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U.S. Department of Energy
Office of Legacy Management

Weldon Spring Site Environmental Report for Calendar Year 2005

July 2006

Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
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Acronyms

AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
BTLs	baseline tolerance limits
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COC	Contaminant of Concern
CWA	Clean Water Act
DA	Department of the Army
DCF	Dose Conversion Factor
DNB	dinitrobenzene
DNT	Dinitrotoluene
DOE	U.S. Department of Energy
DOE−LM	U.S. Department of Energy Office of Legacy Management
DRC	Dispute Resolution Committee
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
FHHS	Francis Howell High School
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
gal	Gallon
GPS	Global Positioning System
GWOU	Groundwater Operable Unit
ha	hectare(s)
IC	Institutional Control
ICO	In-situ Chemical Oxidation
IRA	Interim Response Action
kg	kilogram(s)
lb	pound(s)
L	Liter
LCRS	Leachate Collection and Removal System
LTS&M	Long-Term Surveillance and Maintenance
MCL	Maximum Contaminant Level
MEI	maximally exposed individual
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
mg	milligram(s)
mg/L	milligram(s) per liter
MoDOT	Missouri Department of Transportation
MNA	Monitored Natural Attenuation
mrem/yr	millirem per year
MSD	Metropolitan St. Louis Sewer District
msl	Mean Sea Level
MW	Monitoring Well
MWQS	Missouri Water Quality Standard

µg	microgram(s)
µBq/mL	microbequerel(s) per milliliter
µCi/mL	microcurie(s) per milliliter
µg/L	microgram(s) per liter
NB	nitrobenzene
ND	Non-Detect
NHPA	National Historic Preservation Act
NPL	National Priorities List
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NT	nitrotoluene
OU	Operable Unit
PAHs	Polyaromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	perchloroethene
pCi	picocurie(s)
pCi/L	picocurie(s) per liter
PCOR	Preliminary Closeout Report
QA	quality assurance
QROU	Quarry Residuals Operable Unit
Ra	Radium
RCRA	Resource Conservation and Recovery Act
RME	Reasonable Maximally Exposed
ROD	Record of Decision
RPD	Relative Percent Difference
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SE	Southeast
SP	Spring
SWTP	Site Water Treatment Plant
TCE	Trichloroethene
TDS	Total Dissolved Solids
TEDE	Total Effective Dose Equivalent
Th	Thorium
TNB	trinitrobenzene
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
U-234	uranium-234
U-238	uranium-238
VOC	Volatile Organic Compounds
WSSRAP	Weldon Spring Site Remedial Action Project
WSUFMP	Weldon Spring Uranium Feed Material Plant

Executive Summary

This *Weldon Spring Site Environmental Report for Calendar Year 2005* has been prepared as required by DOE Order 231.1A *Environmental, Safety, and Health Reporting* to provide information about the environmental and health protection programs conducted at the Weldon Spring Site. The Weldon Spring site is in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis. The site consists of two main areas, the former Weldon Spring Chemical Plant and the Weldon Spring Quarry, located on Missouri State Route 94, southwest of U.S. Route 40/61.

The objectives of the *Site Environmental Report* are to present a summary of data from the environmental monitoring program, to identify trends and characterize environmental conditions at the site, and to confirm compliance with environmental and health protection standards and requirements. The report also presents the status of remedial activities and the results of monitoring these activities to assess their impacts on the public and environment. Since the site has reached physical completion, the long-term surveillance and maintenance (LTS&M) activities have become the main focus of the project. Therefore this report has been restructured and revised to reflect the reduction in physical activities and includes more emphasis on LTS&M activities.

<u>Compliance Summary</u>

The Weldon Spring site is listed on the National Priorities List (NPL) and is governed by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Under CERCLA, the Weldon Spring Site has been subject to meeting or exceeding applicable or relevant and appropriate requirements of Federal, State, and local laws. Primary regulations have included the *Resource Conservation and Recovery Act* (RCRA), *Clean Water Act*, and because the U.S. Department of Energy (DOE) is the lead agency for the site, the *National Environmental Policy Act* (NEPA) values are incorporated into CERCLA documents as outlined in the Secretarial Policy statement on NEPA. Many of these regulations are no longer applicable due to the reduction in physical activities and waste handling at the site.

The Site has reached construction completion under CERCLA, which was documented in a Preliminary Closeout Report (PCOR) which was issued by EPA on August 22, 2005.

Because contamination remains at some of the areas of the Site at levels above those that allow unlimited use and unrestricted exposure, CERCLA requires that the remedial actions be reviewed at least every five years. These reviews are commonly called Five-Year Reviews. The DOE is currently preparing the third Five-Year Review for the Site which will be issued in September 2006. The 2005 annual LTS&M inspection also served as the Five-Year Review inspection.

The Weldon Spring Site has one National Pollution Discharge Elimination System (NPDES) permit (MO-0107701) at this time. The permit only covers the former Site Water Treatment Plant (SWTP) discharge line. The SWTP discharge line will only be used if the site ever operates Train 3 at the leachate collection and removal system (LCRS) as a contingency to current disposal methods (see Section 2.1.3.3). This permit's expiration date was in July 2005. The DOE submitted a renewal application to the Missouri Department of Natural Resources (MDNR) in

January 2005, but has not received a renewed permit to date. The site currently operates under the existing permit until MDNR issues a renewed permit.

Environmental Monitoring Summary

Historical water quality and water level data for existing wells can be found on the U.S. Department of Energy Office of Legacy Management website: www.gjo.doe.gov/LM/. Photographs, maps, and physical features can also be viewed on this web page.

Continuing through 2005, monitoring at the Chemical Plant was focused on assessment of the selected remedy of monitored natural attenuation (MNA) that was started in July 2004. This monitoring program consists of a more focused monitoring strategy. A reduction of monitoring locations and parameters has occurred since the 2004 annual report. A total of 72 wells and 5 springs were routinely sampled during 2004 to monitor the groundwater impacts of historical chemical plant operations and recent remedial activities, and to establish baseline for MNA of contaminants of concern in the shallow aquifer. This number was reduced to 50 wells, 4 springs and one surface water location under the MNA program.

Total uranium continues to be present in the groundwater near the former raffinate pits. Four of the 17 wells sampled for uranium exceeded the drinking water standard of 30 µg/L (20 pCi/L). Average nitrate concentrations exceeded the maximum contaminant level (MCL) of 10 mg/L at 12 of the 22 wells sampled for nitrate. Nitroaromatic compounds were monitored in 30 locations across the Chemical Plant area. The Missouri Water Quality Standard (MWQS) for 2,4-DNT of 0.11 µg/L was equaled or exceeded at 7 locations and the MWQS for 1,3-DNB of 1.0 µg/L was exceeded at one location. The risk-based concentration of 2.8 µg/L for 2,4,6-TNT was exceeded at one location and the risk-based concentration of 1.3 µg/L for 2,6-DNT was exceeded at four locations. The MWQS for nitrobenzene (NB) of 17 µg/L was not exceeded at any location. Trichloroethene (TCE) was sampled at 14 locations to monitor the extent of contamination and changes in concentration that may have resulted from remedial activities and groundwater field studies performed in the area of TCE impact. Three of these wells exceeded the MCL of 5 µg/L for TCE.

Burgermeister Spring and Spring 6303 were sampled for nitrate, uranium, TCE, and nitroaromatic compounds as part of the MNA sampling program.. Monitoring results for both springs were within historical ranges and were in the same general range as concentrations reporting in 2004..

Two springs in the Southeast Drainage (SP-5303, SP-5304) and one additional spring located in the Burgermeister Spring Branch (SP-6306) were monitored for uranium during 2005. The uranium was lower in SP-6306 compared to 2004, but significantly higher in SP-5303 and SP-5304

At the Quarry, a total of 34 wells were routinely sampled to monitor the contaminant concentrations in close proximity to the Quarry proper and the water quality in the Missouri River alluvium.

The highest levels of uranium continue to occur in the bedrock downgradient from the Quarry and in the alluvial material north of the Femme Osage Slough. The uranium drinking water standard of 30 µg/L (20 pCi/L) was exceeded at thirteen locations, which were the same locations of uranium exceedance in 2004. All of these monitoring wells are located north of the Femme Osage Slough and have no direct impact on the drinking water sources in the Missouri River alluvium.

Nitroaromatic compound impact continued to be observed in the alluvial materials or bedrock downgradient of the Quarry and north of the Femme Osage Slough. The results were similar to those reported in 2004. Three wells had reported 2,4-DNT concentrations that exceeded the Missouri Water Quality Standard (MWQS) of 0.11 µg/L.

Uranium concentrations were within background ranges, and no detectable concentrations of nitroaromatic compounds were observed in groundwater south of the Femme Osage Slough.

Five groundwater monitoring wells, one spring, and disposal cell leachate were sampled during 2005 as part of the detection monitoring program for the disposal cell. Results of the sampling indicated that the baseline tolerance limits for iron and manganese were exceeded in MW-2032 during December 2004. Resampling in February 2005 confirmed the elevated values. This well was found to be inundated with organic debris as a result of invasion by ants. A demonstration report (DOE 2005c) has been prepared as outlined in the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (DOE 2004b).

Schote Creek, Dardenne Creek, and Busch Lakes 34, 35, and 36 were sampled annually for total uranium. This monitoring was conducted to measure the effects of remediation and surface water discharges from the site on the quality of downstream surface water. Uranium levels at the off-site surface water locations for 2005 were similar to 2004 averages.

Four locations within the Femme Osage Slough were monitored to determine the impact of groundwater migration from the Quarry. These locations were monitored semiannually for uranium. The 2005 levels were similar to the 2004 concentrations.

The Leachate Collection and Removal system (LCRS) collects leachate from the disposal cell. The leachate is sampled semiannually in accordance with the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan.* The uranium data has shown a continued downward trend to less than the drinking water standard of 30 pCi/L. The average discharge from the primary leachate collection system has gone from 325 gallons/day in 2001 to 155 gallons/day in 2005. The combined leachate from the secondary leachate collection system averaged approximately 22 gallons per day for 2001 to 13.6 gallons per day in 2005. The average leak rate for the secondary leachate collection system for 2001 was approximately 0.96 gallon/acre/day. The average leak rate is 2005 was approximately .56 gallons/acre/day. This continues to be much less than 1 percent of the action leakage rate (100 gallons/acre/day). This is a result of superior design and construction, as well as operational controls that optimized the moisture content of the compacted soil waste.

Long-Term Surveillance and Maintenance Activity Summary

The *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Weldon Spring, Missouri, Site* (LTS&M Plan) was issued for review in March and August 2004. The plan was reviewed by the EPA, MDNR and the public. Due to issues regarding institutional controls (ICs), the EPA issued a letter to DOE on November 22, 2004, which invoked the Federal Facility Agreement (FFA) dispute resolution process for the LTS&M Plan. The EPA and DOE worked to resolve this dispute and as agreed the DOE issued an Explanation of Significant Difference (ESD) to the public in February 2005. The objective of the ESD is to clarify the objectives and performance standards for the ICs at the site and to set the requirements for further development of the ICs. The second Draft-Final LTS&M Plan was reissued on March 11, 2005. The Final LTS&M Plan (DOE 2005a) was issued during July 2005.

The Weldon Spring Site Interpretive Center is part of DOE's long-term surveillance and maintenance activities at the site. Attendance for calendar year 2005 totaled 15,405 which represents a 431 percent increase over the 2004 attendance of 3,573.

The second annual public meeting required by the LTS&M plan was held on April 6, 2005. This meeting was held to discuss the 2004 second annual inspection which took place in November 2004. Also discussed were changes to the LTS&M Plan, a summary of environmental data and the interpretive center/prairie activities.

The 2005 annual inspection took place on November 7 and 8, 2005. This inspection also served as the Five-Year Review inspection. The main areas inspected were the disposal cell, the Quarry, the LCRS, and monitoring wells. Areas where future institutional controls will be established were also inspected to verify that no groundwater or resource use that is incompatible with the necessary restrictions was occurring.

1.0 Introduction

This *Weldon Spring Site Environmental Report for Calendar Year 2005* summarizes the environmental monitoring results obtained in 2005 and presents the status of Federal and State compliance activities.

In 2005, environmental monitoring activities were conducted to support remedial action under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA), the *National Environmental Policy Act* (NEPA), the *Clean Water Act* (CWA), and other applicable regulatory requirements. The monitoring program at the Weldon Spring Site has been designed to protect the public and to evaluate the effects on the environment, if any, from remediation activities.

The purposes of the *Weldon Spring Site Environmental Report for Calendar Year 2005* include:

- Providing general information on the Weldon Spring Site and the current status of remedial activities and long-term surveillance and maintenance activities.
- Presenting summary data and interpretations for the environmental monitoring program.
- Reporting compliance with Federal, State, and local requirements and DOE standards.
- Providing dose estimates for public exposure to radiological compounds due to activities at the Weldon Spring Site.
- Summarizing trends and/or changes in contaminant concentrations to support remedial actions, ensure public safety, maintain surveillance monitoring requirements, and demonstrate the effectiveness of the remediation.

1.1 Site Description

The Weldon Spring Site is located in St. Charles County, Missouri, about 30 miles (48 kilometers) west of St. Louis (Figure 1–1). The site comprises two geographically distinct DOE-owned properties: the Weldon Spring Chemical Plant and Raffinate Pit Sites (Chemical Plant) and the Weldon Spring Quarry (Quarry). The Chemical Plant is located about 2 miles (2.3 kilometers) southwest of the junction of Missouri State Route 94 and U.S. Highway 40/61. The Quarry is about 4 miles southwest of the Chemical Plant. Both sites are accessible from Missouri State Route 94.

During the early 1940s, the Department of the Army (DA) acquired 17,232 acres (6,974 hectares) of private land in St. Charles County for construction of the Weldon Spring Ordnance Works facility. The former ordnance works site has since been divided into several contiguous areas under different ownership as depicted in Figure 1–2. Current land use of the former ordnance works area includes the DOE Weldon Spring Chemical Plant and Weldon Spring Quarry, the U.S. Army Reserve Weldon Spring Training area, Missouri Department of Conservation (MDC) and Missouri Department Natural Resources-Division of State Parks managed lands, the Francis Howell High School, a Missouri Department of Transportation (MoDOT) maintenance facility, the St. Charles County water treatment facility and law enforcement training center, the village of Weldon Spring Heights, and a University of Missouri research park.

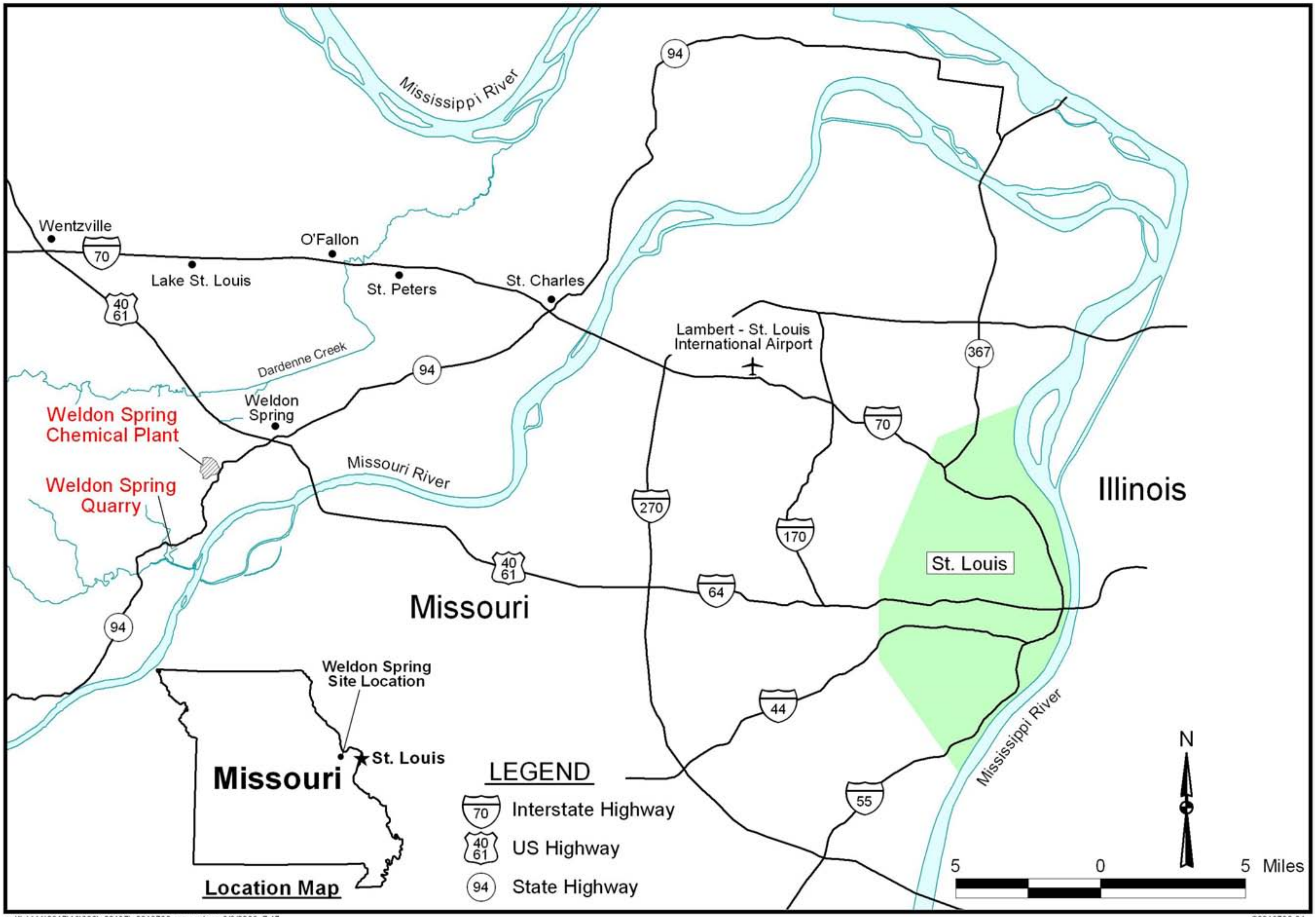

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Figure 1–1. Location of the Weldon Spring, Missouri, Site

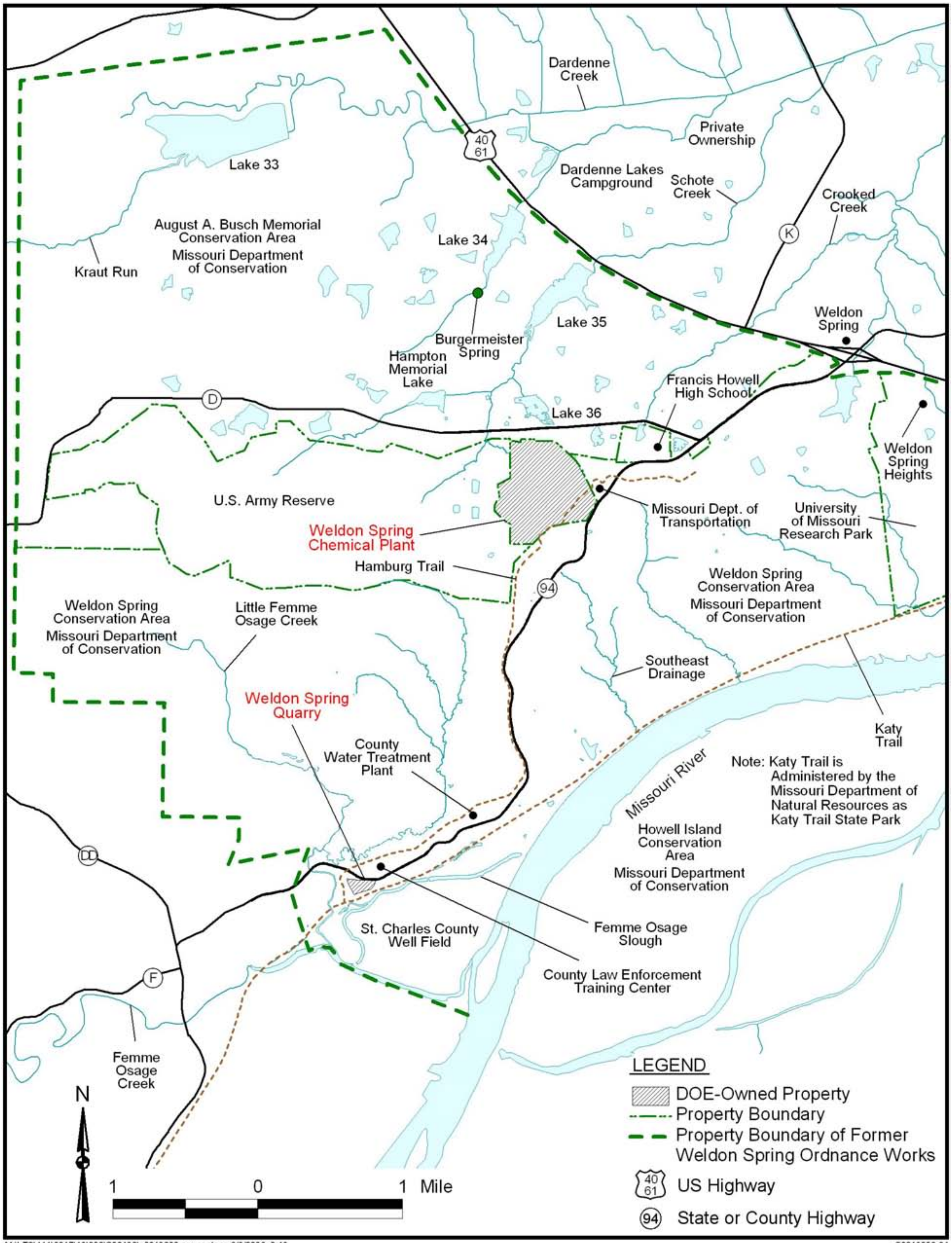

Figure 1–2. Vicinity Map of the Weldon Spring, Missouri, Site

The Chemical Plant and Quarry areas total 228.16 acres (92.33 hectares). The Chemical Plant property is located on 219.50 acres (88.83 hectares); and the Quarry occupies 8.66 acres (3.50 hectares).

1.2 Site History

1.2.1 Operations History

In 1941, the U.S. Government acquired 17,232 acres (6,974 hectares) of rural land in St. Charles County to establish the Weldon Spring Ordnance Works. In the process, the towns of Hamburg, Howell, and Toonerville and 576 citizens of the area were displaced (DA undated). From 1941 to 1945, the DA manufactured trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Ordnance Works site. Four TNT production lines were situated on what was to be the Chemical Plant. These operations resulted in nitroaromatic contamination of soil, sediments, and some off-site springs.

Following a considerable amount of explosives decontamination of the facility by the Army and the Atlas Powder Company, 205 acres (83.0 hectares) of the former ordnance works property were transferred to the U.S. Atomic Energy Commission (AEC) in 1956 for construction of the Weldon Spring Uranium Feed Materials Plant, now referred to as the Weldon Spring Chemical Plant. An additional 14.88 acres (6.02 hectares) were transferred to AEC in 1964. The plant converted processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A small amount of thorium was also processed. Wastes generated during these operations were stored in four raffinate pits located on the plant property. Uranium processing operations resulted in radiological contamination of the same locations previously contaminated by former Army operations.

The Weldon Spring Quarry was mined for limestone aggregate used in construction of the ordnance works. The Army also used the Quarry for burning wastes from explosives manufacturing and disposal of TNT-contaminated rubble during operation of the ordnance works. These activities resulted in nitroaromatic contamination of the soil and groundwater at the Quarry.

In 1960, the Army transferred the Quarry to AEC, who used it from 1963 to 1969 as a disposal area for uranium and thorium residues from the Chemical Plant (both drummed and uncontained) and for disposal of contaminated building rubble, process equipment, and soils from demolition of a uranium processing facility in St. Louis. Radiological contamination occurred in the same locations as the nitroaromatic contamination.

Uranium processing operations ceased in 1966, and on December 31, 1967, AEC returned the facility to the Army for use as a defoliant production plant. In preparation for the defoliant process, the Army removed equipment and materials from some of the buildings and disposed of them principally in Raffinate Pit 4. The defoliant project was canceled before any process equipment was installed, and the Army transferred 50.65 acres (20.50 hectares) of land encompassing the raffinate pits back to AEC while retaining the Chemical Plant. AEC and subsequently DOE managed the site, including the Army-owned Chemical Plant, under caretaker status from 1968 through 1985. Caretaker activities included site security oversight, fence maintenance, grass cutting, and other incidental maintenance. In 1984, the Army repaired several of the buildings at the Chemical Plant, decontaminated some of the floors, walls, and ceilings, and isolated some equipment. In 1985, the Army transferred full custody of the Chemical Plant to DOE, at which time DOE designated control and decontamination of the Chemical Plant, raffinate pits, and Quarry as a major project.

1.2.2 Remedial Action History

EPA placed the Quarry and Chemical Plant areas on the National Priorities List (NPL) in 1987 and 1989, respectively. Initial remedial activities at the Chemical Plant, a series of Interim Response Actions (IRAs) authorized through the use of Engineering Evaluation/Cost Analysis (EE/CA) reports, included:

- Removal of electrical transformers, electrical poles and lines, and overhead piping and asbestos that presented an immediate threat to workers and the environment.
- Construction of an isolation dike to divert runoff around the Ash Pond area to reduce the concentration of contaminants going off site in surface water.
- Detailed characterization of on-site debris, separation of radiological and nonradiological debris, and transport of materials to designated staging areas for interim storage.
- Dismantling of 44 Chemical Plant buildings under four separate IRAs.
- Treatment of contaminated water at the Chemical Plant and the Quarry.

Remediation of the Weldon Spring Site was administratively divided into four Operable Units (OUs): Quarry Bulk Waste OU, Quarry Residuals OU, Chemical Plant OU, and Groundwater OU. The Southeast Drainage was remediated as a separate action through an EE/CA report (DOE 1996). The selected remedies are described in the following sections.

1.2.2.1 Chemical Plant OU

In the *Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (DOE 1993), DOE established the remedy for controlling contaminant sources at the Chemical Plant (except groundwater) and disposing of contaminated materials in an on-site disposal cell.

The selected remedy included:

- Removal of contaminated soils, sludge, and sediment.
- Treatment of wastes, as appropriate, by chemical stabilization/solidification.
- Disposal of wastes removed from the Chemical Plant and stored Quarry bulk wastes in an engineered on-site disposal facility.

The remedy included remediation of 17 off-site vicinity properties affected by Chemical Plant operations. The vicinity properties were remediated in accordance with Chemical Plant Record of Decision (ROD) cleanup criteria.

The *Chemical Plant Operable Unit Remedial Action Report* (DOE 2004a) was finalized in January 2004.

1.2.2.2 Quarry Bulk Waste OU

DOE implemented remedial activities for the Quarry Bulk Waste OU set forth in the *Record of Decision for Management of Bulk Wastes at the Weldon Spring Quarry* (DOE 1990b).

The selected remedy included:

- Excavation and removal of bulk waste (i.e., structural debris, drummed and unconfirmed waste, process equipment, sludge, and soil).
- Transportation of the waste along a dedicated haul road to a temporary storage area located at the Chemical Plant.
- Staging of bulk wastes at the temporary storage area.

1.2.2.3 Quarry Residuals OU

The Quarry Residuals OU remedy was described in the *Record of Decision for the Quarry Residuals Operable Unit at the Weldon Spring Site, Weldon Spring, Missouri* (DOE 1998b). The Quarry Residuals OU addressed residual soil contamination in the Quarry proper, surface water and sediments in the Femme Osage slough and nearby creeks, and contaminated groundwater.

The selected remedy included:

- Long-term monitoring and institutional controls to prevent exposure to contaminated groundwater north of the Femme Osage slough.
- Long-term monitoring and institutional controls to protect the quality of the public water supply in the Missouri River alluvium and implementing a well field contingency plan.
- Confirming the model assumptions regarding extraction of contaminated groundwater and establishing controls to protect naturally occurring attenuation processes.
- Restoring the Quarry and establishing institutional controls.

The *Quarry Residual Operable Unit Remedial Action Report* (DOE 2003b) was finalized in January 2004.

1.2.2.4 Groundwater OU

DOE implemented an interim ROD, which was approved on September 29, 2000, to investigate the practicability of remediating trichloroethene (TCE) contamination in Chemical Plant groundwater, using in situ chemical oxidation (ICO) (DOE 2000b). It was determined based on extensive monitoring that the ICO did not perform adequately under field conditions; therefore the remediation of TCE was reevaluated with the remaining contaminants of concern.

The DOE issued a final ROD (DOE 2004f) in January 2004, which was signed by EPA in February 2004. The Groundwater OU ROD selected a remedy of monitored natural attenuation (MNA) with institutional controls (ICs) to limit groundwater use during the period of remediation. MNA involves the collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations over time. The ROD establishes remedial goals and performance standards for MNA. Activities regarding the Groundwater OU are further discussed in Section 3.1.

1.2.2.5 Southeast Drainage

Remedial action for the Southeast Drainage was addressed as a separate action under CERCLA. The *Engineering Evaluation/Cost Analysis for the Proposed Removal Action at the Southeast Drainage near the Weldon Spring Site, Weldon Spring, Missouri* (DOE 1996) was prepared in August 1996 to evaluate the human and ecological health risks within the drainage. The EE/CA recommended that selected sediment in accessible areas of the drainage should be removed with track-mounted equipment and transported by off-road haul trucks to the Chemical Plant. The excavated materials would be stored temporarily at an on-site storage area until final disposal in the disposal cell. Soil removal was in two phases: 1997-1998 and again in 1999. Post-remediation soil sampling was conducted. More details are included in the *Southeast Drainage Closeout Report Vicinity Properties DA-4 and MDC-7* (DOE 1999b).

1.3 Final Site Conditions

Contamination remains at the Weldon Spring Site at the following locations:

- An on-site disposal cell contains approximately 1.48 million cubic yards of contaminated material.
- Residual groundwater contamination remains in the shallow aquifer beneath the Chemical Plant, at the Quarry, and at some surrounding areas.
- Several springs near the Chemical Plant discharge contaminated groundwater.
- Residual soil and sediment contamination remain in the Southeast Drainage.
- Contamination remains at two culvert locations along Missouri State Route 94 and Highway D.
- Residual soil contamination remains at inaccessible locations within the Quarry.

Residual contamination is addressed in the *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Weldon Spring, Missouri, Site* (LTS&M Plan) (DOE 2005a), which includes institutional controls established to maintain protectiveness of contaminants not contained in the disposal cell. Under current land use conditions, the remaining contamination does not pose unacceptable risks to public health and the environment.

1.4 Geology and Hydrogeology

The Weldon Spring Site is situated near the boundary between the Central Lowland and the Ozark Plateau physiographic provinces. This boundary nearly coincides with the southern edge of Pleistocene glaciation that covered the northern half of Missouri over 10,000 years ago (Kleeschulte, et al. 1986).

The uppermost bedrock units underlying the Weldon Spring Chemical Plant are the Mississippian Burlington and Keokuk Limestone. Overlying the bedrock are unlithified units consisting of fill, top soil, loess, glacial till, and limestone residuum of thicknesses ranging from a few feet to several tens of feet.

There are three bedrock aquifers underlying St. Charles County. The shallow aquifer consists of Mississippian Limestones, and the middle aquifer consists of the Ordovician Kimmswick Limestone. The deep aquifer includes formations from the top of the Ordovician St. Peter Sandstone to the base of the Cambrian Potosi Dolomite. Alluvial aquifers of Quaternary age are present near the Missouri and Mississippi Rivers.

The Weldon Spring Quarry is located in low limestone hills near the northern bank of the Missouri River. The mid-Ordovician bedrock of the Quarry area includes, in descending order, the Kimmswick Limestone, Decorah Formation, and Plattin Limestone. These formations are predominantly limestone and dolomite. Near the Quarry, the carbonate rocks dip to the northeast at a gradient of 11 m/km to 15 m/km (58 ft/mi to 79 ft/mi) (DOE 1990a). Massive Quaternary deposits of Missouri River alluvium cover the bedrock to the south and east of the Quarry.

1.5 Surface Water System and Use

The Chemical Plant and raffinate pits areas are on the Missouri –Mississippi River surface drainage divide. Elevations on the site range from approximately 185 m (608 ft) above mean sea level (msl) near the northern edge of the site to 203 m (665 ft) above msl near the southern edge. (The cell is not included in these elevation measurements.) The natural topography of the site is gently undulating in the upland areas, typical of the Central Lowlands physiographic province. South of the site, the topography changes to the narrow ridges and valleys and short, steep streams common to the Ozark Plateau physiographic province (Kleeschulte, et al. 1986).

No natural drainage channels traverse the site. Drainage from the southeastern portion of the site generally flows southward to a tributary referred to as the Southeast Drainage (or 5300 Drainageway - based on the site's nomenclature) that flows to the Missouri River.

The northern and western portions of the Chemical Plant site drain to tributaries of the Busch Lakes and Schote Creek, which in turn enter Dardenne Creek, which ultimately drains to the Mississippi River. The manmade lakes in the August A. Busch Memorial Conservation Area are used for public fishing and boating. No swimming is allowed in the conservation area, although some may occur. No water from the lakes or creeks is used for irrigation or for public drinking water supplies.

Before remediation of the Chemical Plant and raffinate pits area began, there were six surface water bodies on the site: the four raffinate pits, Frog Pond, and Ash Pond. The water in the raffinate pits was treated prior to release, and the pits were remediated and confirmed clean. Frog Pond and Ash Pond were flow-through ponds that were monitored prior to being remediated and confirmed clean. Throughout the project, retention basins and sedimentation basins were constructed and used to manage potentially contaminated surface water. During 2001, the four sedimentation basins that remained were remediated, and the entire site was brought to final grade and seeded with temporary vegetation. Final seeding was conducted during 2002.

The Weldon Spring Quarry is situated on a bluff of the Missouri River valley about 1.6 k (1 mi) northwest of the Missouri River at approximately River Mile 49. Because of the topography of the area, no direct surface water entered or exited the Quarry before it was remediated. A 0.07 ha (0.2-acre) pond within the Quarry proper acted as a sump that accumulated direct rainfall within the Quarry. Past dewatering activities in the Quarry suggested that the sump interacted directly with the local groundwater. All water pumped from the Quarry before remediation was treated before it was released. Bulk waste removal, which included removal of some sediment from the sump area, was completed during 1995. The Quarry was backfilled, graded, and seeded during 2002.

The Femme Osage Slough, located approximately 213 m (700 ft) south of the Quarry, is a 2.4 km (1.5 mi) section of the original Femme Osage Creek and Little Femme Osage Creek. The University of Missouri dammed portions of the creeks between 1960 and 1963 during construction of a levee system around the University experimental farms (DOE 1990a). The slough is essentially land-locked and is currently used for recreational fishing. The slough is not used for drinking water or irrigation.

1.6 Ecology

The Weldon Spring Site is surrounded primarily by State Conservation Areas that include the 2,828 ha (6,988 acre) Busch Conservation Area to the north, the 2,977 ha (7,356 acre) Weldon Spring Conservation Area to the east and south, and the Howell Island Conservation Area, an island in the Missouri River which covers 1,031 ha (2,548 acres) (Figure 1–2).

The wildlife areas are managed for multiple uses, including timber, fish and wildlife habitat, and recreation. Fishing comprises a relatively large portion of the recreational use. Seventeen percent of the area consists of open fields that are leased to sharecroppers for agricultural production. In these areas, a percentage of the crop is left for wildlife use. The main agricultural products are corn, soybeans, milo, winter wheat, and legumes (DOE 1992b). The Busch and Weldon Spring Conservation Areas are open year-round, and the number of annual visits to both areas totals about 1,200,000.

The Quarry is surrounded by the Weldon Spring Conservation Area, which consists primarily of forest with some old field habitat. Prior to bulk waste removal, the Quarry floor consisted of old-field habitat containing a variety of grasses, herbs, and scattered wooded areas. When bulk waste removal began, this habitat was disturbed. The rim and upper portions of the Quarry still consist primarily of slope and upland forest including cottonwood, sycamore, and oak (DOE 1990a).

1.7 Climate

The climate in the Weldon Spring area is continental with warm to hot summers and moderately cold winters. Alternating warm/cold, wet/dry air masses converging and passing through the area cause frequent changes in the weather. Although winters are generally cold and summers hot, prolonged periods of very cold or very warm to hot weather are unusual. Occasional mild periods with temperatures above freezing occur almost every winter and cool weather interrupts periods of heat and humidity in the summer (Ruffner and Bair).

The National Oceanic and Atmospheric Administration has published the following information on its website based on analysis of long-term meteorological records for the St. Louis area. The information is titled: *The Climatology of St. Louis and the Bi-State Area* and states the following:

> St. Louis is located at the confluence of the Mississippi and Missouri Rivers, and near the geographical center of the US. Its position in the middle latitudes allows

the area to be affected by warm moist air that originates in the Gulf of Mexico, as well as cold air masses that originate in Canada. The alternate invasion of these air masses produces a wide variety of weather conditions, and allows the region to enjoy a true four-season climate.

During the summer months, air originating from the Gulf of Mexico tends to dominate the area, producing warm and humid conditions. Since 1870, records indicate that temperature of 90 degrees or higher occur on about 35-40 days per year. Extremely hot days (100 degrees or more) are expected on no more that five days per year.

Winters are brisk and stimulating, but prolonged periods of extremely cold weather are rare. Records show that temperatures drop to zero or below an average of 2 or 3 days per year, and temperatures as cold as 32 degrees or lower occur less than 25 days in most years. Snowfall has averaged a little over 18 inches per winter season, and snowfall of an inch or less is received on 5 to 10 days in most years.

Normal annual precipitation for the St. Louis is a little less than 34 inches. The three winter months are the driest, with an average total of about 6 inches of precipitation. The spring months of March through May are normally the wettest with normal total rainfall of just under 10.5 inches. It is not unusual to have extended dry periods of one to two weeks during the growing season.

Thunderstorms normally occur on between 40 and 50 days per year. During any year, there are usually a few of these thunderstorms that are severe, and produce large hail and damaging winds.

The on-site meteorological station was dismantled in May 2002 to facilitate final site restoration activities. The precipitation and temperature results in Table 1–1 are from the National Weather Service. Precipitation and average temperature were all within historical ranges for the St. Louis area.

Table 1–1. Monthly Meteorological Monitoring Results for 2005

Month	Total Precipitation (cm)[a]	Average Temp (°C)
January	22.7	1
February	4.7	4.7
March	3.8	6.6
April	5.5	15
May	2.0	19.2
June	13.0	26
July	5.6	26.7
August	9.8	26.7
September	13.5	23.2
October	3.9	14.8
November	8.5	9.2
December	3.2	0

[a]cm = centimeters

1.8 Land Use and Demography

The population of St. Charles County was estimated by the census in 2004 to be about 320,000. This has been a 12.98 percent increase from the 2000 census and about a 30 percent increase over the past 10 years. The three largest communities in St. Charles County are O'Fallon (pop: 67,009), St. Charles (pop: 61,411) and St. Peters (pop: 53, 907) (Figure 1–1). The two communities closest to the site are Weldon Spring and Weldon Spring Heights, about 3.2 km (2 mi) to the northeast. The combined population of these two communities is about 5,000. No private residences exist between Weldon Spring Heights and the site. Urban areas occupy about 6 percent of county land, and nonurban areas occupy 90 percent; the remaining 4 percent is dedicated to transportation and water uses.

Francis Howell High School (FHHS) is about 1 km (0.6 mi) northeast of the site along Missouri State Route 94 (Figure 1–2). The school employs approximately 150 faculty and staff, and about 1,760 students attend school there. In addition, approximately 50 full-time employees work at the high school annex, and about 50 bus drivers park their school buses in the adjacent parking lot.

The Missouri Department of Transportation Weldon Spring Maintenance facility, located adjacent to the north side of the Chemical Plant, employs about 10 workers. The Army Reserve Training Area is to the west of the Chemical Plant and in the past was periodically visited by DA trainees and law enforcement personnel. Presently, there are about 40 full-time personnel working on military equipment at the DA site. During 2005, the training site had 18,000 man-days of usage by all branches of the military and law enforcement. About 300 ha (741 acres) of land east and southeast of the high school is owned by the University of Missouri. The northern third of this land is being developed into a high-technology research park. The conservation areas adjacent to the Chemical Plant are operated by the Missouri Department of Conservation and employ about 50 people.

End of current text

2.0 Compliance Summary

2.1 Compliance Status for 2005

The Weldon Spring Site is listed on the National Priorities List (NPL), and therefore has been and is governed by the CERCLA process. Under CERCLA, the WSSRAP is subject to meeting or exceeding the applicable or relevant and appropriate requirement (ARARs) of Federal, State, and local laws and statutes, such as the *Resource Conservation and Recovery Act* (RCRA), CWA, *Clean Air Act*, *National Historic Preservation Act* (NHPA), *Safe Drinking Water Act* (SDWA), *Endangered Species Act*, and Missouri State regulations. Because the U.S. Department of Energy (DOE) is the lead agency for the site, *National Environmental Policy Act* (NEPA) values must be incorporated. The requirements of DOE Orders must also be met. Section 2.1.1 is a summary of compliance with applicable Federal and State regulations, Section 2.1.2 is a summary of compliance with major DOE Orders, and Section 2.1.3 is a discussion of compliance agreements and permits. With physical completion of the project, the applicability of certain ARARs has been reduced or eliminated.

2.1.1 Federal and State Regulatory Compliance

2.1.1.1 Comprehensive Environmental Response, Compensation and Liability Act

The Weldon Spring Site has integrated the procedural and documentation requirements of CERCLA, as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and NEPA. The remedial actions conducted under CERCLA are discussed in Section 1.2.2.

The Site has reached construction completion under CERCLA, which was documented in a Preliminary Closeout Report (PCOR), which was issued by EPA on August 22, 2005.

Because contamination remains at some of the areas of the Site at levels above those that allow unlimited use and unrestricted exposure, CERCLA requires that the remedial actions be reviewed at least every five years. These reviews are commonly called 5-year reviews. The DOE is currently preparing the third 5-Year Review Report for the Site which will be issued in September 2006.

2.1.1.2 Resource Conservation and Recovery Act

Hazardous wastes at the Weldon Spring Site have been managed as required by RCRA as substantive ARARs. This has included characterization, consolidation, inventory, storage, treatment, disposal, and transportation of hazardous wastes that remained on site after closure of the Weldon Spring Uranium Feed Materials Plant (WSUFMP) and wastes that were generated during remedial activities.

A RCRA treatment, storage, and disposal permit was not required at the site since the remediation has been performed in accordance with decisions reached under CERCLA. Section 121(e) of CERCLA states that no Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on site.

The Weldon Spring Site is now considered a conditionally exempt small quantity generator.

The disposal cell contents are not regulated under the Resource Conservation and Recovery Act (RCRA), but RCRA post-closure disposal cell monitoring and maintenance requirements are ARARs. The RCRA groundwater protection standard (40 CFR 264 Subpart F) sets forth the general groundwater monitoring requirements for the disposal cell. Generally, the disposal cell groundwater monitoring program must provide representative samples of backgroundwater quality, as well as groundwater passing the point of compliance. For a more complete description, see the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (DOE 2004b) which was developed to address these requirements. Additional post-closure requirements for the cell are identified in 40 CFR 264 Subpart N and include action leakage rate and leachate collection and removal requirements. These requirements are addressed in the LTS&M Plan (DOE 2005a). Subpart N also includes requirements to maintain the integrity of the final cover, including making repairs as necessary.

2.1.1.3 Clean Water Act

Effluents discharged to waters of the United States are regulated under the CWA through regulations promulgated and implemented by the State of Missouri. The Federal government has granted regulatory authority for implementation of CWA provisions to states with regulatory programs that are at least as stringent as the Federal program.

Compliance with the CWA at the Site has included meeting parameter limits and permit conditions specified in the National Pollutant Discharge Elimination System (NPDES) permits. Under these permits, both effluent and erosion-control monitoring have been performed. The majority of these remaining permits were terminated in 2003. See Section 2.1.3 for additional discussion regarding the remaining permit.

2.1.1.4 Federal Insecticide, Fungicide, and Rodenticide Act

The Site maintains compliance with the *Federal Insecticide, Fungicide, and Rodenticide Act*. Material Safety Data Sheets are reviewed for all pesticides before they are purchased. The Site does not currently use restricted-use pesticides and, therefore, does not possess a permit/license to purchase these materials. The Site meets State requirements for pesticide application, and reviews each application for State licensing requirements.

2.1.1.5 Safe Drinking Water Act

Safe Drinking Water Act (SDWA) regulations are not applicable because maximum contaminant levels (MCLs) are applicable only to drinking water at the tap, not in groundwater. However, under the National Contingency Plan, MCLs are relevant and appropriate to groundwater that is a potential drinking water source. The principal ARARs for the impacted groundwater at the Chemical Plant are the MCLs and Missouri water quality standards, which were established in the Groundwater Operable Unit (GWOU) ROD, and are shown in Table 2–1.

Table 2–1. Federal and State Water Quality Standards for the Chemical Plant Groundwater OU

Constituent	Standard	Citation
Nitrate (as N)	10 mg/L	40 CFR 141.62
Total Uranium	20 pCi/L	40 CFR 141
1,3-DNB	1.0 µg/L	10 CSR 20-7[a]
2,4-DNT	0.11 µg/L	10 CSR 20-7[a]
NB	17 µg/L	10 CSR 10-7[a]
TCE	5 µg/L	40 CFR 141.61
2,6-DNT	1.3 µg/L	Risk Based[b]
2,4,6-TNT	2.8 µg/L	Risk Based[c]

[a]Missouri Groundwater Quality Standard.
[b]Risk-based concentration equivalent to 10^{-5} for a resident scenario.
[c]Risk-based concentration equivalent to 10^{-6} for a resident scenario.
Key: DNB = dinitrobenzene; NB = Nitrobenzene; DNT = dinitrotoluene; mg/L = milligram(s) per liter; pCi/L = picocurie per liter; µg/L = microgram(s) per liter

Long-term groundwater monitoring for the Quarry Residuals OU consists of two separate programs. Groundwater monitoring is necessary to continue to ensure that uranium-contaminated groundwater has a negligible potential to affect the former St. Charles County (now owned by Public Water District #2 – see Section 3.1.2.2) well field. The first program details the monitoring of uranium and 2,4-DNT south of the slough to ensure that levels remain protective of human health and the environment. The second program consists of monitoring groundwater contaminant levels within the area north of the slough until they attain a predetermined target level indicating negligible potential to affect groundwater south of the slough.

The objective for monitoring groundwater south of the slough is to verify that the groundwater is not impacted. Uranium concentrations south of the slough and in the area of production wells at the well field remain within the observed natural variation within the aquifer; therefore the MCL for uranium of 20 pCi/L has been established as a trigger level only in this area. If concentrations in groundwater south of the slough exceed the MCL of 20 pCi/L, DOE will evaluate risk and take appropriate action.

Under current conditions, groundwater north of the slough poses no imminent risk to human health from water obtained from the well field. A target level of 300 pCi/L for uranium (10 percent of the 1999 maximum) was established to represent a significant reduction in the contaminant levels north of the slough. The target level for 2,4-DNT has been set at 0.11 µg/L, the Missouri Water Quality standard.

2.1.1.6 Emergency Planning and Community Right-to-Know Act

The site no longer stores large quantities of chemicals and none above a threshold level, therefore the site is not required to submit a 2005 *Emergency Planning and Community Right-to-Know Act* (EPCRA) Tier II report.

The Toxic Release Inventory (TRI) report for 2005 is due on July 1, 2006. Based on the chemical usage in 2005, the Weldon Spring Site is not required to submit a TRI report.

2.1.2 DOE Order Compliance

2.1.2.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment

DOE Order 5400.5 establishes primary standards and requirements for DOE operations to protect members of the public and the environment against undue risk from radiation. The DOE operates its facilities and conducts its activities so that radiation exposures to members of the public are maintained within established limits.

The estimated total effective dose equivalent to the hypothetical maximally exposed individual was due to consumption of water from the Southeast Drainage. This dose was calculated to be 0.27 mrem, which is well below the 100 mrem (1 mSv) guideline for all potential exposure pathways.

2.1.2.2 DOE Order 231.1A, Environmental, Safety, and Health Reporting

DOE Order 231.1A and DOE Manual 231.1-1A ensures collection and reporting of information on environment, safety and health that is required by law or regulation. This site environmental report fulfills the requirement of the order to summarize the environmental data annually. These directives also include requirements for occurrence reporting. There were no occurrences as defined by these directives at the site during 2005.

2.1.3 Permit and Agreement Compliance

2.1.3.1 NPDES Permits

The Weldon Spring Site has one NPDES permit (MO-0107701) at this time. The permit only covers the former Site Water Treatment Plant (SWTP) discharge line. The SWTP discharge line will only be used if the site ever operates Train 3 at the leachate collection and removal system (LCRS) as a contingency to current disposal methods (see Section 2.1.3.3). This permit's expiration date was in July 2005. The DOE submitted a renewal application to the Missouri Department of Natural Resources (MDNR) in January 2005, but has not received a renewed permit to date. The site currently operates under the existing permit until MDNR issues a renewed permit.

2.1.3.2 Federal Facility Agreement

A Federal Facility Agreement (FFA) was signed by the EPA and DOE in 1986, and it was amended in 1992. The main purpose of the FFA is to establish a procedural framework and schedule for developing, implementing and monitoring appropriate response actions at the Site in accordance with CERCLA. An FFA Quarterly report is issued to EPA and MDNR each quarter which documents compliance with the FFA and reports on activities at the site.

A new FFA between EPA, DOE and MDNR was recently signed by all parties with the final signature by EPA on March 31, 2006. The focus of the new FFA is long-term surveillance and maintenance activities.

2.1.3.3 Metropolitan St. Louis Sewer District (MSD) Agreement

The Weldon Spring Site has approval from the Metropolitan St. Louis Sewer District to haul disposal cell leachate and purge water to their Bissell Point Plant. The DOE received notification in April 2004 that the leachate must meet the radiological drinking water standard of 30 µg/L (20 pCi/L) prior to acceptance. The disposal cell leachate was very close to this limit in 2004, therefore the DOE exercised a pretreatment contingency process and began treating the leachate through a system of cartridge filters and ion exchange media that is selective for uranium. The leachate was sampled after treatment and found to be significantly below the 30 µg/L limit for uranium. The pretreated levels continued to be close to the 30 µg/L limit during 2005, so the leachate continued to be treated by the same process with the same results of the levels being significantly lower than the 30 µg/l limit. Further information regarding the leachate is discussed in Section 3.3.

End of current text

3.0 Environmental Monitoring Summary

3.1 Groundwater Monitoring

The following are highlights of the 2005 groundwater monitoring program. These items, and others, are discussed in detail in this chapter.

- Continuing through 2005, monitoring at the Chemical Plant was focused on assessment of the selected remedy of monitored natural attenuation (MNA) that was started in July 2004. This monitoring program consists of a more focused monitoring strategy. A reduction of monitoring locations and parameters has occurred since the 2004 annual report.
- Total uranium continues to be present in the groundwater near the former raffinate pits. Four of the 17 wells sampled for uranium exceeded the drinking water standard of 30 μg/L (20 pCi/L). Uranium concentrations in 12 wells exceeded the average background level of 93 pCi/L (0.03 Bq/L) established during the GWOU remedial investigation (DOE 1997).
- The areas of highest impact continue to be present in the Raffinate Pit and Ash Pond areas. Average nitrate concentrations exceeded the MCL of 10 mg/L at 12 of the 22 wells sampled for nitrate.
- Nitroaromatic compounds were monitored in 30 locations across the Chemical Plant area. The areas of highest impact occur in the Frog Pond and Raffinate Pit Areas. The Missouri Water Quality Standard (MWQS) for 2,4-DNT of 0.11 μg/L was equaled or exceeded at 7 locations and the MWQS for 1,3-DNB of 1.0 μg/L was exceeded at one location. The risk-based concentration of 2.8 μg/L for 2,4,6-TNT was exceeded at one location and the risk-based concentration of 1.3 μg/L for 2,6-DNT was exceeded at four locations. The MWQS for nitrobenzene (NB) of 17 μg/L was not exceeded at any location.
- Trichloroethene (TCE) was sampled at 14 locations to monitor the extent of contamination and changes in concentration that may have resulted from remedial activities and groundwater field studies performed in the area of TCE impact. Three of these wells exceeded the MCL of 5 μg/L for TCE.
- Burgermeister Spring (Spring 6301) and Spring 6303 were sampled for nitrate, uranium, TCE, and nitroaromatic compounds as part of the MNA sampling program. Monitoring results for both springs were within historical ranges and were in the same general range as concentrations reported in 2004.
- Two springs in the Southeast Drainage (SP-5303, SP-5304) and an additional spring (SP-6306) located in the Burgermeister Spring Branch were monitored for uranium during 2005. The uranium was lower in SP-6306 compared to 2004, but significantly higher in SP-5303 and SP-5304.
- At the Weldon Spring Quarry, the highest levels of uranium continue to occur in the bedrock downgradient from the Quarry and in the alluvial material north of the Femme Osage Slough. The drinking water standard of 30 μg/L (20 pCi/L) was exceeded at thirteen locations, which were the same locations of uranium exceedance in 2004. All of these monitoring wells are located north of the Femme Osage Slough and have no direct impact on the drinking water sources in the Missouri River alluvium.
- Nitroaromatic compound impact continues to occur in the alluvial materials or bedrock downgradient of the Quarry and north of the Femme Osage Slough. Results were similar to

those reported in 2004. Only three wells had above-detection results. These three wells also had reported data concentrations of 2,4-DNT that exceeded the MWQS of 0.11 µg/L.

- Uranium concentrations were within background ranges, and no detectable concentrations of nitroaromatic compounds were observed in groundwater south of the Femme Osage Slough.
- Iron and sulfate are monitored as indicators of the geochemistry of the groundwater in the vicinity of the Quarry. Results are similar to those reported during 2004, and continue to confirm the presence of a geochemical reducing zone, which is inhibiting migration of uranium-contaminated groundwater.
- Groundwater detection monitoring for the disposal cell that was initiated in June 1998 continued in 2005. Results of the sampling indicated that the baseline tolerance limits (BTLs) for iron and manganese were exceeded in MW-2032 during December 2004. Resampling in February 2005 confirmed the elevated values. This well was found to be inundated with organic debris as a result of invasion by ants. A demonstration report (DOE 2005c) has been prepared as outlined in the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (DOE 2004b).

The groundwater monitoring program at the Weldon Spring Site includes sampling and analysis of water collected from wells at the Chemical Plant, the Quarry site, adjacent properties, and selected springs in the vicinity of the Chemical Plant site. The groundwater monitoring program is formally defined in the LTS&M Plan (DOE 2005a).

Due to lithologic differences, including geologic features that influence groundwater flow, and the geographical separation of the Chemical Plant and Quarry areas, separate groundwater monitoring programs have been established for the two sites. Generalized geologic and hydrologic descriptions of the two sites are found in Section 1.4. A generalized stratigraphic column for reference is provided in Figure 3–1, and hydrogeologic descriptions of lithologies monitored for the program are in Sections 3.1.1.1 and 3.1.2.1. The appropriate cleanup standards for groundwater in each area of the Weldon Spring Site are summarized in Section 2.1.1.5.

3.1.1 Chemical Plant Groundwater

The *Record of Decision for the Final Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site* (GWOU ROD) (DOE 2004f) was signed by the EPA on February 20, 2004. The final GWOU ROD specified a remedy of monitored natural attenuation (MNA) with institutional controls to limit groundwater use during the period of remediation. MNA relies on the effectiveness of naturally occurring processes to reduce contaminant concentrations over time. The GWOU ROD establishes remedial goals and performance standards for MNA.

In July 2004, DOE initiated monitoring for monitored natural attenuation (MNA) as outlined in the *Remedial Design/Remedial Action Work Plan for the Final Remedial Action for the Groundwater Operable Unit at the Weldon Spring Site* (DOE 2004c). This network has since been modified as presented in the *Interim Remedial Action Report for the Groundwater Operable Unit of the Weldon Spring Site* (DOE 2005d) and is described below.

System	Series	Stratigraphic Unit	Typical Thickness (feet)[a]	Physical Characteristics	Hydrostratigraphic Unit
Quaternary	Holocene	Alluvium	0–120	Gravelly, silty loam	Alluvial aquifer
	Pleistocene	Loess and glacial drift[b]	10–60	Silty clay, gravelly clay, silty loam, or loam over residuum from weathered bedrock	Locally a leaky confining unit[c]
Mississippian	Meramecian	Salem Formation[c]	0–15	Limestone, limey dolomite, finely to coarsely crystalline, massively bedded, and thin bedded shale	
		Warsaw Formation[c]	0–80	Shale and thin to medium bedded finely crystalline limestone with interbedded chert	
	Osagean	Burlington-Keokuk Limestone	100–200	Cherty limestone, very fine to very coarsely crystalline, fossiliferous, thickly bedded to massive	Shallow aquifer system
		Fern Glen Limestone	45–70	Cherty limestone, dolomitic in part, very fine to very coarsely crystalline, medium to thickly bedded	
	Kinderhookian	Chouteau Limestone	20–50	Dolomitic argillaceous limestone, finely crystalline, thin to medium bedded	Upper leaky confining unit
Devonian	Upper	Sulphur Springs Group Bushberg Sandstone[d]	40–55	Quartz arenite, fine to medium grained, friable	
		Lower part of Sulphur Springs Group undifferentiated		Calcareous siltstone, sandstone, oolitic limestone, and hard carbonaceous shale	
Ordovician	Cincinnatian	Maquoketa Shale[e]	0–30	Calcareous to dolomitic silty shale and mudstone, thinly laminated to massive	
	Champlainian	Kimmswick Limestone	70–100	Limestone, coarsely crystalline, medium to thickly bedded, fossiliferous and cherty near base	Middle aquifer system
		Decorah Group	30–60	Shale with thin interbeds of very finely crystalline limestone	Lower confining unit
		Plattin Limestone	100–130	Dolomitic limestone, very finely crystalline, fossiliferous, thinly bedded	
		Joachim Dolomite	80–105	Interbedded very finely cystalline, thinly bedded dolomite, limestone, and shale; sandy at base	
		St. Peter Sandstone	120–150	Quartz arenite, fine to medium grained, massive	Deep aquifer system
	Canadian	Powell Dolomite	50–60	Sandy dolomite, medium to finely crystalline, minor chert and shale	
		Cotter Dolomite	200–250	Argillaceous, cherty dolomite, fine to medium crystalline, interbedded with shale	
		Jefferson City Dolomite	160–180	Dolomite, fine to medium crystalline	
		Roubidoux Formation	150–170	Dolomitic sandstone	
		Gasconade Dolomite	250	Cherty dolomite and arenaceous dolomite (Gunter Member)	
Cambrian	Upper	Eminence Dolomite	200	Dolomite, medium to coarsely crystalline, medium bedded to massive	
		Potosi Dolomite	100	Dolomite, fine to medium crystalline, thickly bedded to massive; drusy quartz common	

[a]Thickness estimates vary depending on data source.
[b]Glacial drift unit includes the Ferrelview Formation and is saturated in the northern portion of the Ordnance Works where this unit behaves locally as a leaky confining unit.
[c]The Warsaw and Salem Formations are not present in the Weldon Spring area.
[d]The Sulphur Springs Group also includes the Bachelor Sandstone and the Glen Park Limestone.
[e]The Maquoketa Shale is not present in the Weldon Spring Area.

Figure 3–1. Generalized Stratigraphy and Hydrostratigraphy of the Weldon Spring, Missouri, Site

Contaminants of concern (COCs) for groundwater and springs at the Chemical Plant area are TCE, nitrate, uranium, and nitroaromatic compounds. The set of COCs measured at each location used to monitor MNA depends on the proximity of the particular well or spring to the contaminant plumes.

The objectives specified in the GWOU ROD (DOE 2004f) for the MNA monitoring network are:

- Objective 1 is to monitor the unimpacted water quality at upgradient locations in order to maintain a baseline of naturally occurring constituents from which to evaluate changes in downgradient locations. This objective will be met by using wells located upgradient of the contaminant plume.
- Objective 2 is to verify contaminant concentrations are declining with time at a rate and in a manner that cleanup standards will be met in approximately 100 years as established by predictive modeling. This objective will be met using wells at or near the locations with the highest concentrations of contaminants, both near the former source areas and along expected migration pathways. The objective will be to evaluate the most contaminated zones. Long-term trend analysis will be performed to confirm downward trends in contaminant concentration over time. Performance will be gauged against long-term trends. It is anticipated that some locations could show temporary upward trends due to the recent source control remediation, ongoing dispersion, seasonal fluctuations, analytical variability, or other factors. However, concentrations are not expected to exceed historical maximums.
- Objective 3 is to ensure that lateral migration remains confined to the current area of impact. Contaminants are expected to continue to disperse within known preferential flow paths associated with bedrock lows (paleochannels) in the upper Burlington-Keokuk Limestone and become more dilute over time as rain events continue to recharge the area. This objective will be met by monitoring various downgradient fringe locations that are either not impacted or minimally impacted. Contaminant impacts in these locations are expected to remain minimal or non-existent.
- Objective 4 is to monitor locations underlying the impacted groundwater system to confirm that there is no significant vertical migration of contaminants. This will be evaluated using deeper wells screened in and influenced by the unweathered zone. No significant impacts at these locations should be observed.
- Objective 5 is to monitor contaminant levels at the impacted springs that are the only potential points of exposure under current land use conditions. The springs discharge groundwater that includes contaminated groundwater originating at the Chemical Plant area. Presently, contaminant concentrations at these locations are protective of human health and the environment under current recreational land uses. Continued improvement of the water quality in the affected springs should be observed.
- Objective 6 is to monitor for hydrologic conditions at the site over time in order to identify any changes in groundwater flow that might affect the protectiveness of the selected remedy. The static groundwater elevation of the monitoring network will be measured to establish that groundwater flow is not changing significantly and resulting in changes in contaminant migration.

The monitoring network is designed to collect data to show that either natural attenuation processes are acting as predicted or to trigger the implementation of contingencies when these processes are not acting as predicted (i.e., unexpected expansion of the plume or sustained increases in concentrations within the area of impact). The data analysis and interpretation will satisfy the following:

- Baseline conditions (Objective 1) have remained unchanged.
- Performance monitoring locations (Objective 2) indicate that concentrations within the area of impact are decreasing as expected.
- Detection monitoring locations (Objective 3, 4, and 5) indicate when a trigger has been exceeded.

The guidance documents *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tanks Sites* (EPA 1999) and the *Technical Guidance for the Long-Term Monitoring of Natural Attenuation Remedies at Department of Energy Sites* (DOE 1999c) were used during the development of this monitoring program.

The monitoring network consists of 50 wells, four springs, and one surface water location. The locations and the objectives they satisfy are summarized in Table 3–1 and are depicted on Figure 3–2.

Table 3–1. Monitoring Locations Retained for Assessing MNA at the GWOU

Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6
MW-2017	MW-2012	MW-2032	MW-2021	SP5303	MW-2005
MW-2035	MW-2014	MW-2051	MW-2022	SP5304	MW-2055
MW-4022	MW-2038	MW-3031	MW-2023	SP6301	MW-3025
MW-4023	MW-2040	MW-3037	MW-2056	SP6303	MW-3038
	MW-2046	MW-4013	MW-3006	SW-2007[b]	MW-4001
	MW-2050	MW-4014	MW-4007		MW-4011
	MW-2052	MW-4015	MWD-2		MW-4020
	MW-2053	MW-4026			MW-4037
	MW-2054	MW-4036			
	MW-3003	MW-4039			
	MW-3024	MW-4041			
	MW-3030	MWS-1			
	MW-3034	MWS-4			
	MW-3039				
	MW-3040				
	MW-4013[a]				
	MW-4029				
	MW-4031				
	MW-4036[a]				
	MW-4040				

[a]Location is also an Objective 3 location.
[b]Location is on Dardenne Creek immediately upstream of Highway 40/61, approximately 2.1 miles north of the site.

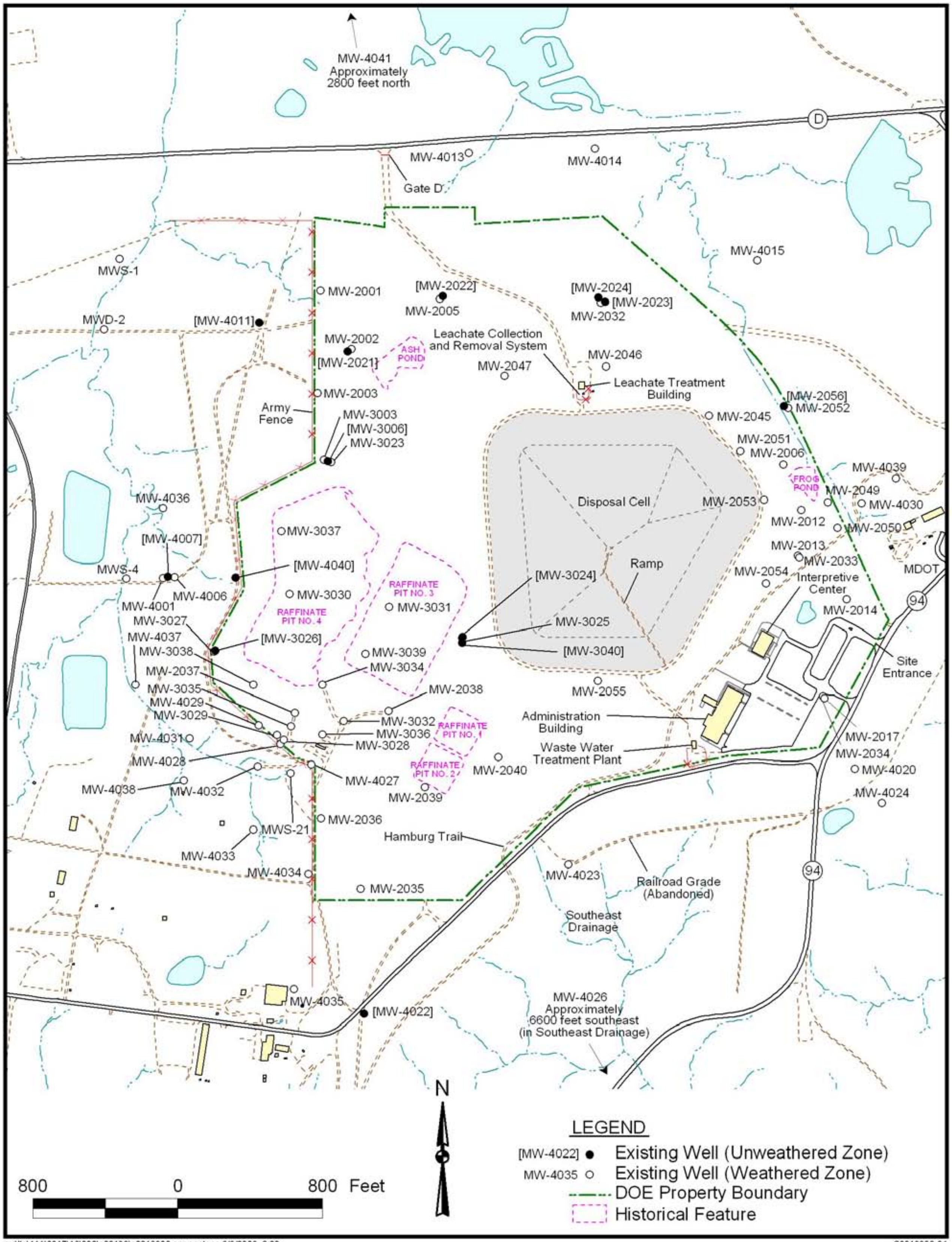

Figure 3–2. Existing Monitoring Well Network

A report will be prepared that documents the status of the monitored natural attenuation (MNA) remedy for groundwater at the Chemical Plant as of 2006. Monitoring in support of MNA formally began in July 2004 and has continued through 2006 with the intent of updating the database that was used to select this remedy for the Chemical Plant operable unit. A primary purpose of the report is to establish current baseline measures of contaminant levels that can be compared to future contaminant concentrations to evaluate the progress of MNA over the next several decades. Data from new wells installed at the site in spring 2004 and preexisting monitor wells are being used to determine whether the initial concentrations of groundwater contaminants identified during a 2003 evaluation of MNA processes at the site (DOE 2005d)) have since changed.

3.1.1.1 Hydrogeologic Description

The Chemical Plant site is in a physiographic transitional area between the Dissected Till Plains of the Central Lowlands province to the north and the Salem Plateau of the Ozark Plateaus province to the south. Subsurface flow and transport of concern in the Chemical Plant area occurs within two major geologic units; unconsolidated surficial materials and carbonate bedrock. The unconsolidated surficial materials are clay-rich, mostly glacially derived units, which are generally unsaturated. Thicknesses of the unconsolidated materials range from 6.1 m to 15.3 m (20 ft to 50 ft) (DOE 1992a).

The southern portion of the site sits on a groundwater divide, from which some groundwater flows north toward Dardenne Creek and then ultimately to the Mississippi River, and the remainder flows south to the Missouri River. Regional groundwater flow for St. Charles County is toward the east. Localized flow is controlled largely by topographic highs and streams and drainages. Much of the groundwater movement is by relatively diffuse flow within continuous porous media. However, localized zones of discrete fracture-controlled flow are also present.

Potential groundwater impacts are assessed by using data collected from the monitoring well network at the site. The aquifer of concern beneath the Chemical Plant, raffinate pits, and vicinity properties is the shallow bedrock aquifer consisting of Mississippian-age Burlington-Keokuk Limestone (the uppermost bedrock unit). The Burlington-Keokuk Limestone is generally described as containing a shallow weathered zone and an underlying unweathered zone. The weathered portion of this formation is highly fractured and exhibits solution voids and enlarged fractures. These features may also be found on a limited scale in the unweathered zone. The unweathered portion of the Burlington-Keokuk Limestone is thinly to massively bedded. Fracture densities are significantly less in the unweathered zone than in the weathered zone. Localized aquifer properties are controlled by fracture spacing, solution voids, and preglacial weathering, including structural troughs along the bedrock-overburden interface.

All monitoring wells at the Chemical Plant are completed in the Burlington-Keokuk Limestone. Most of the wells are completed in the weathered zone of the bedrock where groundwater has the greatest potential to be contaminated. Some wells screened in the unweathered zone of the Burlington-Keokuk Limestone are used to assess the vertical migration of contaminants. Where possible, monitoring wells within the boundaries of the Chemical Plant area are located near historical contaminant sources and preferential flow pathways (paleochannels) to assess transport of dissolved constituents in the groundwater system. Additional wells are located outside the Chemical Plant boundary to detect and evaluate potential off-site migration of contaminants (Figure 3–2).

Springs, a common feature in carbonate terrains, are present in the vicinity of the site. Four springs are monitored routinely. These springs (SP-5303, SP-5304, SP-6301 and SP-6303), shown on Figure 3–3, have been historically influenced by Chemical Plant discharge water and/or groundwater that contained one or more of the contaminants of concern. Spring 6306 is monitored occasionally, as a result of public comments, and has been demonstrated to be unimpacted by site contaminants.

The presence of elevated total uranium and nitrate levels at Burgermeister Spring (SP-6301), which is 1.9 km (1.2 mi) north of the site, indicates that discrete flow paths are present in the vicinity of the site. Groundwater tracer tests performed in 1995 (DOE 1997) indicated that a discrete and rapid subsurface hydraulic connection exists between the northern portion of the Chemical Plant and Burgermeister Spring.

3.1.1.2 Chemical Plant Monitoring Program

As discussed in Section 3.1.1, monitoring at the Chemical Plant was changed in July 2004 to focus on assessment of the selected remedy of monitored natural attenuation (MNA). Under the new monitoring program, total uranium, nitroaromatic compounds, TCE, and nitrate (as N) have been monitored at selected locations throughout the Chemical Plant area (Table 3–2). The sampling locations target areas of highest impact in the shallow aquifer and migration pathways associated with paleochannels in the weathered unit of the Burlington-Keokuk Limestone. Analytical results for all monitored parameters during 2005 are discussed in Section 3.1.1.3.

Prior to construction of the Chemical Plant, the site was part of a DA Ordnance Works complex for production of the nitroaromatic compounds trinitrotoluene (TNT) and dinitrotoluene (DNT). Nitroaromatic compounds occur in groundwater in the northeastern and southwestern portions of the Chemical Plant, where TNT production lines were located. Four nitroaromatic production lines were located within the boundaries of the Chemical Plant area. Wastes generated during early years of production were disposed of in open earthen pits, seepage from which impacted shallow groundwater. One such pit, Lagoon 1, was located along the northeast boundary of the Chemical Plant Site. Wastewater containing nitroaromatic compounds was initially discharged to surface drainages and then later transported through wooden pipe networks. Starting in 1999, upward trends in nitroaromatic concentrations were observed in the Frog Pond area, notably at well MW-2012. The upward trends were most likely the result of excavation of TNT-impacted soil in this area and in the nearby waste lagoon excavated by the Army, and are expected to be temporary. During 2005, selected locations in the Ash Pond, Frog Pond, and Raffinate Pits areas were analyzed for nitroaromatic compounds.

The highest concentrations of nitrate have typically been measured in the vicinities of the Raffinate Pits and Ash Pond, which are historical sources of this contaminant. The mobility of nitrate in the shallow aquifer system is generally greater than the mobility of other contaminants; as a consequence, the spatial extent of nitrate contamination is greater than that for the other contaminants. The Raffinate Pits contained ore-refining wastes from uranium ore concentrates that were digested with nitric acid during original Chemical Plant operations. During 2005, groundwater samples from selected locations in the Raffinate Pits and Ash Pond areas were analyzed for nitrate.

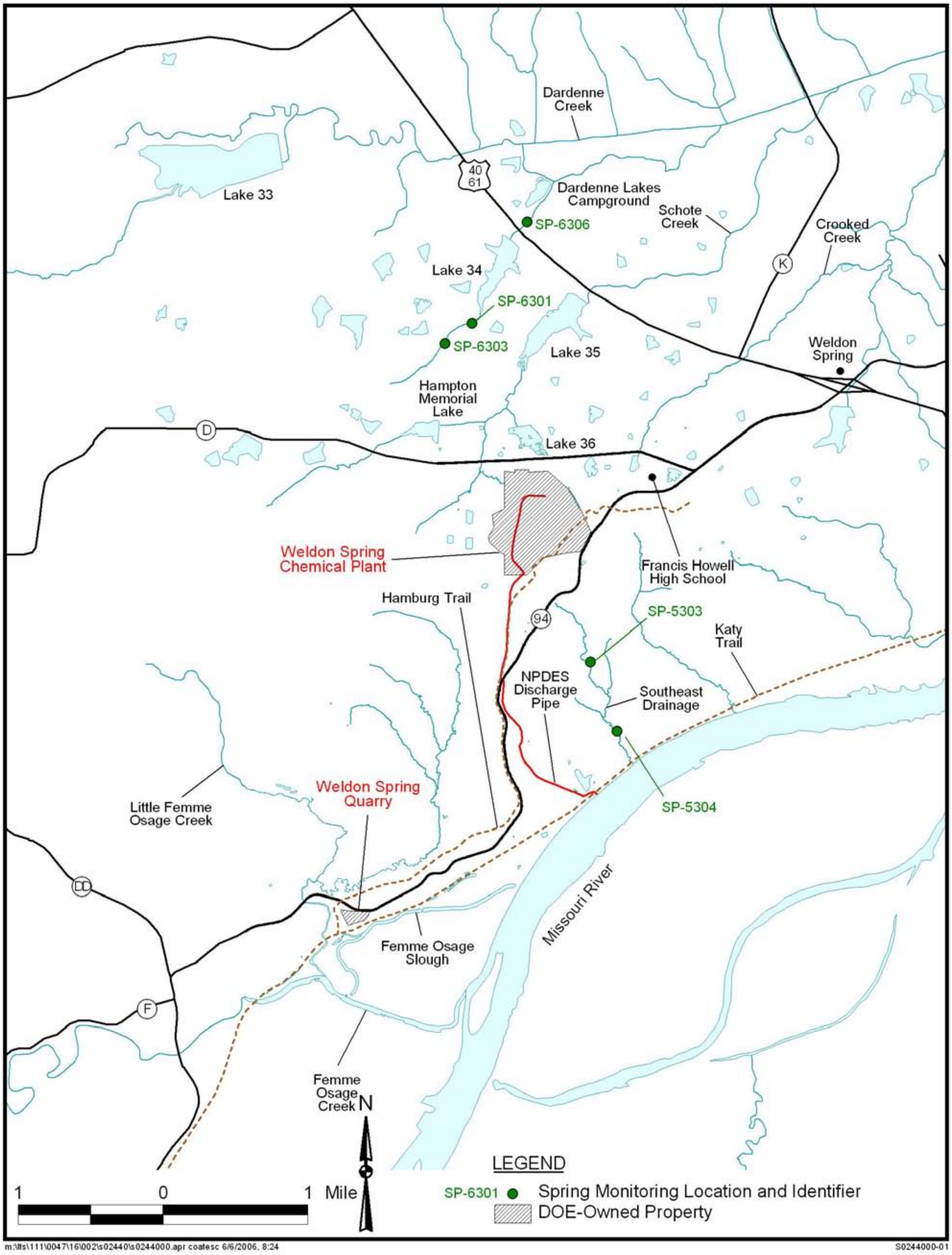

Figure 3–3. Spring Monitoring Locations at the Chemical Plant Area of the Weldon Spring, Missouri, Site

Table 3–2. Monitoring Parameters for MNA Locations

Location	Sampling Frequency[a]	Monitoring Parameters							
		TCE	Nitrate (as N)	Uranium	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-2012	S				✔	✔	✔	✔	✔
MW-2014	S						✔	✔	
MW-2017	S				✔	✔	✔	✔	✔
MW-2021	S		✔						
MW-2022	Q		✔		✔	✔			
MW-2023	Q				✔	✔	✔	✔	✔
MW-2032	S				✔	✔	✔	✔	✔
MW-2035	S	✔	✔	✔			✔		
MW-2038	S		✔				✔		
MW-2040	S		✔			✔			
MW-2046	S					✔			
MW-2050	S						✔	✔	
MW-2051	S				✔	✔	✔	✔	✔
MW-2052	S						✔	✔	
MW-2053	S					✔	✔	✔	
MW-2054	S						✔	✔	
MW-2056	Q				✔	✔	✔	✔	✔
MW-3003	S		✔	✔					
MW-3006	S	✔	✔	✔			✔		
MW-3024	S			✔					
MW-3030	S	✔		✔			✔		
MW-3031	S	✔		✔					
MW-3034	S	✔	✔				✔		
MW-3037	S	✔		✔			✔		
MW-3039	S						✔		
MW-3040	Q	✔	✔	✔					
MW-4007	S	✔	✔						
MW-4013	S		✔				✔	✔	✔
MW-4014	S		✔		✔	✔	✔	✔	✔
MW-4015	S						✔	✔	✔
MW-4022	S		✔	✔					
MW-4023	S		✔	✔					
MW-4026	S			✔					
MW-4029	S	✔	✔						
MW-4031	S		✔						
MW-4036	S	✔	✔	✔			✔		
MW-4039	S				✔	✔	✔	✔	✔
MW-4040	Q	✔	✔	✔			✔		
MW-4041	Q	✔	✔	✔	✔	✔	✔	✔	✔
MWS-1	Q	✔	✔	✔			✔		
MWS-4	Q	✔	✔	✔					
MWD-2	Q		✔	✔					
SP-5303	S			✔					
SP-5304	S			✔					
SP-6301	S	✔	✔	✔	✔	✔	✔	✔	✔
SP-6303	S	✔	✔	✔	✔	✔	✔	✔	✔
SW-2007	Q			✔					

[a]Monitoring frequencies may be decreased to annual or biennial on the basis of trends in at least the first 2 years of data.
S = semiannual
Q = quarterly.

TCE was detected in groundwater southeast of former Raffinate Pit 4 during 1996. The contamination extends from east of former Raffinate Pit 3 to south and southwest of former Raffinate Pit 4, just beyond the boundary of the adjacent Army site. The source of TCE contamination was drums discarded in Raffinate Pit 4. Monitoring for TCE was conducted at selected wells during 2005 to monitor trends in the area of TCE impact, and evaluate the effect of remediation activities on TCE contamination levels.

Uranium contamination occurs in the Raffinate Pits area. The Raffinate Pits were the historical source of uranium in groundwater as it entered the aquifer via downward seepage in the overburden. Adsorption of uranium onto the overburden appears to have limited its extent in groundwater. Uranium was monitored at locations in the Raffinate Pits and Ash Pond areas during 2005.

Groundwater moves under the Chemical Plant area by both relatively diffuse flow in continuous porous media and discrete flow in fractures. To monitor transport in preferential flow zones, five springs were monitored during 2005. All five were monitored for total uranium. Burgermeister Spring and SP-6303 were also monitored for nitrate, nitroaromatic compounds and TCE.

3.1.1.3 Chemical Plant Monitoring Results

Analytical data for contaminants monitored during 2005 (uranium, nitrate, TCE, and nitroaromatic compounds) are summarized in this section and compared with background levels and/or cleanup standards. Average annual concentrations are compared to background levels established during the GWOU remedial investigation (DOE 1997).

Uranium. Total uranium, which was measured at 17 monitoring wells during 2005, continues to be present in the groundwater near the former raffinate pits. In 2005, groundwater from 12 monitoring well locations exceeded the average background level of 0.93 pCi/L (0.03 Bq/L) established during the GWOU remedial investigation (DOE 1997). Four wells exceeded the drinking water standard of 30 µg/L (20 pCi/L) (40 CFR 141). Average uranium concentrations for all 17 wells are shown in Table 3–3.

Nitrate. In 2005, nitrate (as N) was monitored at 22 monitoring wells in the Chemical Plant area as part of the MNA program. The areas of highest impact continued to be present in the Raffinate Pits and Ash Pond areas. Average nitrate concentrations exceeded the MCL of 10 mg/L (40 CFR 141) at 12 of the monitoring locations (Table 3–4).

Nitroaromatic Compounds. Nitroaromatic compounds, which are not naturally occurring, were monitored at 30 locations across the Chemical Plant area. (Table 3–5). The areas of highest impact occurred near Frog Pond and the Raffinate Pits. Levels of nitroaromatic compounds have increased in the Frog Pond area since 1997, most likely as a result of soil remediation by the DOE and Army. During 2005, the Missouri Water Quality Standard (MWQS) for 2,4-DNT of 0.11 µg/L was equaled or exceeded at 7 locations and the MWQS for 1,3-DNB of 1.0 µg/L was exceeded at one location. The risk-based concentration of 2.8 µg/L for 2,4,6-TNT was exceeded at one location and the risk-based concentration of 1.3 µg/L for 2,6-DNT was exceeded at 4 locations. The MWQS for nitrobenzene of 17 µg/L was not exceeded at any location.

Table 3–3. Average Concentrations for Total Uranium at the Weldon Spring Chemical Plant in 2005

Location	Zone	Average (pCi/L)	Number of Samples
MW-2035	Weathered	0.46	2
MW-3003	Weathered	5.1	1
MW-3006	Unweathered	1.2	2
MW-3024	Unweathered	**66.2**	2
MW-3030	Weathered	**46.5**	2
MW-3031	Weathered	2.4	2
MW-3037	Weathered	2.7	2
MW-3040	Unweathered	**87.2**	4
MW-4022	Unweathered	3.5	2
MW-4023	Weathered	2.2	2
MW-4026	Alluvium	ND	2
MW-4036	Weathered	2.1	2
MW-4040	Unweathered	**204.3**	4
MW-4041	Weathered	1. 6	4
MWS-1	Weathered	0.85	4
MWD-2	Unweathered	.20	4
MWS-4	Weathered	0.37	4

Concentrations in **BOLD** - Average concentration exceeds the drinking water standard of 30 µg/L (20 pCi/L).
Note 1: Background uranium concentration equals 0.93 pCi/L (weathered unit) and 0.48 pCi/L (unweathered unit).

Table 3–4. Average Nitrate Concentrations at the Weldon Spring Chemical Plant in 2005

Location	Zone	Average (mg/L)	Number of Samples
MW-2021	Unweathered	ND	2
MW-2022	Unweathered	ND	4
MW-2035	Weathered	0.45	2
MW-2038	Weathered	**503**	2
MW-2040	Weathered	**105**	2
MW-3003	Weathered	**397**	3
MW-3006	Unweathered	ND	2
MW-3034	Weathered	**581**	2
MW-3040	Unweathered	**221**	4
MW-4007	Unweathered	ND	2
MW-4013	Weathered	**88**	2
MW-4014	Weathered	**11.0**	2
MW-4022	Unweathered	0.28	2
MW-4023	Weathered	0 .80	2
MW-4029	Weathered	**550**	2
MW-4031	Weathered	**247**	2
MW-4036	Weathered	**29. 5**	2
MW-4040	Unweathered	**117**	4
MW-4041	Weathered	0.12	4
MWS-1	Weathered	**13.2**	4
MWD-2	Unweathered	ND	4
MWS-4	Weathered	2.43	4

Concentrations in **BOLD** - Average concentration exceeds the MWQS for nitrate (as N) of 10 mg/L.

Table 3–5. Average Concentrations for Nitroaromatic Compounds (µg/L) at the Weldon Spring Chemical Plant in 2005

Location	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB	Number Of Samples
Cleanup Standard	1.0 µg/L	2.8 µg/L	0.11 µg/L	1.3 µg/L	17 µg/L	---
MW-2012	**1.1**	**34**	**915**	**690**	ND	2
MW-2014	ND	ND	ND	0.48	ND	2
MW-2017	ND	ND	ND	ND	ND	2
MW-2022	ND	ND	ND	ND	ND	4
MW-2023	ND	ND	ND	ND	ND	4
MW-2032	ND	ND	ND	ND	ND	2
MW-2035	ND	ND	ND	ND	ND	2
MW-2038	ND	ND	.086	ND	ND	2
MW-2040	ND	ND	ND	ND	ND	2
MW-2046	ND	.62	**.15**	**2.15**	ND	2
MW-2050	.099	ND	**40.5**	**39.5**	ND	2
MW-2051	ND	.071	ND	.133	ND	2
MW-2052	ND	.52	ND	.51	ND	2
MW-2053	ND	1.32	**.265**	**4.6**	ND	2
MW-2054	ND	ND	ND	1.05	ND	2
MW-2056	ND	ND	ND	ND	ND	4
MW-3006	ND	ND	ND	ND	ND	2
MW-3030	ND	ND	**.91**	.47	ND	2
MW-3034	ND	ND	**.15**	.078	ND	2
MW-3037	ND	ND	ND	ND	ND	1
MW-3039	ND	ND	**.565**	.14	ND	2
MW-4013	ND	ND	ND	.328	ND	2
MW-4014	ND	ND	ND	ND	ND	2
MW-4015	ND	ND	ND	.70	ND	2
MW-4036	ND	ND	ND	.385	ND	2
MW-4039	ND	ND	ND	ND	ND	2
MW-4040	ND	ND	ND	ND	ND	4
MW-4041	ND	ND	ND	ND	ND	4
MWS-1	ND	ND	ND	ND	ND	4
MWD-2	ND	ND	ND	ND	ND	4

Concentrations in **BOLD** - Average concentration exceeds the cleanup standard.

TCE. Sampling for TCE is conducted under the GWOU MNA monitoring program to assess the extent of VOC contamination and changes in concentration that may have resulted from remedial activities and groundwater field studies performed in the area of TCE impact. During 2005, four wells had detectable levels of TCE (Table 3–6). TCE concentrations in three of these wells exceeded the MCL for this constituent of 5 µg/L.

Table 3–6. Average TCE Concentrations at the Weldon Spring Chemical Plant in 2005

Location	TCE (µg/L)	Number of Samples
MW-2035	ND	2
MW-3006	ND	2
MW-3030	**455**	2
MW-3031	ND	2
MW-3034	**545**	2
MW-3037	ND	2
MW-3040	ND	4
MW-4007	.61	2
MW-4029	**525**	2
MW-4036	ND	2
MW-4040	ND	4
MW-4041	ND	4
MWS-1	ND	4
MWS-4	ND	4

Concentrations in **BOLD**: Concentration exceeds the Missouri water quality standard of 5 µg/L for TCE.

Burgermeister Spring (SP-6301), a perennial spring that feeds a tributary to Dardenne Creek above Lake 34 (Figure 3–3), represents a primary localized emergence of groundwater impacted by contaminants from the Chemical Plant throughout the year. This spring and an additional one on the same tribuatary (SP-6303) are monitored as part of the MNA program to evaluate contaminant contributions from groundwater and occasional runoff. Average and maximum measured concentrations of nitroaromatic compounds, nitrate, TCE, and uranium at these two springs during 2005 are are presented in Table 3–7. These results are similar to those observed at the springs during 2004. Most dissolved levels of nitroaroamatic chemicals were below their corresponding detection limits. TCE was detected during the year at SP-6303, but not at Burgermeister Spring, and nitrate in both springs was measured at levels below its MCL. Though uranium occurred at relatively low levels in both springs in 2005, the average and maximum uranium concentrations at Burgermeister Spring (SP –6301) were noticeably higher than the equivalent concentrations measured during 2004. This latter observation was likely attributed to the relatively low rainfall that was recorded for the area in 2005, which meant that less water was available for dilution.

Table 3–7. Concentration Data for Burgermeister Spring (SP-6301) and SP-6303 During 2005

	SP-6301		SP-6303	
Parameter	**Average**	**Maximum**	**Average**	**Maximum**
1,3-Dinitrobenzene (µg/L)	ND	ND	ND	ND
2,4,6-Trinitrotoluene (µg/L)	ND	ND	.151	.27
2,4-Dinitrotoluene (µg/L)	ND	ND	ND	.083
2,6-Dinitrotoluene (µg/L)	.08	.11	ND	ND
Nitrobenzene (µg/L)	ND	ND	ND	ND
Nitrate as Nitrogen (mg/L)	5.07	7.19	8.37	11.6
Trichloroethene (µg/L)	ND	ND	.605	.73
Uranium (pCi/L)	57.25	58.8	2.25	3.1

Three other springs were monitored during 2005 to assess the potential for dissolved uranium in Chemical Plant groundwater to discharge to additional exposure points. One of these springs (SP-6306) is located adjcacent to the same tributary to Dardenne Creek that is associated with Burgermeister Spring (Figure 3–3) and is not included in the list of monitoring locations used to evaluate MNA (Table 3–1). The remaining springs are located in the Southeast Drainage (SP-5303 and SP-5304) (Figure 3–3) and are sampled routinely as part of the MNA program. Spring water in the Southeast Drainage is impacted by residual contamination occurring in bedrock fractures. The source of this residual material was historical sewer discharges from the Chemical Plant site and wastewater discharges from the former ordnance works. Results from the sampling of the additional springs are shown in Table 3–8. Of some note is the fact that the uranium concentrations at SP-6303 were lower in 2005 than they were in 2004, but 2005 levels at SP-5303 and SP-5304 were significantly higher. The latter of these observations could also be attributed to the dry conditions that affected the region during 2005.

Table 3–8. Uranium Concentration Data at Springs SP-5303, SP-5304 and SP-6306 During 2005

	SP-5303		SP-5304		SP-6306	
Parameter	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**
Uranium (pCi/L)	91.35	92.7	100	122	.23	.30

3.1.1.4 Trend Analysis

Statistical tests designed to detect temporal trends in COC concentrations at the Chemical Plant were performed using historical and current data from several of the monitoring wells and springs listed in Table 3–1. Trending was assessed for total uranium, nitrate, TCE, and nitroaromatic compounds.

The computer program TREND, developed at Pacific Northwest Laboratory (PNNL), was used to perform the trend analyses; the method employed was the nonparametric Mann-Kendall test. The analyses indicate the potential presence of statistically significant downward or upward trends in concentration at a given location. TREND results serve as approximate indicators of changes in plume behavior and are not intended as predictors of future concentrations. However, program results might be used to indicate areas that should be more closely monitored in the future.

In past years a FORTRAN version of TREND was used to identify potential upward or downward trends at the Chemical Plant. Analysis of 2005 data was performed with a version of the program that has been included in the software package Visual Sample Plan (VSP), which was also developed and is now maintained by PNNL. It was originally developed in the early 1990s as a tool for designing sampling plans. In subsequent years, a variety of features have been added to accommodate more complex sampling designs and some statistical analysis tools. Recently nonparametric Mann-Kendall trend analysis was incorporated in the softwareso that quicker trend analyses could be performed for multiple analytes at multiple wells.

The Mann-Kendall test is used for temporal trend identification because it can easily facilitate missing data and does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). The nonparametric method is valid for scenarios where there are a high number of nondetect data points. Data reported as trace concentrations or less than the detection limit can be used by assigning them a common value that is smaller than the smallest measured value in the data set (i.e., one-half the specified detection limit). This approach is valid because only the relative magnitudes of the data, rather than their measured values, are used in the method. A possible consequence of this approach is that the test can produce biased results if a large fraction of data within a given time series are nondetect and detection limits change between sampling events. To avoid this potential problem with Chemical Plant data, the Mann Kendall test was only applied to data series in which a half or more of the data consisted of detected concentrations.

The trend analyses were performed for all data collected between 2001 and 2005 at Objective 2 and 3 wells and springs used to monitor MNA. To maintain sufficient power of the statistical tests, the analyses were limited to data sets with six or more data points. One-half the specified detection limit (on the date of analysis) was used in place of all concentrations reported at below the detection limit.

The two-tailed version of the Mann-Kendall test was employed to detect either an upward or downward trend for each data set. As part of this approach, a test statistic, Z, was calculated. A positive value of Z indicated that the data were skewed in an upward direction, and a negative value of Z indicated that the data were skewed in a downward direction. The alpha value (or error limit) used to identify a significant trend was 0.05. The null hypothesis of "no trend" was rejected if the absolute value of the Z statistic was greater than Z_1-$\alpha/_2$, where Z_1-$\alpha/_2$ was obtained from a cumulative normal distribution table. In other words, the absolute value of the TREND output statistic, Z was compared to the tabular $Z_{0.975}$ value of 1.96. If the absolute value of the Z output statistic was greater than 1.96, then a significant trend was reported.

A non-parametric estimate of the slope, which is calculated independently of the trend, was determined for each data set using a nonparametric procedure included in the TREND program. In addition, a 95 percent (1-α) two-sided confidence interval about the true slope was obtained. The direction and magnitude of the slope, along with associated upper and lower 95 percent confidence limit estimates, are included in test results presented in the following section.

3.1.1.5 Chemical Plant Trend Results

The trend analyses indicated that most contaminants at wells used to monitor MNA did not show signs of either upward or downward trends during the past five years. This is seen in the test results for uranium in Chemical Plant groundwater (Table 3–9), which show uranium levels in MW-3003 and MW-3031 as possibly trending downward, but no trends are apparent in the remaining 7 wells included in the analyses.

Of 13 wells included in the nitrate trending analysis (Table 3–10), downward trends were identified at three locations (MW-3034, MW-3040, and MWS-4) and upward trends were indicated at two wells (MW-3003 and MWS-1). A nitrate concentration measured in a sample from MW-3003 during 2005 represented a 5-year high for this constituent and well. Similarly, nitrate was detected in MWS-1 during 2005 at a record high level.

Table 3–9. Chemical Plant Groundwater Uranium Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-3003	27	Down	-0.00235	-0.00343	-0.00121
MW-3024	17	None	-0.00763	-0.01821	0.00458
MW-3030	32	None	-0.00048	-0.00232	0.00133
MW-3031	22	Down	-0.00038	-0.00118	-0.00012
MW-3037	7	None	-0.00014	-0.00059	0.00057
MW-3040	8	None	-7.072e-5	-0.03146	0.03290
MW-4036	10	None	-0.00218	-0.01884	0.00073
MW-4040	8	None	0.05590	-0.05096	0.15901
MWS-4	11	None	6.1592e-6	-0.00016	5.4527e-5

Table 3–10. Chemical Plant Groundwater Nitrate Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-2038	44	None	-3.77939	-54.6859	60.6883
MW-2040	14	None	-7.92862	-34.8707	6.33729
MW-3003	28	Up	25.4812	6.74905	45.1303
MW-3034	42	Down	-77.0239	-189.492	-13.3494
MW-3040	8	Down	-34.8454	-162.722	-13.7714
MW-4013	7	None	6.23676	-58.5459	96.9297
MW-4014	7	None	0.61543	-2.01144	8.01859
MW-4029	44	None	24.5382	-8.54433	66.192
MW-4031	30	None	-12.3578	-36.8127	13.309
MW-4036	7	None	-7.47087	-12.0392	5.93997
MW-4040	8	None	22.392	-26.7753	75.5277
MWS-1	7	Up	1.57013	0.43507	2.76144
MWS-4	13	Down	-1.01882	-1.37816	0.36058

Trend analyses for nitroaromatic chemicals in groundwater were limited in number because large proportions of the concentrations reported for these compounds during the past 5 years at Objective 2 and 3 wells tended to be below detection limits. For the nitroaromatic constituents and wells at which trending could be assessed, test results indicated either no trend or upward trends (Table 3–11 through Table 3–14). None of the wells had a sufficient number of nitrobenzene detections to warrant trending analysis for this compound. However, a sufficient quantity of detections were available for 1,3 dinitrobenzene at two wells such that trending analyses could be conducted(Table 3–14).

Table 3–11. Chemical Plant Groundwater 2,4-DNT Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-2012	23	None	94.5334	-11.6125	303.22
MW-2014	20	Up	0.02048	0.0	0.03783
MW-2038	44	None	0.00780	-0.01305	0.04508
MW-2050	22	Up	9.49566	5.20763	14.5311
MW-2052	16	None	-0.01187	-0.03730	0.00036
MW-2054	16	None	-0.06521	-1.90822	1.52521
MW-3030	32	Up	0.12442	0.05877	0.19649
MW-3034	45	None	-0.00609	-0.05771	0.03274
MW-3039	13	None	-0.14535	-0.41088	0.14049
MW-4015	14	None	0.00872	-0.01116	0.03438

Table 3–12. Chemical Plant Groundwater 2,6-DNT Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-2012	23	None	84.5034	-17.2681	226.993
MW-2014	20	Up	0.05513	0.00549	0.14141
MW-2050	22	Up	8.52233	6.79835	9.67937
MW-2051	13	None	0.04964	-0.02978	0.23463
MW-2052	16	None	-0.02516	-0.11991	0.01767
MW-2053	16	None	0.15981	-0.69876	1.15511
MW-2054	16	None	2.09444	-2.19894	12.8011
MW-3030	32	Up	0.08999	0.05280	0.12820
MW-4013	7	None	-0.11372	-0.37051	0.01377
MW-4015	14	None	0.04799	-0.06644	0.19078

Table 3–13. Chemical Plant Groundwater 2,4,6-TNT Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-2012	23	None	0.0	-35.2002	36.6839
MW-2046	11	None	-0.3865	-1.46442	0.21135
MW-2051	13	None	0.00324	-0.02301	0.07123
MW-2053	16	None	-0.21305	-2.30355	1.39823

Table 3–14. Chemical Plant Groundwater 1,3-DNB Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-2012	23	None	0.23431	-0.21627	0.71852
MW-2050	22	None	.03708	0.0	0.10555

Of some interest is the observation that both 2,4-DNT and 2,6-DNT exhibited upward trends in wells MW-2014, MW-2050, and MW-3030 (Table 3–11 and Table 3–12). The first two of these wells are located in the vicinity of Frog Pond, and the latter is located within the historical footprint of former Raffinate Pit 4 (Figure 3–2). As indicated in Table 3–5, 2,4-DNT was not detected at MW-2014 during 2005 and the average 2005 concentration of 2,6-DNT at this well was quite low (0.48 µg/L) despite the fact that upward trends were indicated for this location. In contrast, the average concentrations of 2,4-DNT and 2,6-DNT at MW-2050 during 2005 were relatively high. As discussed in previous annual reports, this latter observation might be due to rebound from remedial actions that took place in the Frog Pond area. The average concentrations of 2,4-DNT and 2,6-DNT at MW-3030 (in the former Raffinate Pits area) were significantly less than those observed at MW-2050 (Table 3–5).

MW-3030 was also the site of a detected upward trend for TCE during the past 5 years (Table 3–15). As shown in Table 3–6, the average concentration of TCE in this well during 2005 was 455 µg/L, which was significantly larger than the MCL for TCE (5 µg/L). Groundwater in the vicinity of MW-3030 may have been affected by rebounds in TCE concentration as a result of previous attempts at remediation in the Raffinate Pits area.

Table 3–15. Chemical Plant Groundwater TCE Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-3030	30	Up	76.0922	58.0986	100.66
MW-3034	40	None	-52.2382	-125.83	12.2989
MW-4029	46	None	-14.0478	-52.1775	7.80077

Testing for temporal trends during the past 5 years for uranium concentrations at springs monitored under the Chemical Plant MNA program (Table 3–16) was possible for SP-5303 and SP-5304 in the Southeast Drainage and Burgermeister Spring (SP-6301) located to the north of the site. Test results for all three of these locations indicated no trend.

Table 3–16. Chemical Plant Springs Uranium Trend Analysis

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
SP-5303	21	None	0.00953	-0.00939	0.02481
SP-5304	38	None	-0.00452	-0.01732	0.00608
SP-6301	43	None	0.00077	-0.00612	0.00772

3.1.2 Weldon Spring Quarry

Since 1987, more than 100 monitoring wells have been used for groundwater observations and sampling in the Quarry area. A total of 34 wells have been routinely sampled to monitor contaminant concentrations in close proximity to the Quarry proper and assess water quality in the Missouri River alluvium (Figure 3–4).

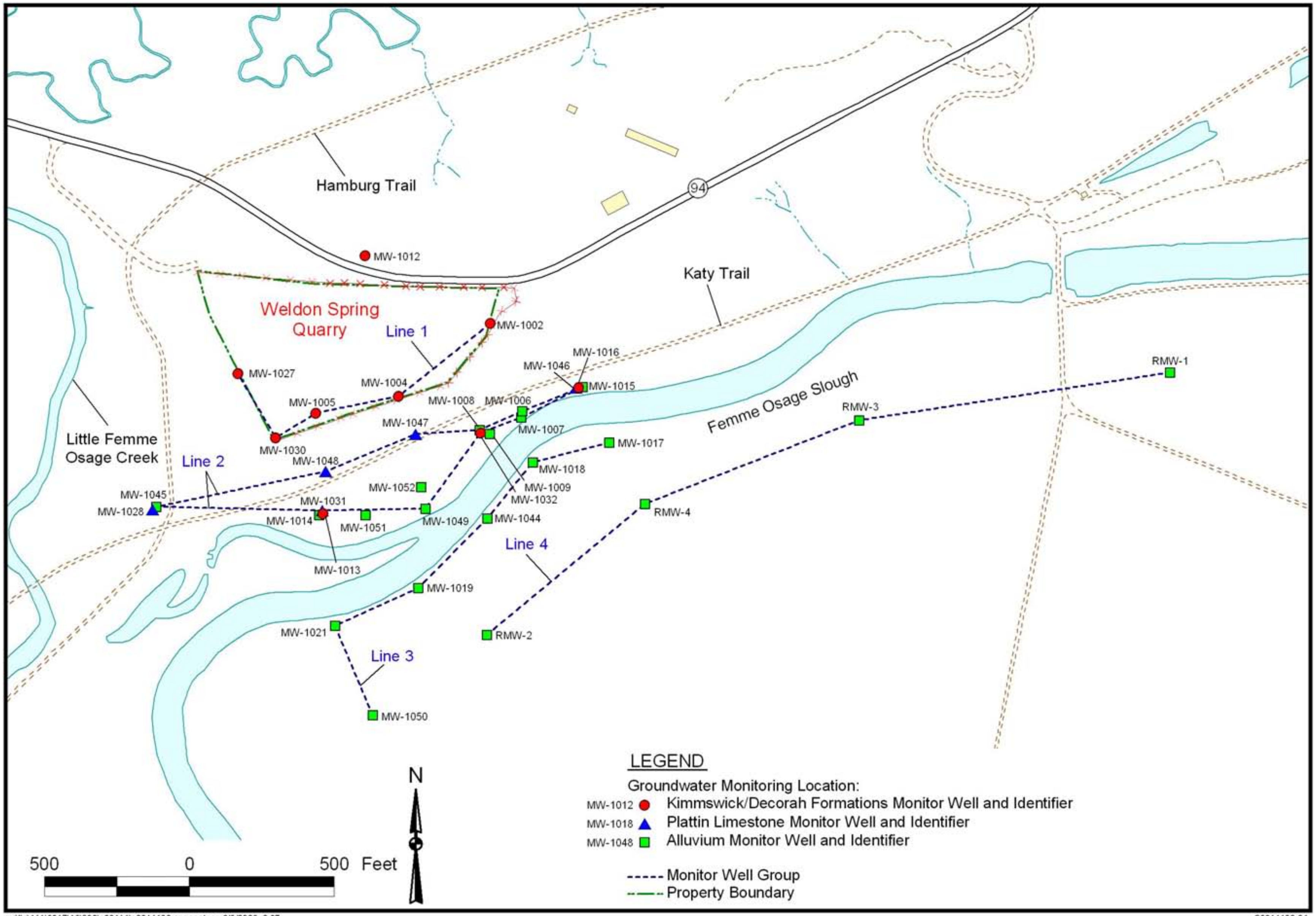

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Figure 3–4. Groundwater Monitor Well Locations at the Quarry Area of the Weldon Spring, Missouri, Site

3.1.2.1 Quarry Hydrogeologic Description

Three different types of geologic materials have bearing on contaminant transport in the Quarry area: upland overburden, Missouri River alluvium, and bedrock. The unconsolidated upland material overlies bedrock, consists of up to 9.2 m (30 ft) of silty clay soil and loess deposits, and is not saturated (DOE 1989). Three Ordovician-age formations comprise the bedrock: the Kimmswick Limestone, the limestone and shale of the Decorah Group, and the Plattin Limestone. The alluvium associated with the Missouri River consists of clays, silts, sands, and gravels above the bedrock. The alluvium thickness increases with distance from the edge of the river floodplain (i.e., near the site) toward the river, where the maximum thickness is approximately 31 m (100 ft).

Alluvium at the site is truncated by an erosional contact with an Ordovician bedrock bluff consisting of Kimmswick, Decorah, and Plattin formations. These same formations also form the rim wall of the Quarry. The bedrock unit underlying alluvial materials north of Femme Osage Slough is the Decorah Group. Femme

The uppermost groundwater flow systems at the Quarry are composed of alluvial and bedrock aquifers. Water levels in the alluvial aquifer are primarily controlled by surface water levels in the Missouri River, and infiltration of precipitation and overland runoff recharge the bedrock aquifer.

Eight groundwater monitoring wells in the Darst Bottom area, located approximately 1.6 km (1 mi) southwest of the former St. Charles County well field, were utilized to study the water quality of the Missouri River alluvium upgradient of the Quarry. Though these wells have been abandoned, data collected from them during earlier years by both the United States Geological Survey (USGS) (1992) and the DOE (1994) provided a reference for background values of uranium in the well field area. A summary of the resulting uranium background values is provided in Table 3–17 (DOE 1998a).

Table 3–17. Background Uranium Concentrations for Aquifer Units at the Quarry

Unit	Uranium (pCi/L)	
	Background Value (UCL95)[d]	**Background Range**
Alluvium[a]	2.77 pCi/L	0.1 - 16
Kimmswick/Decorah[b]	3.41 pCi/L	0.5 - 8.5
Plattin[c]	3.78 pCi/L[e]	1.2 - 5.1

[a] Based on data from Darst Bottom wells (USGS and DOE)
[b]Based on data from MW-1034 and MW-1043 (DOE)
[c]Based on data from MW-1042 (DOE)
[d]UCL95 = 95[th] percentile upper confidence limit on the mean concentration
[e]This background value is lower than previously published as a result of recent data evaluation

3.1.2.2 Quarry Monitoring Program

Long-term monitoring at the Quarry is designed to (1) track uranium concentrations south of the slough to ensure they remain protective of human health and the environment, and (2) monitor contaminant levels within the area of groundwater impact north of the slough until they attain target levels that have been identified as having negligible impact on the groundwater south of the slough (DOE 2000a).

A single well in the Quarry area - MW-1012 – provides data indicative of groundwater conditions a short distance upgradient of the Quarry itself (Figure 3–4). The remaining monitoring wells at the Quarry have been separated into 4 lines (Figure 3–4).), each of which provides specific information relevant to long-term goals at the site:

- The first line of wells (Line 1) monitors the area of impact within the bedrock rim of the Quarry proper. These wells (MW-1002, MW-1004, MW-1005, MW-1027, MW-1030) are sampled to establish trends in contaminant concentrations within areas of higher impact.
- The second line of wells monitors the area of impact within alluvial materials and shallow bedrock north of Femme Osage Slough (MW-1006, MW-1007, MW-1008, MW-1009, MW-1012, MW-1013, MW-1014, MW-1015, MW-1016, MW-1028, MW-1031, MW-1032, MW-1045, MW-1046, MW-1047, MW-1048, MW-1049, MW-1051, MW-1052). These wells are also sampled to establish trends in contaminant concentrations within the areas of higher impact and to monitor the oxidizing and reducing environments that are present within this area.
- The third line of wells monitors the alluvium found directly south of the slough. These wells (MW-1017, MW-1018, MW-1019, MW-1021, MW-1044, MW-1050) have shown no impact from Quarry contaminants and are monitored as the first line of warning for potential migration of uranium south of the slough.
- The fourth line of wells monitors the same portion of the alluvial aquifer that supplies the Public Water Supply District #2 (formerly St. Charles County) well field. These wells (RMW-1, RMW-2, RMW-3, RMW-4) are sampled to monitor the groundwater quality of the productive portions of the alluvial aquifer and to detect potential occurrences of uranium outside the range of natural variation.

The frequency of sampling for each location is based on the distance of the well from the source or migration pathway. Monitoring wells on the Quarry rim are sampled quarterly for total uranium. The sampling is conducted to establish any trend in uranium concentration at these locations and to monitor the effects of Quarry dewatering and bulk waste removal activities on the groundwater system. All locations in the Quarry area are currently sampled at least annually for uranium, nitroaromatic compounds, sulfate and iron.

Until October 2005, St. Charles County had its own well field monitoring program that was initiated in 1989 as a result of cooperative efforts between DOE, St. Charles County, and MDNR. Funded by a DOE grant, the program consisted of annual, quarterly, and monthly sampling events at operating production wells, the RMW-series wells, and raw and treated water from the water plant. Results of this monitoring program can be obtained through the Division of Environmental Services for St. Charles County.

The sale of the St. Charles County Water Treatment Plant from St. Charles County to Public Water Supply District #2 was finalized on September 29, 2005. The sold property also included the county well field and related infrastructure. The monitoring responsibilities for the county well field have been transferred from the County to Public Water District #2.

3.1.2.3 Monitoring Results for Groundwater Within the Area of Impact at the Quarry

Uranium. Uranium concentration values continue to indicate that the highest levels of this constituent occur in bedrock and alluvial materials between the Quarry rim and Femme Osage Slough. The 2005 annual averages for total uranium are summarized in Table 3–18. Eighteen locations north of the slough exceed applicable maximum background concentrations for uranium listed in Table 3–17.

Table 3–18. Average Concentrations for Total Uranium (pCi/L) at the Weldon Spring Quarry During 2005

Location	Line	Geologic Unit	Average Concentration (pCi/L)	Number of Samples
MW-1002	1	Kimmswick-Decorah	4.0	4
MW-1004	1	Kimmswick-Decorah	**853**	4
MW-1005	1	Kimmswick-Decorah	**712**	4
MW-1027	1	Kimmswick-Decorah	**338**	4
MW-1030	1	Kimmswick-Decorah	7.4	4
MW-1006	2	Alluvium	**1506**	4
MW-1007	2	Alluvium	6.35	4
MW-1008	2	Alluvium	**2085**	4
MW-1009	2	Alluvium	0.54	4
MW-1012	2	Kimmswick-Decorah	2.1	4
MW-1013	2	Kimmswick-Decorah	**416**	4
MW-1014	2	Alluvium	**1164**	4
MW-1015	2	Kimmswick-Decorah	146	4
MW-1016	2	Alluvium	113	4
MW-1028	2	Plattin	2.0	2
MW-1031	2	Plattin	12.0	4
MW-1032	2	Kimmswick-Decorah	**997**	4
MW-1045	2	Alluvium	5.5	4
MW-1046	2	Plattin	2.6	4
MW-1047	2	Plattin	1.1	4
MW-1048	2	Plattin	**334**	4
MW-1049	2	Alluvium	.11	4
MW-1051	2	Alluvium	**838**	4
MW-1052	2	Alluvium	**597**	4

Concentrations in **BOLD** - Annual average exceeds target level of 300 pCi/L.

The attainment objective for uranium in groundwater north of the slough is based on the assumption that the measured concentrations in this area during a given year will be normally distributed. Specifically, the objective is to reach a condition in which the 90^{th} percentile associated with that distribution falls below a target level of 300 pCi/L (DOE 2000a). Eleven wells north of the slough exceeded the target level in 2005, and the 90^{th} percentile associated with the concentration data was 1,223 pCi/L. This value represented a slight decrease from 2004, when the 90th percentile for uranium was 1,289 pCi/L. Uranium monitoring will continue in 2006.

Nitroaromatic Compounds. In 2005, samples from Quarry monitoring wells were analyzed for the nitroaromatic compounds listed in Table 3–2. Monitoring wells that have historically been impacted by nitroaromatic compounds are screened in either alluvial materials or bedrock between the Quarry and Femme Osage Slough. During 2005, measured concentrations of the nitroaromatic compounds were generally similar to those reported for 2004.

Average levels of 2,4-DNT for the locations where detectable concentrations were reported during 2005 are presented in Table 3–19. The average concentration of this constituent at location MW-1027 remained above the Missouri Water Quality Standard of 0.11 µg/L during 2005, and location MW-1006 also had an average concentration that exceeded 0.11 µg/L. Though detectable concentrations of 2,4-DNT were measured at MW-1032 in 2004, it was not detected at this well during 2005.

Table 3–19. Average Concentrations for 2,4-DNT (µg/L) at the Weldon Spring Quarry During 2005

Location	Geologic Unit	Average Concentration (µg/L)	Maximum Concentration (µg/L)	Number of Samples
MW-1004	Kimmswick-Decorah	0.05	**0.12**	4
MW-1006	Alluvium	**0.16**	**0.26**	4
MW-1027	Kimmswick-Decorah	**12.5**	**15.0**	4

Concentrations in **BOLD** – Exceeds the Missouri Water Quality Standard of 0.11 µg/L for 2,4-DNT

The attainment objective for 2,4-DNT north of the slough is that the 90th percentile associated with measured concentrations of this compound within a monitoring year is below a target level of 0.11 µg/L and that each well be trended to establish that 2,4-DNT concentration in groundwater north of the slough are decreasing (DOE 2000a). During 2005, the 90th percentile associated with 2,4-DNT concentrations in quarry wells was 0.068 µg/L; however, an upward trend was observed for this constituent in MW-1027. The monitoring for nitroaromatics at the quarry is being evaluated.

Sulfate. Sulfate levels in 2005 at Quarry monitoring wells in bedrock along the Quarry rim and in the alluvial materials north of Femme Osage Slough (Table 3–20) were similar in magnitude to those observed in 2004. Sulfate is monitored as an indicator of oxidation-reduction (redox) conditions in local groundwater. Higher sulfate concentrations are generally observed in an oxidizing environment, and lower sulfate levels are reflective of reducing conditions. Measured concentrations of this constituent during 2005 were relatively high and similar in magnitude to equivalent concentrations reported for 2004, which were in turn of similar magnitude to those observed in 2003. The apparent persistence of relatively oxidizing conditions during the past three years could help to explain the continued co-occurrence of elevated uranium concentrations (Table 3–18) since uranium tends to be quite soluble in oxidizing environments.

Table 3–20. Average Concentrations for Sulfate (mg/L) at the Weldon Spring Quarry During 2005

Location	Line	Geologic Unit	Average Concentration (mg/L)	Number of Samples
MW-1002	1	Kimmswick-Decorah	110	4
MW-1004	1	Kimmswick-Decorah	120	4
MW-1005	1	Kimmswick-Decorah	221	4
MW-1027	1	Kimmswick-Decorah	64.3	4
MW-1030	1	Kimmswick-Decorah	85.5	4
MW-1006	2	Alluvium	101	4
MW-1007	2	Alluvium	1.6	4
MW-1008	2	Alluvium	90.6	4
MW-1009	2	Alluvium	32.2	4
MW-1012	2	Kimmswick-Decorah	42.5	4
MW-1013	2	Kimmswick-Decorah	90	4
MW-1014	2	Alluvium	106	4
MW-1015	2	Kimmswick-Decorah	95.8	4
MW-1016	2	Alluvium	110	4
MW-1028	2	Plattin	34.7	2
MW-1031	2	Plattin	24.8	4
MW-1032	2	Kimmswick-Decorah	128	4
MW-1045	2	Alluvium	38.7	4
MW-1046	2	Plattin	47	4
MW-1047	2	Plattin	85.7	4
MW-1048	2	Plattin	67.1	4
MW-1049	2	Alluvium	ND	4
MW-1051	2	Alluvium	94.2	4
MW-1052	2	Alluvium	26.8	4

Iron. Iron is also monitored as an indicator of redox conditions in Quarry groundwater. Iron concentrations generally increase in a reducing environment. The average concentrations for iron in 2005, listed in Table 3–21, tend to confirm the presence of a chemically reducing zone along the northern margin of the slough, which is inhibiting migration of uranium-contaminated groundwater farther to the south. The reducing conditions appear to cause uranium concentrations in the immediate vicinity of and south of the slough to be low.

Table 3–21. Average Concentrations for Iron (µg/L) at the Weldon Spring Quarry During 2005

Location	Line	Geologic Unit	Average Concentration (µg/L)		Number of Samples
			Iron (Filtered)	Ferrous Iron	
MW-1002	1	Kimmswick-Decorah	21.6	8.0	4
MW-1004	1	Kimmswick-Decorah	89.9	77.5	4
MW-1005	1	Kimmswick-Decorah	896	180	4
MW-1027	1	Kimmswick-Decorah	72.8	< 10.0	4
MW-1030	1	Kimmswick-Decorah	5,588	4,350	4
MW-1006	2	Alluvium	2,445	1,600	4
MW-1007	2	Alluvium	47,325	13,248	4
MW-1008	2	Alluvium	46.3	8	4
MW-1009	2	Alluvium	27,800	15,610	4
MW-1012	2	Kimmswick-Decorah	16.9	17.5	4
MW-1013	2	Kimmswick-Decorah	3,805	2,548	4
MW-1014	2	Alluvium	649	403	4
MW-1015	2	Kimmswick-Decorah	107	< 10.0	4
MW-1016	2	Alluvium	31.7	< 10.0	4
MW-1028	2	Plattin	622	230	2
MW-1031	2	Plattin	18.9	< 10.0	4
MW-1032	2	Kimmswick-Decorah	863	180	4
MW-1045	2	Alluvium	20.7	13.0	4
MW-1046	2	Plattin	509	415	4
MW-1047	2	Plattin	46.5	40	4
MW-1048	2	Plattin	933	690	4
MW-1049	2	Alluvium	62,475	34,233	4
MW-1051	2	Alluvium	196	185	4
MW-1052	2	Alluvium	15,437	3,963	4

3.1.2.4 Monitoring Results for the Missouri River Alluvium

Uranium. Ten monitoring wells located south of the slough were analyzed for uranium during 2005 to verify that levels of this constituent remain within the range of its natural variation in Missouri River alluvium. The results, presented in Table 3–22, indicate that uranium levels in one well, RMW-2, exceed the average background value for this constituent in the alluvium (Table 3–17). However, the reported value at this well is within the range used to calculate the average background concentration and does not indicate impact from southward-migrating groundwater north of the slough. None of the locations south of the slough have uranium levels that exceed the drinking water standard of 20 pCi/L (30 µg/L).

Table 3–22. Average Concentration for Total Uranium in the Missouri River Alluvial Aquifer During 2005

Location	Line	Average (pCi/L)	Number of Samples
MW-1017	3	ND	2
MW-1018	3	ND	2
MW-1019	3	ND	2
MW-1021	3	ND	2
MW-1044	3	ND	2
MW-1050	3	ND	2
RMW-1	4	1.7	1
RMW-2	4	6.5	1
RMW-3	4	1.4	1
RMW-4	4	0.62	1

Background concentrations given in Table 3–17.
ND = nondetect

Nitroaromatic Compounds. During 2005, the RMW-series monitoring wells were sampled for the five nitroaromatic compounds listed in Table 3–2. No detectable concentrations were observed at these locations.

Sulfate and Iron. The monitoring wells located south of the slough were sampled for sulfate and iron during 2005, again for the purpose of assessing redox conditions in the Missouri River alluvium in this area. The resulting average concentrations for these two constituents are summarized in Table 3–23. The data indicate that a strongly reducing environment is prevalent in the groundwater immediately south of the slough (i.e., dissolved iron concentrations are relatively high and sulfate concentrations are relatively low). The RMW-series wells indicate a slightly less reducing environment when compared to the wells immediately south of the slough. This could be attributed to more noticeable effects of recharge of oxygenated water via precipitation in the vicinity of the RMW-series wells.

Table 3–23. Average Iron and Sulfate Concentrations in the Missouri River Alluvial Aquifer During 2005

Location	Sulfate (mg/L)	Iron (Filtered) (µg/L)	Ferrous Iron (µg/L)	Number of Samples
MW-1017	0.16	31,400	12,065	2
MW-1018	1.95	24,400	9,485	2
MW-1019	1.89	22,650	10,375	2
MW-1021	0.41	17,100	9,005	2
MW-1044	0.22	19,850	6,890	2
MW-1050	32.5	14,700	2,940	2
RMW-1	35.1	8,100	4,300	1
RMW-2	31.8	8,450	4,800	1
RMW-3	57.0	20,600	16,400	1
RMW-4	11.2	12,100	9,100	1

3.1.2.5 Quarry Trend Analysis

Testing for temporal trends was performed on Quarry groundwater monitoring well concentration data for total uranium and 2,4-DNT collected between 2001 and 2005. These analyses were performed using the previously described program TREND (Section 3.1.1.4) as incorporated in the Visual Sample Plan software package. As in the case of the Chemical Plant, the method employed was the nonparametric Mann-Kendall test.

3.1.2.6 Quarry Trend Results

Results of the trending analyses for uranium are reported for each of Lines 1 through 4 of the observation wells used to monitor groundwater chemistry at the Quarry. The results for the wells located in the immediate vicinity of the Quarry rim (Table 3–24) show that downward trends were exhibited in MW-1004, MW-1005 and MW-1030. Decreases in uranium at these locations are likely the result of bulk waste removal and restoration activities. Remedial activities at the Quarry are expected to prevent infiltration of precipitation and storm water into the residually contaminated fracture system in the area. Downward trends were also reported in 2003 and 2004 for the three monitoring wells mentioned above.

Table 3–24. Quarry Groundwater Uranium Trend Analysis for Line 1 Monitoring Wells

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-1002	19	None	0.00013	-0.00013	0.00043
MW-1004	19	Down	-0.16873	-0.32268	-0.08837
MW-1005	19	Down	-0.28046	-0.36810	-0.18681
MW-1027	19	None	-0.00583	-0.05439	0.05726
MW-1030	19	Down	-0.00251	-0.00439	-0.00105

At the Line 2 monitoring well network, downward trends were exhibited for uranium (Table 3–25) in MW-1031, MW-1045, MW-1046, and MW-1048. These observations appear to correlate with the previously mentioned downward trends associated with wells at the Quarry proper, which could indicate that the gradual effects of quarry remediation are now being observed at wells located closer to Femme Osage Slough. Downward trends were also reported for the MW-1045 and MW-1046 locations in 2003 and 2004. In contrast to such evidence for decreasing uranium concentrations, upward trends in uranium were identified at MW-1013, MW-1014, MW-1016, MW-1047 and MW-1052 in the Line 2 network (Table 3–25). These wells are located in the area of highest uranium impact at the Quarry area. Upward trends were also reported for MW-1013, MW-1014, MW-1016, and MW-1052 in 2004.

Table 3–25. Quarry Groundwater Uranium Trend Analysis for Line 2 Monitoring Wells

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-1006	19	None	0.13973	-0.01873	0.25100
MW-1007	19	None	-0.00392	-0.00817	0.00049
MW-1008	21	None	-0.19594	-0.54857	0.16893
MW-1009	22	None	-0.00025	-0.00122	0.00012
MW-1013	22	Up	0.05081	0.01283	0.11518
MW-1014	22	Up	0.31411	0.20708	0.41413
MW-1015	19	None	-0.00326	-0.02928	0.01449
MW-1016	19	Up	0.01438	0.00413	0.02265
MW-1028	10	None	-0.00010	-0.00056	0.00041
MW-1031	22	Down	-0.00203	-0.00410	-0.00048
MW-1032	22	None	-0.03058	-0.08970	0.03992
MW-1045	18	Down	-0.00095	-0.00191	-0.00012
MW-1046	19	Down	-0.00124	-0.00177	-0.00061
MW-1047	22	Up	8.18386e-5	0.0	0.00017
MW-1048	22	Down	-0.01226	-0.02518	-0.00034
MW-1051	20	None	0.10944	-0.04075	0.28177
MW-1052	20	Up	0.11182	0.00192	0.44033

None of the 6 wells comprising Line 3 had a sufficient number of detected uranium concentrations to warrant trend analysis. This result is expected given that chemically reducing conditions in the vicinity of Line 3 tend to remove uranium from solution in groundwater.

Data were available to perform trend testing for uranium in three of the Line 4 monitoring wells (RMW-1, RMW-2, and RMW-4). Two of these wells showed no trend and one exhibited an upward trend. Despite this latter result, dissolved uranium in the Missouri River alluvium does not appear to be problematic given that its concentrations in the RMW series of wells are low and below background levels (Table 3–26 and Section 1.1.2.4).

Table 3–26. Quarry Groundwater Uranium Trend Analysis for Line 4 Monitoring Wells

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
RMW-1	11	None	0.00032	-0.00012	0.00056
RMW-2	11	Up	0.00146	0.00039	0.00314
RMW-4	11	None	-0.00023	-0.00047	0.00032

Trend analysis for 2,4-DNT at the Quarry was limited to well MW-1027 in the Line 1 network (Table 3–27) where an upward trend was identified. Trend tests were not possible for the remaining Quarry wells because analyses of samples collected from them during the past five years typically result in nondetects. The apparent preponderance of low concentrations for 2,4-DNT north of the slough suggests that levels of this constituent have been been decreasing in recent times in response to Quarry remediation. Simultaneously, the reducing conditions associated with wells located in the immediate vicinity of and south of the slough are likely to enhance the biodegradation of this nitroaromatic compound.

Table 3–27. Quarry Groundwater 2,4-DNT Trend Analysis for Line 1 Monitoring Wells

Location	No. of Samples	Trend	Slope	Lower Confid. Interval	Upper Confid. Interval
MW-1027	20	Up	2.79433	1.86228	4.07392

The upward trend in 2,4-DNT levels at MW-1027 conforms with a similar finding regarding this well and constituent in the 2004 annual report. This observation may be related to increases in groundwater elevation detected in the area north of the slough prior to 2005. Although water levels in this area during the past five years have remained within historical ranges, locally measured heads have shown a slight to moderate increase in comparison to earlier years, presumably in response to recharge from precipitation. Such recharge of oxygenated water could limit biologically mediated degradation of 2,4-DNT, just as it can lead to apparently increasing uranium concentrations.

3.1.3 Disposal Cell Monitoring

Five groundwater monitoring wells, one spring, and disposal cell leachate were sampled during 2005 as part of the detection monitoring program for the permanent disposal cell. In accordance with the disposal cell monitoring program, data for signature parameters (barium, iron, manganese, and uranium) from each monitoring event were compared to baseline tolerance limits (BTLs) to track general changes in groundwater quality and determine whether statistically significant increases in these parameters have occurred. Signature parameters are those parameters that exist at significantly higher concentrations in the leachate than in the groundwater near the cell and provide a reliable means of detecting potential impacts due to leakage of the disposal cell.

This monitoring is performed to meet the substantive requirements of 40 CFR 264, Subpart F; 10 CSR 25-7.264(2)(F); and 10 CSR 80-3.010(8). These Federal and State hazardous and/or solid waste regulations were identified as ARARs for the selected remedy in the *Record of Decision for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (DOE 1993). Monitoring of these wells and the spring was performed in accordance with the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan*, *Rev. 2* (DOE 2004b).

3.1.3.1 Disposal Cell Monitoring Program

The disposal cell groundwater detection monitoring network consists of one upgradient well (MW-2055), four downgradient wells (MW-2032, MW-2046, MW-2047, and MW-2051), one downgradient spring (SP-6301), and the leachate collection and removal system (LCRS). Semiannual detection monitoring began in mid-1998, after cell construction had begun and waste placement activities were initiated.

The monitoring program for the disposal cell consisted of semiannual sampling for the following parameters:

- Uranium.
- Anions (chloride, fluoride, nitrate [as N], and sulfate).
- Metals (arsenic, barium, chromium, cobalt, iron, lead, manganese, nickel, selenium, and thallium).
- Nitroaromatic compounds.
- Radiochemical parameters (Radium-226 [Ra-226], Radium-228 [Ra-228], Thorium-228 [Th-228], Thorium-230 [Th-230], and Thorium-232 [Th-232]).
- Polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons (PAHs).
- Miscellaneous indicator parameters (pH, specific conductance, chemical oxygen demand, total dissolved solids [TDS], and total organic carbon [TOC]).

Under the monitoring program, signature parameter (barium, iron, manganese, and uranium) data from each monitoring event are compared to the BTLs to trace general changes in groundwater quality and determine whether statistically significant evidence of contamination due to cell leakage exists. Tolerance limits for signature parameters have been calculated using the dataset from 1997 through 2002, using 95 percent confidence limits under the assumption that the data are normally distributed. In the case of the newer wells (MW-2051 and MW-2055), the period of record for available data is fairly small; however, the tolerance limits for these wells are representative of groundwater conditions at these locations.

The data from the remainder of the parameters are reviewed to evaluate the general groundwater quality in the vicinity of the disposal cell and to determine if changes are occurring in the groundwater system. Data are compared to the three most recent years of data to determine if statistically significant increases or trends in concentrations are present. A measured concentration is considered statistically significant if it is greater than the arithmetic mean plus three times the standard deviation for a given location.

Wells with data showing statistically significant increases or decreases are resampled to confirm the exceedance. If the results of the resampling confirm the exceedance, historical leachate analytical data and volumes are evaluated to assess the integrity of the disposal cell. If the leachate data do not indicate that the exceedance could be the result of leakage from the cell, an assessment of the analytical data and review of sitewide monitoring data is performed. If the exceeding parameter is a contaminant of concern for the GWOU, this information is evaluated under the monitoring program for that operable unit.

3.1.3.2 Disposal Cell Monitoring Results

Elevated data were reported for three locations (MW-2032, MW-2046, and MW-2051) during the December 2004 sampling event. These locations were resampled in February 2005 and evaluated in the *Weldon Spring Site Cell Groundwater Monitoring Demonstration Report for the December 2004 Sampling Event*. (DOE 2005)

It was concluded that the concentration exceedances for the signature parameters (iron and manganese) in MW-2032 were caused by biodegradation of natural organic material in the vicinity of the well (dead ants from an ant nest near the well). Information supporting this conclusion included (1) conversion from fully oxidizing conditions in the well during June 2004 to chemically reducing conditions during the December sampling event and (2) field observations of decaying ants on the pump installed in this well. The chemically reducing conditions were identified by negative oxygen-reduction potentials (ORP) of water samples collected from the well, which were distinguished from the more typical positive ORPs measured in groundwater at the site. As part of the process that biodegrades natural organic material, manganese- and iron-reducing bacteria in the local subsurface likely converted solid forms of these metals into dissolved forms, thus increasing their concentrations in groundwater. Evidence for continued biodegradation in MW-2032 was observed during re-sampling in February 2005, as chemically reducing conditions were present and iron and manganese concentrations remained relatively high.

The non-signature parameters sulfate, total organic carbon (TOC) and chemical oxygen demand (COD), and nickel were observed in MW-2032 during December 2004 at concentrations that were considered statistically significant increases above background levels. Subsequent re-sampling for these analytes in February 2005 indicated that the concentrations of the first three had decreased to levels in line with those occurring in June 2004 and under baseline conditions. Consequently, it was determined that the elevated levels of sulfate, TOC, and COD at MW-2032 during late 2004 were unlikely to have been caused by disposal cell leachate. The concentration of the metal nickel during the re-sampling was noticeably lower than observed in December 2004 but remained higher than the June 2004 level. This behavior was attributed to the continuing biodegradation at the well and associated dissolution of solid-phase metals. Dissolved concentrations of nickel in MW-2032 were expected to decrease to more normal values once the biodegradation of ant debris became insignificant.

Assessment of statistically significant increases in the concentration of nitrate at disposal cell monitoring well MW-2046 and chromium at MW-2051 in December 2004 showed that neither was related to the disposal cell. Both of these constituents occur in cell leachate at such low levels that a loss of either from the cell would be inconsequential. The elevated level of chromium at MW-2051 in December 2004 was probably caused by dissolution of stainless steel materials comprising the well screen.

The recommendations from the report included the following:

1. On a bi-monthly basis, redevelop the well using purging techniques.
2. Monitor ORP levels bi-monthly, before and after the purging. This will indicate if the chemistry in the groundwater is chemically reducing or oxidizing.
3. Develop means of preventing ant movement into the well.
4. Attempt to kill ants near the well by applying an insecticide at the ground surface.
5. If elevated levels of iron and manganese and reducing conditions at the well persist into October 2005, propose adding amendments to the well that are capable of either minimizing or eliminating bacterial metabolism in and near the well. If amendments are applied, use the least toxic forms initially (e.g., minimal levels of chlorine), and stronger chemical treatments

only if less aggressive tactics are unsuccessful. If amendments are applied, increase monitoring of surface water at Burgermeister Spring for impacts.

6. Summarize progress in solving the problem in quarterly FFA reports.

The 2005 monitoring results for the signature parameters are presented in Table 3–28 along with applicable BTLs.

Table 3–28. Signature Parameter Results and Associated BTLs at Disposal Cell Monitoring Locations

Parameter	Location	BTL	Results	
			June 2005	December 2005
Barium (µg/L)	MW-2032	337	182	175
	MW-2046	277	225	212
	MW-2047	471	371	400
	MW-2051	285	163	185
	MW-2055	98	19.6	20.4
	SP-6301	180	146	125
Iron (µg/L)	MW-2032	1,125	73.7	125
	MW-2046	1,578	7.3	79.1
	MW-2047	1,485	ND	70.9
	MW-2051	2,896	199	301
	MW-2055	10,579	44.5	7.3
	SP-6301	2,608	ND	215
Manganese (µg/L)	MW-2032	57	212	27.2
	MW-2046	187	2.7	6.2
	MW-2047	171	5.3	6.0
	MW-2051	265	2.8	6.9
	MW-2055	179	4.8	4.1
	SP-6301	88	1.6	2.7
Uranium (pCi/L)	MW-2032	6.4	2.4	4.4
	MW-2046	1.8	1.2	1.7
	MW-2047	2.7	1.2	1.8
	MW-2051	4.5	1.0	1.8
	MW-2055	7.5	2.2	2.4
	SP-6301	159	55.7	58.8

Results of general groundwater quality monitoring for the disposal cell wells in June 2005 are presented in Table 3–29. Noteworthy observations include:

- The concentration of sulfate in MW-2032 constituted a new high; however, this value was not considered statistically significant because it was less than the mean concentration plus 3 standard deviations for the last 3 years of data.
- The concentration of chloride in MW-2046 was at a new high and had been steadily increasing in prior years, however, this value was not considered statistically significant because it was less than the mean concentration plus 3 standard deviations for the last 3 years of data.
- The concentration of nitrate was at a 5-year high in MW-2047, but the value was not considered statistically significant.
- The concentration of barium in MW-2046 was at a 5-year high and the barium level in MW-2047 was elevated, but neither value was considered statistically significant
- The concentrations of chromium and nickel were detected at 3-year highs in MW-2046; however, the values were not considered statistically significant. Chromium and nickel concentrations returned to more normal values in December 2005.

Results of general groundwater quality monitoring for the disposal cell wells in December 2005 are presented in Table 3–30. Noteworthy data include:

- The concentration of sulfate in MW-2032 was reduced significantly from the June concentration.
- The concentration of chloride in MW-2046 was a new high again and has been steadily increasing, however, this value is not considered statistically significant because it is less than the mean plus 3 standard deviations for the last 3 years of data.
- The concentration of nitrate was again at a 5-year high in MW-2047, but the value was not considered statistically significant.
- The concentration of barium in MW-2046 decreased slightly from the June sampling, but the concentration was increased in MW-2047 and was at a 5-year high.

Table 3–29. Summary of Monitoring Data for the Disposal Cell Well Network (June 2005)

Parameter	MW-2032	MW-2046	MW-2047	MW-2051	MW-2055	SP-6301
Chloride (mg/L)	6.4	30.9	8.1	23.2	5.6	25.8
Fluoride (mg/L)	.18	.093	.10	.15	.11	0.25
Nitrate-N (mg/L)	.824	2.49	86.3	2.03	1.17	7.19
Sulfate (mg/L)	174	57.3	23.5	29.1	256	29.2
Arsenic (µg/L)	ND	ND	ND	ND	ND	ND
Chromium (µg/L)	ND	3.7	6.8	14.5	8.9	ND
Cobalt (µg/L)	.5	ND	ND	.52	ND	ND
Lead (µg/L)	ND	ND	ND	ND	.57	ND
Nickel (µg/L)	7.6	26.8	6.2	8.1	20.1	3.0
Selenium (µg/L)	ND	4.7	2.6	.66	15.3	.65
Thallium (µg/L)	ND	ND	ND	ND	.95	ND
COD (mg/L)	3.0	ND	ND	5.0	ND	ND
TDS (mg/L)	307	583	676	354	774	362
TOC (mg/L)	0.43	NS	NS	NS	5.275	NS
1,3,5-TNB (µg/L)	ND	3.0	ND	0.15	ND	ND
1,3-DNB (µg/L)	ND	0.13	ND	0.21	ND	ND
2,4,6-TNT (µg/L)	ND	1.2	ND	.11	ND	ND
2,4-DNT (µg/L)	ND	.27	0.09	0.08	ND	ND
2,6-DNT (µg/L)	ND	2.3	.25	.22	ND	.11
Nitrobenzene (µg/L)	ND	ND	ND	ND	ND	ND
Radium-226 (pCi/L)	ND	0.18	.34	.34	ND	ND
Radium-228 (pCi/L)	ND	ND	1.13	ND	ND	ND
Thorium-228 (pCi/L)	ND	ND	ND	ND	.32	ND
Thorium-230 (pCi/L)	.23	.33	.29	0.20	.13	0.34
Thorium-232 (pCi/L)	ND	ND	ND	ND	ND	ND
PCBs/PAHs (µg/L)	ND	ND	ND	ND	ND	ND
DO (mg/L)	2.03	8.65	6.89	11.66	6.04	7.96
ORP (mV)	-125.9	215.1	126.9	102.6	245.8	216.2
pH (s.u.)	7.12	6.94	7.10	7.35	7.06	6.6
SC (µmohs/cm)	496	1004	1242	6.19	1141	647
Temperature (C)	18.25	19.55	17.62	11.24	18.59	11.68

ND Nondetect.
NS Not sampled.

Table 3–30. Summary of Monitoring Data for the Disposal Cell Well Network (December 2005)

Parameter	Results					
	MW-2032	MW-2046	MW-2047	MW-2051	MW-2055	SP-6301
Chloride (mg/L)	3.5	31.3	8.1	21.3	4.7	14.2
Fluoride (mg/L)	.23	.11	.11	.20	.16	0.13
Nitrate-N (mg/L)	1.86	2.02	95.2	1.22	.63	2.95
Sulfate (mg/L)	61.9	57.3	25.3	27.2	292	29.2
Arsenic (µg/L)	1.8	ND	1.3	ND	ND	3.3
Chromium (µg/L)	3.9	1.6	5.3	62	8.1	ND
Cobalt (µg/L)	ND	2.8	ND	ND	1.00	ND
Lead (µg/L)	ND	ND	ND	ND	ND	ND
Nickel (µg/L)	7.7	5.5	6.2	7.4	13.8	3.2
Selenium (µg/L)	ND	4.6	3.7	1.3	12.9	ND
Thallium (µg/L)	ND	3.0	ND	ND	ND	4.9
COD (mg/L)	5.0	9.0	3.0	10.0	5.0	5.0
TDS (mg/L)	300	255	560	432	754	215
TOC (mg/L)	1.3	2.1	1.2	.97	.77	2.1
1,3,5-TNB (µg/L)	ND	3.1	ND	ND	ND	ND
1,3-DNB (µg/L)	ND	0.07	ND	ND	ND	ND
2,4,6-TNT (µg/L)	ND	1.1	ND	ND	ND	ND
2,4-DNT (µg/L)	ND	ND	ND	ND	ND	ND
2,6-DNT (µg/L)	ND	2.0	ND	ND	ND	ND
Nitrobenzene (µg/L)	ND	ND	ND	ND	ND	ND
Radium-226 (pCi/L)	ND	ND	.37	.34	ND	.20
Radium-228 (pCi/L)	2.0	ND	ND	1.86	2.0	ND
Thorium-228 (pCi/L)	ND	ND	ND	ND	ND	ND
Thorium-230 (pCi/L)	.18	.19	.38	.12	.30	0.32
Thorium-232 (pCi/L)	ND	ND	ND	ND	ND	ND
PCBs/PAHs (µg/L)	ND	ND	ND	ND	ND	ND
DO (mg/L)	3.21	8.46	6.79	9.89	8.33	10.0
ORP (mV)	198.8	284.7	47.7	293	259	25.2
pH (s.u.)	6.67	6.61	6.97	6.95	6.85	6.74
SC (µmohs/cm)	538	983	1243	620	1095	428
Temperature (C)	9.33	11.52	10.81	9.21	12.58	12.56

ND Nondetect.

The 2005 monitoring results for the disposal cell leachate are presented in Table 3–31. The LCRS is sampled semiannually for disposal cell well analytes and the data are used for comparison with corresponding concentrations in wells if elevated levels of constituents are identified in the groundwater. The composition of the leachate is similar to that measured in 2004. The four signature parameters (barium, iron, manganese, and uranium) remain at concentrations higher than those measured in nearby groundwater.

Table 3–31. Summary of Disposal Cell Leachate Monitoring Data During 2005

Parameter	Concentrations	
	June 2005	December 2005
Chloride (mg/L)	35.9	35.1
Fluoride (mg/L)	0.25	0.23
Nitrate-N (mg/L)	0.0027	0.408
Sulfate (mg/L)	33.3	32.8
Arsenic (mg/L)	.0045	.0027
Barium (mg/L)	1.020	.743
Chromium (mg/L)	ND	ND
Cobalt (mg/L)	.0051	.0023
Iron (mg/L)	4.20	1.67
Lead (mg/L)	ND	ND
Manganese (mg/L)	.949	.433
Nickel (mg/L)	.0084	.0073
Selenium (mg/L)	ND	.0027
Thallium (mg/L)	ND	.0013
COD (mg/L)	31.0	38.0
TDS (mg/L)	749	633
TOC (mg/L)	10.37	12.3
1,3,5-TNB (µg/L)	ND	ND
1,3-DNB (µg/L)	ND	ND
2,4,6-TNT (µg/L)	ND	ND
2,4-DNT (µg/L)	ND	ND
2,6-DNT (µg/L)	ND	ND
Nitrobenzene (µg/L)	ND	ND
Radium-226 (pCi/L)	0.36	0.37
Radium-228 (pCi/L)	0.74	ND
Thorium-228 (pCi/L)	ND	ND
Thorium-230 (pCi/L)	0.43	0.19
Thorium-232 (pCi/L)	ND	ND
Uranium (pCi/L)	15.8	24.2
PCBs/PAHs (µg/L)	ND	ND

ND Nondetect.

The elevated concentrations of non-signature parameters that exhibited statistically significant increases in the disposal cell monitoring wells tend to be larger than constituent concentrations in the leachate, indicating that the source of these elevated constituents is external to the disposal cell. The elevated signature parameters reported in MW-2032 have been addressed in a demonstration report (DOE 2005c), as outlined in the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (DOE 2004b).

3.1.3.3 Groundwater Flow

Groundwater flow rate and direction are evaluated annually as specified in the *Disposal Cell Groundwater Monitoring Plan* (DOE 2004b). The groundwater flow direction was determined by constructing a potentiometric surface map of the shallow aquifer using the available wells at the Chemical Plant (Figure 3–5). The potentiometric surface has remained relatively unchanged since the construction of the disposal cell. The groundwater flow direction is generally to the north. A groundwater divide is present along the southern boundary of the site.

The average groundwater flow rate (average linear velocity) is calculated using the following equation:

$$v = -Ki/n_e$$

The average hydraulic conductivity (K) using data from the cell monitoring wells is 7×10^{-3} cm/s. An effective porosity (n_e) of 0.10 was selected to estimate the maximum groundwater flow rate in this area. The hydraulic gradient (i) in the disposal cell area is 0.011 ft/ft and is based on data from MW-2032 and MW-2055, located 2,100 ft apart. This approach is consistent with the calculations presented in the *Disposal Cell Groundwater Monitoring Plan* (DOE 2004b). The average flow rate for 2005 was 2.2 ft/day, which is similar to the average flow rates calculated since 1998 (DOE 2004b).

3.2 Surface Water

3.2.1 Chemical Plant Surface Water

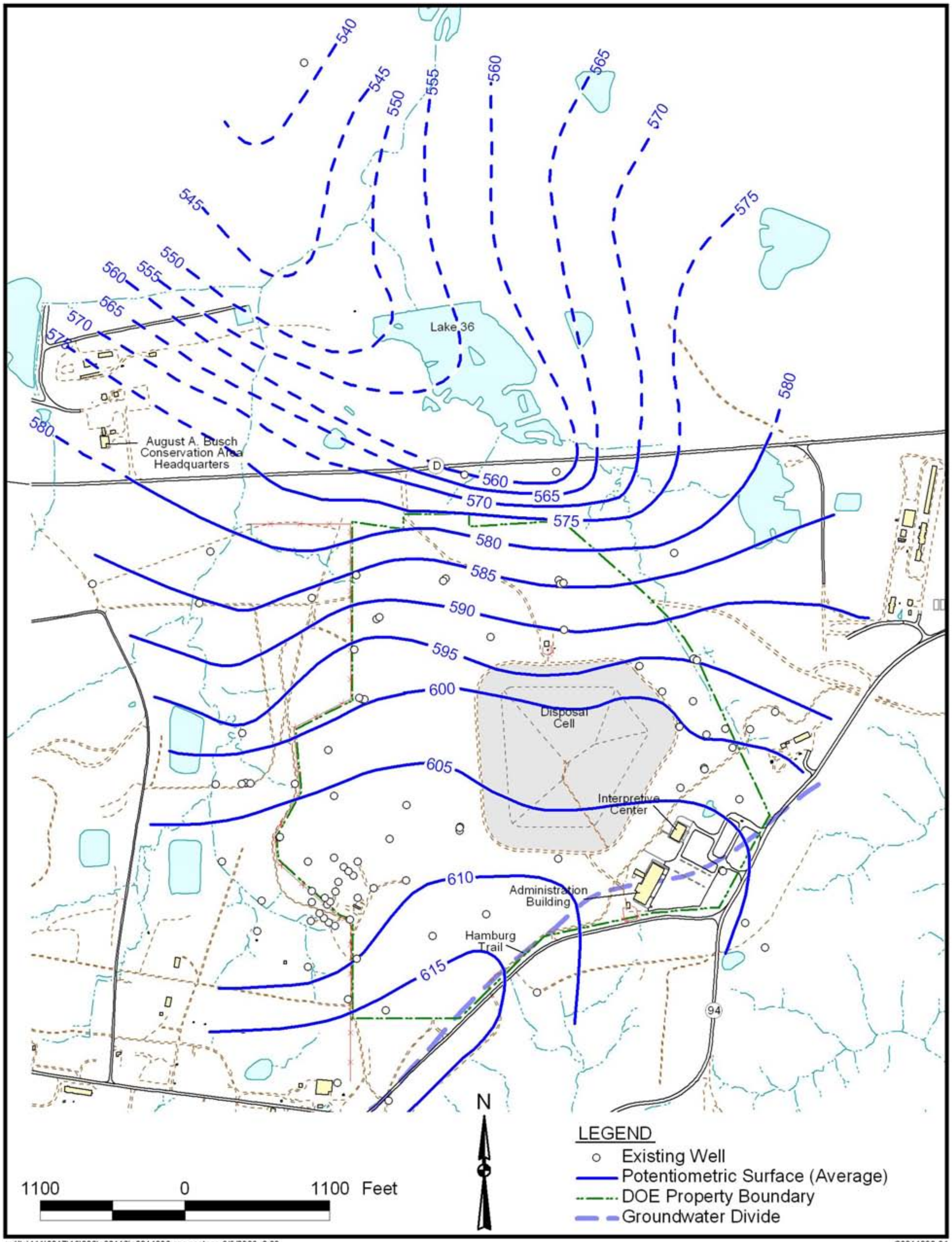
The surface water locations, Schote Creek, Dardenne Creek, and Busch Lakes 34, 35 and 36 (Figure 3–6), were sampled annually for total uranium. This monitoring was conducted to measure the effects of remediation and surface water discharges from the site on the quality of downstream surface water.

The results for the Chemical Plant surface water sampling are presented in Table 3–32 along with the recent 3 year high for each location for comparison. Uranium levels at the off-site surface water locations for 2005 were similar to 2004 averages. The uranium levels at Busch Lake 34 continue to be elevated compared to the remainder of the locations, however, uranium levels at the Busch Lake outlets have shown an overall decline since remediation started. The Schote Creek and Dardenne Creek locations are downstream of the lakes and have always shown relatively low levels because the chemical plant portion of the watershed is much smaller than the total watershed area,

Table 3–32. Average Concentrations of Total Uranium (pCi/L) at Weldon Spring Chemical Plant Area Surface Water Locations

LOCATION	Uranium	Recent 3 Year High*
SW-2004 (Lake 34)	3.7	7.18
SW-2005 (Lake 36)	2.5	4.1
SW-2012 (Lake 35)	.81	4.5
SW-2016 (Dardenne)	0.95	1.36
SW-2024 (Schote)	2.1	2.77

- *2002-2004



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S0244200-01

Figure 3–5. Potentiometric Surface of the Shallow Aquifer (Weathered Zone)

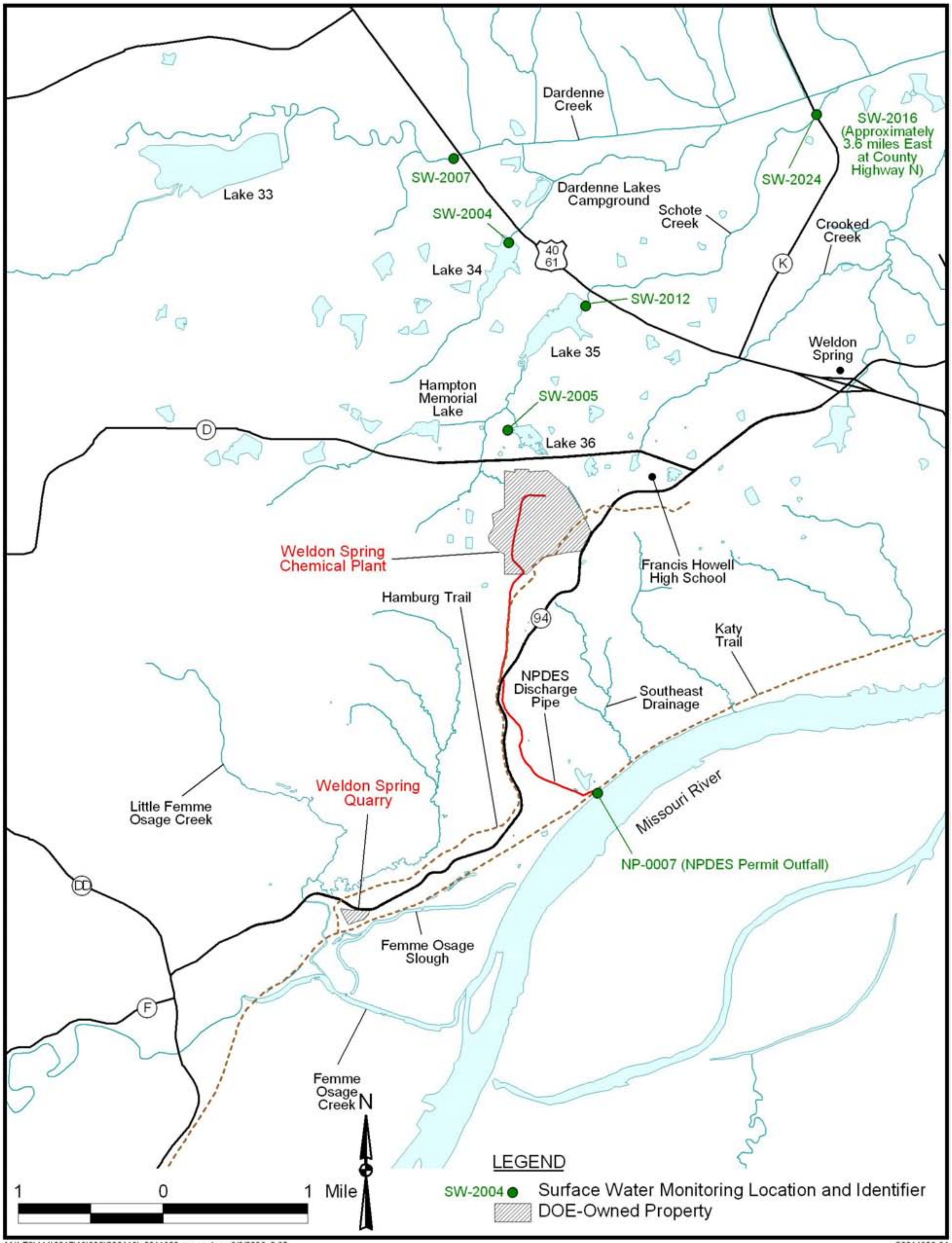

Figure 3–6. Surface Water Monitoring Locations at the Chemical Plant Area of the Weldon Spring, Missouri, Site

In 2005, location SW-2007 was sampled quarterly for uranium as an indicator of background conditions in accordance with the MNA program. This sampling site is located on Dardenne Creek immediately upstream of Highway 40/61, approximately 2.1 miles north of the site. Results are shown in Table 3–33.

Table 3–33. Results for Total Uranium Concentrations (pCi/L) at Chemical Plant Area Surface Water Background Location SW-2007

Date	Uranium
02/07/2005	0.35
05/19/2005	0.81
08/11/2005	0.88
11/21/2005	0.81

3.2.2 Quarry Surface Water

Four locations within Femme Osage Slough were monitored semiannually to determine the impact of groundwater migration from the Quarry. These sampling sites, shown on Figure 3–7, are located in the upper section of the slough. This part of the slough is known to receive groundwater contributions from the Quarry area of uranium impact. The 2005 semiannual uranium concentrations for the Quarry surface water locations are summarized in Table 3–34. The 2005 levels were similar to the 2004 concentrations.

Table 3–34. Semiannual Results for Total Uranium (pCi/L) at Weldon Spring Quarry Surface Water Locations

Location	1st Semiannual	2nd Semiannual	Average	Recent 3 Year High *
SW-1003	32.3	21.6	27.0	33.1
SW-1004	32.4	20.5	26.5	36.4
SW-1005	25.6	16.5	21.1	15.8
SW-1010	24.6	24.9	24.8	24.8

* 2002-2004

3.3 Leachate Collection and Removal System

The Leachate Collection and Removal System (LCRS) collects leachate from the disposal cell. The leachate had been sampled quarterly since generation for an extensive list of chemical and radiological constituents; however, beginning in calendar year 2003, the leachate is sampled semiannually in accordance with the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (DOE 2004b). The leachate analytical data for 2005 were discussed previously in Section 3.1.3.2 and are shown in Table 3–31.

As needed, the leachate is pumped from the sump and transported to the Metropolitan St. Louis Sewer District (MSD) for treatment in their Bissell Point plant wastewater treatment facility. A sample of leachate is collected and analyzed in accordance with MSD requirements for each hauling event. The MSD requirements for the leachate are discussed in Section 2.1.3.3.

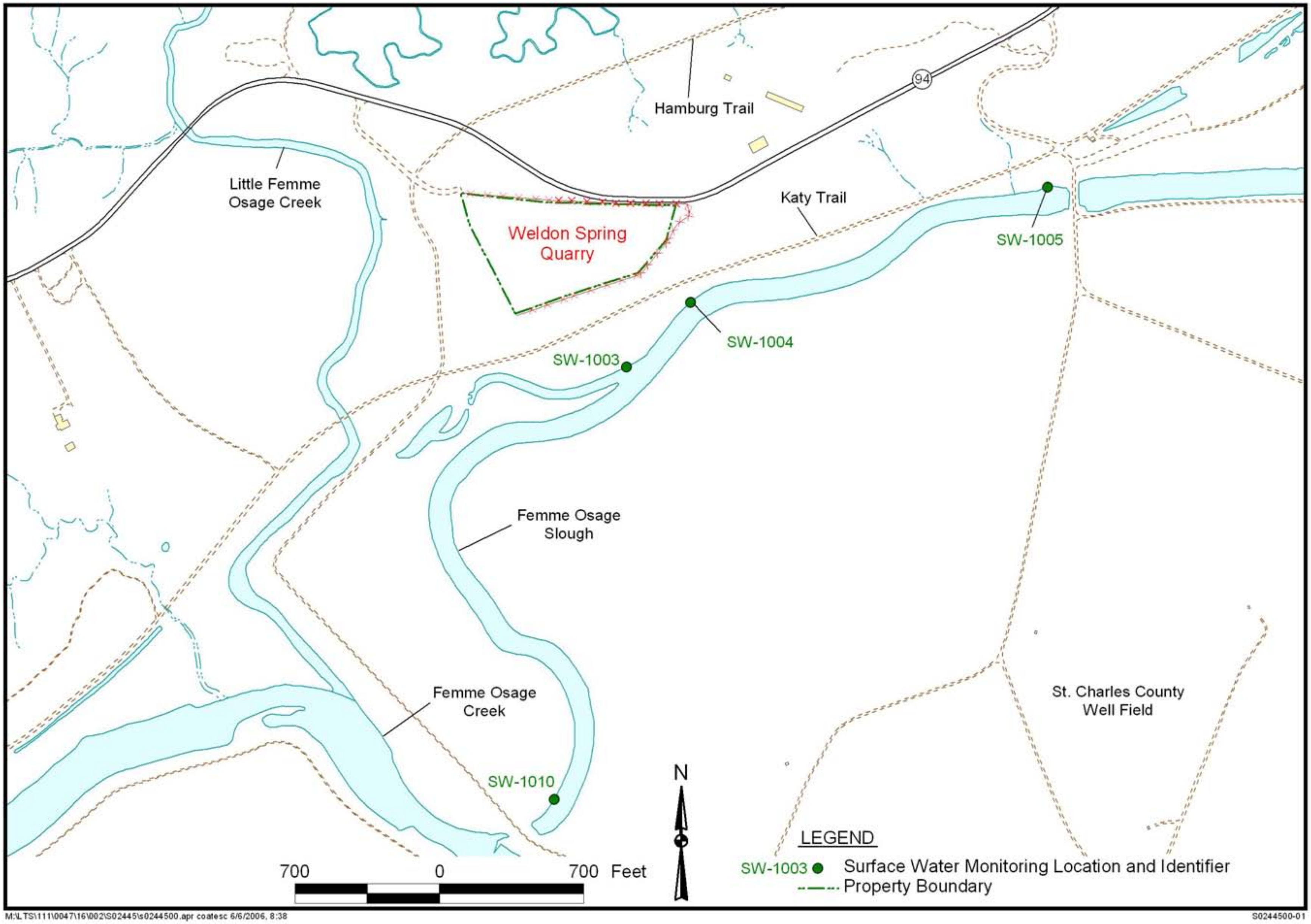

Figure 3–7. Surface Water Monitoring Locations at the Quarry Area of the Weldon Spring, Missouri, Site

Uranium concentrations in untreated leachate during 2005 averaged approximately 20 pCi/L. The concentration data were similar to the comparable data from 2004, as uranium levels remained near 20 pCi/L. Average uranium concentrations in the untreated leachate are shown in Figure 3–8.

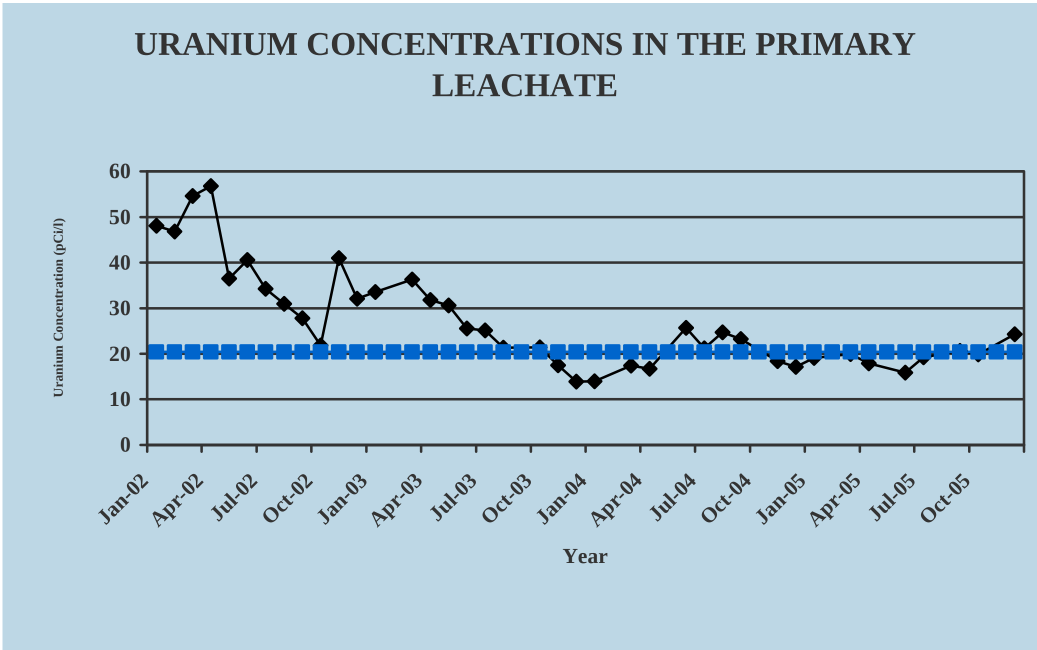

Figure 3–8. Average Uranium Concentrations

Monitoring of leachate flow rates at the disposal cell and inspections of the LCRS were reduced to a biweekly frequency from a weekly occurrence beginning in October 2005. In contrast, measure of the leachate level was recorded on an as-generated basis with a data logger and was downloaded at least once per month. The regulations in 40 CFR 264.303(c) only require monthly recording and, if stable, quarterly flow recording thereafter. Leachate flow rates are reported in units of gallons per day and compared to the action leakage rate of 100 gallons/acre/day established for the secondary (or lower) leachate collection system.

During 2004 and 2005, discharge from the primary leachate collection system generated approximately 185 gallons per day and 155 gallons per day, respectively. The daily averages for the primary leachate flow rate are shown in Figure 3–9. The combined leachate flow rate from the secondary leachate collection system averaged approximately 15.7 gallons per day during 2004 and 13.6 gallons per day in 2005. On a per-acre basis, the average leakage rate for the secondary leachate collection system between 2004 and 2005 was approximately 0.57 gallons/acre/day. This rate continues to be significantly less than 1 percent of the action leakage rate of 100 gallons/acre/day.

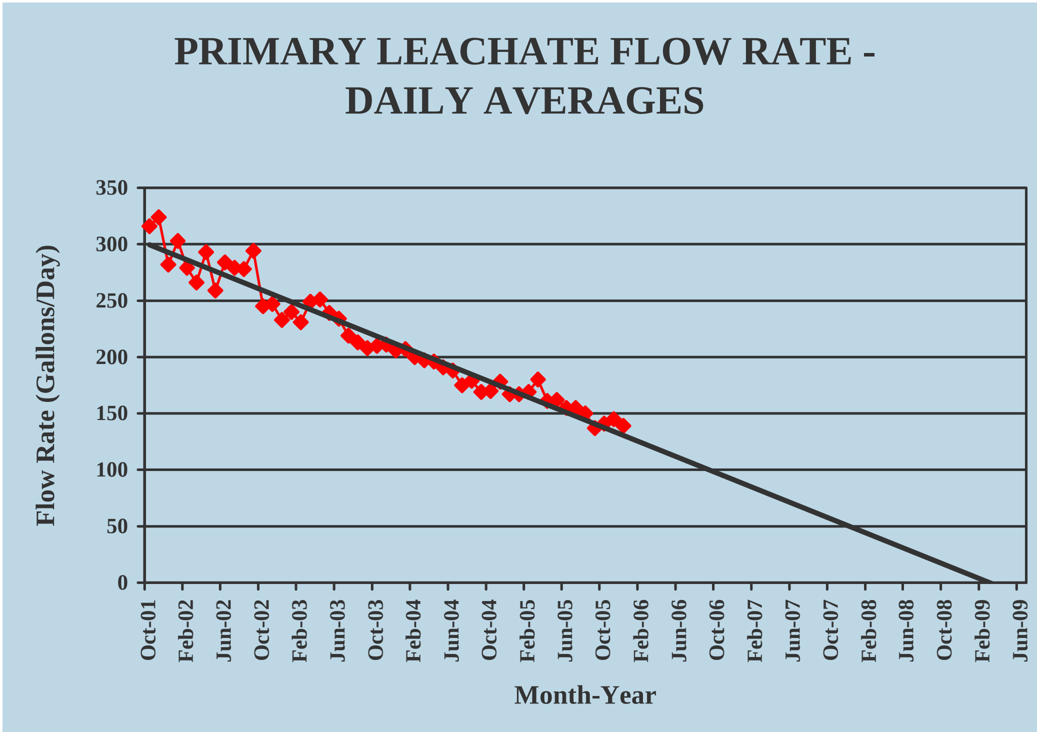

Figure 3–9. Daily Averages

3.4 Air

In the past, the Weldon Spring Site Remedial Action Project (WSSRAP) operated an extensive environmental airborne monitoring and surveillance program in accordance with U.S. Department of Energy (DOE) Orders, U.S. Environmental Protection Agency (EPA), National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, and the WSSRAP *Environmental Monitoring Plan* (DOE 2003a). Throughout the remediation of contaminated soils and materials, the potential for airborne releases and atmospheric migration of radioactive contaminants was closely monitored by measuring concentrations of radon, gamma exposure, airborne radioactive particulates, airborne asbestos, and fine particulate matter at various site perimeter and off-site locations. The potential for airborne release of radionuclides was eliminated with the final disposition of contaminated materials in the permanent disposal cell. With the completion of most site activities, no air monitoring has been conducted since 2001 (DOE 2001a).

3.5 Radiation Dose Analysis

This section evaluates the potential effects of remaining surface water and groundwater discharges of radiological contaminants from the Weldon Spring Site in 2005. Effective dose equivalent has been calculated for 2005 based on the applicable exposure pathway. Doses resulting from airborne emissions are no longer calculated since the potential for airborne release of radiological contaminants has been eliminated and, therefore, 40 CFR 61, Subpart H *(National Emission Standards for Emissions of Radionuclides other than Radon From Department of*

Energy Facilities) regulations are no longer relevant. Similarly, doses resulting from external gamma radiation are no longer calculated since the radon sources have been remediated and are contained within the permanent disposal cell. The cell cover effectively mitigates radon releases to levels comparable to background locations.

For this report, the potential exposure in terms of dose to an individual who consumes spring water contaminated with uranium is calculated. This calculation represents that exposure for the reasonable maximally exposed (RME) individual since data from the spring with the highest uranium concentration is used (i.e., for SP-5304 which is located in the SE Drainage with a reported uranium concentration of 122 pCi/L for 2005). The estimated total effective dose equivalent (TEDE) to this RME is about 0.27 mrem (2.7 E-3 mSv). This result is compared to U.S. Department of Energy (DOE) limits contained in DOE Order 5400.5 to demonstrate compliance with regulatory requirements.

3.5.1 Pathway Analysis and Exposure Scenario

In developing specific elements of the Weldon Spring Site environmental monitoring program, potential exposure pathways and health effects of the radioactive and chemical materials present on site are evaluated to determine if potential pathways of exposure exist. Under current site conditions, the only potential pathway to consider is that of a recreational visitor to the Weldon Spring Conservation Area possibly coming into contact with spring water specifically at the Southeast Drainage. A dose calculation for a population within 80 km (49.6 mi) of the site is not estimated since airborne release of radioactive contaminants is not a factor.

Consumption of contaminated groundwater both at the Chemical Plant/former Raffinate Pits and the Quarry areas is not a pathway of concern under current conditions as no drinking water wells are located in the vicinity of the contaminated groundwater in the Chemical Plant and raffinate pits area, and there is no access to the impacted groundwater at the Quarry area. Concentrations of uranium in the production wells near the Weldon Spring Quarry are comparable to background concentrations.

The inhalation of airborne particulates, radon gas and external gamma irradiation pathways are also no longer pathways of concern since the contaminated soils and other materials have been remediated and placed in the on-site cell. Hence, these pathways were not included in the dose estimates for 2005.

The radiological public dose guideline contained in DOE Order 5400.5 is applicable for comparing potential doses at the Weldon Spring Site. This guideline provides for an annual limit of 100 mrem (1 mSv) total effective dose equivalent accounting for all exposure pathways (excluding background).

3.5.2 Dose Equivalent Estimates

Total effective dose equivalent (TEDE) estimate for the exposure scenario was calculated using 2005 environmental monitoring data. The dose is well below the standards set by the DOE for annual public exposure.

This section discusses the estimated total effective dose equivalent to a hypothetical individual assumed to frequent the SE Drainage (SP-5304) of the Weldon Spring Conservation Area. No private residences are adjacent to the SE Drainage, which is situated on land currently managed by the Missouri Department of Conservation (MDC). Therefore, the calculation of dose equivalent is based on a recreational user of the Conservation Area who drank from Spring 5304 twenty times per year during 2005.

Exposure scenario assumptions particular to this dose calculation include the following:

- The maximally exposed individual drank one cup (0.2 liter [L]) of water from the Spring twenty times per year (equivalent to 1.05 gal (4.0L) of water for the year).
- The maximum uranium concentration in water samples taken from spring locations during 2005 was found at SP-5304 (122 pCi/L). This concentration was assumed to be present in all of the water ingested by the maximally exposed individual. For comparison, the maximum uranium concentration at Burgermeister Spring during 2005 was 59 pCi/L.

On the basis of the following natural uranium activity ratios: U-234: 49.1%, U-235: 2.3%, and U-238: 48.6%, the dose conversion factors (DCFs) for ingestion for U-238 and U-234 were used for calculating the dose. These DCFs are 2.69E-4 mrem/pCi and 2.83E-4 for U-238 and U-234, respectively (Eckerman 1988).

The total effective dose equivalent (TEDE) is calculated as shown below:

TEDE (ingestion of contaminated water for uranium) = Concentration (pCi/L) x Volume of Water Ingested (l) x DCF (U-238 + U-234) (mrem/pCi)

TEDE (total uranium) = 122 pCi/L x 4L x (2.69 E-4 mrem/pCi + 2.83E-4 mrem/pCi) = 0.27 mrem (2.7 E-3mSv)

This value represents less than 0.27 percent of the DOE standard of 100 mrem (1 mSv) TEDE above background. In comparison, the annual average exposure to natural background radiation in the United States results in a TEDE of approximately 300 mrem (3 mSv) (Beir 1990).

4.0 Environmental Quality

4.1 Highlights of the Quality Assurance Program

- Quality assurance for sampling activities for 2005 followed the *Groundwater and Surface Water Sampling and Analysis Plan for GJO Projects* (DOE 2003c).
- Average relative percent differences calculated for groundwater, surface water, samples, and springs were generally within the 20 percent criterion recommended by the Contract Laboratory Program (CLP).
- The data validation program accepted 99.7 percent of the all data in 2005 (including field data).

4.2 Program Overview

The environmental quality assurance program includes management of the plans and procedures governing environmental monitoring activities at the Weldon Spring Site and at the subcontracted off-site laboratories. This section discusses the environmental monitoring standards at the Weldon Spring Site and the goals for these programs, plans and procedures.

The environmental quality assurance program provides the Weldon Spring Site with reliable, accurate, and precise monitoring data. The program furnishes guidance and directives to detect and prevent quality problems from the time a sample is collected until the associated data are evaluated and utilized. Key elements in achieving the goals of this program are compliance with the quality assurance program and environmental quality assurance program procedures; use of quality control samples; complete documentation of field activities and laboratory analyses; and review of data documentation for precision, accuracy, and completeness (Data Validation).

The *Groundwater and Surface Water Sampling and Analysis Plan for GJO Projects* (DOE 2003c) summarizes the data quality requirements for collecting and analyzing environmental data. The LTS&M Plan (DOE 2005a) lists the sampling locations and provides site-specific detail for quality control samples. These plans describe administrative procedures for managing environmental data, data validation, database administration, and data archiving.

Analytical data are received from subcontracted analytical laboratories. Uncensored data have been used in reporting and calculations of annual averages (when available). Uncensored data are data that do not represent a non-detect and instead report instrument responses that quantitative to values below the reported detection limit. When there was no instrument response, non-detect data were used in calculations of averages at a value of one-half the detection limit.

4.2.1 Applicable Standards

Applicable standards for environmental quality assurance include: (1) use of the approved analytical and field measurement methodologies; (2) collection and evaluation of quality control samples; (3) accuracy, precision, and completeness evaluations; and (4) preservation and security of all applicable documents and records pertinent to the environmental monitoring programs.

4.2.2 Analytical and Field Measurement Methodologies

Analytical and field measurement methodologies used at the Weldon Spring Site comply with applicable standards required by the DOE, EPA, and the American Public Health Association. Analytical methodologies used by subcontracted laboratories for environmental monitoring primarily follow the EPA SW-846 requirements and the EPA drinking water and radiochemical methodologies or methods that are reviewed prior to analysis. Field measurement methodologies typically follow the American Public Health Association *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association 1992).

4.3 Quality Control Samples

Quality control samples for environmental monitoring are collected in accordance with the required sampling plan, which specifies the frequency of quality control sample collection. Quality control samples are normally collected in accordance with guidelines. Descriptions of the Quality Control samples collected at the Weldon Spring Site are detailed in Table 4–1.

Table 4–1. Quality Control Sample Description

Type of Qc Sample	Description
Equipment Rinsate Blank	Monitors the effectiveness of decontamination procedures used on non-dedicated sampling equipment. Equipment blanks include rinsate and filter blanks.
Trip Blank	Monitors volatile organic compounds that may be introduced during transportation or handling at the laboratory. Trip blanks are collected in the Weldon Spring Site laboratory with distilled water.
Field Duplicate	Monitors field conditions that may affect the reproducibility of samples collected from a given location. Field replicates are collected in the field at the same location.
Matrix Spike*	Assesses matrix and accuracy of laboratory measurements for a given matrix type. The results of this analysis and the routine sample are used to compute the percent recovery for each parameter.
Matrix Duplicate*	Assesses matrix and precision of laboratory measurements for inorganic parameters in a given matrix type. The results of the matrix duplicate and the routine sample are used to compute the relative percent difference for each parameter.
Matrix Spike Duplicate*	Assesses matrix and precision of laboratory measurements for organic compounds. The matrix spike duplicate is spiked in the same manner as the matrix spike sample. The results of the matrix spike and matrix spike duplicate are used to determine the relative percent difference for organic parameters.

*A laboratory sample is split from the parent sample.

4.3.1 Quality Control Sample Results

The quality control program is assessed by analyzing quality control sample results and comparing them to actual samples using the following methodology.

4.3.2 Duplicate Results Evaluation

Field duplicate analyses were evaluated in 2005. The matrix duplicate analyses were performed at subcontracted laboratories from aliquots of original samples collected at the Weldon Spring Site and are not summarized in this document. Matrix duplicates were used to assess the precision of analyses and also to aid in evaluating the homogeneity of samples or analytical interference of sample matrixes. Matrix duplicates were assessed during data validation process for each sample group.

Generally, field duplicate samples were analyzed for the same parameters as the original samples and are collected at the rate of approximately one for every 20 samples. Twenty-two field duplicates were collected in 2005 from 284 locations sampled (7.7 percent). Typically, duplicate samples were analyzed for more common parameters (e.g., uranium, inorganic anions, and metals).

When field duplicate samples were available, the average relative percent difference (RPD) was calculated. This difference represents an estimate of precision. The equation used was:

$$RPD = |S-D| /((S+D) /2) \times 100 \text{ percent}$$

Where: S = concentration in the normal sample
D = concentration in the duplicate analysis

Table 4–2 summarizes the calculated relative percent difference (RPD) for field duplicate samples for groundwater, springs, and surface water matrices. Parameters that were not commonly analyzed for and/or were not contaminants of concern were not evaluated. The RPD was calculated only for samples whose analytical results exceeded five times the detection limit and did not have any quality control problems, (i.e., blank contamination).

Table 4–2. Summary of Calculated Relative Percent Differences

Parameter	Number of Samples	Avg. RPD
Uranium	13	9.7
Iron	6	6.9
Barium	1	1.9
Nickel	1	9.0
Nitrate-N	8	9.4
Chloride	1	0.0
Sulfate	10	4.9
Flouride	1	13.3
Total Dissolved Solids	1	1.6
Trichloroethene	2	15.9
Nitroaromatics	14	18.3

The results in Table 4–2 demonstrate that average relative percent differences (RPDs) calculated were within the 20 percent criterion. Several individual parameters exceeded the 20 percent criteria and were assessed in the data validation reports. As a result, the average field duplicate sample analyses in 2005 were of acceptable quality.

4.4 Blank Sample Results Evaluation

Various types of blanks are collected to assess the conditions and/or contaminants that may be introduced during sample collection and transportation. These conditions and contaminants are monitored by collecting blank samples to ensure that environmental samples are not being contaminated. Blank samples evaluate the:

- Environmental conditions under which the samples (i.e., volatile analyses) were shipped (trip blanks).
- Ambient conditions in the field that may affect a sample during collection (trip blanks).
- Effectiveness of the decontamination procedure for sampling equipment used to collect samples (equipment blanks).

Sections 4.4.1 through 4.4.2 discuss the sample blank analyses and the potential impact of blank contamination upon the associated samples.

4.4.1 Trip Blank Evaluation

Trip blanks are collected to assess the impact of sample collection and shipment on groundwater and surface water samples analyzed for volatile organic compounds. Trip blanks are sent to the laboratory with each shipment of volatile organic samples.

In 2005, 16 trip blanks were analyzed for volatile organic compounds. No compounds were detected in 15 trip blanks and 1 trip blank detected trichloroethene above the detection limit, but below the reporting limit. All environmental samples associated with this trip blank sample were evaluated. Several locations had similar detections of tricholorethene between the detection limit and reporting limit and were qualified appropriately in the database.

4.4.2 Equipment Blank Evaluation

Equipment blanks are samples that are collected by rinsing decontaminated equipment with distilled water. The collected rinse water is then analyzed for contaminants of concern. This procedure is used to determine the effectiveness of the decontamination process. At the Weldon Spring Site, most of the groundwater samples are collected from dedicated equipment (ex. pumps, dedicated bailers), and spring water is collected by placing the sample directly into a sample container. Therefore, no equipment blanks are required for groundwater or spring locations.

Surface water is collected using a dip cup or similar container. An equipment blank (rinsate) is collected to assess the cleanliness of the equipment. Three equipment rinsate blanks were collected in 2005 to assess the dip cups used for surface water sampling. Samples were analyzed for only total uranium. Uranium was not detected in either blank and therefore there is no concern of cross contamination in the dip cups in 2005.

4.5 Data Validation Program Summary

The data validation program at the Weldon Spring Site follows the *Groundwater and Surface Water Sampling and Analysis Plan for GJO Projects* (DOE 2003c). This program involves reviewing and qualifying 100 percent of the data collected during a calendar year. The data points represent the number of parameters analyzed (e.g., toluene), not the number of physical analyses performed (e.g., volatile organics analyses).

Table 4–3 identifies the number of quarterly and total data points that were validated in 2005, and indicates the percentage of those selected that were complete. Data points in this table include all sample types including field parameters.

Table 4–3. Validation Summary for Calendar Year 2005

Calendar Quarter	No. of Data Points Validated	No. of Validated Data Points Rejected	Completeness[a]
Quarter 1	1101	2	99.8
Quarter 2	1535	9	99.4
Quarter 3	686	0	100
Quarter 4	1497	0	100
2004 Total	4819	11	99.7

[a]Completeness is a measure of acceptable data. The value is given by:

$$\text{Completeness} = \frac{(\text{\# validated - \# rejected})}{\text{\# validated}}$$

Reflects all validatable data for the calendar year.

Table 4–4 identifies validation qualifiers assigned to the selected data points as a result of data validation. The Weldon Spring Site validation technical review was performed in accordance with the *Sampling and Analysis Plan for GJO Projects* (DOE 2003c). For calendar year 2005, 100 percent of data validation has been completed. Data points in this table include groundwater, leachate, surface water, and spring water samples.

Table 4–4. Validation Qualifier Summary for Calendar Year 2005

	FIELD	ANIONS	METALS	MISC.	NITRO-AROMATICS	RADIO-CHEMICAL	SEMI-VOLATILES	VOLATILES	TOTAL
Number of Data Points									
Accepted	1731	276	691	52	1371	103	383	201	4808
Rejected	0	0	0	4	6	0	1	0	11
Not Validatable	0	0	0	0	0	0	0	0	0
Total	1731	276	691	56	1377	103	384	201	4819
Percentages									
Accepted	100%	100%	100%	92.8%	99.6%	100%	99.7%	100%	99.7%
Rejected	0%	0%	0%	7.2%	0.4%	0%	0.3%	0%	0.3%
Not Validatable	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

End of current text

5.0 Long-Term Surveillance and Maintenance

The site has entered the LTS&M phase of the project in many aspects. The status of these different aspects and activities which took place during 2005 are discussed below:

5.1 Long-Term Surveillance and Maintenance Plan

The LTS&M Plan (DOE 2005a) has been under development for several years. It has undergone several rounds of regulator and stakeholder review and comments. Several public meetings/workshops were held on the development of this plan. The status of the plan for 2004 and 2005 is as follows:

The third draft of the LTS&M Plan was issued on March 12, 2004. This plan reflected updates regarding institutional controls, *the Disposal Cell Groundwater Monitoring Plan*, and the Groundwater Operable Unit.

The LTS&M Plan was resubmitted to EPA and the State in August 2004 as a Draft-Final in accordance with the FFA. In response to EPA comments, the DOE issued the *Institutional Controls Evaluation (ICE) Report: Summary of Supporting Information for the Identification and Evaluation of Institutional Controls for the Weldon Spring Site* (DOE 2004d) and a revised LTS&M Appendix E: Institutional Controls Plan on October 1, 2004. Due to issues regarding institutional controls, the EPA issued a letter to DOE on November 2, 2004, which invoked the FFA dispute resolution process for the LTS&M Plan.

On November 23, 2004, EPA issued a letter to DOE, which agreed on several steps toward resolution and extended the Dispute Resolution Committee (DRC) period of time to consider the dispute until December 22, 2004.

On December 1, 2004, DOE issued a letter to EPA, which responded to three issues contained in the November 2, 2004, dispute letter.

On December 9, 2004, EPA issued a letter to DOE, which provided DOE an initial response to their December 1 letter and provided an update on the work the EPA agreed to provide.

On December 22, 2004, DOE, as agreed, issued to EPA a Draft-Final Explanation of Significant Difference (ESD) to complete the decision making for the remedial actions as well as the Southeast Drainage removal action. The objective of the ESD is to clarify the objectives and performance standards for the ICs at the site and to set the requirements for the further development of the ICs.

The ESD (DOE 2005b) was finalized on February 20, 2005. The second Draft-Final LTS&M Plan was reissued on March 11, 2005. The EPA and DOE worked diligently to resolve the dispute, but the dispute was elevated to the Senior Executive Committee on May 27, 2005. A 30-day extension of the dispute resolution period was granted during this time. EPA provided DOE with specific text changes to the LTS&M Plan during June 2005. These changes were incorporated and the Final LTS&M Plan (DOE 2005a) was issued during July 2005.

5.2 Institutional Controls

The LTS&M Plan (DOE 2005a) includes a revised Section 3 which summarizes information pertinent to the implementation of ICs to meet the objectives of the use restrictions described in the Explanation of Significant Differences (ESD) (DOE 2005b) issued in February 2005. Section 3 of the LTS&M Plan includes current site conditions and the risk-basis for why restrictions are needed, the objectives of the use restrictions, specific ICs already in place and additional mechanisms identified for implementation. The schedule, which is included in the LTS&M Plan, and the status for implementing the additional ICs is discussed below.

1) Special Area Designation Under the State Well Drillers' Act – DOE will submit a package that proposes special area designation to the Missouri Department of Natural Resources (MDNR) within 4 months of the effective date of this plan.

   Status: DOE and its contractor traveled to Kansas City, Missouri and met with the U.S. Army Corps of Engineers and the 89th Readiness Reserves (Army) on September 15, 2005, to coordinate a request for special area designation for the overlapping contaminated groundwater areas from both sites. Both parties collaborated on a combined presentation for the Missouri Well Installation Board at their regularly scheduled meeting on November 4, 2005, at Springfield, Missouri.

   DOE and its contractor participated in a meeting with the Army and MDNR on October 18, 2005, at Rolla, Missouri, to discuss the presentation for the Missouri Well Installation Board.

   The DOE and Army made their presentation to the Missouri Well Installation Board at their regularly scheduled meeting of November 4, 2005. The presentation consisted of the history and background for the two sites and a request for a Special Area Designation for the groundwater restricted areas.

   An informational meeting was held on December 13, 2005, at the Weldon Spring Site by the MDNR to present information to the public regarding the Special Use Area Designation for the DOE and Army sites and to receive feedback from stakeholders and the general public

2) Memorandum of Understanding (MOU) with the Army – DOE will submit a draft updated (or revised) MOU to the Army for review and comment within 6 months of the effective date of this plan.

   Status: DOE also met with Army representatives on September 15 to discuss the updated MOU.

3) Easements – DOE will submit proposed easements to the state agencies within 8 months of the effective date of this LTS&M Plan.

   Status: The DOE issued initial letters, dated October 12, 2005, to the surrounding State agency property owners in order to reinitiate discussions regarding the proposed easements.

5.3 Interpretive Center

The Weldon Spring Site Interpretive Center is part of DOE's long-term surveillance and maintenance activities at the Weldon Spring Site. The purpose of this facility is to inform the public of site history, remedial action activities, and final conditions. The center provides information about the long-term surveillance and maintenance program for the site, provides access to surveillance and maintenance information, and supports community involvement activities.

Current exhibits in the Interpretive Center present:

- The history of the towns that once occupied this area.
- A timeline of significant events at the Weldon Spring Site from 1900 to the present.
- The legacy of the Weldon Spring Ordnance Plant and Uranium Feed Material Plant and the manufacturing wastes.
- The events and community efforts to cleanup the Site and the people that made it happen.
- The multi-faceted phases of the Weldon Spring Site Remedial Action Project.

These exhibits may be changed as appropriate to changing conditions or emerging issues at and near the site. The hours of operation at the Interpretive Center are posted at the Site. The current hours of operation are Monday through Friday: 9:00 a.m. to 5:00 p.m., Saturday: 10:00 a.m. to 4:00 p.m. (10:00 a.m. to 2 p.m. November 1 – March 31), and Sunday: 12:00 p.m. to 4:00 p.m. The Interpretive Center is closed on holidays.

Attendance at the Interpretive Center has seen a steady upward trend since opening in August of 2002. Walk-in attendance (general public) has risen as the community continues to gain awareness about the Center. Local school involvement (primary, secondary and college) has risen sharply as the Centers educational programs have been developed and promoted.

Interpretive Center marketing and communication efforts have allowed contact with many St. Charles and St. Louis County schools and community groups to ensure awareness of Center educational programs. These efforts have led to an overall increase in attendance.

Attendance for calendar year 2005 totaled 15,405 which represents a 431 percent increase over the 2004 attendance of 3,573 (Table 5–1).

Table 5–1. Interpretive Center Attendance

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2002								301	224	190	40	31	786
2003	6	44	44	85	174	191	161	233	251	350	125	122	1,786
2004	52	61	166	182	104	324	192	353	379	850	556	354	3,573
2005	123	605	1056	2048	1888	1408	1370	1091	1511	1663	1739	903	15,405
													21,550

On November 29, 2005, the Interpretive Center hosted an unveiling ceremony for the new "Tribute to the Mallinkrodt Uranium Workers" display. More than 200 people were in attendance including Missouri Senators, Congressmen and State Representatives.

The 150 acres surrounding the disposal cell has been planted with over 80 species of native prairie grasses and wildflowers. Plants such as Prairie Blazing Star, Little Bluestem, and Wild Bergamot will once again dominate this area which was a large native prairie prior to European settlement. Howell Prairie is one of the largest planting of its kind in the St. Louis metropolitan area.

A variety of prairie maintenance activities have been completed throughout the previous 12 months. In order to track the effectiveness of future invasive weed eradication efforts, infested areas were mapped early in the growing season. Areas of infestation were field-located and electronically superimposed onto an aerial photograph of the site. Later in the growing season, spot-spraying individual invasive weed plants with herbicide was performed as part of on-going efforts to reduce numbers and control encroachment of this species throughout the prairie area. The map of infested areas was utilized during this spot-spraying effort in order to streamline fieldwork. Mowing of selected areas was also performed in order to establish initial fire breaks in anticipation of a potential prescribed burn in late February or early March of 2006.

A garden that consists entirely of plants native to the state of Missouri was designed and planted during 2004. The Native Plant Educational Garden contains extensive planting of species from Howell Prairie as well as other perennials, shrubs and trees. Walking paths, benches, and markers to identify the various plants are located through the 8-acre garden. Garden maintenance consisting of manual weeding and occasional irrigation was performed throughout the growing season. In December 2005, dried seed heads from forbs were harvested from the garden to be utilized for hand overseeding on the prairie area of the site.. An increasing number of volunteers performed garden maintenance activities throughout 2005.

The Howell Prairie, Native Plant Educational Garden, and Interpretive Center were designed to serve as institutional controls. These areas will attract visitors to the Weldon Spring Site, thus ensuring long-term community education about the remediation project and enhancing the overall educational mission of the site.

5.4 Inspections

The annual LTS&M inspection took place at the Weldon Spring Site on November 7 and 8, 2005. The inspection was conducted in accordance with the *Long-Term Surveillance and Maintenance Plan for the Weldon Spring, Missouri, Site* (DOE 2005a), and associated inspection checklist. Representatives from the U.S. Environmental Protection Agency (EPA) and Missouri Department of Natural Resources (MDNR) participated in the inspection. Representatives from the Weldon Spring Citizens Commission (WSCC) and the Missouri Department of Conservation (MDC) participated in portions of the inspection. This inspection also served as the five-year review inspection to support the site's CERCLA Five-Year Review Report which is required to be issued in 2006.

The main areas inspected at the site were areas where future institutional controls will be established, the quarry, the disposal cell, Leachate Collection and Recovery System (LCRS), monitoring wells, and assorted general features.

The Institutional Control areas were inspected to ensure that pending restrictions such as excavating soil, groundwater withdrawal, residential use, etc., were not being violated. Each area was inspected and no indications of violations of future restrictions were observed.

An aerial survey of the disposal cell was flown in September 2005. This survey is required by the LTS&M Plan and checklist to be conducted every five years in conjunction with the 5-year review inspection. The previous aerial survey was conducted in 2003 in conjunction with the first annual LTS&M inspection. The survey results were discussed during the inspection.

The disposal cell was inspected by walking ten transects over the cell and around the cell perimeter at the grade break and the base. Hand-held global positioning system (GPS) equipment was used to navigate the ten transects. Five areas of the cell which had been marked and located by GPS survey equipment during the 2003 annual inspection were located and observed for any signs of rock degradation. The LCRS also was inspected and found to be in good condition. Each of the 119 groundwater monitoring wells were inspected and found to be in generally good condition. Some of the wells were inspected in the weeks prior to and after the scheduled 2-day inspection. Other site features including the prairie, site markers, and roads also were inspected.

The inspection also included contacting stakeholders and institutional control contacts. Seventeen telephone contacts were made and documented.

The second annual public meeting required by the LTS&M Plan (DOE 2005a) was held on April 5, 2005. This meeting was held to discuss the 2004 inspection which took place in November 2004. Also discussed were changes to the LTS&M Plan, a summary of environmental data and the interpretive center/prairie. The third annual public meeting to discuss the 2005 inspection was held on April 11, 2006.

End of current text

6.0 References

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40 CFR 141. U.S. Environmental Protection Agency, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, July 1, 2005.

40 CFR 192. U.S. Environmental Protection Agency, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, July 1, 2005.

40 CFR 264. U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, July 1, 2005.

10 CSR 20-7.031. Missouri *Code of State Regulations*, Title 10, "Department of Natural Resources," Division 20, "Clean Water Commission," Chapter 7.031, "Water Quality Standards."

10 CSR 25-7.264. Missouri *Code of State Regulations*, Title 10, "Department of Natural Resources," Division 25, "Hazardous Waste Management Commission," Chapter 7.264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities."

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Appendix A

Edits to the Long-Term Surveillance and Maintenance Plan

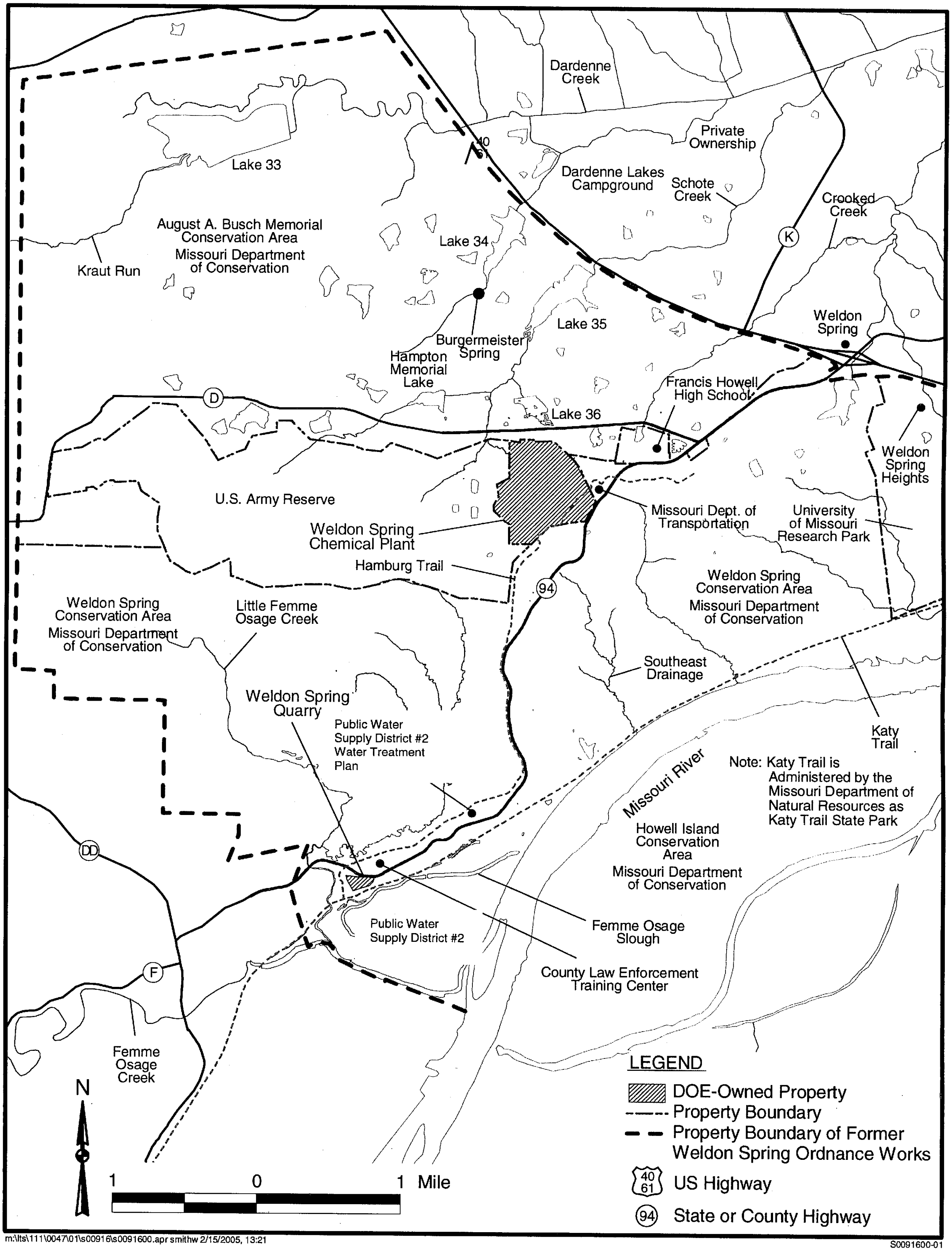

Figure 1–2. Vicinity Map of the Weldon Spring, Missouri, Site

Plant. These operations resulted in nitroaromatic contamination of soil, sediments, and some off-site springs.

Following a considerable amount of explosives decontamination of the facility by the Army and the Atlas Powder Company, 205 acres (83.0 hectares) of the former ordnance works property were transferred to the U.S. Atomic Energy Commission (AEC) in 1956 for construction of the Weldon Spring Uranium Feed Materials Plant, now referred to as the Weldon Spring Chemical Plant. An additional 14.88 acres (6.02 hectares) were transferred to AEC in 1964. The plant converted processed uranium ore concentrates to pure uranium trioxide, intermediate compounds, and uranium metal. A small amount of thorium also was processed. Wastes generated during these operations were stored in four raffinate pits located on the plant property. Uranium processing operations resulted in radiological contamination of the same locations previously contaminated with nitroaromatic compounds by former Army operations.

The Quarry was mined for limestone aggregate used in construction of the Ordnance Works site. The Army also used the Quarry for burning wastes from explosives manufacturing and disposal of TNT-contaminated rubble during operation of the Ordnance Works. These activities resulted in nitroaromatic contamination of the soil and groundwater at the Quarry.

In 1960, the Army transferred the Quarry to AEC, who used it from 1963 to 1969 as a disposal area for uranium and thorium residues from the Chemical Plant (both drummed and uncontained) and for disposal of contaminated building rubble, process equipment, and soils from demolition of a uranium processing facility in St. Louis.

Uranium processing operations ceased in 1966, and on December 31, 1967, AEC returned the facility to the Army for use as a defoliant production plant. In preparation for the defoliant process, the Army removed equipment and materials from some of the buildings and disposed of them principally in Raffinate Pit 4. The defoliant project was canceled before any process equipment was installed, and the Army transferred 50.65 acres (20.50 hectares) of land encompassing the raffinate pits back to AEC while retaining the Chemical Plant. AEC and subsequently DOE managed the site, including the Army -owned Chemical Plant, under caretaker status from 1968 through 1985. Caretaker activities included site security, fence maintenance, grass cutting, and other incidental maintenance. In 1984, the Army repaired several of the buildings at the Chemical Plant, decontaminated some of the floors, walls, and ceilings, and isolated some equipment. In 1985, the Army transferred full custody of the Chemical Plant to DOE, at which time DOE designated control and decontamination of the Chemical Plant, raffinate pits, and Quarry as a major project.

1.3.2 Remedial Action History

EPA placed the Quarry and Chemical Plant areas on the National Priorities List (NPL) on July 30, 1987, and March 30, 1989, respectively. A Federal Facility Agreement (FFA) was signed by the EPA and DOE in 1986, and it was amended in 1992. A new FFA was signed in 2006 between EPA, DOE, and MDNR. The main purpose of this FFA was to focus more on long-term site management activities. Initial activities at the Chemical Plant, a series of Interim Response Actions (IRAs) undertaken with removal authority, included:

- Removal of electrical transformers, electrical poles and lines, and overhead piping and asbestos that presented an immediate threat to workers and the environment.

Long-term groundwater monitoring for the QROU consists of two separate programs. Groundwater monitoring is necessary to continue to ensure that uranium-contaminated groundwater has a negligible potential to affect the Public Water Supply District #2 (formerly St. Charles County) well field. The first program details the monitoring of uranium and 2,4-DNT south of the slough to ensure that levels remain protective of human health and the environment. The second program consists of monitoring groundwater contaminant levels within the area north of the slough until they attain a predetermined target level indicating negligible potential to affect groundwater south of the slough.

The objective for monitoring groundwater south of the slough is to verify that the groundwater is not impacted. Uranium concentrations south of the slough and in the area of production wells at the Public Water Supply District #2 (formerly St. Charles County) well field remain within the observed natural variation within the aquifer, therefore the MCL for uranium of 30 micrograms per liter (µg/L) (20 picocuries per liter [pCi/L]) has been established as a trigger level only in this area. If concentrations in groundwater south of the slough exceed the MCL of 30 µg/L, DOE will evaluate risk and take appropriate action, as discussed in Appendix L.

Under current conditions, groundwater north of the slough poses no imminent threat to the well field. A target level of 300 pCi/L for uranium (10 percent of the 1999 maximum) was established to represent a significant reduction in the contaminant levels north of the slough and the level at which there is no longer the potential for significant impact to the groundwater south of the slough. The target level for 2,4-DNT has been set at the Missouri Water Quality standard of 0.11 µg/L.

The Official Contact List (Appendix F) and the Distribution List (Appendix G) will be reviewed and updated on at least an annual basis, in conjunction with the annual inspections, as part of the 5-year reviews, and in conjunction with other significant site announcements and notifications.

2.2.2 DOE Contacts

Contact information for the DOE staff responsible for implementing the Weldon Spring Site surveillance and maintenance program will be posted at the Interpretive Center and made available via the DOE–LM website. These communications will encourage the public to actively participate with DOE in the surveillance and maintenance process by reporting sightings or concerns such as visible changes to the cell cover, erosion, suspicious land use, damaged monitor wells, or vandalism.

The DOE contact list will also serve an informational purpose by providing a mechanism for the public to submit questions or requests for information if or when there is no continuous on-site DOE presence. The following contact list will be maintained and revised on an annual basis, as necessary, to reflect the most current contact information. Changes to this list will not cause the issuance of a revision to the LTS&M Plan. At times when the LTS&M Plan is reissued to address a major change, these changes will be included within the revision.

- Tom Pauling, Weldon Spring Site Manager
  U.S. Department of Energy
  2597 B 3/4 Road, Grand Junction, CO 81503
  (970) 248-6048

- Ray Plieness, LM-50, Acting Office Director
  U.S. Department of Energy
  2597 B 3/4 Road, Grand Junction, CO 81503
  (970) 248-6001

- Yvonne Deyo, Site Manager
  S.M. Stoller Corporation
  7295 Hwy 94 South, St. Charles, MO 63304
  (636) 300-0012

- Grand Junction 24-Hour Monitored Security Telephone Numbers
  (877) 695-5322
  (970) 248-6070

- Website for the Weldon Spring Site
  http://www.lm.doe.gov/land/sites/mo/weldon/weldon.htm

2.2.3 Document Review and Public Meetings

Interested stakeholders as discussed in Section 2.2.1, "Regulator, Stakeholder, and Responder Contacts," will be notified of the availability of both annual and each CERCLA 5-year review reports available to the public at the Interpretive Center, the Middendorf-Kredell branch of the St. Charles City-County Library System, and on the DOE website for the Weldon Spring Site. This notification will ensure that the public is aware of site activities and changes. Comments and/or questions can be directed to the DOE contacts listed in Section 2.2.2, "DOE Contacts."

To ensure a mechanism whereby the public can be briefed on and participate in periodic site reviews, a schedule for a public meeting will be included in the notification letter sent with each annual site inspection report and posted on the website. The annual meeting will include discussions of site surveillance and maintenance activities and observations during the previous year, proposed changes to the LTS&M Plan, and public comments and concerns.

2.2.4 Interpretive Center Operation

DOE will maintain and operate the Weldon Spring Site Interpretive Center at the Site. The purpose of the Interpretive Center is to inform the public of Site history, remedial action activities, and final conditions. The Interpretive Center also will provide information about the long-term surveillance and maintenance program for the Site, provide access to surveillance and maintenance information, and support community involvement activities. It will serve to communicate the historical legacy of the Site, provide educational and research opportunities for current and future generations, and make available information about contamination present at the Site to guide people in making decisions about appropriate activities at the Site.

Current exhibits in the Interpretive Center present:

- The history of the towns that once occupied this area.
- A timeline of significant events at the Weldon Spring Site from 1900 to the present.
- The legacy of the Weldon Spring Ordnance Plant and Uranium Feed Material Plant and the manufacturing wastes.
- The events and community efforts to cleanup the Site and the people that made it happen.
- The multi-faceted phases of the Weldon Spring Site Remedial Action Project.

These exhibits may be changed as appropriate to changing conditions or emerging issues at and near the Site. The hours of operation of the Interpretative Center are posted at the Site. The current hours of operation are Monday through Friday: 9:00 a.m. to 5:00 p.m., Saturday: 10:00 a.m. to 4:00 p.m. (10:00 a.m. to 2:00 p.m. November 1 through March 31) and Sunday: 12:00 p.m. to 4:00 p.m. The Interpretative Center is closed on holidays. These hours are subject to change and current hours will be posted on the website.

DOE will provide staff and funding needed to operate the Interpretive Center. DOE will monitor center usage and public perception of its value, and may discontinue operations, with the approval of EPA in consultation with the State (per the LTS&M Plan revision procedures), if the Interpretive Center is not utilized in a manner that enhances the purposes discussed above. If and when DOE proposes closing the Interpretive Center, it will propose other activities to serve these purposes, as appropriate. DOE will also consult with the community on this decision through the revision process for this Plan.

2.7 Environmental Monitoring

The Remedial Design/Remedial Action (RD/RA) work plans for the Weldon Spring Site specify environmental monitoring requirements for specific OUs, which are implemented through this plan. Results will be reported in the annual site environmental report and summarized in the 5-year review report. Environmental data results are available on the Internet (http://www.gjo.doe.gov/LM/sites/maps/mo/weldon/weldon.htm). In accordance with current laboratory turnaround times and review protocol, the data will be available on the website approximately 90 days after sampling.

DOE may conduct additional site environmental monitoring that is not required as part of an approved remedy but is required under DOE Order 450.1, *Environmental Protection Program*. DOE will report the results of the additional monitoring in the annual site environmental report.

Separate groundwater monitoring programs have been established for the Chemical Plant and Quarry because of geographic separation and differences in the hydrogeologic features that influence groundwater flow. Groundwater monitoring locations will include local springs where groundwater emerges from conduit flow paths (DOE 2003).

Monitoring results are compared to EPA and State of Missouri groundwater quality standards that are identified as ARARs in Table 1–2.

2.7.1 Disposal Cell Detection Monitoring

Disposal cell detection monitoring is summarized in Table 2–3. Specific procedures for evaluation of monitoring results and required responses are presented in the "Disposal Cell Groundwater Monitoring Plan" (Appendix K). The cell detection monitoring locations are shown on Figure 2–2 and in Appendix K.

DOE will monitor groundwater upgradient and downgradient of the disposal cell and also will monitor Burgermeister Spring (SP–6301) during low flow as part of the disposal cell monitoring program. Burgermeister Spring is a primary localized resurgence point of groundwater from the Chemical Plant and represents surface water hydraulically connected to the Chemical Plant.

Table 2–3. Detection Monitoring Program for the Disposal Cell at the Weldon Spring, Missouri, Site

Sample Locations	Hydrologic Relationship	Sampling Frequency	Analytes (all locations)
MW–2032	Downgradient	Semiannual	Total uranium, radium-226, radium-228, thorium-228, thorium-230, thorium-232, nitrate (as N), sulfate, chloride, fluoride, arsenic, barium, chromium, cobalt, iron, lead, manganese, nickel, selenium, thallium 1,3,5-TNB, 1,3-DNB, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, chemical oxygen demand, total dissolved solids, total organic carbon, polychlorinated biphenyl, polycyclic aromatic hydrocarbon, field parameters (pH, temperature, and conductivity).
MW–2046	Downgradient		
MW–2047	Downgradient		
MW–2051	Downgradient		
MW–2055	Upgradient		
SP–6301	Downgradient		

Note: DNB = dinitrobenzene; DNT = dinitrotoluene; TNB = trinitrobenzene; TNT = trinitrotoluene

2.7.2 Groundwater OU

In July 2004, DOE initiated monitoring for monitored natural attenuation (MNA) as outlined in the *Remedial Design/Remedial Action Work Plan for the Final Remedial Action for the Groundwater Operable Unit at the Weldon Spring Site* (DOE 2004b). This network has since been modified as presented in the *Interim Remedial Action Report for the Groundwater Operable Unit of the Weldon Spring Site* (DOE 2005a) and is described below.

Contaminants of concern (COCs) for groundwater and springs at the Chemical Plant area are TCE, nitrate, uranium, and nitroaromatic compounds. The set of COCs measured for each of the monitoring locations presented in Table 2–4 depends on the proximity of the particular well or spring to the contaminant plumes.

The objectives specified in the ROD (DOE 2004b) for the MNA monitoring network are:

- Objective 1 is to monitor the unimpacted water quality at upgradient locations in order to maintain a baseline of naturally occurring constituents from which to evaluate changes in downgradient locations. This objective will be met by using wells located upgradient of the contaminant plume.
- Objective 2 is to verify contaminant concentrations are declining with time at a rate and in a manner that cleanup standards will be met in approximately 100 years as established by predictive modeling. This objective will be met using wells at or near the locations with the highest concentrations of contaminants, both near the former source areas and along expected migration pathways. The objective will be to evaluate the most contaminated zones. Long-term trend analysis will be performed to confirm downward trends in contaminant concentration over time. Performance will be gauged against long-term trends. It is anticipated that some locations could show temporary upward trends due to the recent source control remediation, ongoing dispersion, seasonal fluctuations, analytical variability, or other factors. However, concentrations are not expected to exceed historical maximums.
- Objective 3 is to ensure that lateral migration remains confined to the current area of impact. Contaminants are expected to continue to disperse within known preferential flowpaths associated with bedrock lows (paleochannels) in the upper Burlington-Keokuck Limestone and become more dilute over time as rain events continue to recharge the area. This objective will be met by monitoring various downgradient fringe locations that either are not impacted or minimally impacted. Contaminant impacts in these locations are expected to remain minimal or non-existent.
- Objective 4 is to monitor locations underlying the impacted groundwater system to confirm that there is no significant vertical migration of contaminants. This will be evaluated using deeper wells screened and influenced by the unweathered zone. No significant impacts at these locations should be observed.
- Objective 5 is to monitor contaminant levels at the impacted springs that are the only potential points of exposure under current land use conditions. The springs discharge groundwater that includes contaminated groundwater originating at the Chemical Plant area. Presently, contaminant concentrations at these locations are protective of human health and the environment under current recreational land uses. Continued improvement of the water quality in the affected springs should be observed.

Table 2–4. Monitoring Parameters for MNA Locations

Location	Sampling Frequency[a]	Monitoring Parameters							
		TCE	Nitrate (as N)	Uranium	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
MW-2012	S				✓	✓	✓	✓	✓
MW-2014	S						✓	✓	
MW-2017	S				✓	✓	✓	✓	✓
MW-2021	S		✓						
MW-2022	S		✓		✓	✓			
MW-2023	S				✓	✓	✓	✓	✓
MW-2032	S				✓	✓	✓	✓	✓
MW-2035	S	✓	✓	✓			✓		
MW-2038	S		✓				✓		
MW-2040	S		✓			✓			
MW-2046	S					✓			
MW-2050	S						✓	✓	
MW-2051	S				✓	✓	✓	✓	✓
MW-2052	S						✓	✓	
MW-2053	S					✓	✓	✓	
MW-2054	S						✓	✓	
MW-2056	S				✓	✓	✓	✓	✓
MW-3003	S		✓	✓					
MW-3006	S	✓	✓	✓			✓		
MW-3024	S			✓					
MW-3030	S	✓		✓			✓		
MW-3031	S	✓		✓					
MW-3034	S	✓	✓				✓		
MW-3037	S	✓		✓			✓		
MW-3039	S						✓		
MW-3040	S	✓	✓	✓					
MW-4007	S	✓	✓						
MW-4013	S		✓				✓	✓	✓
MW-4014	S		✓		✓	✓	✓	✓	✓
MW-4015	S						✓	✓	✓
MW-4022	S		✓	✓					
MW-4023	S		✓	✓					
MW-4026	S			✓					
MW-4029	S	✓	✓						
MW-4031	S		✓						
MW-4036	S	✓	✓	✓			✓		
MW-4039	S				✓	✓	✓	✓	✓
MW-4040	S	✓	✓	✓			✓		
MW-4041	S	✓	✓	✓	✓	✓	✓	✓	✓
MWS-1	S	✓	✓	✓			✓		
MWS-4	S	✓	✓	✓					
MWD-2	S		✓	✓					
SP-5303	S			✓					
SP-5304	S			✓					
SP-6301	S	✓	✓	✓	✓	✓	✓	✓	✓
SP-6303	S	✓	✓	✓	✓	✓	✓	✓	✓
SW-2007	S			✓					

[a]Monitoring frequencies may be decreased to annual or biennial on the basis of trends in at least the first 2 years of data.
S = semiannual.

2.7.2.3 *Detection Monitoring (Objective 3, 4, and 5 Locations)*

Contaminants are expected to continue to disperse within known preferential flow paths associated with bedrock lows (paleochannels) in the upper Burlington-Keokuk Limestone and become more dilute over time. This objective will be met by monitoring various downgradient perimeter locations that are either impacted or minimally impacted. Contamination should not go any deeper than it already has. Slight nitrate, uranium, and nitroaromatic compound impact has been observed in the unweathered Burlington-Keokuk Limestone at the Chemical Plant. No significant impacts at these locations should be observed.

The springs discharge groundwater that includes contaminated groundwater originating from the Chemical Plant. Presently, contaminant concentrations at these locations are protective of human health and the environment under current recreational land uses. Continued improvement of the water quality in these affected springs should be observed.

Maximum trigger levels also have been established for each contaminant for the detection monitoring locations and the springs. These triggers are summarized in Table 2–6.

2.7.2.4 *Hydrologic Monitoring (Objective 6 Locations)*

Site hydrologic conditions over time are being monitored using all the wells included in the MNA network (wells listed for Objectives 1 to 4 in addition to those listed as Objective 6 wells) in order to identify any changes in groundwater flow that might affect the protectiveness of the selected remedy. The static groundwater elevation of the monitoring network will be measured to establish that groundwater flow is not changing significantly and resulting in changes in contaminant migration. COC data will not be collected from Objective 6 wells.

Groundwater elevation will be created and evaluated to verify that the groundwater flow directions and rates are sufficient to support the attenuation of the contaminants in the predicted timeframes. Also, groundwater flow directions will be evaluated against the IC boundary to verify that the restricted use area is adequate.

2.7.3 Quarry Residuals OU

DOE monitors groundwater wells at the Quarry, and until October 1, 2002, DOE conducted this monitoring in accordance with the Weldon Spring Site *Environmental Monitoring Plan*. After that date, monitoring requirements began to be conducted in accordance with the *Remedial Design/Remedial Action Work Plan for the Quarry Residuals Operable Unit* (DOE 2000a).

The major source of groundwater contamination was removed under the ROD for the Quarry Bulk Waste OU by removal of contaminated soil, debris, and surface water from the Quarry. The QROU remedy prescribes long-term monitoring to confirm that natural processes are effective in attenuating groundwater contaminants before they reach the Public Water Supply District #2 (formerly St. Charles County) well field. The remedy also includes ICs to prevent groundwater use or disturbance of a naturally occurring reduction zone. The rationale for the monitoring activities at the Quarry are described in the *Remedial Design/Remedial Action Work Plan for the Quarry Residuals Operable Unit* (DOE 2000a). Contaminants of concern in the Quarry groundwater are uranium and 2,4-DNT.

The Quarry monitoring program has two primary objectives:

- Monitor uranium concentrations in groundwater south of Femme Osage Slough to verify that the groundwater is not impacted.
- Monitor contaminant concentrations within the area of affected groundwater north of the slough until they attain target concentrations, indicating negligible potential to degrade groundwater south of the slough.

Groundwater north of the slough contains elevated concentrations of uranium. Uranium concentrations south of the slough and in the area of production wells at the St. Charles County well field remain within the observed natural variation within the aquifer, ranging from 0.1 pCi/L to 14.3 pCi/L; an average background is 2.77 pCi/L (See Appendix A). DOE detected a maximum uranium concentration of 2,740 pCi/L north of the slough in 1999 and set an administrative target level of 300 pCi/L (90 percent reduction) as the remediation goal for the groundwater in the plume north of the slough. Uranium is attenuated through either precipitation as the groundwater passes through a geochemical reduction zone or adsorption onto aquifer materials. Modeling indicates that recharge from the area of impact north of the slough accounts for less than 1 percent of the total flow through the Public Water Supply District #2 (formerly St. Charles County) well field (DOE 2000a). If, after attaining the target level of 300 pCi/L attenuation were to become ineffective, the increase to the well field would be 3 pCi/L. If concentrations in groundwater south of the slough exceed the maximum contaminant level of 20 pCi/L, DOE will evaluate risk and take appropriate action (see Section 2.9.1.3, "Quarry Residuals OU").

North of the slough, 2,4-DNT has been detected at one location in concentrations exceeding the Missouri regulatory limit of 0.11 μg/L. Concentrations have generally decreased since completion of bulk waste removal activities from the Quarry contamination. The target level for 2,4-DNT has been set at the Missouri State Water Quality standard.

The Quarry groundwater monitor well network consists of wells arrayed in four "lines" between the Quarry and the Public Water Supply District #2 (formerly St. Charles County) well field (Figure 2–3). The first and second lines are established to monitor the effect of residual Quarry contaminants on groundwater quality within the alluvium and shallow bedrock north of Femme Osage Slough. The third line, consisting of wells completed in the alluvial aquifer south of the slough, is monitored to provide early warning of contaminant migration across the reduction zone and toward the well field. The fourth line of wells, which consists of monitor wells installed by St. Charles County, are completed in the same portion of the aquifer from which the municipal water supply wells withdraw water. The purpose of the fourth line wells is to monitor water quality in the alluvial aquifer and monitor for occurrence of uranium at concentrations outside the range of natural variance.

Monitoring frequencies were established to (1) provide adequate warning of contaminant migration, taking into account travel times from known plume locations to critical locations upgradient of the well field; and (2) provide data adequate for valid statistical analysis of groundwater conditions. Aquifer hydraulic characterization results indicate that groundwater travel time from north of the slough to immediately south of the slough is approximately 1 year. Travel time between Lines 3 and 4 is slower because of a lower hydraulic gradient (DOE 2000a).

2.7.4 Disposal Cell LCRS Monitoring and Operation

The LCRS requires periodic monitoring to ensure the system is functioning as designed and sump capacity is not exceeded. Monitoring will indicate if the secondary leachate collection system is collecting leachate, either as a result of primary liner leakage or from another source. Liquid levels in the secondary sump containment must be monitored. DOE will remove and dispose of leachate at a frequency sufficient to prevent leachate volume from reaching the maximum capacity of the sump. Section 303(c) of 40 CFR 264 (which is relevant and appropriate to this activity) requires that after the final cover is installed, the amount of liquids removed from the sump be recorded at least monthly. If the liquid level in the sump stays below the pump operating level for two consecutive months, the amount of liquids in the sump must be recorded at least quarterly. If the liquid level in the sump stays below the pump operating level for two consecutive quarters, the amount of liquids in the sump must be recorded at least semiannually. If at any time during the postclosure care period the pump operating level is exceeded on quarterly or semiannual recording schedules, the recording of amount of liquids must return to monthly until the liquid level again stays below the pump operating level for two consecutive months. "Pump operating level" for the Weldon Spring Site is defined as the maximum amount of liquid in the sump, which equals 11,200 gallons. Leachate production rates, analytical results, and disposal records will be archived with the site surveillance and maintenance records at the DOE office in Grand Junction and summarized in the annual report. Monitoring and operating procedures are specified in Appendix I.

Leachate level and flow rates will be monitored and recorded weekly at the outset. As a reliable database is generated, DOE may modify the sump level monitoring frequency in accordance with regulations in 40 CFR 264.303(c) which requires only monthly and then quarterly flow recording. Flow rates will be reported in units of gallons per day and compared to the action leakage rate of 100 gallons/acre/day established for the leachate collection system. See Section 2.9.2.2, "Action Leakage Rate" for more information regarding the action leakage rate.

During 2004 and 2005, discharge from the primary leachate collection system has generated approximately 185 gallons per day and 155 gallons per day, respectively. The amount of discharge was 325 gallons per day. The combined leachate from the secondary leachate collection system has averaged approximately 15.7 gallons per day for 2004 and 13.6 gallons per day for 2005. The average leak rate for the secondary leachate collection system for 2004 and 2005 has been approximately 0.57 gallon/acre/day, significantly less than 1 percent of the action leakage rate (100 gallons/acre/day). This is a result of superior design and construction, as well as operational controls that optimized the moisture content of the compacted soil waste.

2.7.4.1 Leachate Chemistry Monitoring and Disposal

The leachate has been sampled quarterly since generation for an extensive list of chemical and radiological constituents. Beginning in calendar year 2003, the leachate has been sampled semiannually in accordance with Appendix K "Disposal Cell Groundwater Monitoring Plan." The list of analytes is included in the plan. As needed, the leachate is pumped from the sump and transported to the Metropolitan St. Louis Sewer District (MSD) for treatment in their Bissell Point wastewater treatment facility. The approval letter from MSD and subsequent amendments to that letter are included in Appendix I. A sample of leachate is collected and analyzed in accordance with MSD requirements for each hauling event (Appendix I). DOE has an allocation of 0.15 millicuries per year of radioactivity and 25,000 gallons per month. Leachate uranium activity during 2002 typically was 50 pCi/L, which is equivalent to an annual radioactivity of approximately 0.02 millicuries. The 2003 through 2005 data have shown a continued downward trend to less than 30 pCi/L.

The DOE received notification in April 2004 that the leachate must meet the radiological drinking water standard of 30 μg/L (20 pCi/L) prior to acceptance. The disposal cell leachate was very close to this limit in 2004; therefore the DOE exercised a pretreatment contingency process and began treating the leachate through a system of cartridge filters and ion exchange media that is selective for uranium. The leachate was sampled after treatment and found to be significantly below the 30 μg/L limits for uranium. DOE requested and received approval to raise the allocation of 15,000 gpm to 25,000 gpm. The disposal cell is not generating any additional leachate, but the increased volume limit provides added operational flexibility related to the pretreatment options and hauling.

2.7.5 Air Monitoring

Because radioactive and asbestos waste handling operations were complete, and waste was encapsulated in the disposal cell, DOE halted air monitoring at the site perimeter and at off-site locations for radon-222, thoron (radon-220), and particulates in 2000. Radon flux measurements collected on the first foot of the 3-foot-thick layer of the radon barrier averaged less than 5 percent of the regulatory limit of 20 pCi per square meter per second (DOE 2001a). Therefore, no postclosure radon monitoring is required.

2.8 Regulatory Compliance Monitoring

At the time of the routine site inspection, DOE will evaluate the degree of compliance with regulations governing surveillance and maintenance activities at the Weldon Spring Site. Those regulations are specified in Section 1.5, "Current Regulatory Requirements."

An evaluation of regulatory compliance may be required at other times as well, in response to unusual or nonroutine occurrences. The results of this monitoring will be presented in the annual report. However, if DOE identifies instances of noncompliance that necessitate corrective action, DOE will inform EPA and MDNR of site conditions as soon as they are assessed.

2.9 Emergencies, Contingency Planning, and Corrective Action

Emergency measures are the actions DOE will take in response to "unusual damage or disruption" that threatens or compromises site safety or security, such as exposure or release of cell contents. DOE will contain and manage radioactive or hazardous materials that are the responsibility of DOE in the unlikely event such materials are discovered or released. Certain circumstances may arise during the surveillance and maintenance phase of the Weldon Spring Site that require implementation of contingency actions. To the extent these actions can be anticipated and planned for (e.g., the Quarry well field contingency plan), they have been incorporated into RODs and RD/RA workplans. Unanticipated contingency actions will be subject to CERCLA processes prior to implementation. Certain options under CERCLA, which will be evaluated, include emergency or time-critical actions, IRAs, and changes or amendments to the RODs. DOE is responsible for any future hazards posed by releases from or at the Site and

2.9.1 Groundwater Contingency Actions

2.9.1.1 Disposal Cell Groundwater Corrective Action

If it is determined that leakage from the disposal cell has resulted in deterioration of the groundwater at the Chemical Plant, a review of the remedy will be necessary. This is based on the condition that the remedy is not behaving as expected and may no longer be protective of human health and the environment. Modifications or actions would be documented under CERCLA and would be consistent with RCRA 40 CFR 264.100. At this time, a modification of this program would be documented in collaboration with the EPA and MDNR.

2.9.1.2 Groundwater OU

The monitoring program has been developed to recognize any of the following observations that could lead to reconsideration of the remedy:

- A sustained upward trend in contaminant concentration in groundwater or springwater, indicating that undiscovered sources may be present;
- Trends in contaminant concentrations that are inconsistent with meeting cleanup goals within a reasonable timeframe; or
- Significant increases in the areal or vertical extent of contamination, resulting in new impacts to adjacent (both horizontal and vertical) unimpacted groundwater systems.

Trigger concentrations have been assigned at appropriate locations as indicators of changed conditions or of having a potential for impact outside those areas where migration is expected to occur (i.e., paleofeatures). Responses will range from data verification and increased monitoring to reevaluation of MNA timeframes. Decision trees have been developed for each monitoring program (Appendix M) that outline courses of action for exceeding trigger levels.

In the event that recalculation of the MNA timeframes is required, the methodology to be used is presented in the *Remedial Design/Remedial Action Work Plan for the Final Remedial Action for the Groundwater Operable Unit at the Weldon Spring Site* (DOE 2004b). The original calculations were based on a larger set of wells than the set used to monitor MNA. Collection of data from nearby existing wells will be necessary to complete this task; therefore, it is not expected that recalculation will be performed routinely as a performance measure of MNA.

Should an alternative to MNA be needed, it will be implemented in accordance with the CERCLA process for post-ROD changes. If the remedy requires immediate action, a time-critical removal will be considered. Alternatives other than MNA will be reevaluated and will include in-situ chemical oxidation (ICO) as well as other treatment or containment technologies that may be available in the future.

2.9.1.3 Quarry Residuals OU

Groundwater from the Public Water Supply District #2 (formerly St. Charles County) well field located south of Femme Osage Slough is used for residential purposes. Monitoring data indicate that uranium concentrations in this area are within the range of background concentrations for the Missouri River alluvium. Because removal of major sources of contamination has been completed, no significant amounts of additional contaminants should be introduced into the groundwater system. However, because of the presence of uranium in groundwater north of the slough, contingency actions have been considered in the event that uranium concentrations increase or uranium from the Quarry is observed in groundwater south of the slough.

During bulk waste removal activities, a well field contingency plan (DOE 1992) was prepared to address concerns about the protection of the well field in the event contaminants were mobilized due to remedial actions. The monitoring and contingency action portions of the contingency plan have been incorporated into this LTS&M Plan. If an alternate source of drinking water is required, engineering design and construction will proceed based on the design criteria that was presented in the contingency plan (Appendix L). The contingency plan also outlined the preliminary planning and preparation that will be necessary to implement the construction of new wells in the existing well field or a partial or full replacement well field.

The Quarry groundwater monitor well network consists of wells arrayed in four "lines" between the Quarry and the St. Charles County well field. The first and second lines are established to monitor the effect of residual Quarry contaminants on groundwater quality within the alluvium and shallow bedrock north of Femme Osage Slough. The third line, consisting of wells completed in the alluvial aquifer south of the slough, is monitored to provide early warning of contaminant migration toward the well field. The fourth line consists of monitor wells completed in the same portion of the aquifer from which the water supply wells withdraw water and whose purpose is to monitor the water quality in the alluvial aquifer and monitor for occurrence of uranium at concentrations outside the range of natural variance.

If a consistently upward trend in uranium or 2,4-DNT concentrations is observed for three consecutive sampling events in the groundwater north or south of the slough, DOE will investigate the contaminant source and transport mechanism. This may include conducting hydrogeologic and geochemical investigations, installing additional monitor wells, or increasing sampling frequency of the monitoring network.

If uranium concentrations in groundwater south of the slough exceed the trigger level of 20 pCi/L, DOE will notify EPA Region VII, MDNR, and Public Water Supply District #2 (formerly St. Charles County) as soon as the condition is confirmed. Confirmation may include reanalyzing samples, if possible, or resampling the locations in question and other potentially affected locations and submitting the samples to analytical laboratories for expedited analysis.

If the elevated uranium concentration is valid, DOE will reevaluate the potential for impacts to the well field and the alluvial aquifer. This evaluation may include

- Increasing the frequency of sample collection.
- Performing hydrogeologic and/or contaminant transport investigations to identify migration pathways.
- Installing additional monitor wells.
- Conducting groundwater modeling to predict long-term impacts.

- Conducting a risk evaluation consistent with methods outlined under CERCLA.
- Determining the need for and feasibility of groundwater remediation.
- Installing new production wells in the existing well field, or partial or full replacement of the well field in an alternate location.

2.9.2 Disposal Cell Contingency Actions

2.9.2.1 Leachate Contingency Treatment

Prior to obtaining approval to dispose of leachate in the regional water treatment system, DOE designed a dedicated water treatment plant (referred to as Train 3) to decrease manganese and uranium levels. DOE constructed a treatment building and installed some of the required equipment. The plant was not completed as an automated system, but DOE will modify the equipment to function as a manually operated batch treatment system, if needed. The circumstances that could lead to the use of the contingency treatment system include shipping the leachate to MSD becoming not available as an option. The system will use chemical precipitation to remove manganese and ion exchange resin columns to remove uranium.

Note: As discussed in Section 2.7.4.1, the system has been updated to use ion exchange resin columns to remove uranium.

Treated leachate will be sampled before discharge. Leachate will be pumped into a dedicated pipeline and discharged to the Missouri River at National Pollutant Discharge Elimination System (NPDES) Outfall 007 in accordance with DOE's NPDES permit. DOE will maintain the NPDES permit for the discharge point (outfall) of the discharge line, for possible future use.

The *LCRS/Train 3 Treatment Contingency Plan* is included as Appendix J (see also the *Leachate Collection and Removal System Operating Plan* in Appendix I).

2.9.2.2 Action Leakage Rate

As outlined in the Notice of Final Rulemaking, *Federal Register* Volume 57, Number 19, dated January 29, 1992, EPA recommends 100 gallons/acre/day for land disposal units meeting the minimum required design specifications. However, the final rule allows the owner/operator to calculate an action leakage rate based on site-specific design of the unit. The calculated action leakage rate should be based on calculations of the maximum flow capacity of the leak detection system so as not to exceed one foot head on the bottom liner. Based on the site specific design, the calculated action leakage rate for the Weldon Spring Site disposal cell is 2,640 gallons/acre/day. For the 26.5-acre waste footprint within the disposal cell, this converts to 69,960 gallons per day. As a more practical number, the DOE agreed to use the recommended 100 gallons/acre/day as the action leakage rate for the disposal cell. The actual combined secondary flow rates recorded at the end of December 2002 were less than 1 gallon/acre/day (100 times less than the action leakage rate). The average flow rates for 2003 were approximately 0.6 gallon per acre per day.

In accordance with EPA regulations (40 CFR 264.304), if the action leakage rate is exceeded, DOE will notify EPA and MDNR within 7 days of the determination. A preliminary written assessment of the determination will be submitted within 14 days and will include amount of

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During the period of time required to complete installation of the replacement well field, the present well field would operate without the reserve provided by the affected wells. In a worst case scenario, the present well field might not meet production demands during the period of new well field construction. In this instance, service demands for Public Water Supply District #2 Plant No. 1 would have to be met through an alternate source or rationing (such as water used for lawn care and car washing, etc.) until the replacement well field went on line or demand subsided due to the normal demand cycle.

L1.8 Well Design

Figure L–3 illustrates the preliminary design of the replacement wells.

L2.0 References

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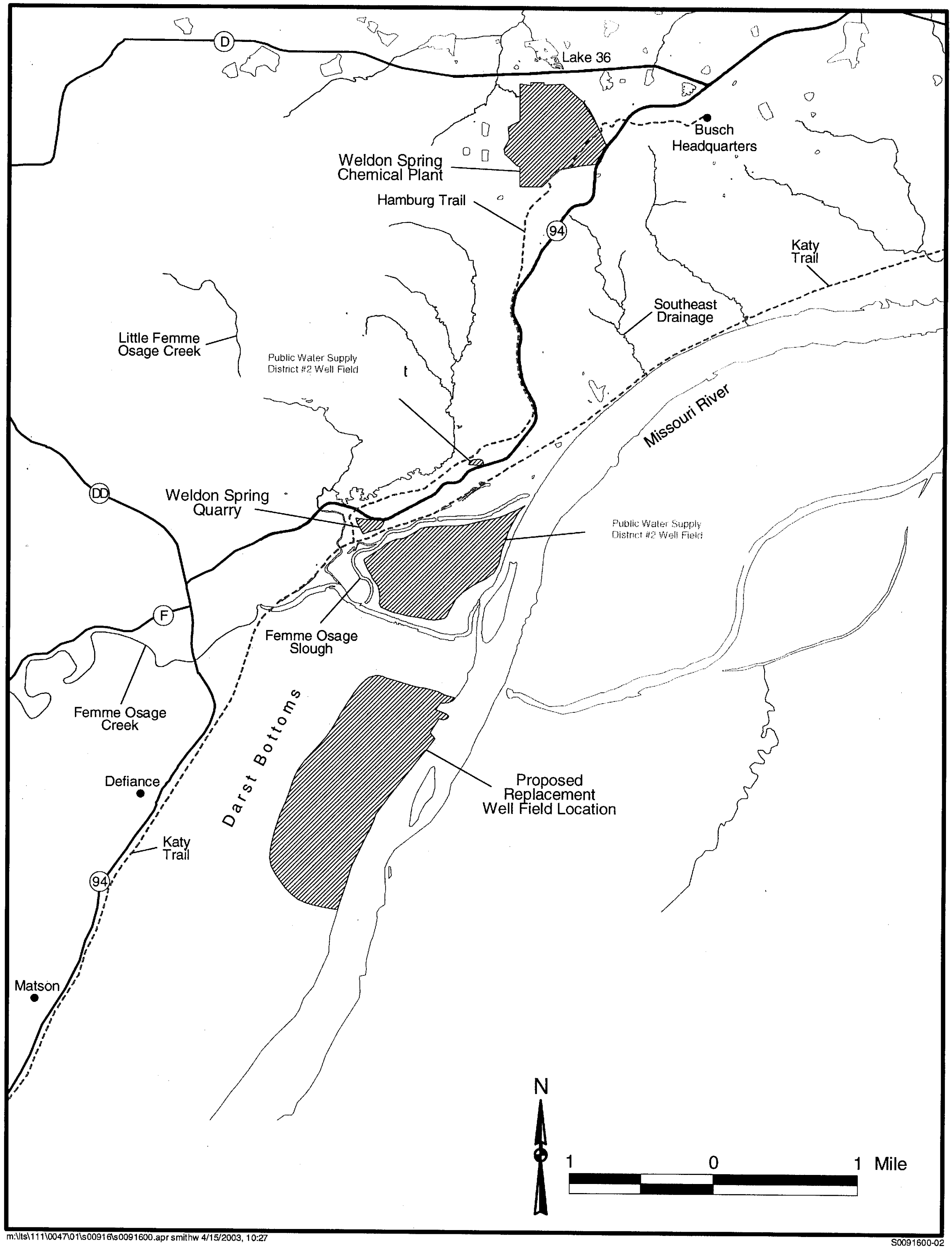

Figure L–1. Proposed Replacement Well Field Location

Appendix G
Distribution List

Except for individual stakeholders, this distribution list is composed of people representing organizations, which have expressed interest in site activities. When individual turnover occurs in these positions, DOE will revise the list to reflect the current holder of these positions. This type of revision is considered minor and not subject to review. All individuals on this list will receive notices of upcoming meetings or the availability of certain documents such as the annual site inspection report, the 5-Year Review and proposed revisions of this Long-Term Surveillance and Maintenance Plan.

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St. Charles, MO 63301

St. Charles County Agencies/ Companies/Organizations (continued)

The Honorable Doug Funderburk, Councilman
District #4, County Council
St. Charles County Courthouse
100 North Third Street
St. Charles, MO 63301

The Honorable Joseph McCulloch, Councilman
District #5, County Council
St. Charles County Courthouse
100 North Third Street
St. Charles, MO 63301

The Honorable Dan Foust, Councilman
District #6, County Council
St. Charles County Courthouse
100 North Third Street
St. Charles, MO 63301

The Honorable John White, Councilman
District #7, County Council
St. Charles County Courthouse
100 North Third Street
St. Charles, MO 63301

Mr. Mike Duvall
Director – Division of Environmental Services
St. Charles County
201 North Second Street, Suite 537
St. Charles, MO 63301

Mr. Wayne Anthony
St. Charles County Planning and Zoning
201 North Second Street, Suite 420
St. Charles, MO 63301

Mr. Gil Copley
St. Charles County Department of Health
1650 Booneslick
St. Charles, MO 63301

St. Charles County Agencies/ Companies/Organizations (continued)

Mr. Barry Drucker, Environmental Sanitarian
St. Charles County Health Department
1650 Booneslick
St. Charles, MO 63301

Ms. Bettie Yahn-Kramer, CPRP Director
St. Charles County Parks and Recreation Department
201 North Second Street, Suite 510
St. Charles, MO 63301

Middendorf-Kredell Library
Ms. Anna Sylvan, Documents Manager
2750 Highway K
O'Fallon, MO 63366

Mr. Steve Wilkins, Water Plant Supervisor
Public Water Supply District #2
1635 Highway 94 South
Defiance, MO 63341

Captain Jim Hudson
St. Charles County Sheriff Office
101 Crossing Industrial Ct
O'Fallon, MO 63366

Weldon Spring Citizens Commission (8 copies)
c/o Helene Diller
7295 Highway 94 South
St. Charles, MO 63304

Ms. Nancy Dickens
Technical Consultant to Weldon Spring Citizens Commission
150 E. Dunn
Edwardsville, IL 62025

Mr. Richard Hoormann, County Program Director
University of Missouri-Cooperative Extension Service
260 Brown Road
St. Peters, MO 63376

St. Charles County Agencies/ Companies/Organizations (continued)

Mr. Ron Molly, Manager
Missouri American Water Company
P.O. Box 355
Cottleville, MO 63338-0355

Mr. Mike Dougherty
Division Manager
Alliance Water Resources
410 East Elm St.
O'Fallon, MO 63366

Tim Geraghty, P.E.
Manager of Engineering and Operations
Public Water Supply District #2
P.O. Box 370
O'Fallon, MO 63366

Mark Bailey, Assistant Fire Chief
Cottleville Fire Department
P.O. Box 385
Cottleville, MO 63338

St. Louis County Agencies/ Companies/Organizations

The Honorable Charlie A. Dooley
County Executive
St. Louis County
Administration Building, 9th floor
41 South Central Avenue
Clayton, MO 63105

Ms. Jacquelynn A. Meeks, Director
Environmental Administration
St. Louis County Health Department
111 South Meramec, 2nd Floor
Clayton, MO 63105

Mr. Roland A. Biehl
Environmental Associate Engineer
Metropolitan St. Louis Sewer District
10 East Grand Avenue
St. Louis, MO 63147-2913

St. Louis County Agencies/ Companies/Organizations (continued)

Director
Environmental Engineering &
Site Services Department
Anheuser Busch
One Busch Place
St. Louis, MO 63118

Dr. Robert Nicolotti
St. Louis County Health Department
111 South Meremac
Fifth Floor
St. Louis, MO 63105

Mr. Frank Hartman
Vice President for Production
Missouri American Water Company
535 North New Ballas Road
St. Louis, MO 63141

Mr. Don Rea
City of St. Louis Water Division
Chain of Rocks Plant
10450 Riverview Drive
St. Louis, MO 63137

Mr. Gary Schmidt
Hanson Professional Services
4227 Earth City Expressway, Suite 130
St. Louis, MO 63045

Mr. Curtis Skouby
City of St. Louis Water Division
Howard Bend Plant
14769 Olive St.
Chesterfield, MO 63017

Mr. Mike Zlatic
St. Louis County Department of Health
111 S. Meramec
Clayton, MO 63105

Mr. Jack Frauenhoffer
Director, Site Development & Community Relations
Mallinckrodt Inc.
P.O. Box 5840
St. Louis, MO 63134

State - Elected Officials

The Honorable Matt Blunt, Governor
State of Missouri
State Capitol, Room 216
P.O. Box 720
Jefferson City, MO 65102

The Honorable Jon Dolan
D-2nd District
Missouri State Senator
State Capitol, Room 428
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Charles Gross
R-23rd District
Missouri State Senator
State Capitol, Room 227
201 West Capitol Avenue
Jefferson City, MO 65101

Ms. Vicky Huesemann
Office of Senator Charles Gross
415 N. 2nd Street
St. Charles, MO 63301

The Honorable Sherman Parker
R-12th District
Missouri House of Representatives
State Capitol, Room 130-DA
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Scott T. Rupp
R-13th District
Missouri House of Representatives
State Capitol, Room 304-B
201 West Capitol Avenue
Jefferson City, MO 65101

State - Elected Officials (continued)

The Honorable Joe Smith
R-14th District
Missouri House of Representatives
State Capitol, Room 316
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Sally Faith
R-15th District
Missouri House of Representatives
State Capitol, Room 200 BC
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Carl L. Bearden
R-16th District
Missouri House of Representatives
State Capitol, Room 301
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Vicki Schneider
R-17th District
Missouri House of Representatives
State Capitol, Room 407B
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Thomas D. Dempsey
R-18th District
Missouri House of Representatives
State Capitol, Room 309
201 West Capitol Avenue
Jefferson City, MO 65101

The Honorable Kevin Threlkeld
R-109th District
Missouri House of Representatives
State Capitol, Room 415A
201 West Capitol Drive
Jefferson City, MO 65101

State Agencies

Mr. Doyle Childers
Director, Missouri Department of Natural Resources
Post Office Box 176
Jefferson City, MO 65102

Mr. Robert Geller
Missouri Department of Natural Resources
Post Office Box 176
Jefferson City, MO 65102

Mr. Larry Erickson
Missouri Department of Natural Resources
Post Office Box 176
Jefferson City, MO 65102

Mr. Thomas Siegel
Missouri Department of Natural Resources
7545 S. Lindbergh Blvd., Suite 210
St. Louis, MO 63125

Mr. Ben Moore
Missouri Department of Natural Resources
Post Office Box 176
Jefferson City, MO 65102-0176

Ms. Mimi Garstang, Director
Division of Geology and Land Survey
Missouri Department of Natural Resources
Post Office Box 250
Rolla, MO 65402

Ms. Myrna Rueff
Missouri Department of Natural Resources
Division of Geology and Land Survey
Post Office Box 250
Rolla, MO 65402

Ms. Jennier Frazier, Real Estate Manager
Missouri Department of Natural Resources
Division of State Parks
P.O. Box 176
Jefferson City, MO 65102

State Agencies (continued)

Ms. Ramona Huckstep
Community Relations Coordinator
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Ms. Lorna Domke
Missouri Department of Conservation
Post Office Box 180
Jefferson City, MO 65102

Mr. John Hoskins
Missouri Department of Conservation
Post Office Box 180
Jefferson City, MO 65102

Mr. John Vogel
Missouri Department of Conservation
August A. Busch Memorial Conservation Area
2360 Highway D
St. Charles, MO 63304

Mr. Marvin Boyer
Missouri Department of Conservation
August A. Busch Memorial Conservation Area
2360 Highway D
St. Charles, MO 63304

Mr. Joel Porath
Missouri Deparment of Conservation
August A. Busch Memorial Conservation Area
2360 Highway D
St. Charles, MO 63304

Ms. Denise Garnier, Asst. to the Director
Missouri Department of Conservation
Post Office Box 180
Jefferson City, MO 65102-0180

State Agencies (continued)

Ms. Cynthia Green, Realty Specialist
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102

Mr. Lee Hughes
Missouri Department of Conservation
Post Office Box 180
Jefferson City, MO 65102

Mr. Ed Warhol, Buildings and Grounds Specialist
Missouri Department of Transportation
1590 Woodlake Dr.
Chesterfield, MO 63017

Mr. Thomas Ryan, Assistant District Engr.
Missouri Department of Transportation
1590 Woodlake Dr.
Chesterfield, MO 63017

Mr. Kevin Wideman
Environmental Compliance Coordinator
Missouri Department of Transportation
Post Office Box 270
Jefferson City, MO 65102

Mr. Gale Carlson
Assessment Unit Chief
Missouri Department of Health and Senior Services
Post Office Box 570
Jefferson City, MO 65102

Dr. Bao Ping Zhu
State Epidemiologist
Missouri Department of Health and Senior Services
P.O. Box 570
Jefferson City, MO 65102

Federal - Elected Officials

The Honorable Christopher S. Bond
U.S. Senate
274 Russell Senate Office Building
Washington, D.C. 20510

Federal - Elected Officials (continued)

The Honorable James Talent
U.S. Senate
493 Russell Senate Office Building
Washington, D.C. 20510

The Honorable Russ Carnahan
U.S. House of Representatives
1232 Longworth House Office Building
Washington, D.C. 20515

The Honorable Kenny Hulshof
U.S. House of Representatives
412 Cannon House Office Building
Washington, D.C. 20515

Office of Congressman Kenny Hulshof
516 Jefferson Street
Washington, MO 63090

The Honorable W. Todd Akin
U.S. House of Representatives
117 Cannon House Office Building
Washington, D.C. 20515

Mr. Jim Mitas
Office of Congressman W. Todd Akin
301 Sovereign Court, Suite 201
Ballwin, MO 63011

The Honorable William L. Clay
U.S. House of Representatives
131 Cannon House Office Building
Washington, D.C. 20515

Office of Congressman William L. Clay
625 North Euclid St., Suite 200
St. Louis, MO 63108

Federal Agencies

Mr. James B. Gulliford
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U.S. Environmental Protection Agency
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901 North 5th Street
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Federal Agencies (continued)

Ms. Denise Jordan-Izaguire
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ATSDR c/o EPA Region VII
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Mr. Dan Wall (2 copies)
Superfund Division
U.S. Environmental Protection Agency
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Mr. Ed Louis
U.S. Army Corps of Engineers
Kansas City District (CENWK-PM-ED)
601 NE 12th Street
Kansas City, MO 64106

Mr. Dave Nelson
Program and Project Management Division
Attn: CENWK-EC-ED
U.S. Army Corps of Engineers
Kansas City District
601 East 12th Street
Kansas City, MO 64106

Mr. William S. (Tex) Titterington
Chief, Environmental Division
AFRC-CKS-ENE
89th Regional Readiness Command
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Wichita, KS 67210

Barry McFarland
Regional Environmental Program Coordinator
89th Regional Readiness Command
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Mr. Roy Stevenson
89th Regional Readiness Command
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7301 Highway 94 South
St. Charles, MO 63304

Federal Agencies (continued)

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Mail Stop 200
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Ms. Mary Picel
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St. Charles, MO 63304

Administrative Record
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