduces the likelihood that real risks are significant.

The Parcels 6, 7, and 8 RRE did not address exposure to seep water because it was considered insignificant; however, because there are no controls on access to seeps it does constitute a complete exposure pathway and is considered briefly in this five-year review for the sake of completeness. Tritium and TCE are the most consistently elevated constituents in the seeps. Tritium concentrations have been observed as high as an order of magnitude above the MCL of 20,000 picocuries per liter (pCi/L); the majority of data, however range from half to five times the standard. Most data for TCE range from just below to four times the drinking water standard, with occasional values up to an order of magnitude above the drinking water standard. Based on these only slightly elevated levels (compared to drinking water standards), risks associated with infrequent incidental contact with contaminated seep water are expected to be negligible.

6.6.3 Toxicity Values

Five-year reviews require an assessment of toxicity data to determine if there have been any changes that would alter the protectiveness of the remedy. The RRE methodology (DOE 1997b) uses risk-based guideline values (RBGVs) as a screening tool for identifying constituents of concern to continue assessing under the residual risk evaluation of a given parcel. The RBGVs are based, in part, on toxicity values. These values have been adjusted over time as new toxicity data have become available. However, the RRE methodology calls for using a value of 1/10 the RBGV as an initial screen for inclusion of constituents for further evaluation. Because of this conservative approach it is highly unlikely that any constituents were screened out in the past that would warrant inclusion based on current toxicity values.

Table 17 shows toxicity values that were used to calculate the original RGBVs (DOE 1997b) for the main risk drivers in soil. Shortly after the development of the RGBVs, EPA completed an update of radionuclide slope factors in the HEAST based on Federal Guidance Report No. 13 (EPA 1999). A comparison of risks calculated using the original RBGVs and updated data from HEAST was included as part of the Parcel 3 RRE (DOE 2001c), which was completed shortly after the HEAST update. This comparison indicated that the new toxicity data had little effect on the calculated risks (some risk estimates were slightly higher, some lower). Since that time there have been no further changes in relevant HEAST values. It is unlikely that total risks estimated for portions of the site using older toxicity values for radionuclides would be significantly different than total risks estimated with current values.

Table 17 also contains several of the chemical constituents that were the main risk drivers in site soils, including arsenic and several polynuclear aromatic hydrocarbon compounds. Toxicity values for these selected constituents have not changed since the original RBGVs were developed. While a review was not conducted for every toxicity value used in past assessments at the site, there have been no recent changes in the understanding of the major site-related constituents in soils that would call into question the protectiveness of the remedy.

6.6.4 Remedial Action Objectives

The primary RAO for residual contaminated soil at the site is to ensure that exposures to soil do not result in an aggregate excess cancer risk of greater than the upper end of EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} or a hazard index greater than 1. This is accomplished primarily through the use of ICs at the site that:

- Limit land use to industrial/commercial usage only
- Prohibit the removal of soil from the property unless prior written approval from OEPA and ODH is obtained

The long-term RAO for groundwater is to meet MCLs (1) through MNA in the Phase I and Parcels 6, 7, and 8 areas (2) through hydraulic containment in the OU-1 area. Until these goals are achieved, the near-term RAO is to prohibit the extraction and use of groundwater underlying the premises unless prior written approval is obtained from OEPA and ODH.

Table 17. Evaluation of Toxicity Values for Soil at the Mound Site

Constituent	Exposure Pathway	Type	Toxicity Value RBGV Report (1997)	Current Toxicity Values (source)	Change
Benzo*(a)*pyrene	oral/dermal	C	7.3[a]	7.3[a] (I)	None
Benz*(a)*anthracene	oral	C	7.3E-01[a]	7.3E-01[a] (E)	None
Dibenz*(a,h)*anthracene	oral/dermal	C	7.3[a]	7.3[a] (E)	None
Plutonium 238	oral	C	3.0E-10[b]	2.72E-10[b] (H)	Decrease
Radium 226(+D)	external	C	6.7E-06[c]	8.49E-06[c] (H)	Increase
Radium 228(+D)	external	C	4.53E-06[c,e]	4.53E-06[c] (H)	None
Uranium 233/234	external	C	3.5E-11[c,f]	9.82E-10[c,f] (H)	Increase
Uranium 233/234	oral	C	4.5E-11[b,f]	1.6E-10[f] (H)	Increase
Arsenic[d]	oral	N	3.0E-04[d]	3.0E-04 (I)	None

Notes:
[a] Oral slope factor $(mg/kg/day)^{-1}$; these same slope factors are adjusted to calculate risks for dermal exposure
[b] Oral slope factor (risk/pCi)
[c] External slope factor (risk/yr per pCi/g soil)
[d] Oral reference dose (mg/kg/day)
[e] Value from RRE for Parcels 6,7,8 (DOE 2007)
[f] Higher of U-233 or U-234

Abbreviations:
C = carcinogenic
E = EPA Environmental Criteria and Assessment Office
H = HEAST
I = IRIS
N = non-carcinogenic

6.6.5 Changes in Risk Assumptions Since Last Five-Year Review

There have been no changes in risk assumptions since the last five-year review.

6.7 Data Review

Data from calendar years 2006 through 2010 is discussed below for each of the three remedies (i.e., Phase I groundwater; Parcels 6, 7, and 8 groundwater; and the OU-1 P&T system). Annual reports have been prepared for the Phase I MNA Groundwater Remedy since 2004 and for the Parcels 6, 7, and 8 MNA Groundwater Remedy since 2006. Data for the OU-1 P&T system has been reported in monthly project reports. Historical water quality and water level data for existing wells can be found on the LM website: http://gems.lm.doe.gov/. Photographs, maps, and physical features can also be viewed on this website.

The monitoring programs at the Mound Site include sampling and analysis of water collected from on-site and off-site wells and on-site seeps. The monitoring programs are formally defined in the following three documents:

- *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2004c)
- *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Draft Final) (DOE 2006b)
- *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000)

6.7.1 Phase I Groundwater

Groundwater in Phase I is monitored for TCE and its degradation products to verify that the concentration of TCE is decreasing by natural attenuation to concentrations less than the MCL. This groundwater monitoring program was established to ensure that the BVA is not negatively affected by TCE-contaminated groundwater within the Phase I bedrock aquifer system. The objective of this monitoring is to protect the BVA by verifying that (1) the concentration of TCE in the vicinity of well 0411, well 0443, and seep 0617 is decreasing and (2) TCE is not adversely affecting the BVA. This program may be decreased or terminated when TCE concentrations in well 0411, well 0443, and seep 0617 meet the conditions outlined in the monitoring plan, such as reaching the MCL for four consecutive sampling events.

Although not part of the selected remedy, monitoring was performed to evaluate the impact of barium, radium, chromium, and nickel on the Phase I groundwater. On the basis of investigations, none of these parameters were considered to be contaminants of concern in Phase I.

Monitoring for barium and radium is performed to provide assurance that the understanding of the barium and radium in groundwater is correct. If monitoring indicates that the concentrations are not decreasing below the MCL within a reasonable timeframe, the need for an active remediation for these contaminants or additional characterization will be considered. Investigations in this area confirmed that an upgradient salt source located on the surface had been infiltrating into the bedrock formation and mobilizing naturally occurring barium and radium in a low-flow area of the bedrock aquifer. Use of the salt storage shed was discontinued in 2003.

Nickel and chromium concentrations in BVA wells 0319 and 0400 and bedrock wells 0399 and 0411 are likely the result of corrosion of the stainless steel well casings and not the result of plant operations (DOE 2002). Monitoring was performed to obtain a more comprehensive set of data to support this conclusion.

In the 2007 Groundwater Monitoring Report, modifications to the monitoring program were recommended on the basis of the data collected through 2007. These modifications included reducing sampling frequencies and removing sampling locations for the MNA and confirmatory sampling programs. Minor changes to the program recommended in the 2007 Groundwater Monitoring Report (DOE 2008c) were made based on comments from the regulators.

The 2009 Groundwater Monitoring Report (DOE 2010d) recommended discontinuing confirmatory sampling at well 0443. Results collected through 2009 supported the conclusion that the elevated concentrations of metal in well 0411 did not represent the overall groundwater quality in the bedrock groundwater system.

6.7.1.1 Contaminants of Interest

During the remedial investigation program for the project, VOC contamination was identified in the Phase I area. Concentrations of TCE greater than the MCL of 5 milligrams per liter (mg/L) were identified in well 0411 and seep 0617. Soil and groundwater data from the wells in the vicinity of well 0411 suggest that the TCE contamination is most likely limited to the area adjacent to the well. There is no known continuing source of TCE contamination in the soil in Phase I; however, TCE was widely used in plant operation.

Groundwater data collected for both routine monitoring and to support parcel transfer yielded unusual and unexpected results. Relatively high concentrations of radium and barium were observed in low-yielding bedrock wells that are located in two different areas of the Mound Site. Neither of the subject areas is located in the central part of the site that involved production or materials handling. An investigation is described in the *Geochemical Evaluation of Elevated Ba and Ra in Bedrock at the Miamisburg Closure Project* (DOE 2006c). The investigation's hypothesis for the presence of the elevated parameters is that the brines in wells 0335 and 0445 originate from dissolution of salt stored at the ground surface. The dense brine infiltrated into an area of the bedrock that is relatively isolated from the main groundwater system. Interactions of this brine with the bedrock released radium and barium to the groundwater.

Field investigations indicated elevated nickel and chromium concentrations occur in wells constructed of stainless steel (DOE 2006d). Fieldwork showed that elevated chromium and nickel in the wells was highly localized and not widespread. Crevice corrosion of the wire slotted stainless steel well casing was the suspected mechanism for releasing the chromium and nickel from the casing to the groundwater adjacent to the well. This condition is more evident in samples collected using low-flow sampling techniques. The elevated levels observed in wells 0319, 0399, 0400, and 0411 are the likely result of corrosion of the well casing and not the result of plant operation.

6.7.1.2 Monitoring Program

Under the Phase I MNA monitoring program, samples were collected quarterly from selected wells and a seep (Figure 7) and analyzed as outlined in Section 4.3 of the Phase I Groundwater Monitoring Plan (DOE 2004c) and in Table 18. In 2007, the sampling frequency was reduced to semiannually with the approval of the Mound Core Team. Sampling is performed in the first and third quarters of each calendar year.

Table 18. Remedy (MNA) Monitoring for Phase I

Monitoring Location	Area	Parameters
Well 0411	Well 0411 area	Trichloroethylene (TCE) Dichloroethylene (DCE) Vinyl chloride (VC)
Well 0443		
Well 0353	Downgradient bedrock monitoring	
Well 0444		
Well 0445		
Seep 0617		
Well 0400	Downgradient BVA monitoring	
Well 0402		
Well P033		

Sampling frequency was reduced from quarterly to semiannually in 2007.

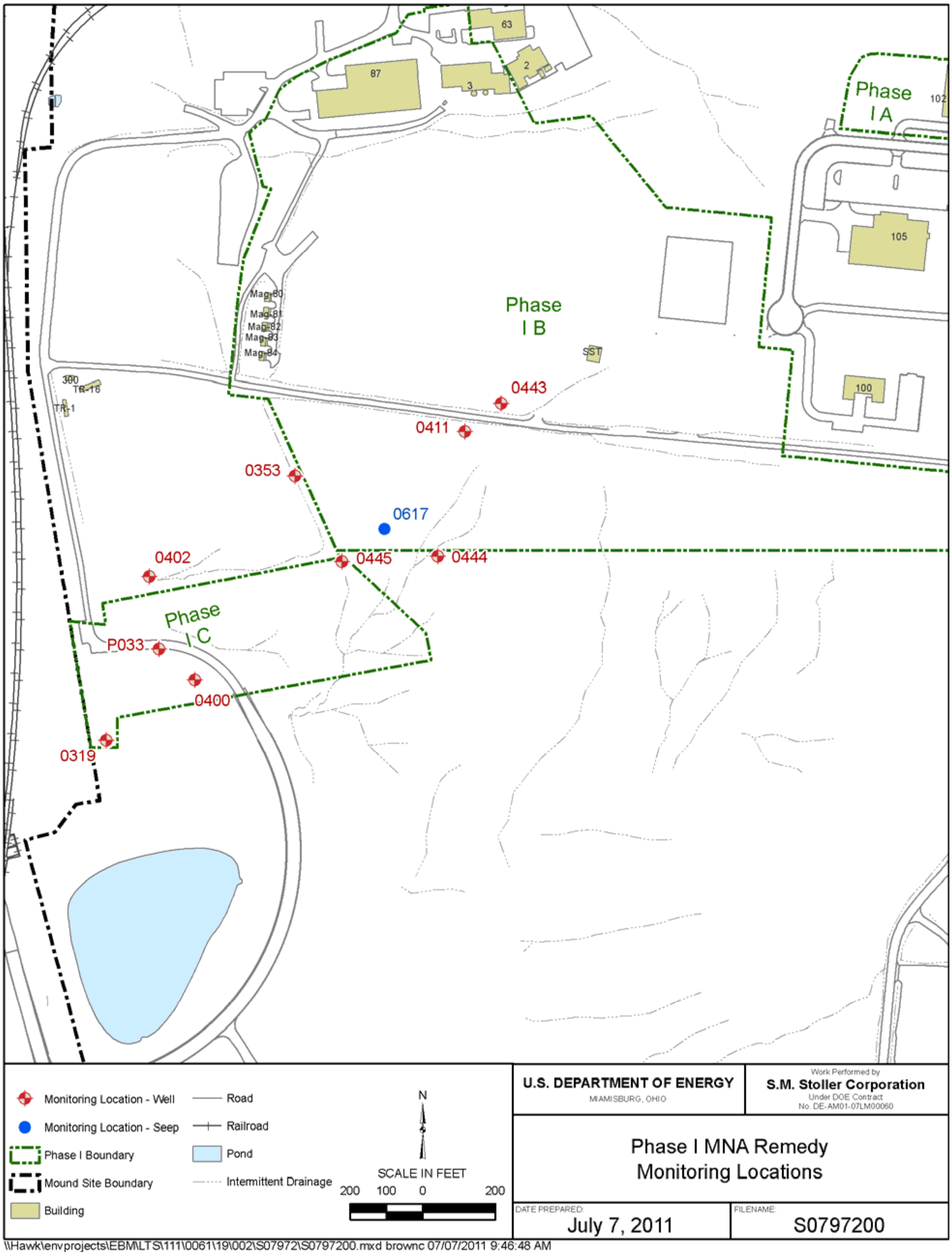

Figure 7. Phase I MNA Remedy Monitoring Locations

The confirmatory sampling program was modified with approval from the Mound Core Team in 2007 and 2009. Presently, confirmatory samples to evaluate the presence of elevated barium and combined radium 226/228 (Ra-226/228) are collected semiannually for selected wells, as outlined in Table 19. Sodium and chloride are also analyzed in these wells, as salt is considered the mechanism that has mobilized naturally occurring radium and barium in the bedrock groundwater. Confirmatory samples to evaluate the presence of elevated chromium and nickel in select stainless-steel wells was modified in 2007 and discontinued in 2009.

Table 19. Confirmatory Monitoring for Phase I

Location	Chromium	Nickel	Ra-226/228	Barium	Sodium	Chloride	Notes
Well 0319	X	X					Cr/Ni sampling discontinued in 2007.
Well 0400	X	X	X	X	X	X	Cr/Ni sampling discontinued in 2007. Sampling frequency reduced to semiannual in 2007.
Well 0402			X	X	X	X	Sampling frequency reduced to semiannual in 2007.
Well 0442	X	X					Cr/Ni sampling discontinued in 2007.
Well 0443	X	X					Cr/Ni sampling discontinued in 2009.
Well 0445			X	X	X	X	Sampling frequency reduced to semiannual in 2007.
Well P033			X	X	X	X	Sampling frequency reduced to semiannual in 2007.

The contaminant data are evaluated against previous data collected at each location to determine if MNA is adequately addressing groundwater impact and to monitor the geochemical conditions in the aquifer. Trigger levels and response actions have been established for each contaminant as presented in the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2004c). The triggers are summarized in Table 20.

EPA and OEPA are notified if trigger levels are exceeded. After notification, the Mound Core Team (EPA, OEPA, and DOE) will determine an appropriate course of action.

Table 20. Trigger Levels for Phase I MNA Remedy and Confirmatory Monitoring Programs

Location	TCE (µg/L)	DCE (µg/L)	VC (µg/L)	Chromium (µg/L)	Nickel (µg/L)	Ra-226/228 (pCi/L)	Barium (mg/L)
0319				100	100		
0353	5	70	2				
0400	5	70	2	100	100	5	1
0402	5	70	2			5	1
0411	30	70	2				
0442				100	100		
0443	30	70	2	100	100		
0444	5	70	2				
0445	5	70	2			75	15
P033	5	70	2			5	1
0617 (seep)	16	70	2				

µg/L = micrograms per liter
pCi/L = picocuries per liter
mg/L = milligrams per liter

6.7.1.3 MNA Remedy Monitoring

Monitoring results (Table 21) indicate low-level TCE and *cis*-1,2-dichloroethylene (DCE) detections in wells 0411 and 0443 and in seep 0617. All VOC concentrations were below the applicable trigger levels. Concentrations of TCE in wells 0411 and 0443 and seep 0617 continue to exceed the MCL of 5 micrograms per liter (µg/L). Estimated detects less than 1 µg/L of *trans*-1,2-DCE were reported at these three locations in 2008. No detectable concentrations of vinyl chloride were reported at any of the monitoring locations during the review period.

No detectable concentrations of TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, or VC were reported in the remainder of the downgradient BVA wells, except in well 0402. Estimated detects less than 1 µg/L were reported in well 0402 and were determined not to be attributable to the TCE-impacted groundwater in the upgradient bedrock, but rather to OU-1.

Table 21. Summary of VOC Monitoring Results in Phase I—2006 through 2010

Well ID	Location	Parameter	2006	2007	2008	2009	2010
Source Area Wells							
0411	0411 Area	TCE (µg/L)	**11.7**	**13.1**	**13.2**	**12.0**	**9.9**
		cis-1,2-DCE (µg/L)	2.8	2.2	1.8	3.1	3.3
		trans-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	0.14 (J)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0443	0411 Area	TCE (µg/L)	**7.7**	**9.8**	**11.1**	**6.2**	**6.4**
		cis-1,2-DCE (µg/L)	0.92 (J)	1.9	0.99 (J)	0.54 (J)	0.37 (J)
		trans-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	0.22 (J)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0617	Seep/ Bedrock	TCE (µg/L)	**6.9**	**6.9**	**8.4**	**6.3**	**5.5**
		cis-1,2-DCE (µg/L)	2.0	2.0	2.3	1.7	1.4
		trans-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)		ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
Downgradient Wells							
0353	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0444	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0445	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0400	BVA	TCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0402	BVA	TCE (µg/L)	ND (< 1)	1.8 (J)	ND (< 1)	0.71 (J)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
P033	BVA	TCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)

Values in **bold** exceed the MCL of 5 µg/L for TCE.
J = Estimated value less than the reporting limit

TCE concentrations in well 0411 (Figure 8) have decreased since monitoring began in 1999; however, concentrations appear to have remained between 9 and 15 micrograms per liter (µg/L) during the review period. The time-concentration plots for well 0443 and seep 0617 show concentrations that are variable and typically less than those in well 0411.

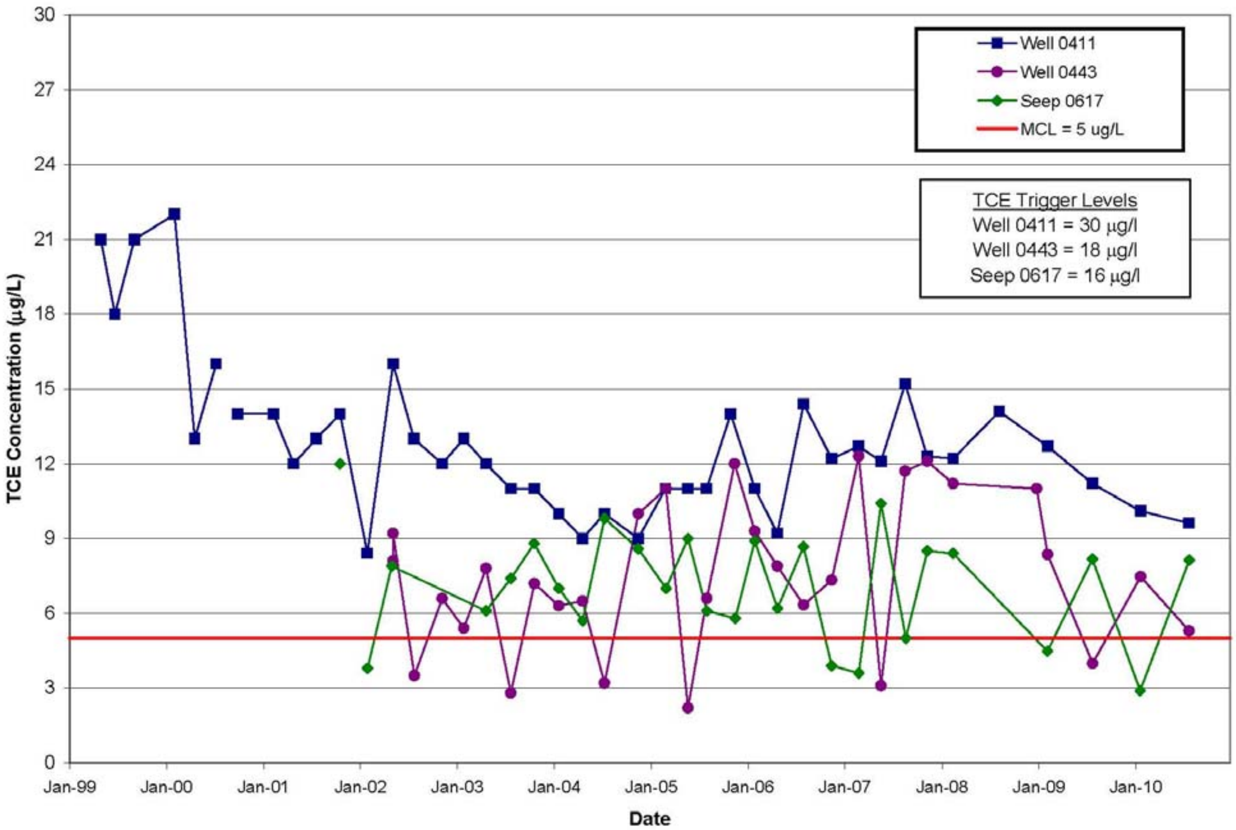

Figure 8. TCE Concentrations in Wells 0411 and 0443 and Seep 0617 (1999–2010)

The concentrations of *cis*-1,2-DCE in groundwater (Figure 9) are low and less variable than TCE. Concentrations in well 0411 and seep 0617 are within the same range of concentrations. Concentrations in well 0443 are generally lower than those measured in well 0411 and seep 0617. None of the locations exceeded the MCL of 70 µg/L for *cis*-1,2-DCE.

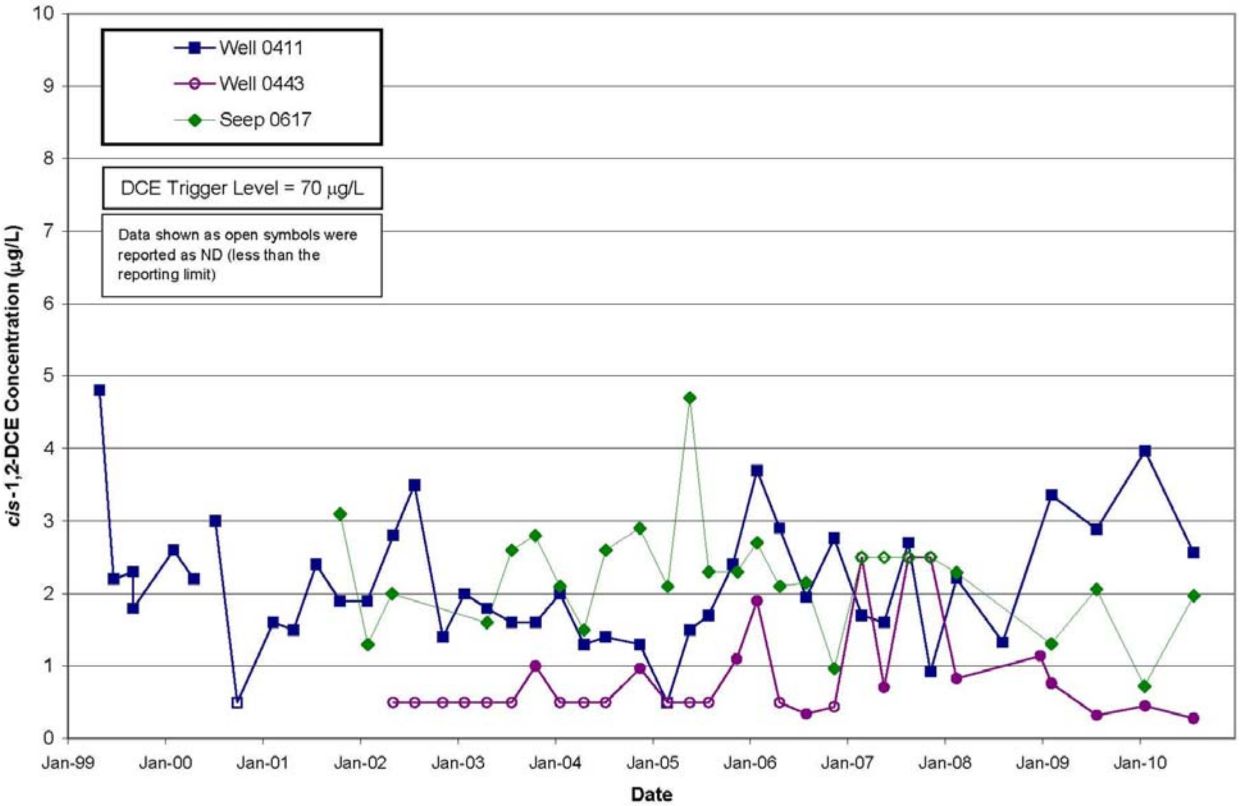

Figure 9. cis-*1,2-DCE Concentrations (1999–2010)*

Trend analysis was performed on TCE and *cis*-1,2-DCE data using the non-parametric Mann-Kendall test (DOE 2011b). This test is used for temporal trend identification, because it does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). This type of long-term trend analysis can be used to confirm trends in contaminant concentrations over time.

Trend analysis for TCE data collected from 2006 through 2010 continues to indicate decreasing TCE concentrations in well 0411 and seep 0617, as indicated by negative slopes (Table 22). Concentrations in well 0443 are increasing slightly, as indicated by a positive slope. A statistical downward trend was calculated for TCE in well 0411. No trends were determined for TCE in well 0443 and seep 0617.

Decreasing *cis*-1,2-DCE concentrations, although small, are present in seep 0617, as indicated by a negative slope. No trends, either upward or downward, were calculated from the *cis*-1,2-DCE data in the wells and seep.

Table 22. Summary of Trend Analysis Results for TCE in Phase I, 2006–2010

Location	Analyte	No. of Samples	Trend	Slope (µg/L/year)	Confidence Interval (µg/L/yr)	
					Lower	Upper
0411	TCE	41	**Down**	-0.40	-0.75	-0.12
0443		29	None	0.33	-0.23	0.92
0617		28	None	-0.17	-0.53	0.12
0411	*cis*-1,2-DCE	41	None	0	-0.08	0.11
0443		29	None	0	-0.01	0.06
0617		27	None	-0.06	-0.16	0.06

µg/L/year = micrograms per liter per year

Evaluation of the slope of the TCE concentrations in well 0411 may give an indication on the timeframe when concentrations may approach the MCL of 5 µg/L. The non-parametric slope calculated for the trend analysis suggests that the MCL might be reached by 2022. The exponential curve fit to the data estimates that the MCL might be reached by 2030. The non-parametric analysis and the exponential curve fit typically represent the decrease of contaminants in groundwater over time and provide good estimates of cleanup timeframes.

6.7.1.4 Confirmatory Monitoring for Barium and Radium

Monitoring results 2006 through 2010 (Table 23) show combined Ra-226/228 levels greater than the MCL of 5 pCi/L and greater than the level of concern (LOC) of 75 pCi/L in well 0445 (Table 23). The concentrations of barium in 0445 exceeded the MCL of 2,000 µg/L but were less than the LOC of 15 mg/L. Combined Ra-226/228 and barium levels remain low in the downgradient BVA wells.

Table 23. Summary of Confirmatory Monitoring Results for Barium and Radium, 2006–2010

Well ID	Location	Parameter	2006	2007	2008	2009	2010
Source Area Well							
0445	0445 Area	Ra-226 (pCi/L)	**40.3**	**26.9**	**48.4**	**55.0**	**70.9**
		Ra-228 (pCi/L)	**40.2**	**23.6**	**12.0**	**24.7**	**50.2**
		Barium (µg/L)	**7,000**	**3,200**	**8,100**	**11,740**	**12,400**
Downgradient Wells							
0400	BVA	Ra-226 (pCi/L)	0.39	0.96	0.73	0.67	1.7
		Ra-228 (pCi/L)	ND (< 0.66)	0.59	ND (< 0.66)	ND (< 1.1)	ND (< 0.77)
		Barium (µg/L)	79.9	76.4	88.8	113	117
0402	BVA	Ra-226 (pCi/L)	0.43	0.55	0.41	0.35	1.3
		Ra-228 (pCi/L)	ND (< 0.66)	0.57	ND (< 0.86)	0.79	0.66
		Barium (µg/L)	50.4	59.9	68.3	72.2	64.6
P033	BVA	Ra-226 (pCi/L)	0.21	0.75	ND (< 0.50)	0.90	0.88
		Ra-228 (pCi/L)	0.59	0.64	ND (< 0.70)	0.99	0.47
		Barium (µg/L)	82.2	88.8	102	97.6	101

Combined Ra-226/228 reported as "<" when both isotopes were reported as less than method detection limit.
Values in **bold** exceed the MCL (2,000 mg/L for barium and 5 pCi/L for combined Ra-226/228.
J = one of the isotopes was reported as an estimated value less than the reporting limit

Barium concentrations vary in well 0445 (Figure 10), which is screened within the bedrock. The concentrations of barium in this well indicate a general decline starting in 2004; however, starting in 2009, concentrations were higher than previous years. This general decrease coincides with removal of the salt from the storage area (SST building on Figure 7) in 2003. A dramatic decrease was indicated in early 2007; however, it is likely that the anomalously low data reported in 2007 were not representative of groundwater quality as these concentrations have not been replicated in subsequent sampling events. The higher concentrations reported since the end of 2008 may be the result of changing sampling methods. Until the second half of 2008, well 0445 was typically bailed or pumped dry and then sampled the next day. During 2008, dedicated bladder pumps capable of sampling low flows (100 mL per minute) were installed in the Phase I monitoring wells. The samples collected since the second half of 2008 have been sampled using the low-flow method instead of being pumped dry, allowed to recharge, and sampled at a later time.

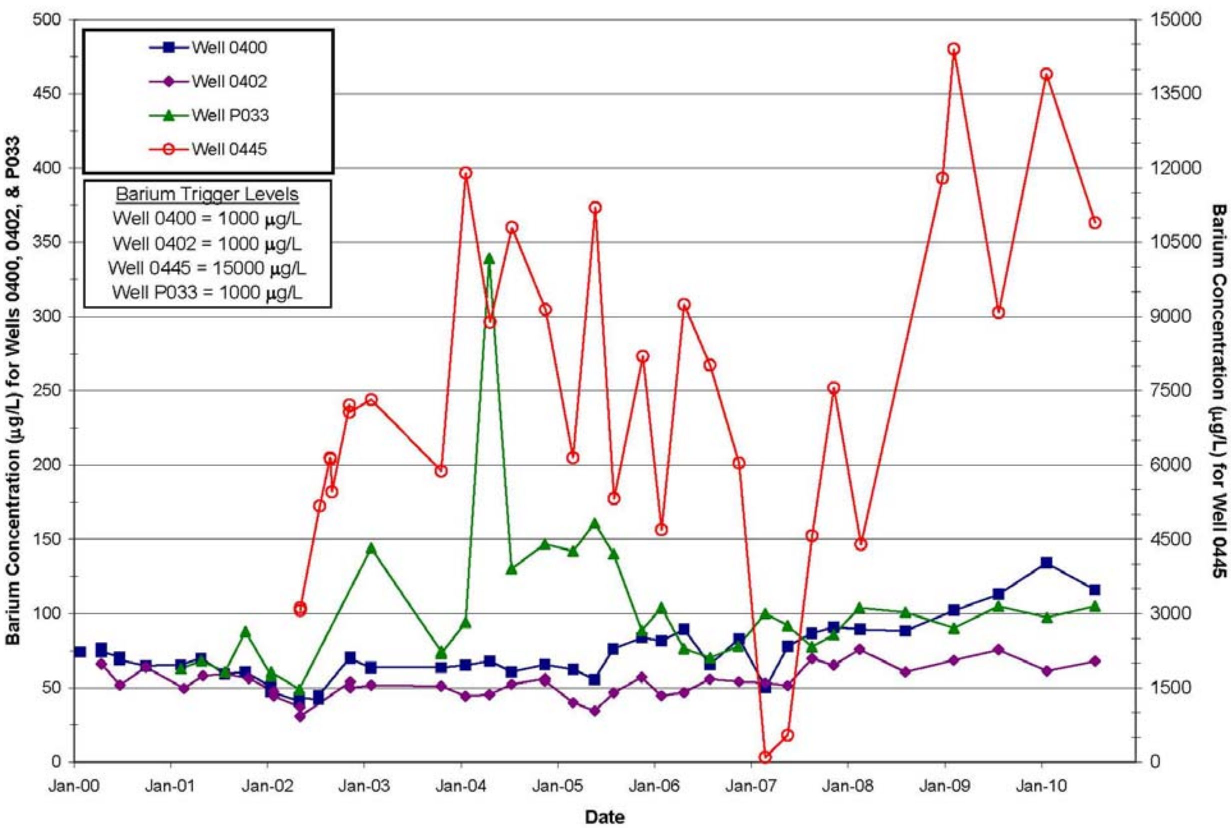

Figure 10. Barium Concentrations (2000–2010)

Barium concentrations in well P033 (BVA well) were variable and exhibited similar fluctuations in concentrations as those observed in well 0445. However, barium concentrations have been relatively stable in downgradient BVA wells 0400, 0402, and P033 since 2006. The levels of barium in these three wells are similar to background (310 µg/L). Background values were obtained from the *Phase I Residual Risk Evaluation* (DOE 2003b).

Radium levels vary over time in all of the wells (Figure 11), but the largest fluctuations occur in well 0445. The levels of combined Ra-226/228 at this location consistently exceed the MCL of

5 pCi/L and have exceeded the 75 pCi/L LOC numerous times. Data from 2007 showed a dramatic decrease; however, these anomalously low data likely do not represent groundwater quality and have not been replicated in subsequent sampling events. Levels measured in 2010 are generally higher than those reported in previous years.

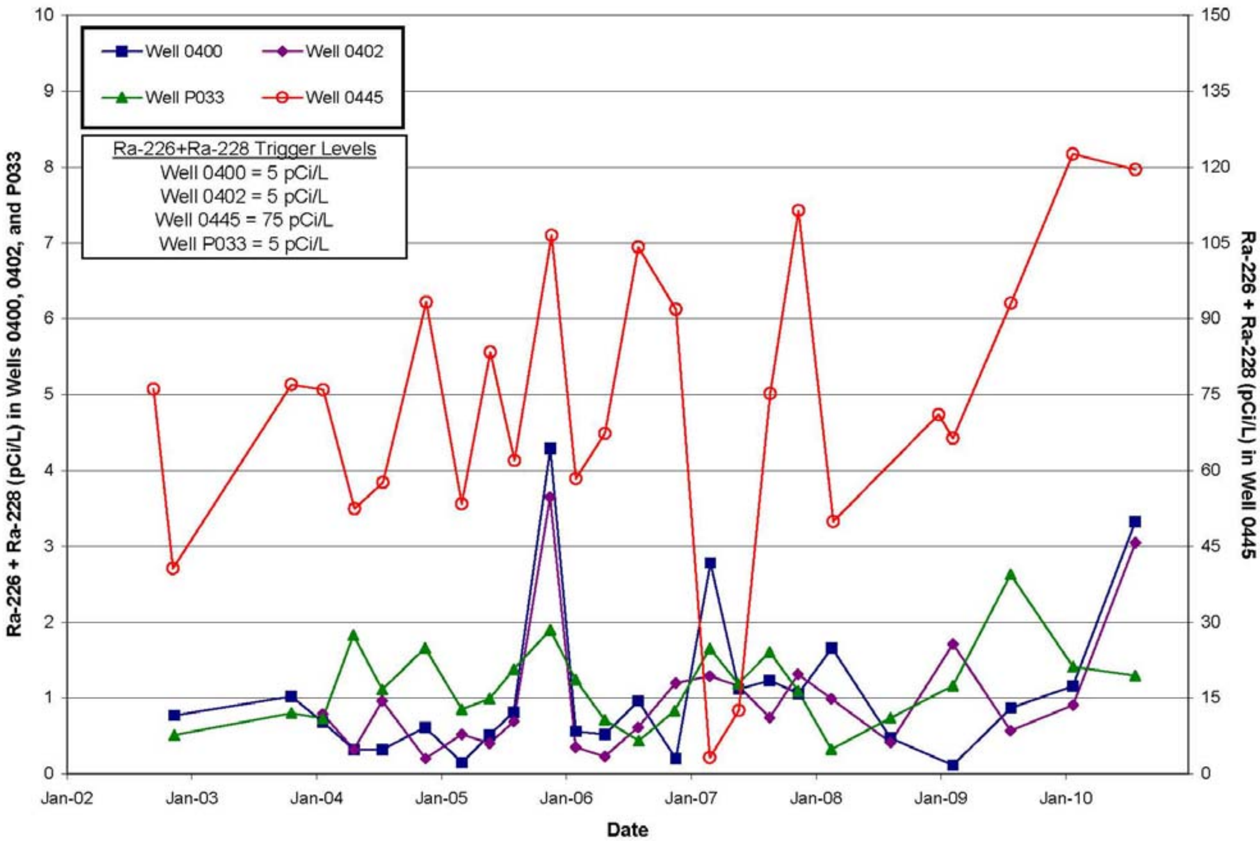

Figure 11. Ra-226/228 Levels (2002–2010)

Radium levels have been less variable over time in wells 0400, 0402, and P033, which are BVA wells downgradient of well 0445. Well P033 had slightly higher radium levels than the other two BVA wells and exhibited a similar pattern in variability when compared to well 0445. However, data from 2010 indicate that levels in wells 0400 and 0402 have increased and are greater than those reported in P033. The levels of Ra-226 in the BVA wells (0400 and 0402) are similar to background (0.996 pCi/L for Ra-226). Background values were obtained from the *Phase I Residual Risk Evaluation* (DOE 2003b). No background values were provided for Ra-228.

Sodium and chloride are monitored in conjunction with radium and barium, because salt is considered the mechanism that has caused elevated radium and barium levels in the bedrock groundwater system. Salt was no longer stored in the SST building after 2003. Sodium and chloride monitoring results (Table 24) indicate that the highest concentrations occur in well 0445, which is where elevated radium and barium levels occur.

Table 24. Summary of Confirmatory Monitoring Results for Sodium and Chloride, 2006–2010

Well ID	Location	Parameter	2006	2007	2008	2009	2010
Source Area Well							
0445	0445 Area	Chloride (mg/L)	9,360	5,700	7,340	12,800	10,800
		Sodium (mg/L)	4,220	2,370	4,270	5,700	5,380
Downgradient Wells							
0400	BVA	Chloride (mg/L)	101	66.0	68.4	96.0	108
		Sodium (mg/L)	49.8	41.4	43.4	52.1	61.6
0402	BVA	Chloride (mg/L)	90.1	82.7	83.2	111	81.2
		Sodium (mg/L)	53.8	55.0	50.5	73.4	56.8
P033	BVA	Chloride (mg/L)	228	162	191	138	126
		Sodium (mg/L)	167	102	114	83.5	80.8

mg/L = milligrams per liter

Extremely high concentrations of sodium and chloride have been reported in well 0445 (Figure 12 and Figure 13), which also has had increased radium and barium levels; however, levels show substantial variation over time. Downgradient BVA well P033 had elevated concentrations of sodium and chloride, which vary in a similar pattern to those observed in well 0445. Substantial decreases in sodium and chloride concentrations were reported in BVA well P033 starting in 2004 and are similar to the changes observed in barium and radium levels at this location. Sodium and chloride concentrations have been stable in BVA wells 0400 and 0402, but are slightly higher than in previous years.

Review of the sodium and chloride data indicates that well P033 showed a delayed and lower concentration response to the elevated levels observed in well 0445; however, this response is not as obvious as in previous years. This observation was illustrated more prominently in the sodium data than the chloride data. The decrease in response indicates there is less salt entering into the groundwater system and being detected in the downgradient wells. It is apparent that groundwater affected by salt is stored in the lower permeable bedrock near well 0445, resulting in greater contact time with the shale, which is the source of barium and radium. Naturally occurring barium and radium are leached from the bedrock, put into solution in this discrete portion of the saturated bedrock, and slowly released through the bedrock groundwater system into the downgradient BVA.

Trend analysis was performed on barium, radium, sodium, and chloride data using the non-parametric Mann-Kendall test (DOE 2011b). This test is used for temporal trend identification, because it does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). This type of long-term trend analysis can be used to confirm trends in contaminant concentrations over time. Trending was performed using data from 2004 through 2010, as this set of data reflects possible influence from the removal of salt from the SST building. However, the two anomalously low data points reported in well 0445 on 2007 were not included in the data set as they likely do not represent actual groundwater quality.

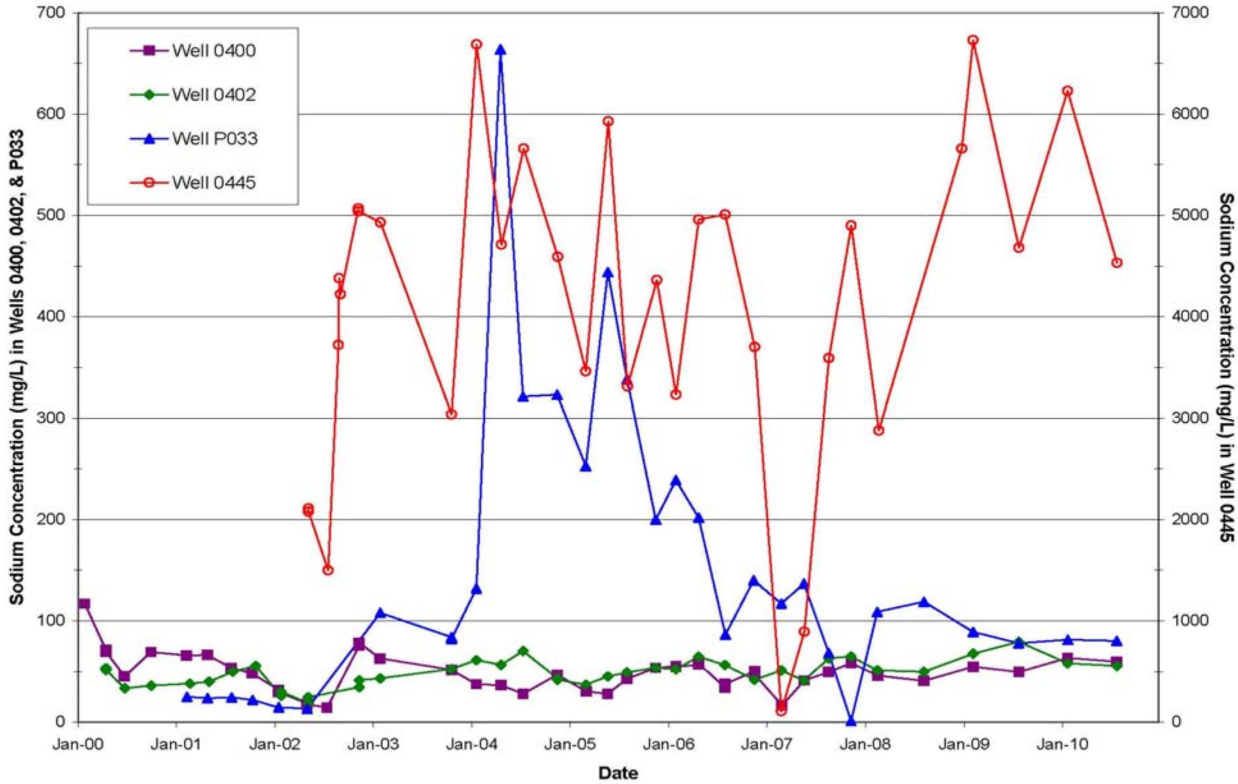

Figure 12. Sodium Concentrations (2000–2010)

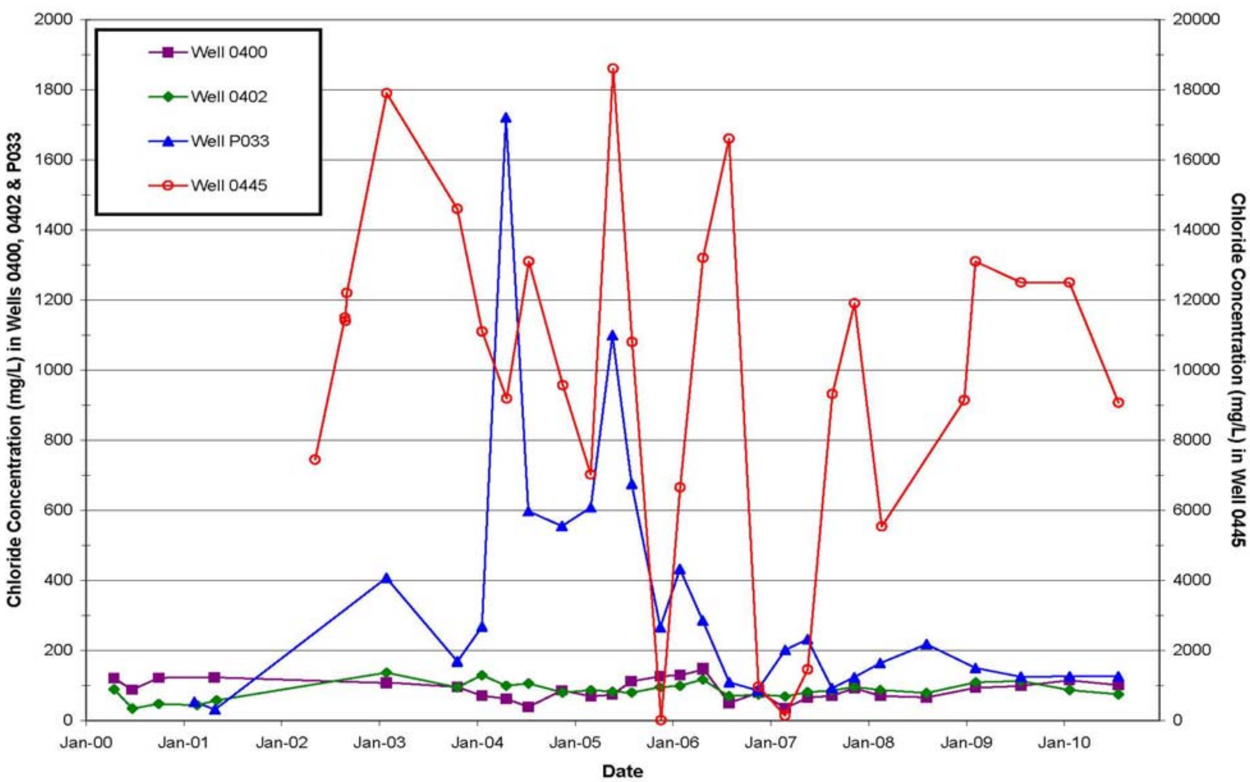

Figure 13. Chloride Concentrations (2000–2010)

Trend analysis indicates increased levels of barium and combined Ra-226/228 in wells 0400, 0402, and 0445, as indicated by positive slopes. Barium concentrations decreased in well P033, as indicated by a negative slope. Statistically upward trends were calculated for both barium and Ra-226/228 in wells 0400 and 0402 (Table 25).

Table 25. Summary of Trend Analysis Results for Barium and Combined Radium in Phase I for 2010

Location	Analyte	No. of Samples	Trend	Slope (mg/L/yr)	Confidence Interval (mg/L/yr)	
					Lower	Upper
0400	Barium	22	**Up**	0.008	0.006	0.011
0402		22	**Up**	0.005	0.003	0.007
0445		20	None	0.002	-1.1	0.95
P033		22	None	-0.006	-0.014	0.002
Location	**Analyte**	**No. of Samples**	**Trend**	**Slope (pCi/L/yr)**	**Confidence Interval (pCi/L/yr)**	
					Lower	**Upper**
0400	Ra-226/228	22	**Up**	0.15	0.02	0.32
0402		22	**Up**	0.12	0	0.31
0445		20	None	5.6	-0.08	11.2
P033		22	None	0	-0.17	0.15

pCi/L/yr = picocuries per liter per year

Trend analysis indicates decreased chloride in wells 0402, 0445, and P033 and decreased sodium in wells 0445 and P033, as indicated by negative slopes (Table 26). Statistically downward trends were calculated for both chloride and sodium in well P033. Increasing chloride concentrations were indicated in well 0400, was indicated by a positive slope. Sodium also increased in wells 0400 and 0402. A statistically upward trend in sodium was calculated for well 0400.

Table 26. Summary of Trend Analysis Results for Sodium and Chloride in Phase I for 2010

Location	Analyte	No. of Samples	Trend	Slope (mg/L/yr)	Confidence Interval (mg/L/yr)	
					Lower	Upper
0400	Chloride	22	None	5.3	-2.0	11.1
0402		22	None	-1.6	-5.8	2.5
0445		22	None	-19.1	-1362	1006
P033		22	**Down**	-90.2	-152	-31.0
0400	Sodium	22	**Up**	3.5	1.1	5.8
0402		22	None	1.8	-1.4	4.6
0445		22	None	-75.0	-450	292
P033		22	**Down**	-49.5	-78.9	-24.6

6.7.1.5 Confirmatory Monitoring for Chromium and Nickel

Nickel and chromium MCL exceedences were measured in BVA wells 0319 and 0400 and in bedrock wells 0399 and 0411. Studies have indicated that these exceedences were likely related to corrosion of the stainless steel well casings and are not the result of plant operations. Data were collected in the BVA wells using high-flow sampling methods to determine the ambient chromium and nickel concentrations in wells 0319 and 0400. Wells 0442 and 0443 (both constructed from PVC) are monitored as "mirror" wells to wells 0399 and 0411 for the same purpose.

Monitoring results (Table 27) indicate elevated levels of chromium and nickel in BVA wells 0319 and 0400 under low-flow sampling conditions (Figure 14 and Figure 15). Both nickel and chromium concentrations in the low-flow samples from wells 0319 and 0400 have exceeded the 100 µg/L LOC. Concentrations from samples collected using a high-flow sampling method have not exceeded the LOC and are lower than those measured using low-flow methods. These wells are sampled under both low-flow and high-flow conditions to evaluate the source of chromium at these locations.

Table 27. Summary of Confirmatory Monitoring Results for Chromium and Nickel, 2006–2009

Well ID	Location	Parameter	Average Concentration (µg/L)			
			2006	2007	2008	2009
0319	BVA	Chromium – Low	75.0	53.3	NS	NS
		Chromium – High	12.3	5.7	NS	NS
		Nickel – Low	**347**	**284**	NS	NS
		Nickel – High	49.0	39.8	NS	NS
0400	BVA	Chromium – Low	26.1	92.7	NS	NS
		Chromium – High	19.3	22.9	NS	NS
		Nickel – Low	54.2	35.8	NS	NS
		Nickel – High	23.4	15.3	NS	NS
0442	Bedrock	Chromium	3.4	1.0	NS	NS
		Nickel	6.5	1.2	NS	NS
0443	Bedrock	Chromium	3.6	20.3	1.7	1.6
		Nickel	6.7	11.7	1.1	4.3

"High" and "Low" denotes sampling flow conditions.
Concentrations in bold exceeded the applicable LOC.
Chromium LOC = 100 µg/L
Nickel LOC = 100 µg/L
J = Estimated value less than the reporting limit

Review of the data indicates that levels of chromium and nickel in low-flow samples from wells 0319 and 0400 are consistently higher than those collected under high-flow conditions. This has been consistent since sampling using the two methods began in 2004. It has been considered that the high-flow samples better represent the groundwater quality in this area. Data from 2007 indicated that the turbidity of the low-flow samples is generally higher than that measured in the high-flow samples. Data from the low-flow samples likely reflect nickel and chromium that have leached from the well casing and have adhered to colloids in the aquifer matrix. When the samples are preserved, these metals are leached into solution and result in elevated concentrations of chromium and nickel. These values do not represent the actual groundwater quality of the aquifer in this area.

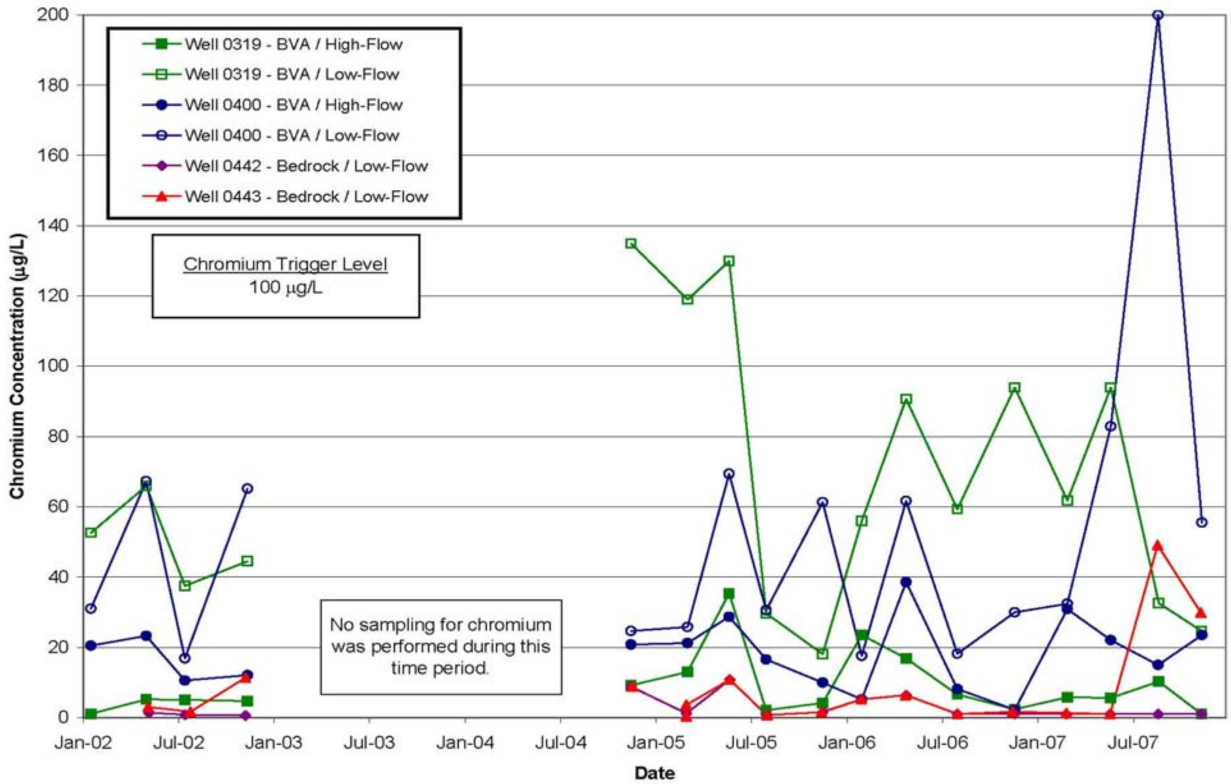

Figure 14. Chromium Concentrations Over Time (2002–2007)

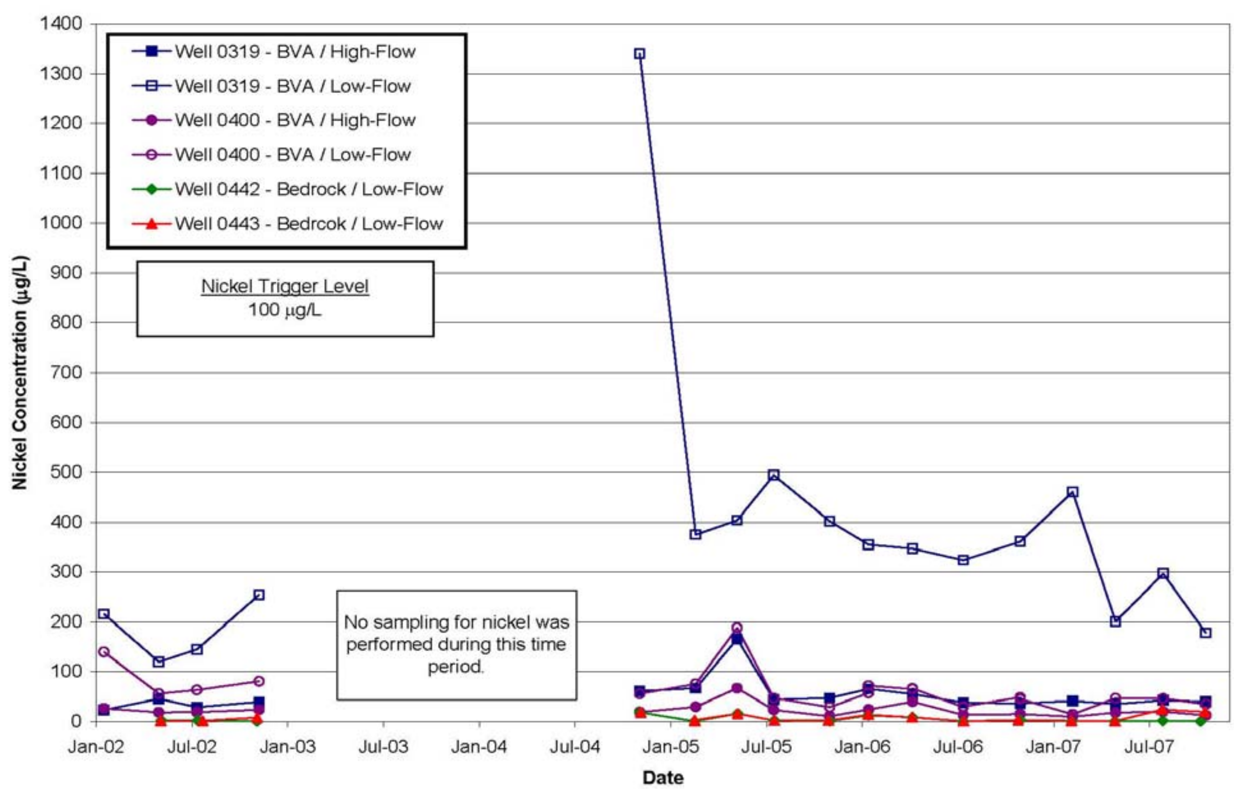

Figure 15. Nickel Concentrations Over Time (2002–2007)

Chromium and nickel concentrations in bedrock wells 0442 and 0443 (Table 27) were typically low and similar to background (chromium = 1.93 µg/L and nickel = 7.73 µg/L). Background values were obtained from the *OU9 Hydrogeologic Investigation—Groundwater Sweeps Report* (DOE 1996). These wells were installed to “mirror” stainless steel wells 0399 and 0411. During the third and fourth quarters of 2007, elevated concentrations of chromium were reported in well 0443; however, subsequent samples were similar to background.

The chromium and nickel concentrations in the bedrock wells 0442 and 0443 showed that the concentrations of these two metals in the bedrock groundwater were low and similar to background concentrations. This was expected, as these two wells were installed in close proximity to wells 0399 and 0411 (stainless steel wells that had anomalously high concentrations of chromium and nickel) to determine the groundwater quality in these two discrete areas. A cause for the increase in well 0443 during 2007 was not identified.

It is likely that the geochemistry of the aquifer in the vicinity of these wells has resulted in leaching of these metals from the stainless steel casings. This can be a common occurrence in aquifers that have fine-grained reducing environments (oxidation-reduction potential averages: - 20 millivolts [mV] in 0319 and 52 mV in 0400). The results for the high-flow sampling indicate much lower concentrations. Sampling at wells 0442 and 0443 did not duplicate the elevated concentrations measured at wells 0399 and 0411. Chromium impact is limited to a discrete area around the stainless steel monitoring wells.

6.7.2 Parcels 6, 7, and 8 Groundwater

Groundwater in Parcels 6, 7, and 8 is monitored for PCE, TCE and its degradation products, and tritium to verify that the levels are decreasing by natural attenuation to levels less than the MCLs. This groundwater monitoring program was established to ensure that the BVA is not negatively affected by contaminated groundwater originating from the Main Hill. The objective of this monitoring is to protect the BVA by verifying that the concentration of TCE and levels of tritium are decreasing and these constituents are not adversely affecting the BVA. This program may be decreased or terminated when TCE concentrations in wells and tritium levels in seeps meet conditions outlined in the monitoring plan, such as reaching the MCL for four consecutive sampling events.

6.7.2.1 Contaminants of Interest

Two monitoring wells in the BVA indicate VOC impact, primarily TCE that exceeds the MCLs established in the Safe Drinking Water Act. MNA was selected as the remedy for the VOCs in the groundwater associated with the Main Hill (DOE 2009a). Sampling is being performed to assess the contaminant concentrations and to ensure that the downgradient BVA is not being affected.

Also associated with this area are seeps located along the Main Hill of the plant property. Two seeps are within the plant property boundary, and the remaining five seeps are off site to the north. Several seeps in this area have elevated levels of tritium and VOCs. One seep also has elevated levels of radium (Ra-226, Ra-228) and strontium (Sr-90). These seeps and several downgradient wells are being monitored to verify that source removal (buildings and soil) on the Main Hill will result in decreasing concentrations over time.

6.7.2.2 Monitoring Program

The sampling is separated into two programs that relate to the areas of impact. These areas are:

- **Wells 0315/0347 Area:** Wells at the edge of the BVA on the southwestern corner of Parcel 8 that have elevated concentrations of VOCs. The program consists of (1) wells that have TCE greater than the MCL and (2) downgradient BVA wells to the south and west.
- **Main Hill Seeps:** Seeps on the northern and southern sides of the Main Hill that have elevated concentrations of VOCs and tritium. The program consists of seeps and downgradient wells to the west.

Under the Parcels 6, 7, and 8 MNA monitoring program, samples are collected quarterly for selected wells and seeps (Figure 16) and analyzed as outlined in Sections 4.1 and 4.2 of the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Final Draft) (DOE 2006b).

The two source wells and other selected downgradient BVA wells are monitored for VOCs—namely, PCE, DCE, TCE, and VC. A summary of the monitoring locations is provided in Table 28.

Table 28. Monitoring for the Wells 0315/0347 Area

Monitoring Location	Area	VOC
Well 0315	Source Wells	TCE PCE DCE Vinyl Chloride
Well 0347		
Well 0124	Downgradient BVA Monitoring	
Well 0126		
Well 0386		
Well 0387		
Well 0389		
Well 0392		

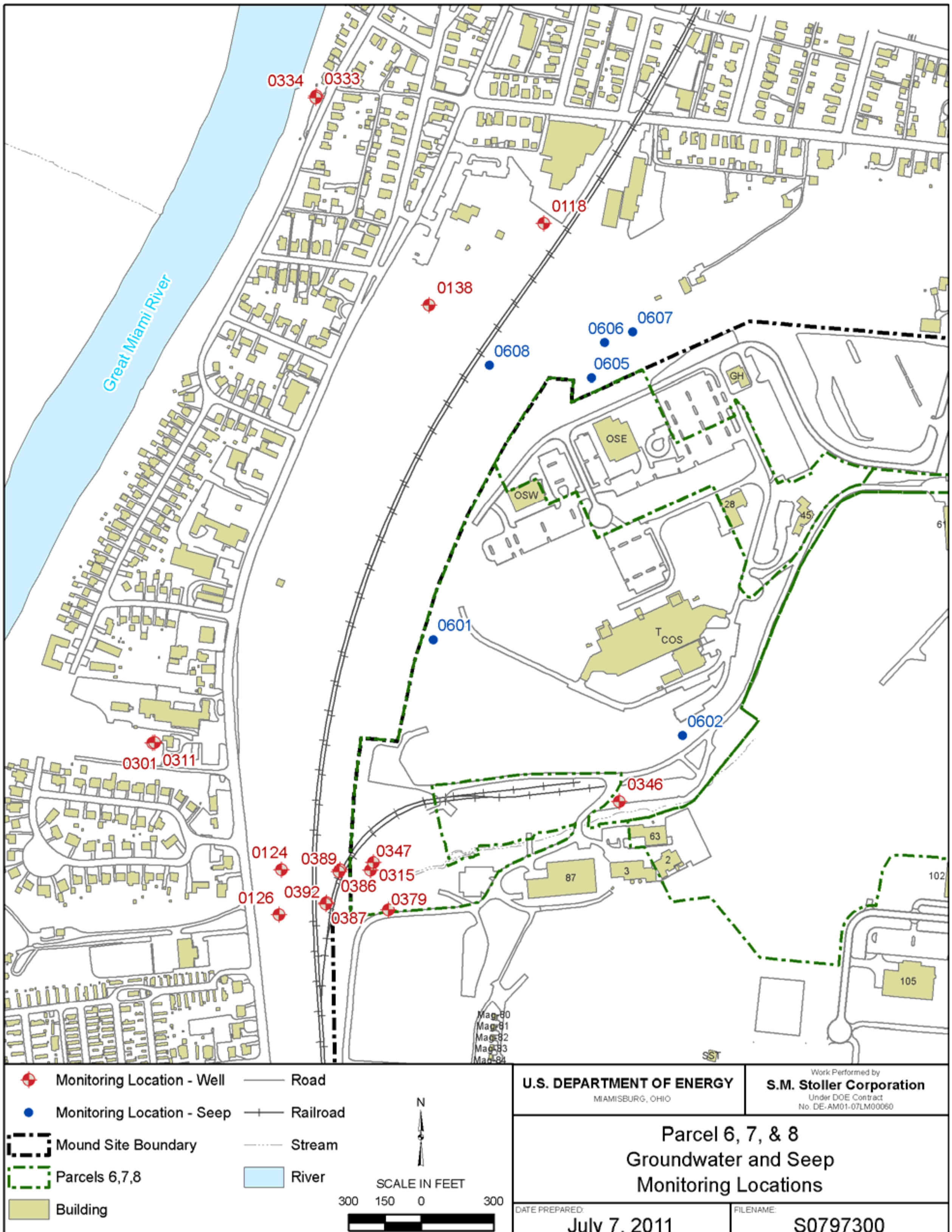

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Figure 16. Parcels 6, 7, and 8 Groundwater and Seep Monitoring Locations

Water from seeps 0601, 0602, 0605, 0606, 0607, and 0608 is collected and analyzed for VOCs and the radiological constituents shown in Table 29. Wells within the BVA that are downgradient of the bedrock groundwater discharge area of the Main Hill are also sampled to monitor the levels of tritium and VOC contamination.

Table 29. Monitoring for the Main Hill Seeps and Groundwater

Monitoring Location	Area	Parameters
Seep 0601	Main Hill Seeps	TCE PCE DCE Vinyl Chloride Ra-226 and Ra-228 Tritium Sr-90
Seep 0602 Seep 0605 Seep 0606 Seep 0607 Seep 0608		TCE PCE DCE Vinyl Chloride Tritium
Well 0118 Well 0138 Well 0301 Well 0346 Well 0379	Downgradient BVA Monitoring Wells	TCE PCE DCE Vinyl Chloride Tritium

The contaminant data are evaluated against previous data collected at each location to determine if downward trends are occurring. Trigger levels and response actions have been established for each contaminant as presented in the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (Draft Final) (DOE 2006b). The triggers are summarized in Table 30.

Table 30. Trigger Levels for Parcels 6, 7, and 8 Monitoring Locations

Location	TCE (µg/L)	PCE (µg/L)	Tritium (nCi/L)	Ra-226/228 (pCi/L)	Sr-90 (pCi/L)
0315	30				
0347	30				
0124	5				
0126	5				
0386	5				
0387	5				
0389	5				
0392	5				
0601 (seep)		75	1,500	20	20
0605 (seep)	150				

EPA and OEPA must be notified if these trigger levels are exceeded. After notification, the Mound Core Team (EPA, OEPA, and DOE) will determine an appropriate course of action.

6.7.2.3 Wells 0315/0347 Area Monitoring Results

Monitoring results from 2006 through 2010 (Table 31) continued to show detection of TCE in wells 0315, 0347, 0386, and 0389; the highest concentrations were detected in wells 0315 and 0347 (source wells), where concentrations also exceeded the MCL. Estimated detections of TCE were reported in wells 0387 and 0392. No detectable concentrations of TCE were measured in the remainder of the wells. TCE concentrations were below applicable trigger levels, except in well 0347 (Figure 17).

Table 31. Summary of VOC Results in the 0315 and 0347 Area—2006 through 2010

Well ID	VOC	Average Concentrations (µg/L)				
		2006	**2007**	**2008**	**2009**	**2010**
Source Wells						
0315	TCE	**5.6**	**13.4**	**11.9**	**12.5**	**11.9**
	PCE	0.31 (J)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0347	TCE	**24.3**	**14.4**	**19.5**	**26.5**	**26.5**
	PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
Downgradient BVA Wells						
0124	TCE	ND (< 1)	ND (< 5)	0.39 (J)	ND (< 1)	ND (< 1)
	PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0126	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
	PCE	0.93 (J)	1.1 (J)	0.98 (J)	0.98 (J)	1.0
0386	TCE	3.5	2.4	2.2	1.7	1.5
	PCE	0.15 (J)	ND (< 5)	0.15 (J)	ND (< 1)	ND (< 1)
0387	TCE	ND (< 1)	ND (< 5)	0.39 (J)	0.13 (J)	0.12 (J)
	PCE	0.14 (J)	ND (< 5)	0.18 (J)	0.21 (J)	0.20 (J)
0389	TCE	1.0	1.1	0.63 (J)	0.78 (J)	0.95 (J)
	PCE	0.69 (J)	0.52 (J)	0.30 (J)	0.30 (J)	0.33 (J)
0392	TCE	ND (< 1)	ND (< 5)	ND (< 1)	0.12 (J)	0.13 (J)
	PCE	0.42 (J)	0.33 (J)	0.27 (J)	0.33 (J)	0.33 (J)

TCE trigger level for wells 0315 and 0347 = 30 µg/L
TCE trigger level for other wells = 5 µg/L
ND = Not detected
J = Estimated value that is less than the reporting limit

The concentration of TCE reported in well 0347 during the fourth quarter of 2006 and first quarter of 2010was greater than the trigger level of 30 µg/L for the source area wells (Figure 17). The first exceedence was discussed in the 2006 annual report (DOE 2007c). EPA and OEPA were notified on March 10, 2010, regarding the second trigger exceedence (DOE 2010d).

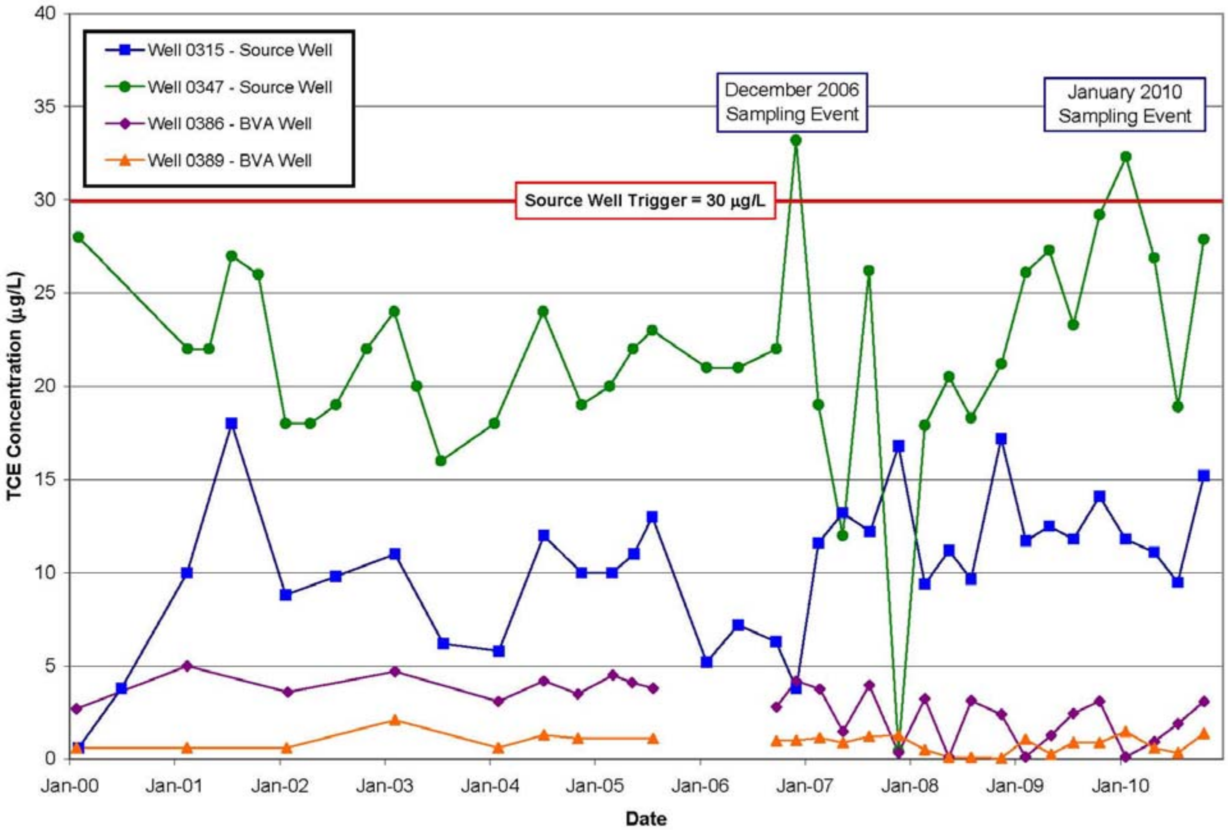

Figure 17. TCE Concentrations in Wells 0315/0347 Area (2000–2010)

TCE concentrations in wells 0315 and 0347 have been variable (Figure 17). Changes in concentrations in these two wells were similar until the end of 2006, when a substantial increase was identified in well 0347 while TCE concentrations decreased in 0315. Data was highly variable in well 0347 and starting in 2008 TCE concentrations increased in this well. TCE concentrations were lower in well 0315 during 2006 and then rebounded and remained steady. Site improvements began in late 2006 on the Main Hill, and the changes in TCE concentrations may be due to surface water infiltration into exposed tritium capture pits near the location of the SW building. These pits extend into the bedrock and surface water was infiltrating into the subsurface. The access into the pits was covered in October 2009. Starting in 2000, the concentrations in the two downgradient BVA wells (0386 and 0389) decreased below the MCL.

Low levels of PCE (typically less than 1 µg/L) were reported in wells 0386, 0387, 0389, and 0392 during the review period (Table 31). No trigger levels are established for PCE. No *cis*-1,2-DCE, *trans*-1,2-DCE, or VC was detected in any of these wells during the review period.

Trend analysis was performed on TCE data using the non-parametric Mann-Kendall test (DOE 2011c). This test is used for temporal trend identification, because it does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). This type of long-term trend analysis can be used to confirm trends in contaminant concentrations over time. Trending was performed using data from 2005 through 2010, as this set of data reflects possible influence from the building and soil removal that was completed on the Main Hill in 2005.

Statistical analysis of the TCE data collected since 2005 from wells 0315, 0347, 0386, and 0389 indicates increasing concentrations of TCE in source wells 0315 and 0347, as indicated by positive slopes (Table 32). No statistical trends, upward or downward, were identified in these two wells. Decreasing TCE concentrations are indicated for wells 0386 and 0389, as indicated by negative slopes. A downward trend was calculated for well 0386. Trend analysis was not performed on data from the remainder of the wells because results consistently showed nondetects or sporadic estimated detections.

Table 32. Summary of Trend Analysis Results for TCE in the Source Area and Downgradient Wells (2005−2010)

Location	Number of Samples	Trend	Slope (µg/L/year)	Confidence Interval (µg/L/year)	
				Lower	Upper
0315	23	None	0.68	-0.12	1.74
0347	23	None	1.26	-0.27	2.48
0386	21	**Down**	- 0.43	-0.83	-0.17
0389	19	None	-0.04	-0.23	0.12

6.7.2.4 Main Hill Seeps Monitoring Results

Although TCE concentrations in some Main Hill seeps continued to exceed the MCL during the review period (Table 33), no locations had concentrations that exceeded the trigger level of 150 µg/L (established for seep 0605). The highest concentrations in 2010 were in seep 0602, which is on site. This seep was dry during the third and fourth quarters of 2010. PCE concentrations continued to exceed the MCL of 5 µg/L in seep 0601; however, PCE concentrations at this location did not exceed the trigger level of 75 µg/L. Estimated detections of PCE were reported in seeps 0602 and 0605. Detectable concentrations of *cis*-1,2-DCE were observed in seeps 0602, 0605, 0607, and 0608; seep 0602 had the highest concentrations. Estimated detections of *cis*-1,2-DCE (less than 1 µg/L) were reported in seeps 0601 and 0606. Estimated detections of *trans*-1,2-DCE (less than 1 µg/L) were reported in seeps 0602 and 0605. No vinyl chloride was detected in the seeps.

Monitoring results (Table 33) showed low concentrations of TCE in well 0379 downgradient of the Main Hill seeps. Elevated concentrations of TCE are reported in well 0347 (discussed in Section 3.0). Estimated detections of PCE were reported in wells 0311 and 0379. No trigger levels have been set for these locations. Only the concentrations of TCE in well 0347 exceeded the MCL of 5 µg/L. Neither DCE nor VC was detected in the downgradient wells.

Table 33. Summary of VOC Results in the Main Hill Area (2006–2010)

Location	Area	VOC	Average Concentrations (µg/L)				
			2006	**2007**	**2008**	**2009**	**2010**
Seeps							
0601	On site	TCE	**5.7**	**5.9**	4.4	**5.1**	4.2
		PCE	**14.9**	**17.6**	**12.9**	**17.2**	**6.0**
		cis-1,2-DCE	1.2	0.96 (J)	0.65 (J)	0.73 (J)	0.50 (J)
		trans-1,2-DCE	0.88	ND (< 5)	0.35	ND (< 1)	ND (< 1)
0602	On site	TCE	**19.6**	**26.9**	**58.5**	**41.5**	**38.9**
		PCE	ND (< 1)	ND (< 5)	0.24	0.26	0.21
		cis-1,2-DCE	18.4	20.6	24.9	18.3	23.4
		trans-1,2-DCE	0.69	ND (< 5)	0.38	0.31	0.39
0605	Off site	TCE	**15.4**	**15.8**	**14.1**	**13.1**	**12.9**
		PCE	0.32	ND (< 5)	ND (< 1)	0.21 (J)	0.21 (J)
		cis-1,2-DCE	12.2	23.5	6.9	7.0	4.3
		trans-1,2-DCE	0.63	0.47	0.33	0.30	0.25
0606	Off site	TCE	3.8	NS	NS	NS	2.9
		PCE	ND (< 1)	NS	NS	NS	ND (< 1)
		cis-1,2-DCE	1.0	NS	NS	NS	0.47
		trans-1,2-DCE	1.0	NS	NS	NS	ND (< 1)
0607	Off site	TCE	**6.7**	**8.6**	**6.1**	**7.1**	**5.6**
		PCE	0.34	3.8 (J)	0.39 (J)	0.23 (J)	ND (< 1)
		cis-1,2-DCE	1.9	2.4	1.0	1.9	1.2
		trans-1,2-DCE	0.88	ND (< 5)	0.35	ND (< 1)	ND (< 1)
0608	Off site	TCE	0.91	0.54	1.1	1.1	1.1
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE	0.65 (J)	ND (< 5)	0.39 (J)	0.17 (J)	0.18 (J)
		trans-1,2-DCE	0.88	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
Downgradient Wells							
0118	Off site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0138	Off site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0301	Off site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0311	Off site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		PCE	0.28 (J)	3.8 (J)	0.20 (J)	0.22 (J)	0.22 (J)
0333	Off site	TCE	0.29 (J)	3.8 (J)	0.40 (J)	0.20 (J)	NS
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	NS
0334	Off site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	NS
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	NS
0346	On site	TCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0347	On site	TCE	**24.3**	**14.4**	**19.5**	**26.5**	**26.5**
		PCE	ND (< 1)	ND (< 5)	ND (< 1)	ND (< 1)	ND (< 1)
0379	On site	TCE	2.0	2.2 (J)	2.0	1.7	1.9
		PCE	0.42 (J)	0.37 (J)	0.45 (J)	0.53 (J)	0.45 (J)

ND = Not detected
NS = Not sampled
J = Estimated value that is less than the reporting limit
PCE trigger level at 0601 = 75 µg/L
TCE trigger level at the seeps = 150 µg/L
Values in **bold** exceed the MCL

A graph of TCE concentrations in the seeps since 2005 (Figure 18) shows that concentrations in seep 0602 have increased since the end of the remediation of contaminated buildings and soil on the Main Hill (mid-2006). The concentrations measured in the fourth quarter of 2009 and the second quarter of 2010 were lower than previous values. A possible cause for the sudden changes and subsequent increases may be surface water infiltration upgradient of the seeps resulting in flushing of residual VOCs. Site improvements started in 2006 on the Main Hill and a new parking lot was constructed where the SW building was located. It was discovered in late 2009 that grading in the area had exposed two manholes over a large tritium capture pit that was located along the western side of the building. These test pits extend into the weathered bedrock. Surface water had been infiltrating into these uncovered access ports and was lost to the subsurface. The access points were covered in October 2009.

In seep 0601, PCE concentrations (Figure 19) were slightly higher than TCE concentrations. The concentrations of PCE have ranged between 10 and 20 µg/L but showed a general decrease in 2010 and are similar to those measured prior to remediation on the Main Hill. Estimated detections of PCE (less than 1 µg/L) were reported in seeps 0602 and 0605.

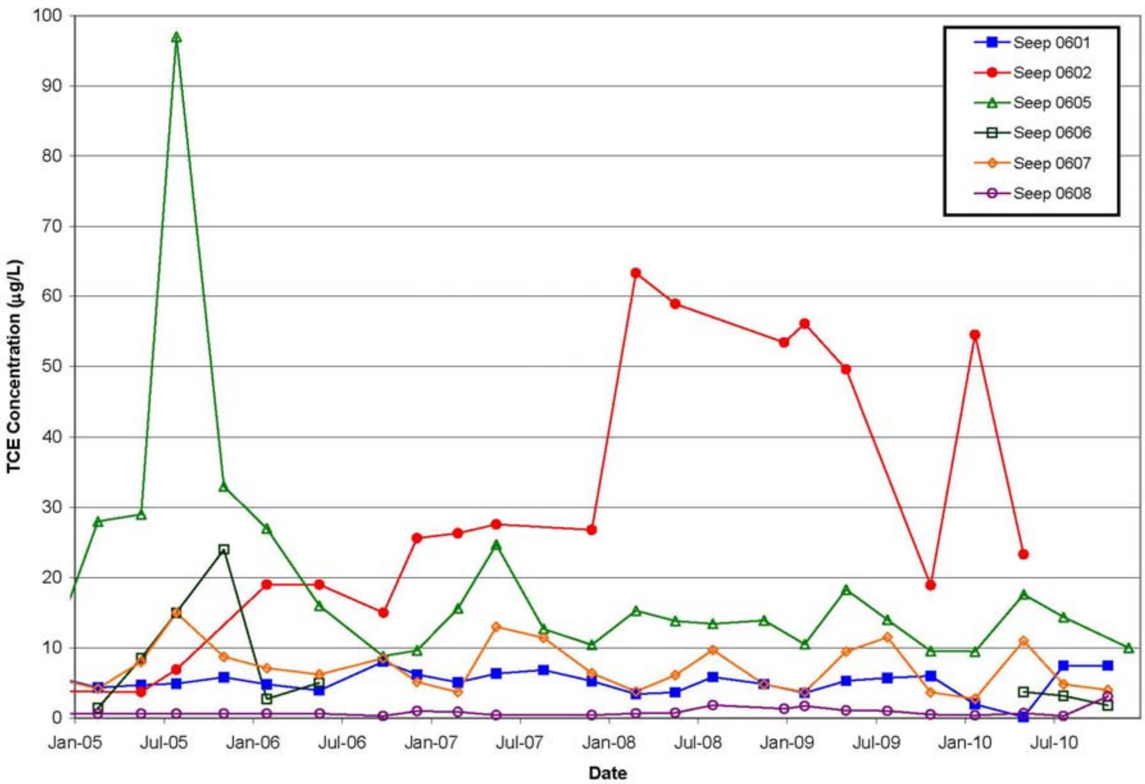

Figure 18. TCE Concentrations in the Main Hill Seeps (2005–2010)

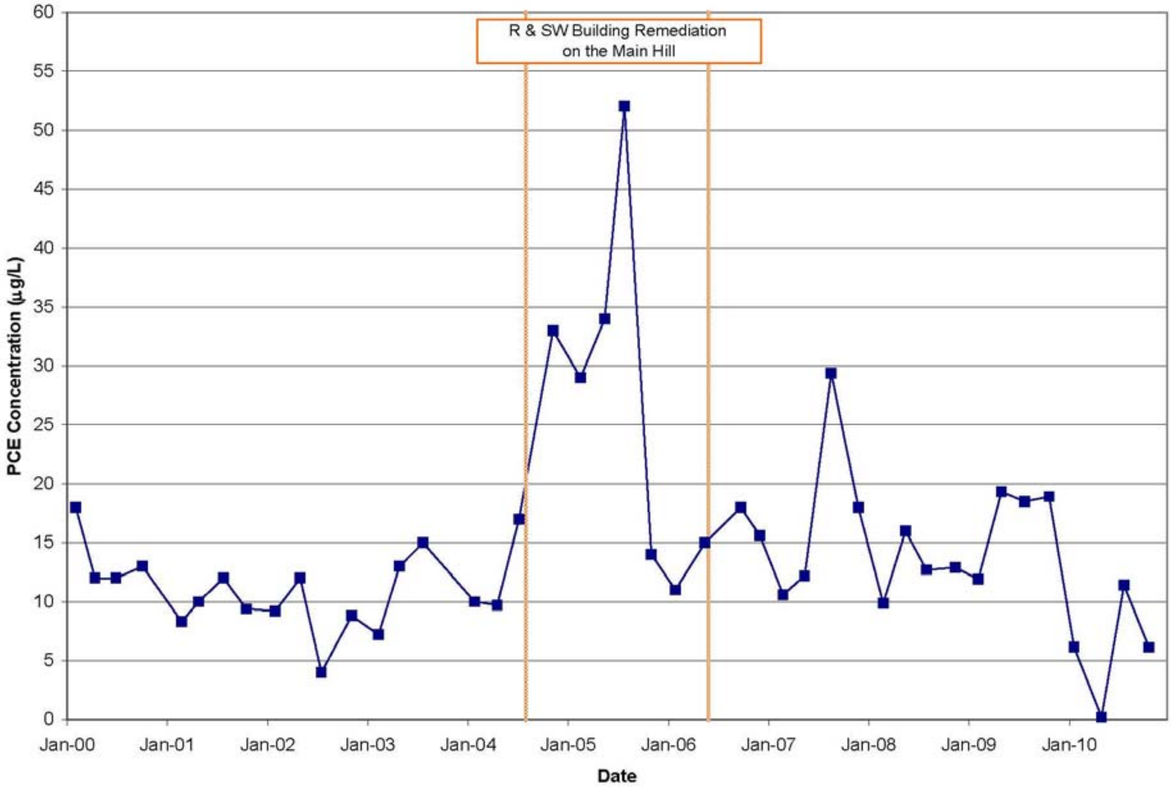

Figure 19. PCE Concentrations in Seep 0601 (2000–2010)

Concentrations of *cis*-1,2-DCE were reported in all of the seeps. The highest concentrations were reported in seeps 0602 and 0605. A comparison of TCE and *cis*-1,2-DCE concentrations (Figure 20) in these two seeps indicates that the concentration changes in the two contaminants generally behaved similarly. Although an increase in *cis*-1,2-DCE concentrations is an expected indicator of TCE degradation, in this instance, it is likely the result of flushing of residual DCE from the system. When degradation occurs, TCE concentrations typically decrease as *cis*-1,2-DCE concentrations increase. Subsequent data will continue to be evaluated for evidence of TCE degradation.

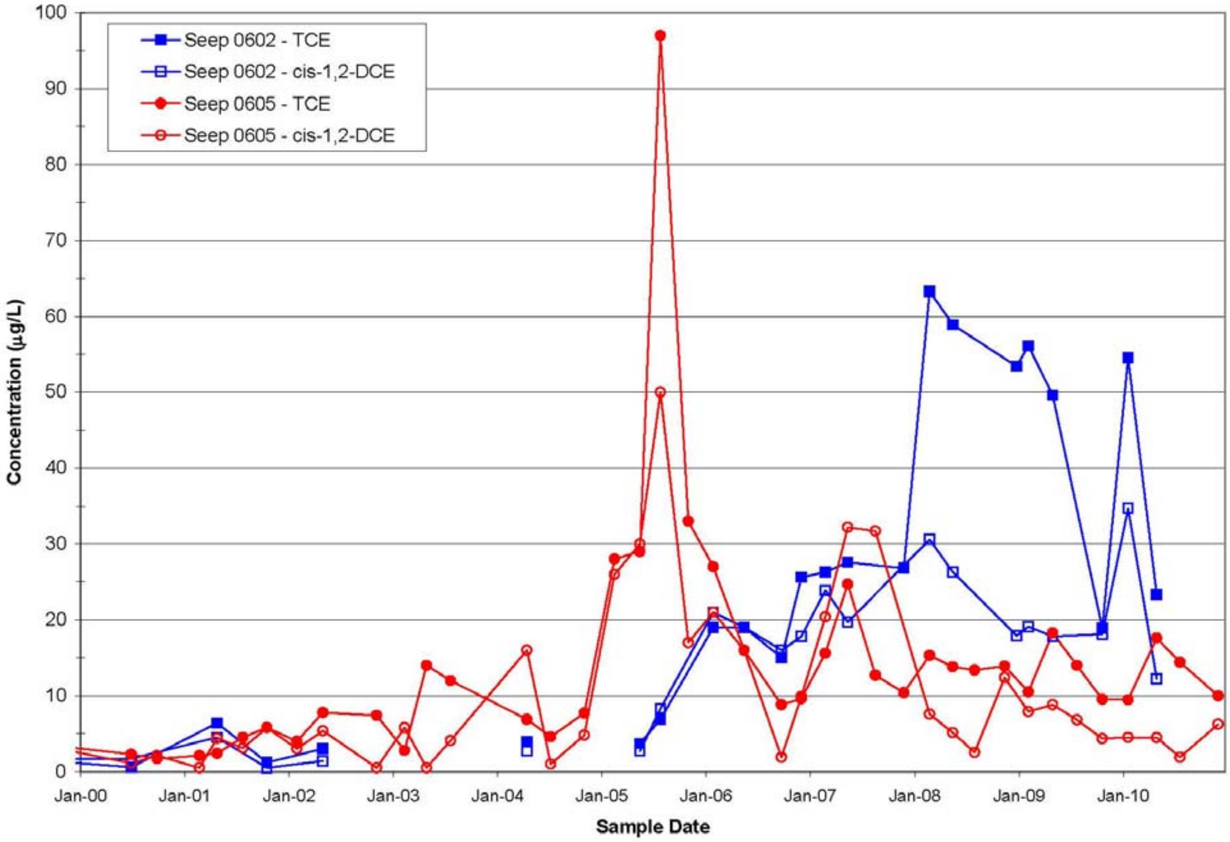

Figure 20. TCE and cis-*1,2-DCE Concentrations in Seeps 0602 and 0605 (2000–2010)*

Trend analysis was performed on TCE data using the non-parametric Mann-Kendall test (DOE 2011c). This test is used for temporal trend identification, because it does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). This type of long-term trend analysis can be used to confirm trends in contaminant concentrations over time. Trending was performed using data from 2005 through 2010, as this set of data reflects possible influence from the building and soil removal that was completed on the Main Hill in 2005.

Trend analysis for TCE data collected since 2005 indicates increasing TCE concentrations in seeps 0601, 0602, and 0608, as indicated by positive slopes (Table 34). An upward trend was calculated for TCE in seep 0602. TCE concentrations are decreasing in seeps 0605, 0606, and 0607, as indicated by negative slopes. A downward trend was calculated for seep 0605. No trend was indicated in the TCE data from seep 0601.

Data from the downgradient wells were not trended. TCE concentrations have been sporadic in these wells, with the exception of well 0347, which was previously discussed.

Table 34. Summary of Trend Analysis Results for TCE in the Main Hill Seeps (2005–2010)

Location	Number of Samples	Trend	Slope (µg/L/year)	Confidence Interval (µg/L/year)	
				Lower	Upper
0601	24	None	0.11	-0.45	0.38
0602	17	**Up**	9.6	2.4	13.6
0605	24	**Down**	-2.4	-4.4	-0.44
0606	9	None	-0.85	-4.4	2.0
0607	24	None	-0.59	-1.3	0.34
0608	23	None	0.02	-0.03	0.19

Tritium levels in the Main Hill seeps continued to be elevated in 2010 and were higher than those in the downgradient groundwater wells (Table 35). The highest tritium activity was observed in seep 0601, which is located on site. Seep 0601 is the only location that exceeded the MCL of 20 nanocuries per liter (nCi/L) during 2010. None of the seeps had tritium levels that exceeded the trigger level of 1,500 nCi/L.

Table 35. Summary of Tritium Results in the Main Hill Area (2006–2010)

Location	Average Tritium Activity (nCi/L)				
	2006	2007	2008	2009	2010
Seeps					
0601	**151**	128	**86.3**	**70.5**	**47.9**
0602	**40.5**	**37.5**	**22.6**	17.2	13.3
0605	**64.4**	**26.9**	**20.7**	19.9	15.9
0606	**25.6**	NS	NS	NS	13.7
0607	**21.1**	12.1	9.4	7.2	5.6
0608	**40.9**	**30.2**	**20.9**	17.7	12.6
Downgradient Wells					
0118	< 0.60	0.26 (J)	0.21 (J)	< 0.33	< 0.36
0138	9.6	5.0	2.6	1.6	1.4
0301	< 0.60	0.15 (J)	< 0.35	< 0.33	< 0.36
0311	1.2	1.0	1.2	1.4	0.81
0333	< 0.60	< 0.34	< 0.35	< 0.33	NS
0334	0.45	0.37	0.24	0.16 (J)	NS
0346	3.2	2.1	1.8	1.9	1.6
0347	12.7	10.0	6.8	6.1	5.8
0379	1.7	1.9	1.8	1.6	1.4

NS = Not sampled
Tritium trigger level at the seeps = 1,500 nCi/L
Values in **bold** exceed the MCL of 20 nCi/L

Five wells downgradient of the Main Hill area continued to show detectable levels of tritium in 2010 (Table 35). The highest levels were observed in well 0347, downgradient of seeps 0601 and 0602. The four remaining wells had tritium levels similar to background (1.5 nCi/L). None of the groundwater wells had tritium levels that exceeded the MCL of 20 nCi/L.

Tritium levels in the seeps were highest during remediation activities on the Main Hill (2004−2006). Tritium data collected after building demolition and soil removal indicate decreasing levels in all of the seeps (Figure 21). The decreasing tritium levels from post-remediation data suggest that the majority of the source was removed from the Main Hill area and that, with continued flushing, levels should continue to decline. Changes in tritium levels in seep 0601 indicate a seasonal effect as levels typically increase in the fall due to more precipitation and flushing. Variation in tritium levels in seep 0602 may also follow a similar seasonal pattern, but is less pronounced. Comparisons of tritium concentrations in the seeps with those measured in downgradient monitoring wells indicates that the seeps responded more quickly than the wells because they are direct discharge points for groundwater originating beneath the Main Hill.

A graph of tritium levels in downgradient wells (Figure 22) illustrates that groundwater impact lagged behind that of the seeps. Groundwater impact increased near the end of remediation activities on the Main Hill, and impact in the seeps occurred as remediation activities were being performed and began to decrease as activities were completed. Wells 0138 and 0347 had the highest levels of tritium and responded rapidly to remediation activities. Tritium levels in wells 0138, 0346, and 0379 have leveled off and are similar to background.

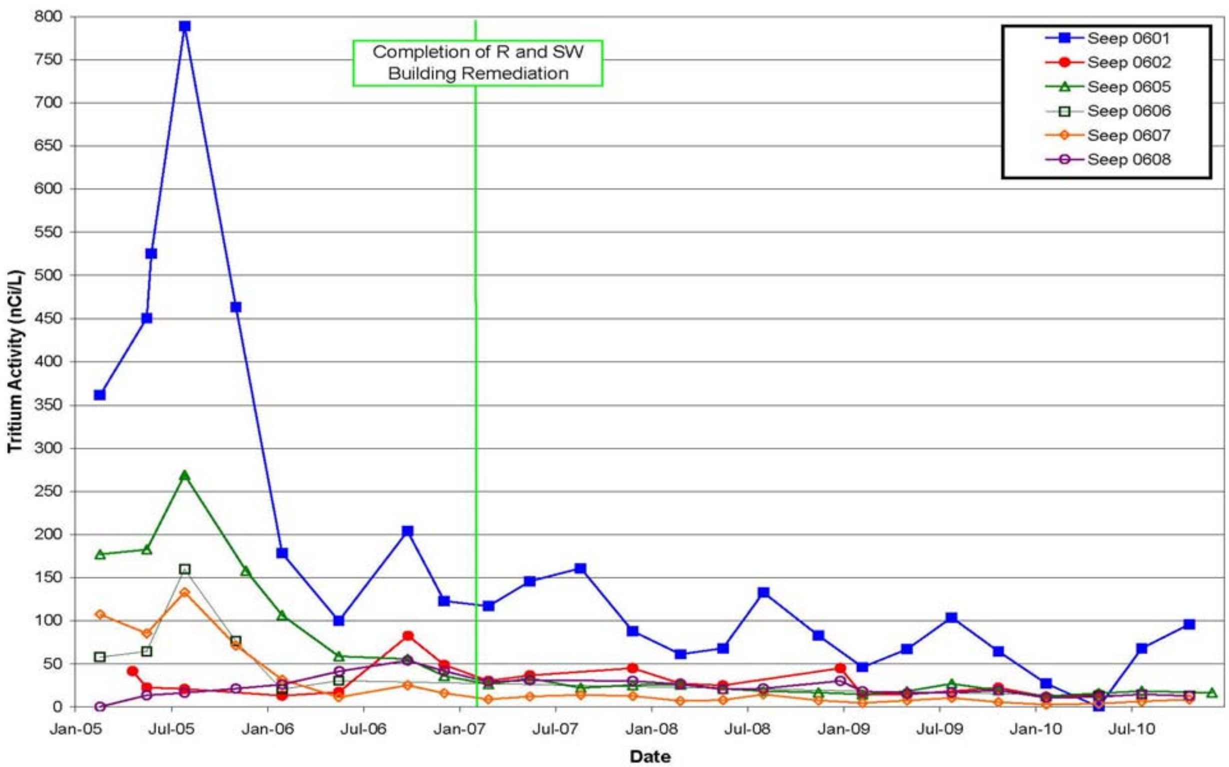

Figure 21. Tritium Activity in Seeps (2005−2010)

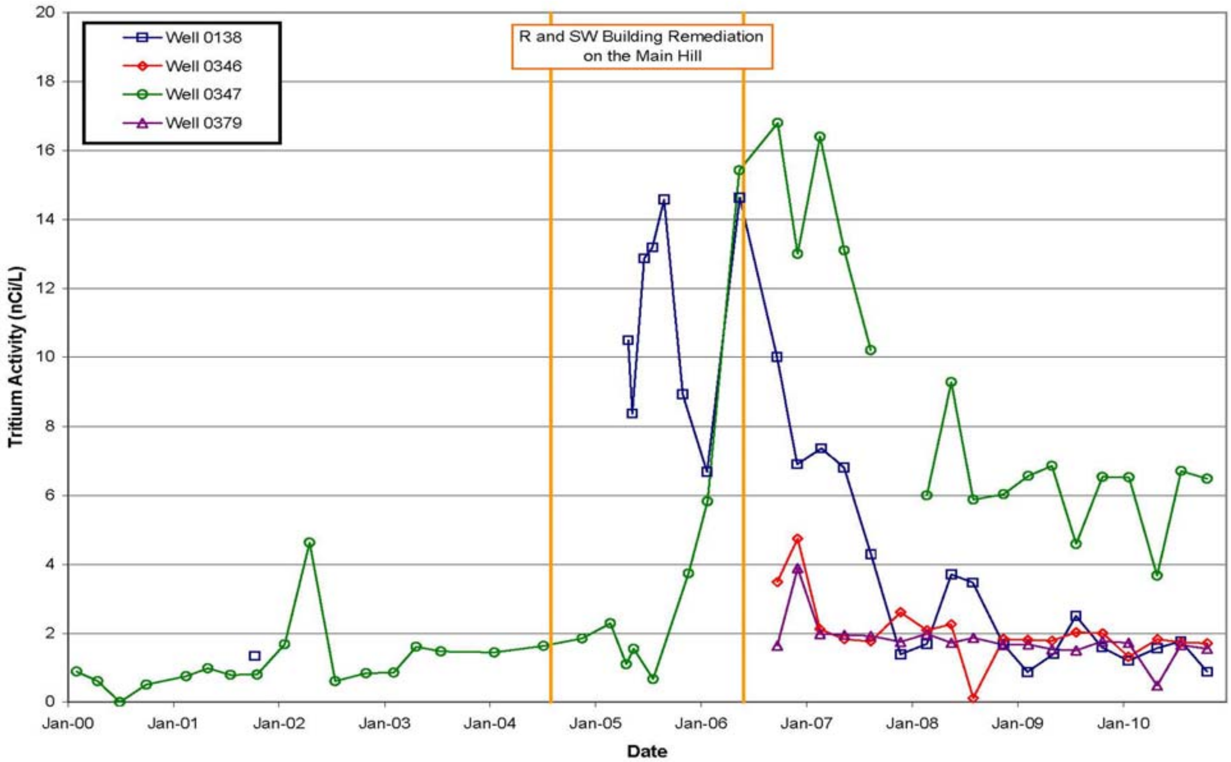

Figure 22. Tritium Activity in Wells 0138, 0346, 0347, and 0379 (2000–2010)

Trend analysis for tritium data collected since 2005 indicates decreasing tritium levels in all of the seeps and the four wells with detectable tritium levels, as indicated by negative slopes. Downward trends in tritium were calculated in seeps 0601, 0605, 0606, and 0607 and in wells 0138, 0346, 0347, and 0379 (Table 36).

Table 36. Summary of Trend Analysis Results for Tritium in the Main Hill Seeps and Downgradient Wells (2005−2010)

Location	Number of Samples	Trend	Slope (µg/L/year)	Confidence Interval (nCi/L/year)	
				Lower	Upper
0601	25	**Down**	-47.8	-83.5	-28.0
0602	18	None	-3.0	-9.2	0.61
0605	24	**Down**	-12.4	-30.1	-6.8
0606	9	**Down**	-9.0	-32.0	-0.80
0607	24	**Down**	-5.5	-12.7	-2.6
0608	23	None	-3.0	-6.1	0.09
0138	26	**Down**	-2.0	-2.7	-1.5
0346	18	**Down**	-0.10	-0.17	-0.03
0347	25	**Down**	-0.12	-0.14	-0.09
0379	18	**Down**	-0.22	-0.49	-0.04

Ra-226, Ra-228, and Sr-90 continued to be present in seep 0601 (Table 37). The activities observed at this location did not exceed the trigger level of 20 pCi/L for Sr-90 or combined Ra-226/228. Graphs of the concentrations over time (Figure 23 and Figure 24) indicate that levels have decreased since 2004. An increase in combined Ra-226/228 was observed at the end of 2009; however, levels decreased in 2010. Data from unimpacted seeps in Parcel 4 were used to estimate background levels for these isotopes in the bedrock aquifer. The maximum Ra-226 level measured in the Parcel 4 seeps was 0.81 pCi/L and the maximum Sr-90 level was 2.8 pCi/L. The levels of Sr-90 in seep 0601 are similar to those measured in Parcel 4 seeps. Levels of Ra-226 are slightly greater than those measured in Parcel 4 seeps.

Table 37. Summary of Radionuclides in Seep 0601 (2006–2010)

Location	Radionuclide	Average Activity (pCi/L)				
		2006	2007	2008	2009	2010
0601	Ra-226	0.45 (J)	0.86 (J)	0.67 (J)	0.80	1.0
	Ra-228	1.7	0.43 (J)	0.61 (J)	0.71 (J)	0.75 (J)
	Sr-90	3.5	2.4	1.6	1.6	1.4

J = Estimated value that is less than the reporting limit
Ra-226/228 trigger level at seep 0601 = 20 pCi/L
Sr-90 trigger level at seep 0601 = 20 pCi/L

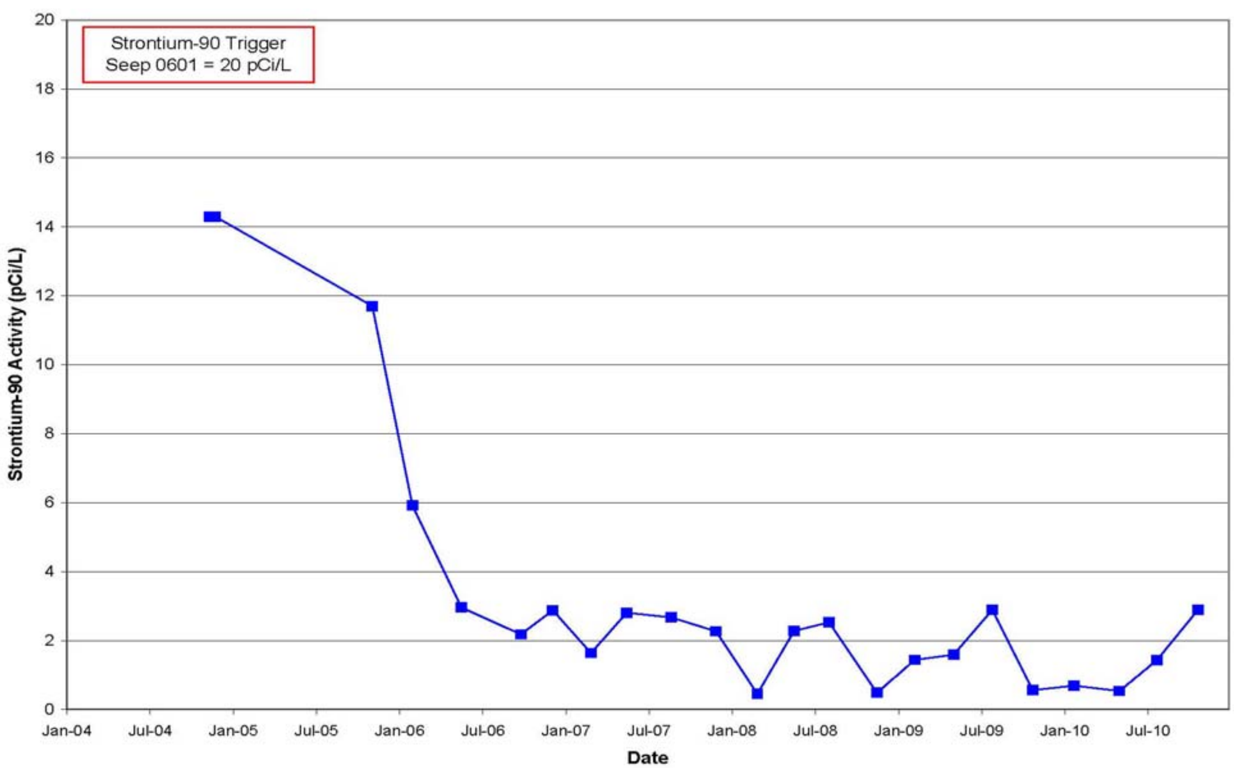

Figure 23. Sr-90 Activity Over Time in Seep 0601 (2004–2010)

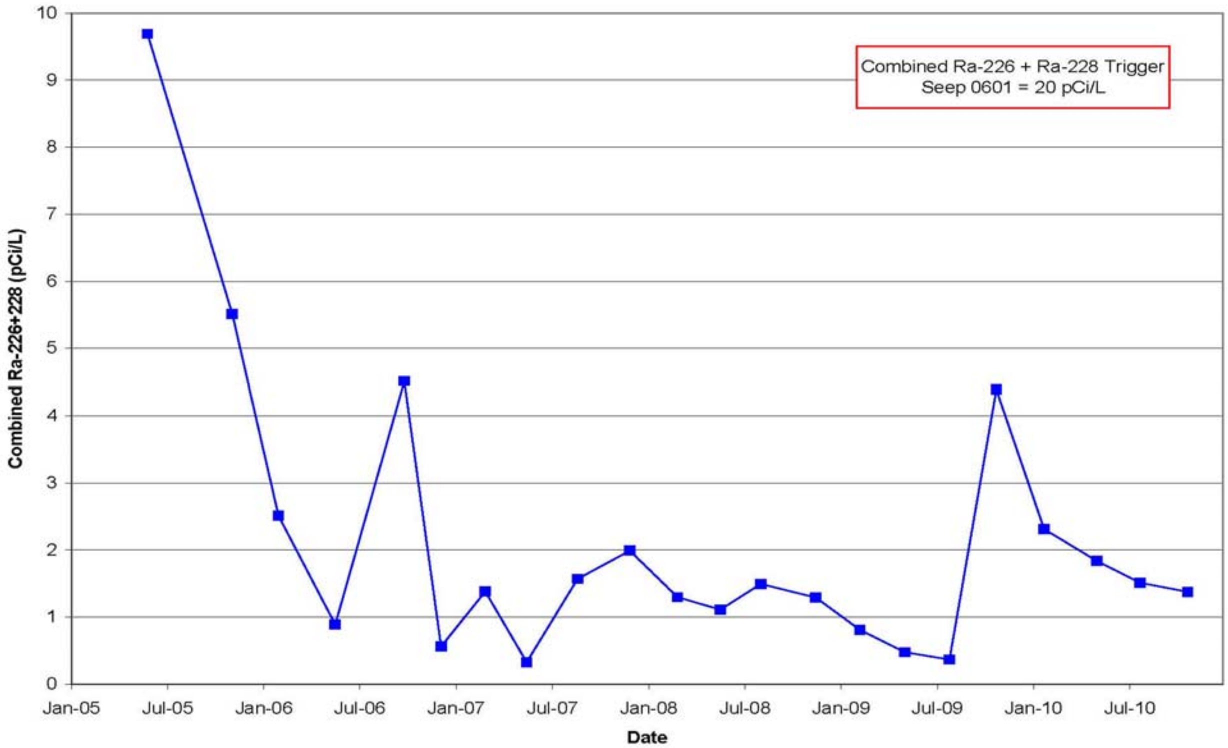

Figure 24. Combined Ra-226/228 Activity Over Time in Seep 0601 (2005–2010)

Trend analysis for Sr-90 and combined Ra-226/228 from seep 0601 (Table 38) indicates decreasing levels in both constituents, as indicated by negative slopes. A downward trend in Sr-90 was calculated for this location. No trend was reported in the combined radium levels.

Table 38. Summary of Trend Analysis Results for Other Radionuclides in Seep 0601 (2005−2010)

Radionuclide	Number of Samples	Trend	Slope (µg/L/year)	Confidence Interval (nCi/L/year)	
				Lower	Upper
Ra-226/228	12	None	-0.22	-0.89	0.14
Sr-90	10	**Down**	-0.56	-0.98	-0.15

6.7.3 Operable Unit 1

Necessary data to assess the performance of the OU-1 P&T system are outlined in the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000). The performance of the P&T system was assessed by three different metrics:

- VOC mass removal and mass removal rate
- System uptime verses downtime
- Hydraulic containment of the contaminant plume/area

When these three factors were maximized, then the system was operating in an acceptable manner. A large amount of data was collected for the OU-1 P&T system to monitor the performance of the system. This data included water level measurements, groundwater samples, effluent samples, influent samples, and volumes treated.

In January 2007, excavation of the OU-1 landfill was started to support future reuse of the property. Operation of the P&T system was modified to address the changing conditions as excavation activities progressed. Focus was placed on maintaining hydraulic capture and assessing downgradient groundwater quality.

Starting in January 2007, sampling was performed in wells downgradient of the landfill to assess the groundwater quality in the BVA and the distribution of TCE closer to the landfill area and extraction wells. Sampling was performed according to the requirements in the *Work Plan for the Replacement of the OU-1 Extraction Wells*, which was developed to address the removal of the remaining two extraction wells (0413 and 0414) to accommodate additional source removal (i.e., the excavation of contaminated soil and debris from the landfill area). The sampling program changed over time to address changing conditions as excavation activities progressed.

6.7.3.1 System Performance

The P&T system is designed to operate continuously, or as near to as continuous as practicable, as it is the primary system that contains the contaminant plume. The P&T system has generally run more than 90 percent of the time each month. Downtime is typically for general maintenance activities. Exceptions are the result of mechanical failures or power outages, which resulted in shorter percentages of operation.

The VOC contaminants of concern were monitored monthly in both the influent and effluent. Historically, the influent concentrations were used to determine the mass of contaminants removed; however, in 2003 determination of the mass removed was discontinued because it was deemed minimal. Data continued to show that the P&T system was being effective in the removal of the contaminants of concern (COCs) from the groundwater by the rate of which the mass of the contaminants present in the influent is decreasing. The influent concentrations in the three extraction wells remained steady or decreased (Figure 25), indicating that the concentrations within the area of groundwater impact are also decreasing. The effluent data demonstrates the effectiveness of the air stripper in removing the COCs from the water being treated. The concentrations of VOCs in the effluent are generally nondetectable.

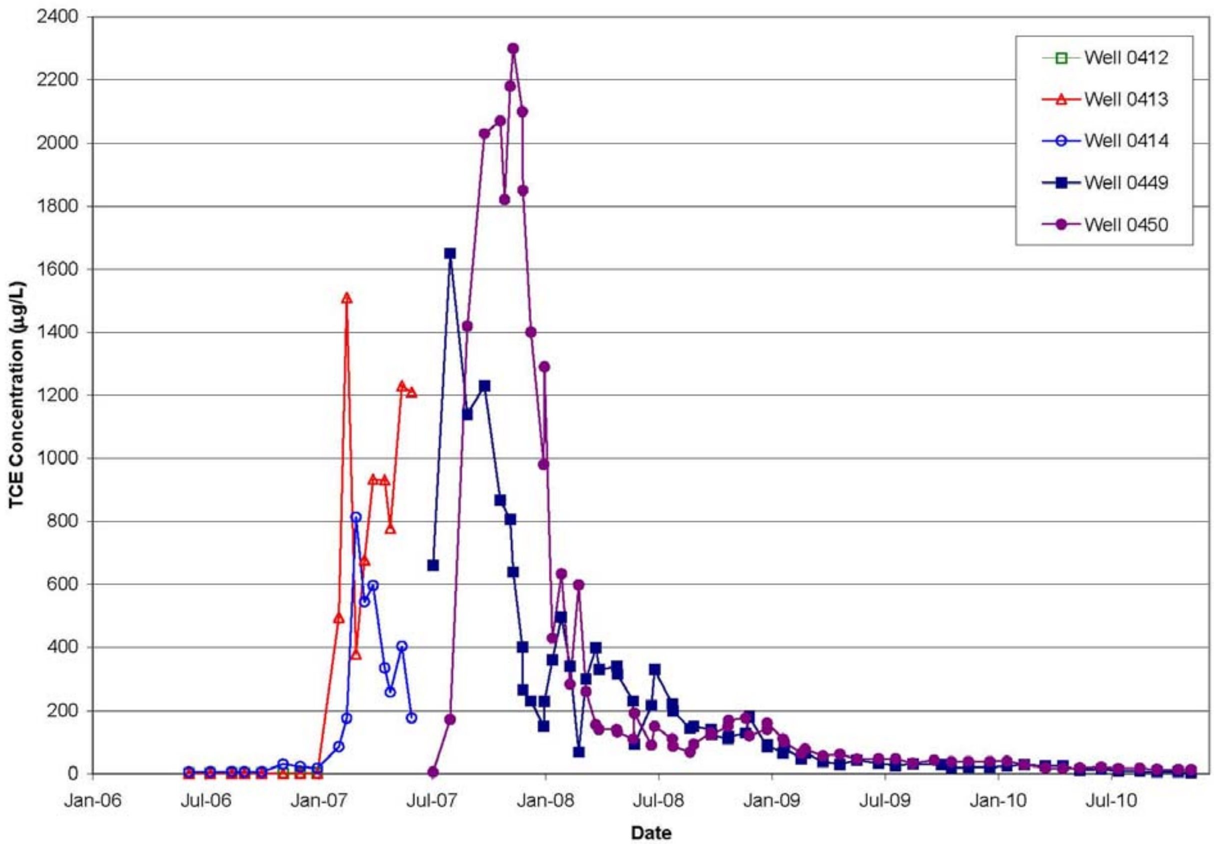

Figure 25. VOC Concentrations in OU-1 P&T System Extraction Wells

During excavation activities in the OU-1 area, the extraction wells were sampled bimonthly and later monthly to assess the VOC concentrations. Concentrations increased significantly in the wells during excavation activities in the landfill area. Concentrations began to decline in 2008 after the bulk of the VOC impacted soil had been excavated and the area backfilled. Concentrations continued to decline through 2010.

The following is a summary of the operation and removal of extraction wells 0412, 0413, and 0414 and the installation and operation of extraction wells 0449 and 0450 since January 2007:

- Extraction well 0412 was removed from service on January 31, 2007, and wells 0413 and 0414 were removed from service on June 11, 2007. These wells were removed to accommodate the excavation of soil contaminated with VOCs.
- Extraction wells 0449 and 0450 were installed and developed on July 10 and 11, 2007, and were put into operation on July 13, 2007. The extraction rates after initial optimization were 3.8 gallons per minute (gpm) for well 0449 and 1.1 gpm for well 0450. These rates were considerably lower than the 30 gpm rate maintained by the original extraction wells.
- Extraction wells 0449 and 0450 were redeveloped in August 2007 due to continued low production rates from the wells. The recovery tests performed before and after development indicated that redevelopment significantly improved the extraction rates.

- In an effort to increase the extraction rates in the wells, new pumps were installed in the wells on September 6, 2007. By the end of December 2007, the pumps operated at rates of 10.8 gpm (well 0449) and 11.7 gpm (well 0450).
- A program to incrementally increase the extraction rates in each well, while maintaining 1 ft of water over the pump, was started on January 14, 2008. This program was started after a review of extraction rates from previous months indicated that rates had been increasing slightly since redevelopment but had remained constant during December 2007. By January 15, 2008, the extraction rates were 20 gpm in well 0449 and 16 gpm in well 0450. By the end of February 2008, the extraction rates were maintained at 21 gpm in well 0449 and 10.5 gpm in well 0450.
- During April and May 2008, the extraction rate in well 0450 decreased to 7 gpm, while the rate in 0449 remained at 20.5 gpm. A review of the groundwater elevations in extraction well 0450 did not indicate a significant lowering in the water levels, which would indicate dewatering. The loss of production capacity was investigated in May 2008. A walkdown of the system revealed that the flow meter for well 0450 was not functioning properly.
- A short duration step test was conducted in May 2008 in response to lower than anticipated pumping rates (5 to 8 gpm) in well 0450. The results indicated that well 0450 could sustain an extraction rate of 10 to 11 gpm. It was speculated that the faulty flow meter on well 0450 was resulting in incorrectly low readings.
- During October 2008, digital flow meters and pressure transducers were installed in the extraction wells, allowing for remote access to the water elevations and flow rates.
- During November and December 2008, the pumping rates in the two extraction wells decreased substantially as a result of the lower water table in the OU-1 area that had been prevalent since August 2008.
- In response to higher groundwater levels, the extraction rates in both wells increased substantially in January 2009. Since then, the extraction rate in well 0449 has been approximately 18.5 gpm, the maximum rate that the present pump can attain. The extraction rate in well 0450 has varied and is affected by the water levels in the OU-1 area.
- Since July 2009, the flow in well 0449 has averaged 18.5 gpm. The pumping rate in well 0450 has decreased slowly due to the declining water table in the OU-1 area. The pump in well 0450 began cycling on September 22, 2009, resulting in lower than typical pumping rates at the end of the month.
- Extraction well 0450 was redeveloped on October 22, 2009, in response to declining extraction rates. The extraction rate increased from less than 4 gpm to approximately 9 gpm, and this rate was maintained through December 2009.
- The extraction rate in well 0450 declined from 9 gpm in December 2009 to 6 gpm in April 2010 despite increased water levels in the OU-1 area.
- Extraction well 0450 was redeveloped on May 6, 2010, in response to declining pumping rates even during periods when groundwater elevations were higher than typical. Redevelopment increased the pumping rate from 5 gpm to 16 gpm.
- The extraction rate in well 0450 has averaged above 17 gpm since redevelopment of the well in May 2010. Prior to redevelopment, the operation of the wells was dependent on water levels. Since redevelopment, this has not been the case.

6.7.3.2 Hydraulic Capture

During 2006, local hydraulic gradients were determined by conducting three-point evaluations using monitoring wells that straddle the compliance boundaries. Two sets of monitoring wells were utilized to determine if hydraulic containment is achieved. Wells 0305, 0410, and 0417 were used to verify containment at the southern boundary, and wells 0422, 0423, and P003 were used to verify containment at the western boundary. The compliance boundaries are the west and south access roads located adjacent to the landfill area. The groundwater gradients were calculated to determine whether groundwater flow direction has been reversed and flow was coming inward across the compliance boundaries. It was assumed from a groundwater model that complete hydraulic control could be assumed if a 0.002 ft/ft average inward gradient was maintained across at least a 25-ft wide border centered on the compliance boundary. A summary of the data collected in 2006 and early 2007 is presented in Table 39. Although the 0.002 ft/ft gradient was not continuously maintained across the compliance boundary, the results show that the system captured the contaminated groundwater by maintaining a positive gradient across the compliance boundaries. The negative gradient calculated in November 2006 was the result of groundwater elevations on the west side of the OU-1 landfill increasing in response to a high river stage. This was a discrete short-term event and the inward flow quickly resumed.

Table 39. Summary of Hydraulic Gradients for the OU-1 P&T System in 2006 and 2007

Date	Hydraulic Gradient (ft/ft)	
	0422 / 0423 / P003	0305 / 0410 / 0417
1/4/2006	0.0027	0.0021
2/2/2006	0.0026	0.0027
3/2/2006	0.0023	0.0030
3/30/2006	0.0024	0.0017
4/26/2006	0.0025	0.0025
6/1/2006	0.0024	0.0027
7/5/2006	0.0020	0.0026
8/1/2006	0.0025	0.0029
9/5/2005	0.0023	0.0025
10/2/2006	0.0023	0.0026
11/1/2006	0.0077	-0.0030
11/16/2006	0.0024	0.0030
12/4/2006	0.0032	0.0035
1/2/2007	0.0026	0.0021
2/1/2007	0.0014	0.0028
3/5/2007	0.0024	0.0028
4/2/2007	0.0018	0.0014
5/1/2007	0.0020	0.0036
6/4/2007	Well P003 removed	0.0026
6/11/2007		0.0034

Positive gradients indicate inward flow

Starting in 2008, a new set of wells along the southern side of the OU-1 landfill were selected to determine the inward gradients maintained by the new extraction wells 0449 and 0450. Initially water levels were measured in wells 0305, 0419, and P043 to determine groundwater elevations. In late 2009, it was determined that well 0410 would replace well 0419 as it provided more representative data for the water table in the OU-1 area.

As before, the groundwater gradients were calculated to determine whether groundwater flow direction was reversed and flow was coming inward toward the extraction wells. Although the 0.002 ft/ft average inward gradient was not consistently maintained, the results show that the system captured the contaminated groundwater by maintaining a positive inward gradient. A summary of the data collected from 2008 through 2010 is presented in Table 40.

Table 40. Summary of Hydraulic Gradients for the OU-1 P&T System in 2008 and 2010

Date	Hydraulic Gradient (ft/ft)	Date	Hydraulic Gradient (ft/ft)
1/29/2008	0.0029	7/21/2009	0.0020
2/25/2008	0.0026	8/24/2009	0.0015
3/24/2008	0.0040	9/30/2009	0.0012
4/28/2008	0.0032	10/26/2009	0.0008
5/27/2008	0.0016	11/2/2009	0.0021
6/30/2008	0.0012	11/16/2009	0.0037
7/28/2008	0.0016	12/14/2009	0.0031
8/25/2008	0.0028	1/19/2010	0.0031
9/22/2008	0.0018	2/22/2010	0.0034
10/21/2008	0.0020	3/31/2010	0.0034
11/17/2008	0.0017	4/19/2010	0.0027
12/15/2008	0.0011	5/19/2010	0.0059
1/20/2009	0.0018	6/21/2010	0.0053
2/21/2009	0.0012	7/26/2010	0.0057
3/16/2009	0.0016	8/30/2010	0.0065
4/20/2009	0.0023	9/27/2010	0.0058
5/11/2009	0.0037	10/25/2010	0.0063
6/17/2009	0.0012	11/22/1020	0.0056
7/6/2009	0.0016	12/29/2010	0.0051

In 2010, an assessment of the performance of the OU-1 P&T System was performed to address concerns of continued TCE concentrations in some downgradient wells and the lower extraction rates maintained by the extraction wells installed after excavation activities began. The *OU-1 Pump and Treatment System Performance Evaluation* (DOE 2010e) documented an analysis of the capture zone using methods outlined in *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (EPA 2008), an evaluation of the water table under unstressed conditions, and the results of a drawdown test. It was concluded that containment of TCE-impacted groundwater has been maintained with the present pumping configuration of the wells operating at a combined rate between 20 to 28 gpm. A determination of the area of influence and capture zone for the extraction wells was made from field data and hydraulic calculations. These numbers are in general agreement with each other. Capture can be attained in approximately 400 minutes after startup of the extraction wells.

6.7.3.3 Groundwater Monitoring

Prior to excavation of the landfill in 2007, the measurement of contaminant concentrations in groundwater in the vicinity of the OU-1 P&T system was performed in accordance with the OU-1 O&M Plan. The measurements provided the definite long-term feedback on the operation of the system. Wells on the western and southern compliance boundaries exhibited concentrations less than the MCL (Table 41). Downgradient wells exhibited concentrations of TCE and PCE less than the detection limit of 5 µg/L. These low concentrations were maintained due to hydraulic containment created by the operation of the P&T system.

Table 41. Average VOC Concentrations for OU-1 in 2006

Well ID	Location	TCE (μg/L)	PCE (μg/L)
0305	Compliance Boundary	2.0	1.4
0410		< 5	1.3
0417		< 5	2.1
0418		2.5	1.9
0419		2.4	4.5
P015		Not sampled	
P027	Downgradient	< 5	< 5
P031		< 5	< 5

Excavation of the OU-1 landfill was started in early 2007. This work resulted in removal of the original extraction wells, as they were installed within the footprint. A sampling program was started in January 2007 to monitor groundwater quality in the OU-1 area during the excavation activities. Because of the removal of the original extraction wells, increased TCE levels in groundwater during excavation, and the continued presence of elevated TCE levels in wells immediately downgradient of the new extraction wells, sampling frequencies have changed periodically in order to better assess changes in contaminant distribution.

Sampling was performed in downgradient wells to assess the groundwater quality in the BVA and the distribution of TCE closer to the landfill area and extraction wells (Table 42). Sampling was performed according to the requirements in the *Work Plan for the Replacement of the OU-1 Extraction Wells*, which was developed and approved by the Mound Core Team to address the removal of the remaining two extraction wells (0413 and 0414) to accommodate additional source removal (i.e., the excavation of contaminated soil and debris from the landfill area). The sampling program's locations and sampling frequencies changed over time to address changes in activities and groundwater quality.

Concentrations of TCE increased significantly in wells downgradient of the compliance boundary in response to the extraction wells being removed in early 2007 (Figure 26). New extraction wells were installed and began operating in July 2007. However, the extraction rates for the wells were significantly lower than the original wells and were not as effective in reversing the gradient and drawing the TCE-impacted water back. After operation of the extraction wells was optimized in late 2007, the TCE concentrations in the downgradient wells decreased dramatically.

During 2007, when TCE concentrations were the highest in the wells downgradient of the landfill, the TCE concentrations in wells P027 and P031, which are located further downgradient increased slightly. However, the concentrations of TCE or PCE did not exceed the MCL.

Through continued operation and optimization of the extraction well system, the concentrations of TCE have continued to decrease, indicating capture of the TCE-impacted water that initially was released during 2007. Concentrations of TCE in well 0418 are depicted in Figure 27 to illustrate this capture.

Table 42. Sampling Frequencies for OU-1 Wells During Excavation Activities

Well ID	Sampling Frequency
0305	Monthly
0410	
0416	
0417	
0418	
0419	
0449 – extraction well	
0450 – extraction well	
P053	
P054	
P056	
0424	Bimonthly
0425	
P015	
P027	
0422	Quarterly
0423	
P031	

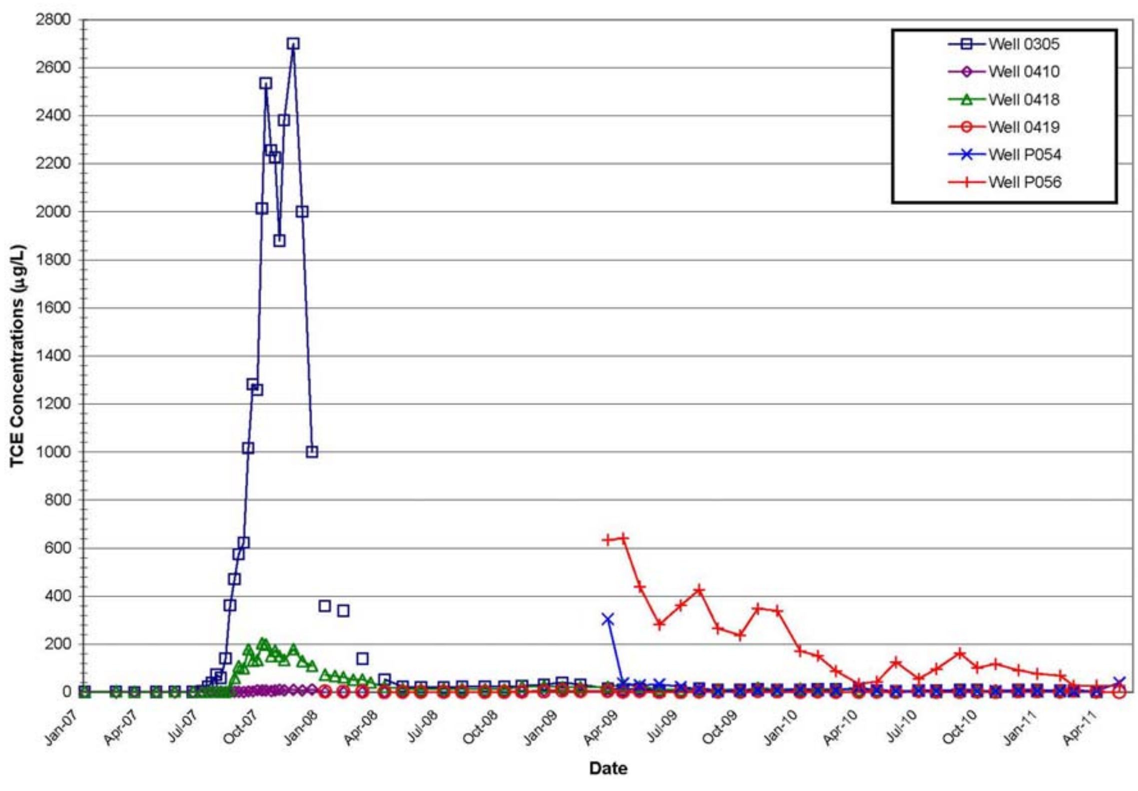

Figure 26. TCE Concentrations in Downgradient Wells (2007–2010)

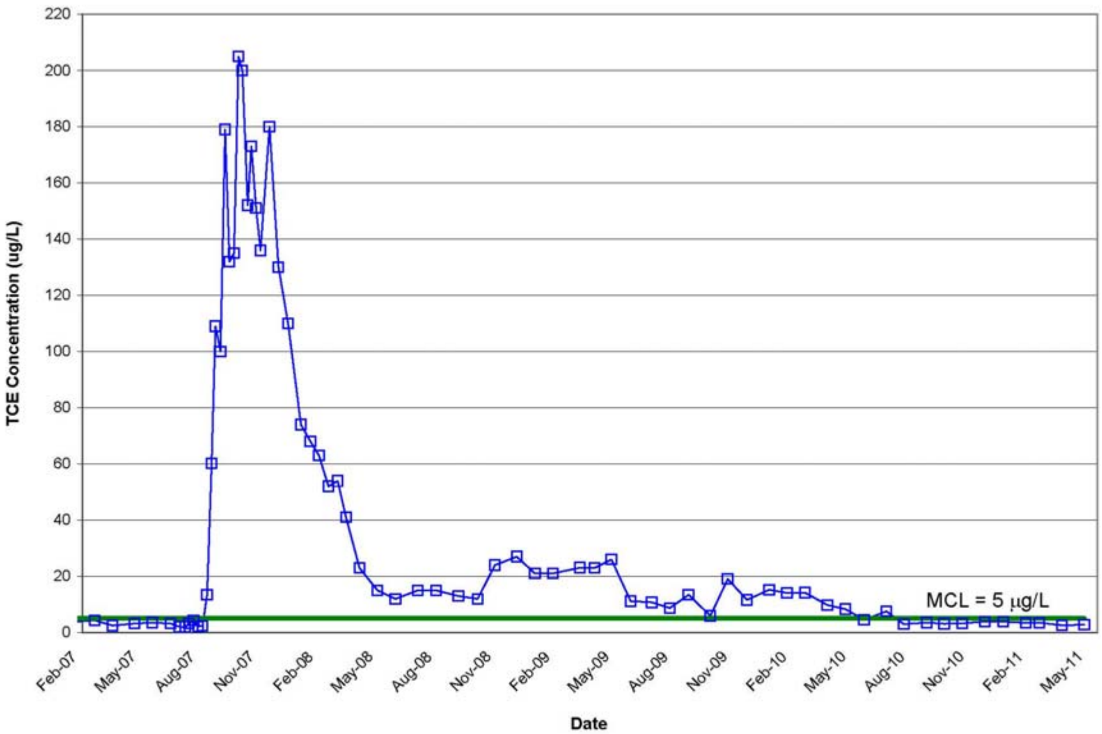

Figure 27. TCE Concentrations in Well 0418 (2007–2011)

6.7.3.4 Compliance Monitoring

The effluent from the P&T system is monitored and discharged in accordance with the CERCLA authorization to discharge under NPDES (Authorization Number 1IN90010*BD) (Table 43). The samples are designated as outfall 003. These data are reported monthly to OEPA. The VOC data from the effluent is typically nondetectable, indicating that system is effective at removing the organic compounds from the groundwater.

The 16 constituents sampled for outfall 003 are collected daily, weekly, or monthly. There have not been any exceedences of these parameters at outfall 003. Twice per year (April and October) samples are collected to perform acute and chronic toxicity testing of the effluent on Ceriodaphnia dubia. There are no limits stated in the ATD; however, any values above the method detection limit (MDL) require further evaluation. From 2007 through 2010 there were six occasions when the chronic toxicity value was greater than the MDL. In all cases discussions were held with OEPA about these slightly elevated values. In all but one of the cases, the conclusion was that the value reported was a statistical artifact and did not require further evaluation. For one event, it was determined that the samples should not have been taken because a flock of geese were nesting in the outfall and the geese droppings were harmful to the species being tested.

Table 43. Monitoring Requirements for Outfall 003

Parameter	Discharge Limits			Sample Type	Frequency
	Maximum	Minimum	Monthly		
Flow Rate – MGD	---	---	---	24-hr total	daily
pH – S.U.	9.0	6.5	---	grab	weekly
Dissolved oxygen – mg/L	---	---	---	grab	monthly
Copper, total recoverable – µg/L	---	---	---	24-hr composite	monthly
Mercury, total (low level) – ng/L	2200	---	23	grab	monthly
CBOD, 5 day – mg/L	---	---	---	24-hr composite	monthly
Carbon tetrachloride - µg/L	10	---	5	grab	monthly
Chloroform - µg/L	10	---	5	grab	monthly
Methylene chloride - µg/L	10	---	5	grab	monthly
Tetrachloroethylene - µg/L	10	---	5	grab	monthly
Trichlorofluoromethane - µg/L	10	---	5	grab	monthly
1,1,1-Trichloroethane - µg/L	10	---	5	grab	monthly
1,2-*trans*-Dichloroethylene - µg/L	10	---	5	grab	monthly
Vinyl chloride - µg/L	10	---	5	grab	monthly
Trichloroethylene - µg/L	10	---	5	grab	monthly
cis-1,2-Dichloroethylene - µg/L	10	---	5	grab	monthly
Chronic toxicity	---	---	---	grab	semiannually
Acute toxicity	---	---	---	grab	semiannually

MGD = million gallons per day
S.U. = standard units
CBOD = carbonaceous biological oxygen demand

7.0 Technical Assessment

7.1 Institutional Controls

Question A: Is the remedy functioning as intended by the decision documents?

Answer A: Yes, the remedy is functioning as intended by the decision documents.

7.1.1 Remedial Action Performance

The review of documents and the results of the annual and five-year review inspections indicate that the remedies for Parcels D, H, 3, 4, 6, 7, and 8 and for Phase I are functioning as intended. The remedies consist of ICs on land and groundwater use, soil removal, and use of areas of T building.

ICs have been implemented in the form of deed restrictions on future land use. A summary is prepared and included with the parcel deed that fulfills the requirements of CERCLA Section 120(h). The summary includes a discussion of the contamination that was present, the remedial actions that have taken place, and the residual risk that remains. The ICs for Parcel 9 will be in the form of an environmental covenant and will be developed at a later date.

The current land owner has implemented several measures to ensure that ICs are not violated. For example, language about the prohibition against removing excavated soil from the site is included in the technical requirements of all Requests for Proposal and Work Orders for work being performed on transferred parcels.

7.1.2 Operations and Maintenance

O&M activities are performed as outlined in the *Operation and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property*. DOE has performed annual walkovers and records reviews with respect to ICs and has found that portion of the remedy to be functioning as intended, thus far.

7.1.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.1.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial objectives used at the time of the remedy are still valid.

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

The RAO for soils is to ensure that exposures do not exceed an excess cancer risk of 10^{-4} or a hazard index of 1 through use of the site for occupational exposures (e.g., office worker and construction worker). Site use continues to be industrial/commercial and this RAO remains protective. RBGVs used to evaluate site conditions have changed slightly over time due to changes in toxicity values for various constituents (some increases, some decreases). However, these changes have not affected contaminant identification at the site and do not significantly change estimates of site risks. A comparison of risks calculated using older and revised toxicity values for radionuclides was conducted for Parcel 3 (DOE 2001c). This comparison indicated changes in risk estimates of less than an order of magnitude. Risk evaluations conducted for some parcels did not include a dermal exposure pathway for soils and could slightly underestimate total site risks. However, exposures through the oral and external pathways make up the bulk of site risks and these have been accounted for in all risk analyses. Results of the risk information review do not suggest that there is a need to update any of the risk calculations that have already been completed.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer C: No other information has come to light that could call into question the protectiveness of the remedy.

7.2 OU-1 Remedy

Question A: Is the remedy functioning as intended by the decision documents?

Answer A: Yes, the remedy is functioning as intended by the decision documents.

7.2.1 Remedial Action Performance

The review of documents and environmental monitoring data and the results of the five-year review inspection indicate that the remedy for OU-1, which consists of controlling contaminant migration through the use of a P&T system, is functioning as intended. Hydraulic and groundwater data indicate that the migration of the plume has been controlled by the use of the extraction wells. The performance monitoring indicates that VOC contamination is being extracted by the wells and treated to levels typically less than the detectable limit through the air stripper. Based on groundwater monitoring, potential receptors have not been exposed to VOC contamination from the landfill.

7.2.2 Operations and Maintenance

O&M activities are performed as outlined in the *OU-1 Pump and Treatment Operational and Maintenance Plan*. DOE also performs annual inspections on long-term remedies as called out in this plan and other O&M Plans. DOE has performed groundwater monitoring, effluent monitoring, and system monitoring and has found this remedy to be functioning as intended, thus far.

Groundwater level measurements and groundwater contaminant information have been collected as prescribed. These data indicate that the plume has been contained and unacceptable migration has not occurred.

Influent and effluent data from the P&T system indicate that VOC contaminated groundwater is being extracted and the mass removed over time has decreased. Effluent data supports the assertion that the air stripper system is effective in removing VOC contamination from the groundwater.

7.2.3 Opportunities for Optimization

A rebound study is being performed to assess whether a passive groundwater remedy can be implemented to address the OU-1 groundwater following completion of the landfill excavation in 2010. This study was started in June 2011 and is expected to continue for a period of 18 to 24 months. Data from this study will be used to create an exit strategy for the OU-1 groundwater.

7.2.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer: Yes, the exposure assumptions, toxicity data, clean-up levels, and remedial objectives used at the time of the remedy are still valid.

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

> ***Question C: Has any other information come to light that could call into question the protectiveness of the remedy?***
>
> **Answer C: No other information has come to light that could call into question the protectiveness of the remedy.**

7.3 Phase I Groundwater (MNA) Remedy

> ***Question A: Is the remedy functioning as intended by the decision documents?***
>
> **Answer A: Yes, the remedy is functioning as intended by the decision documents.**

7.3.1 Remedial Action Performance

The review of documents and environmental monitoring data and the results of the annual and five-year review inspections indicate that the remedy for Phase I, which consists of MNA to address groundwater impact and ICs on land and groundwater use, is functioning as intended.

7.3.2 Operations and Maintenance

O&M activities are performed as outlined in the *Operations and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* and the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. DOE has performed annual walkovers and records reviews with respect to ICs and has found that portion of the remedy to be functioning as intended. DOE has also performed groundwater monitoring and has found the groundwater remedy to be functioning as intended, thus far.

Groundwater monitoring has been performed as prescribed in the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. Results from this monitoring indicate that concentrations do not exceed target levels. Decreasing TCE concentrations are occurring in one of the source area wells and the downgradient seep. Monitoring in the downgradient BVA wells continue to indicate no adverse impact from TCE source area. Confirmatory sampling for radium and barium is ongoing. Although the data support the source of these constituents are naturally occurring, increasing levels have been observed in the downgradient BVA. Confirmatory sampling for chromium and nickel were discontinued during the review period as data supported the source of these two contaminants were the stainless steel casing these wells were constructed from.

7.3.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.3.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

> ***Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?***
>
> **Answer B: Yes, the exposure assumptions, toxicity data, clean-up levels, and remedial objectives used at the time of the remedy are still valid.**

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

> ***Question C: Has any other information come to light that could call into question the protectiveness of the remedy?***
>
> **Answer C: No other information has come to light that could call into question the protectiveness of the remedy.**

7.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

> ***Question A: Is the remedy functioning as intended by the decision documents?***
>
> **Answer A: Yes, the remedy is functioning as intended by the decision documents.**

7.4.1 Remedial Action Performance

The review of documents and environmental monitoring data and the results of the annual and five-year review inspections indicate that the remedy for Parcels 6, 7, and 8, which consists of MNA to address groundwater impact and ICs on land and groundwater use, is functioning as intended. The quitclaim deed for Parcels 6, 7, and 8 have been designated; however, they have not been recorded as of the date of this review. It is recommended that verification of the quitclaim deed being recorded prior to transfer of the property.

7.4.2 Operations and Maintenance

O&M activities are performed as outlined in the *Operation and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* and the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. DOE has performed annual walkovers and records reviews with respect to ICs and has found that portion of the remedy to be functioning as intended, thus far. DOE has also performed groundwater monitoring and has found the groundwater remedy to be functioning as intended, thus far.

Groundwater monitoring has been performed as prescribed in the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. Results from this monitoring indicate that variability in the data, which is consistent with data collected after recent source removal. Concentrations in one onsite well have exceeded target level for TCE on two occasions and increases in TCE have been reported in one onsite seep. Tritium levels show decreases in several onsite wells and seeps. Monitoring in the downgradient BVA wells continue to indicate no adverse impact from TCE or tritium from the Main Hill.

7.4.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.4.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer B: Yes, the exposure assumptions, toxicity data, clean-up levels, and remedial objectives used at the time of the remedy are still valid.

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer C: No other information has come to light that could call into question the protectiveness of the remedy.

8.0 Issues

No issues were identified as the result of this five-year review. It has been determined that remedies are functioning as designed. Adequate oversight mechanisms appear to be in place to identify possible deficiencies, and adequate resources are available to correct or mitigate any problems, if they were to occur.

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9.0 Recommendations and Follow-Up Actions

The following three recommendations were identified as the result of this five-year review and associated actions are outlined in Table 44.

1. Verify that the quitclaim deed for Parcels 6, 7, and 8 is appropriately recorded and is free and clear of all liens and encumbrances.
2. Finalize the sitewide IC Management/Land Use Control Plan (with CERCLA Summary).
3. Finalize the sitewide O&M Plan for groundwater remedies.

Table 44. Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1	Verify recording of Parcels 6, 7, and 8 quitclaim deed	DOE	DOE	Within 6 months	N	N
2	Finalize Sitewide IC Management/Land Use Control Plan (with CERCLA Summary)	DOE	DOE	Within 6 months	N	N
3	Finalize the sitewide O&M Plan for groundwater remedies	DOE	DOE	Within 12 months	N	N

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10.0 Protectiveness Statements

10.1 Institutional Controls

The remedy for Parcels D, H, 3, and 4 and the ICs associated with Phase I and Parcels 6, 7, and 8 are protective of human health and the environment because controls are functioning as intended.

10.2 Operable Unit 1

The remedy at OU-1 currently protects human health and the environment because containment of the plume is functioning as intended. Exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and Federal ownership of the land. However, in order for the remedy to be protective in the long-term, ICs to restrict soil removal and groundwater use need to be implemented. The OU-1 ROD is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. As stated in the OU-1 ROD, the ICs for OU-1 would be developed prior to transfer and therefore, will be outlined in future documentation for Parcel 9.

10.3 Phase I Groundwater (MNA) Remedy

The remedy for Phase I is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent usage of the groundwater in the restricted area.

10.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

The remedy for Parcels 6, 7, and 8 is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals, through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent usage of the groundwater in the restricted area.

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11.0 Next Review

This is the third statutory five-year review for this site. The next five-year review will be conducted in 2016.

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