GWOU ADMINISTRATIVE RECORD
SECTION TITLE:
GW-900-902-1.06

DOE/OR/21548-917
CONTRACT NO. DE-AC05-86OR21548

WELDON SPRING SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2001

WELDON SPRING SITE REMEDIAL ACTION PROJECT
WELDON SPRING, MISSOURI

JULY 2002 **REV. 0**

U.S. Department of Energy
Oak Ridge Operations Office
Weldon Spring Site Remedial Action Project

Prepared by MK-Ferguson Company and Jacobs Engineering Group

Printed in the United States of America. Available from the National Technical Information Service, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

NTIS Price Codes - Printed Copy: A09
Microfiche: A01

070202

MORRISON KNUDSEN CORPORATION MK-FERGUSON GROUP Weldon Spring Site Remedial Action Project Contract No. DE-AC05-86OR21548	Rev. No. 0
PLAN TITLE: Weldon Spring Site Environmental Report for Calendar Year 2001	

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DOE/OR/21548-917

Weldon Spring Site Remedial Action Project

EXECUTIVE SUMMARY

Weldon Spring Site Environmental Report for Calendar Year 2001

Revision 0

July 2002

Prepared by

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and
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St. Charles, Missouri 63304

for the

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations Office
Under Contract DE-AC05-86OR21548

EXECUTIVE SUMMARY

This *Weldon Spring Site Environmental Report for Calendar Year 2001* has been prepared to provide information about the public safety and environmental protection programs conducted by the Weldon Spring Site Remedial Action Project (WSSRAP). 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 Raffinate Pits area and the Weldon Spring Quarry. The chemical plant and raffinate pits area and the quarry are 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.

This report presents environmental monitoring data from routine radiological and nonradiological sampling activities. These data include estimates of dose to the public from activities at the Weldon Spring site, estimates of effluent releases, and trends in groundwater contaminant levels. Additionally, applicable compliance requirements, quality assurance programs, and special studies conducted in 2001 to support environmental protection programs are discussed.

Dose estimates presented in this report are based on hypothetical exposure scenarios for public use of areas near the site. Release estimates have been calculated on the basis of 2001 National Pollutant Discharge Elimination System (NPDES) data.

MONITORING OVERVIEW

WSSRAP environmental management programs are designed to ensure that releases from the site are at levels demonstrably and consistently "as low as reasonably achievable" (ALARA). Throughout the remediation, the ALARA principle has driven the work activities conducted under U.S. Environmental Protection Agency (EPA) enforcement of the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA).

Effluent and environmental monitoring programs provide early detection of contaminants, assessment of potential impacts to the environment, and data needed to implement the ALARA strategy. Routine monitoring also demonstrates compliance with applicable State and Federal permits and regulations.

REGULATORY COMPLIANCE

The Weldon Spring site is listed on the National Priorities List (NPL) and is governed by the CERCLA. Under the CERCLA, the WSSRAP is subject to meeting or exceeding applicable or relevant and appropriate requirements of Federal, State, and local laws. Primary regulations include the *Resource Conservation and Recovery Act* (RCRA), *Clean Water Act* (CWA), *Clean Air Act* (CAA), *Toxic Substances Control Act* (TSCA), *National Historic Preservation Act* (NHPA), and because the U.S. Department of Energy (DOE) is the lead agency for the site, *National Environmental Policy Act* (NEPA) values are incorporated into CERCLA documents as outlined in the Secretarial Policy statement on NEPA.

The following major tasks were completed at the Weldon Spring site during 2001:

- The quarry water treatment plant was decommissioned, dismantled, and placed in the disposal cell.
- In-situ chemical oxidation of TCE in groundwater was evaluated by awarding four bench-scale testing subcontracts, and a separate subcontract was awarded to conduct pilot-scale treatment.
- The disposal cell construction was completed.
- The chemical plant area and raffinate pits received final grading and temporary seeding.
- The quarry reclamation design was completed, and the first 75,000 cy of backfill was placed. The borrow area for this backfill was restored to a wetland condition.
- The Quarry Interceptor Trench System was operated to determine the mass and rate of uranium removal achievable downgradient of the quarry.
- Groundwater field studies were conducted to evaluate various methods of extracting and treating groundwater in the chemical plant/raffinate pits area.

MONITORING SUMMARY

Environmental monitoring data showed that dose estimates were below the DOE guidelines for the public of 100 mrem (1 mSv) annual total effective dose equivalent for all exposure pathways. Release estimates for total uranium in water (which include storm water and water from the treatment plants) decreased from the 2000 release estimate of 5.38 kg/yr (11.84 lb/yr) to 3.34 kg/yr (7.35 lb/yr) in 2001. The annual release of total uranium for 2001 was a 99% reduction from the 1987 annual estimate. Effluent releases were well below the DOE derived concentration guide level of 600 pCi/l. Data from groundwater and surface water monitoring indicated no measurable impact on drinking water sources from Weldon Spring site contaminants.

Dose Estimates

Radiation dose estimates are discussed in Section 5. Taking into account all applicable exposure pathways, the total effective dose equivalent to a maximally exposed individual was from consumption of water at Burgermeister Spring and was 0.24 mrem (2.4E-3 mSv). This estimate is well below the DOE guideline of 100 mrem (1 mSv). By comparison, the annual total effective dose equivalent in the United States due to naturally occurring sources of radioactivity is approximately 300 mrem (3 mSv).

The collective population effective dose equivalent was estimated to be 0.10 person-rem (1.03E-3 person-Sv) for users of the Busch Memorial Conservation Area.

Air Monitoring

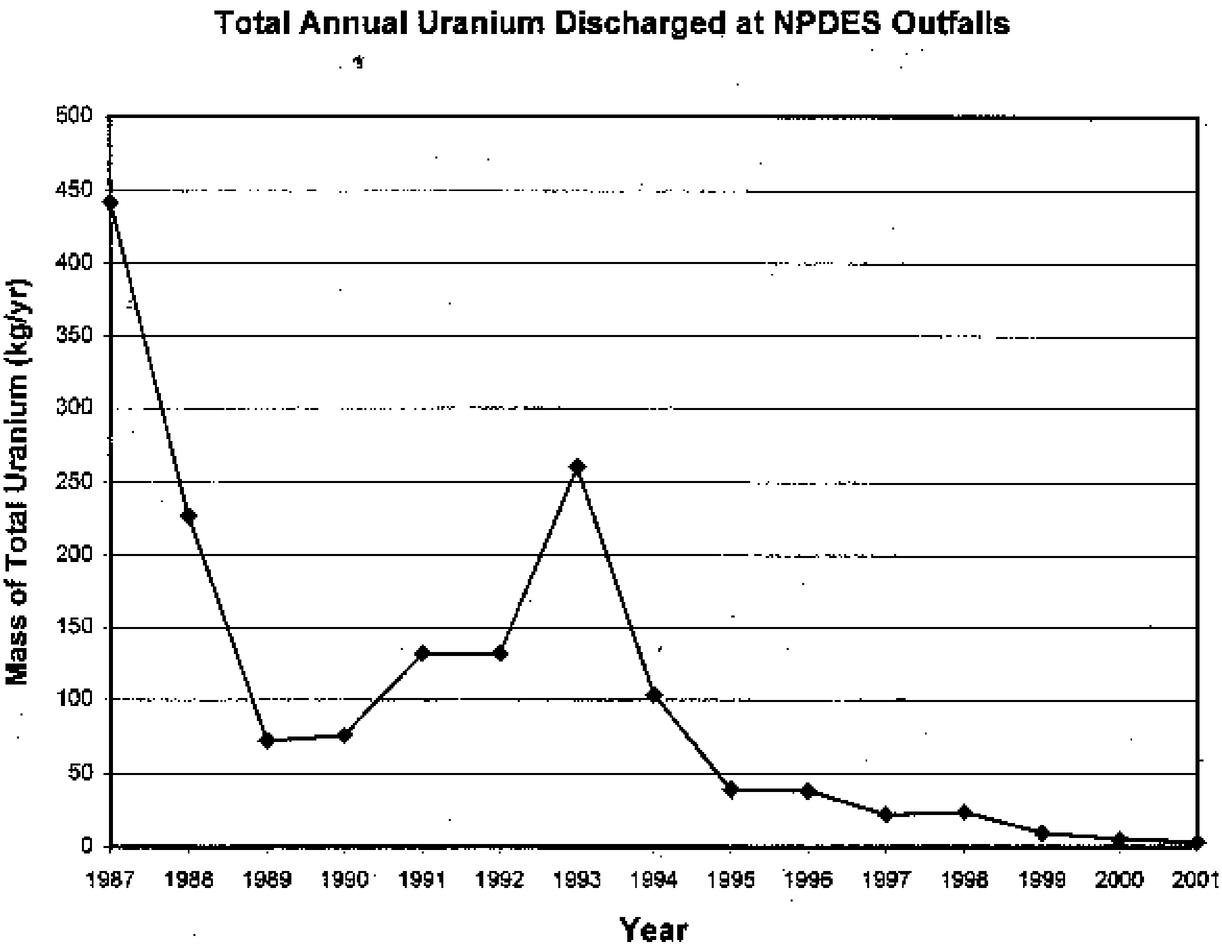
The air monitoring program is discussed in Section 4. No environmental radiological air monitoring was conducted in 2001, due to the near completion of radioactive waste handling activities. Work zone air monitors were used during the brief period of final waste placement and clean cover activities. Ambient dust was monitored downwind from major dust-producing activities to assess ambient concentrations of inhalable particulate matter (PM-10). All measurements were substantially below the 150 $\mu g/m^3$ site action level.

NPDES Monitoring

In 2001, surface water runoff at the chemical plant transported uranium from the site through seven major discharge routes that are identified in Section 6 of this report. The total mass of uranium migrating off-site in storm water and treated effluent was 3.34 kg/yr (7.35 lb/yr). Based on natural uranium activity ratios, this is equivalent to an activity of 0.0023 Ci/yr (8.51E7 Bq/yr). The total mass of uranium was less than the CY 2000 mass of 5.38 kg/yr (11.84 lb/yr). The graph below, also presented as Figure 10-5 in Section 10, shows that the total mass of uranium migrating off site in storm water and treated effluent has decreased substantially since remedial activities began, and is expected to decrease further still when the site vegetation becomes permanently established.

Annual average uranium concentrations at the NPDES outfalls were all well below the derived concentration guideline of 600 pCi/l. With respect to 2000 levels, average uranium concentrations have decreased or remained substantially the same at all outfalls. Historical uranium trends for the three major NPDES outfalls (i.e., NP-0002, NP-0003, and NP-0005) are discussed in Section 10.

Radiological parameters at the outfalls were in compliance with NPDES permit requirements during 2001. Other parameters were also in compliance with the exception of five storm water settleable solids results. Details of these exceedances are presented in Section 2.5.



Surface Water Monitoring

Surface water monitoring in 2001 indicated that contaminant concentrations were within historic ranges. Additionally, average uranium levels at four of the five off-site surface water locations downgradient of the chemical plant and at all six off-site surface water locations near the quarry were lower than 2000 levels.

Groundwater Monitoring

The groundwater monitoring programs included extensive monitoring for radiological and chemical compounds, as discussed in Section 7. Contaminant levels generally remained within historic ranges at all chemical plant and quarry groundwater locations.

At the quarry, radiological results for the St. Charles County well field remained within background levels, and no detectable concentrations of the six nitroaromatic compounds were observed.

Chemical plant area monitoring continued to show elevated concentrations of nitroaromatic compounds in the former Frog Pond area. Four new monitoring wells were installed to further define the extent of this contamination. In the Raffinate Pit area, TCE monitoring continued; and 13 new monitoring wells were installed to further define the extent of contamination. Four additional monitoring wells were installed in this area to support the pump and treat field study.

Monitoring data from wells placed around the permanent disposal cell showed no exceedances of baseline for radiological parameters. Several wells exceeded baseline levels for nonradiological contaminants, but these data are likely due to variations in the existing groundwater contamination underlying the site.

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ABSTRACT

This *Site Environmental Report for Calendar Year 2001* describes the environmental monitoring programs at the Weldon Spring Site Remedial Action Project (WSSRAP). The objectives of these programs are to assess actual or potential exposure to contaminant effluents from the project area by providing public use scenarios and dose estimates to demonstrate compliance with Federal and State permitted levels and regulations, and to summarize trends and/or changes in contaminant concentrations identified through environmental monitoring.

The total effective dose equivalent (TEDE) to a hypothetical maximally-exposed individual who frequented the Weldon Spring Vicinity Properties during 2001 was 0.24 mrem (2.4E-3 mSv). This estimate is well below the U.S. Department of Energy (DOE) requirement of 100 mrem (1 mSv) annual TEDE for all exposure pathways. The collective population effective dose equivalent (CPEDE) for the population assumed to frequent the Busch Memorial Conservation Area during 2001 was 0.103 person-rem (1.03E-3 person-Sv).

Concentration limits are specified for liquid effluent pollutants in the National Pollutant Discharge Elimination System (NPDES) permits. Parameters were in compliance with the permit limits except for five samples which exceeded the 1.0 ml/l/hr settleable solids limit for storm water. The total mass of uranium migrating off-site in storm water and treated effluent during 2001 was 3.34 kg (7.35 lb).

Extensive groundwater monitoring at the WSSRAP showed that there was no radiological impact to any drinking water sources. Several field studies were conducted to assess the technological feasibility of removing groundwater contaminants at both the quarry and the chemical plant/raffinate pits area.

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1. INTRODUCTION

The Weldon Spring Site Remedial Action Project (WSSRAP) is part of the U.S. Department of Energy (DOE) Environmental Restoration Program, one of the remedial action programs under the direction of the DOE Office of Environmental Management. This *Weldon Spring Site Environmental Report for Calendar Year 2001* summarizes the environmental monitoring results obtained in 2001 and presents the status of Federal and State compliance activities.

DOE requirements for environmental monitoring and protection of the public, the mandate for this document, are designated in DOE Order 5400.1, *General Environmental Protection Program;* DOE Order 5400.5, *Radiation Protection of the Public and Environment*; and the implementation guide for DOE Order 5400.5, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance.*

In 2001, environmental monitoring activities were conducted to support remedial action under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA), the *Clean Air Act* (CAA), the *National Environmental Policy Act* (NEPA), the *Clean Water Act* (CWA), and other applicable regulatory requirements. The monitoring program at the WSSRAP 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 2001* include:

- Providing general information on the WSSRAP and the current status of remedial activities.
- Presenting summary data and interpretations for the 2001 environmental monitoring program.
- Providing information regarding ongoing remedial actions.
- Reporting compliance with Federal, State, and local requirements and DOE standards.
- Providing dose estimates for public exposure to radiological compounds due to remedial activities at the WSSRAP.

- 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

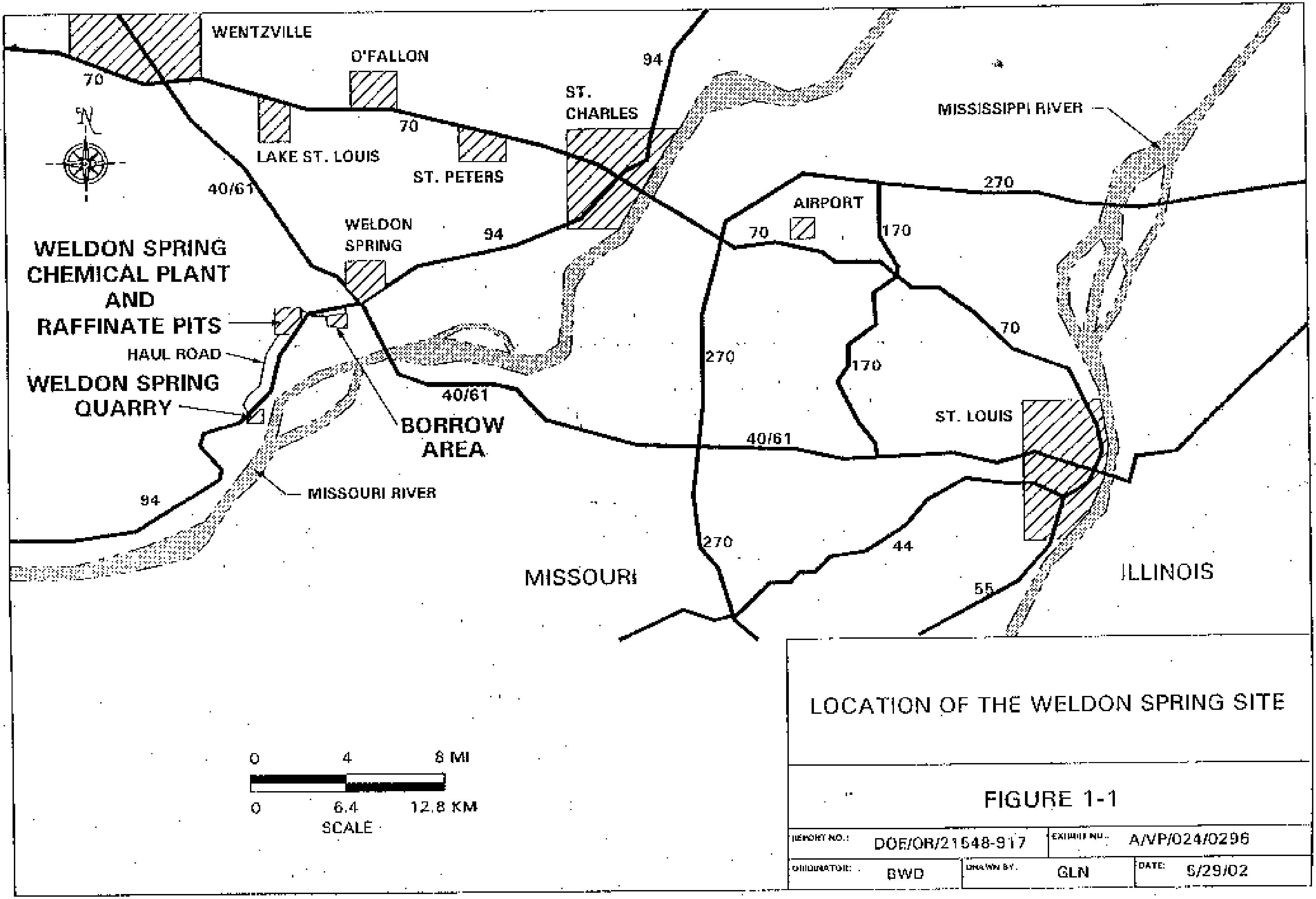
The Weldon Spring site is in southern St. Charles County, Missouri, approximately 48 km (30 mi) west of St. Louis, as shown in Figure 1-1. The site consists of two main areas, the former Weldon Spring Chemical Plant and Raffinate Pits area and the Weldon Spring Quarry, both located along Missouri State Route 94.

The Weldon Spring Chemical Plant is a 91 ha (226 acre) area that operated as the Weldon Spring Uranium Feed Materials Plant (WSUFMP) until 1966 (see Figure 1-2). Buildings were contaminated with asbestos, hazardous chemical substances, uranium, and thorium. (Building dismantlement was completed in 1994.) Radiological and chemical (polychlorinated biphenyls [PCBs], nitroaromatic compounds, metals and inorganic ions) contaminants were found in the soil in many areas around the site. These contaminated soils have all been remediated. The Raffinate Pits on the chemical plant site consisted of four settling basins that covered approximately 10.5 ha (26 acres). These pits were characterized as being contaminated with uranium and thorium residues and chemical contaminants including nitrate, fluoride, PCBs, and various heavy metals (Ref. 2). During 1999 and 2000, the four raffinate pits were remediated and backfilled.

The Weldon Spring Quarry is a former 3.6 ha (9 acre) limestone quarry south-southwest of the chemical plant area (Figure 1-3). Bulk waste stored in the quarry contained radiological and chemical contaminants including uranium, radium, thorium, metals, nitrates, PCBs, semivolatile organic compounds, nitroaromatics, and asbestos (Ref. 1). The quarry bulk waste removal operation was completed in 1995. Until 2001, the quarry was essentially a closed basin; surface water within the rim flowed to the quarry floor and into a sump. The amount of water in the sump varied in response to quarry water treatment plant operations and precipitation. In 2001, the quarry water treatment plant was dismantled and backfilling of the quarry was begun.

1.2 Site History

From 1941 to 1945, the U.S. Department of the Army produced trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Weldon Spring Ordnance Works, which covered 6,974 ha (17,233 acres) of land that now includes the Weldon Spring site. By 1949, all but about 809 ha (2,000 acres) had been transferred to the State of Missouri (August A. Busch Memorial Conservation Area) and to the University of Missouri (agricultural land). Except for several small parcels transferred to St. Charles County, the remaining property became the Army training area.



LOCATION OF THE WELDON SPRING SITE

FIGURE 1-1

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/VP/024/0296	
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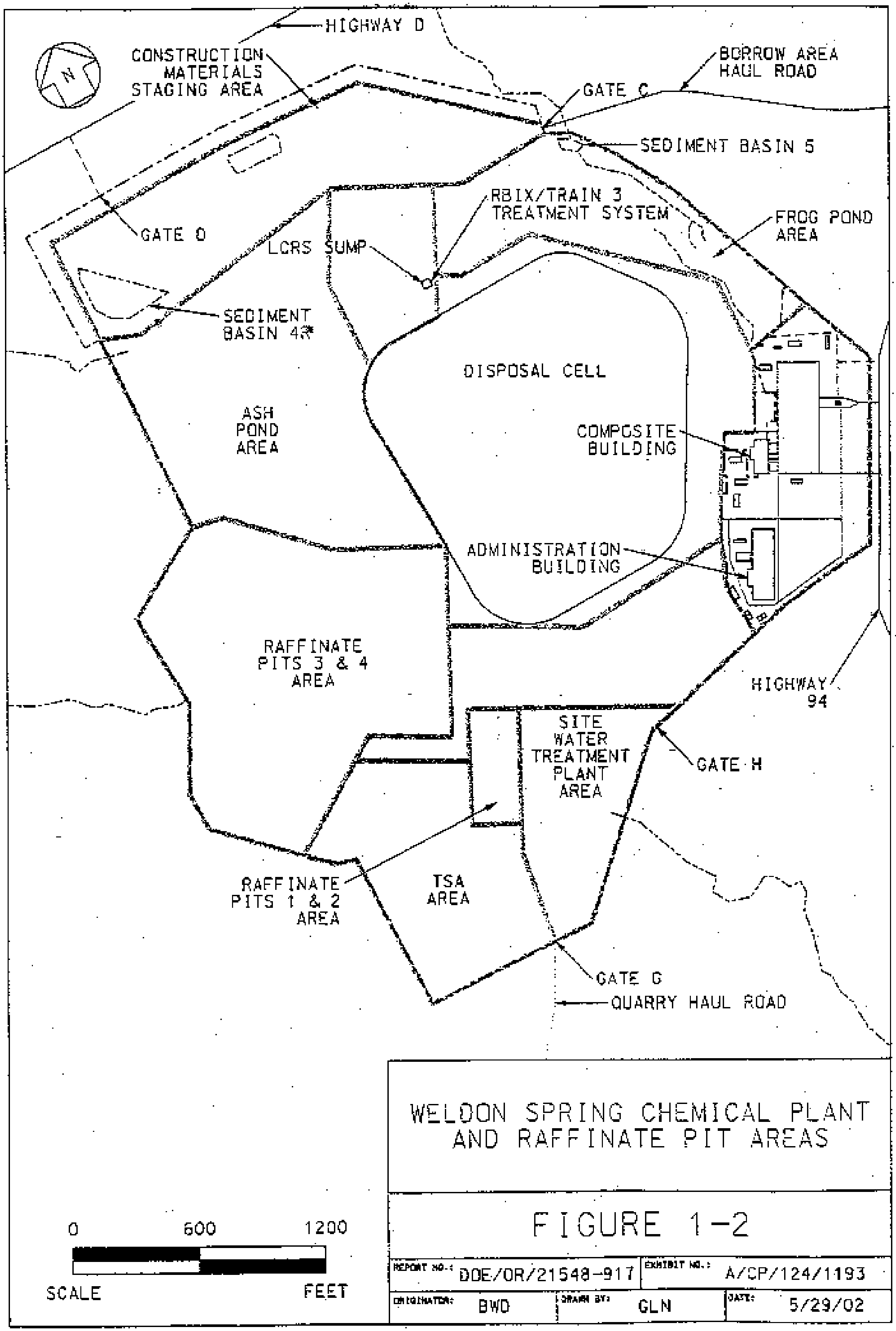
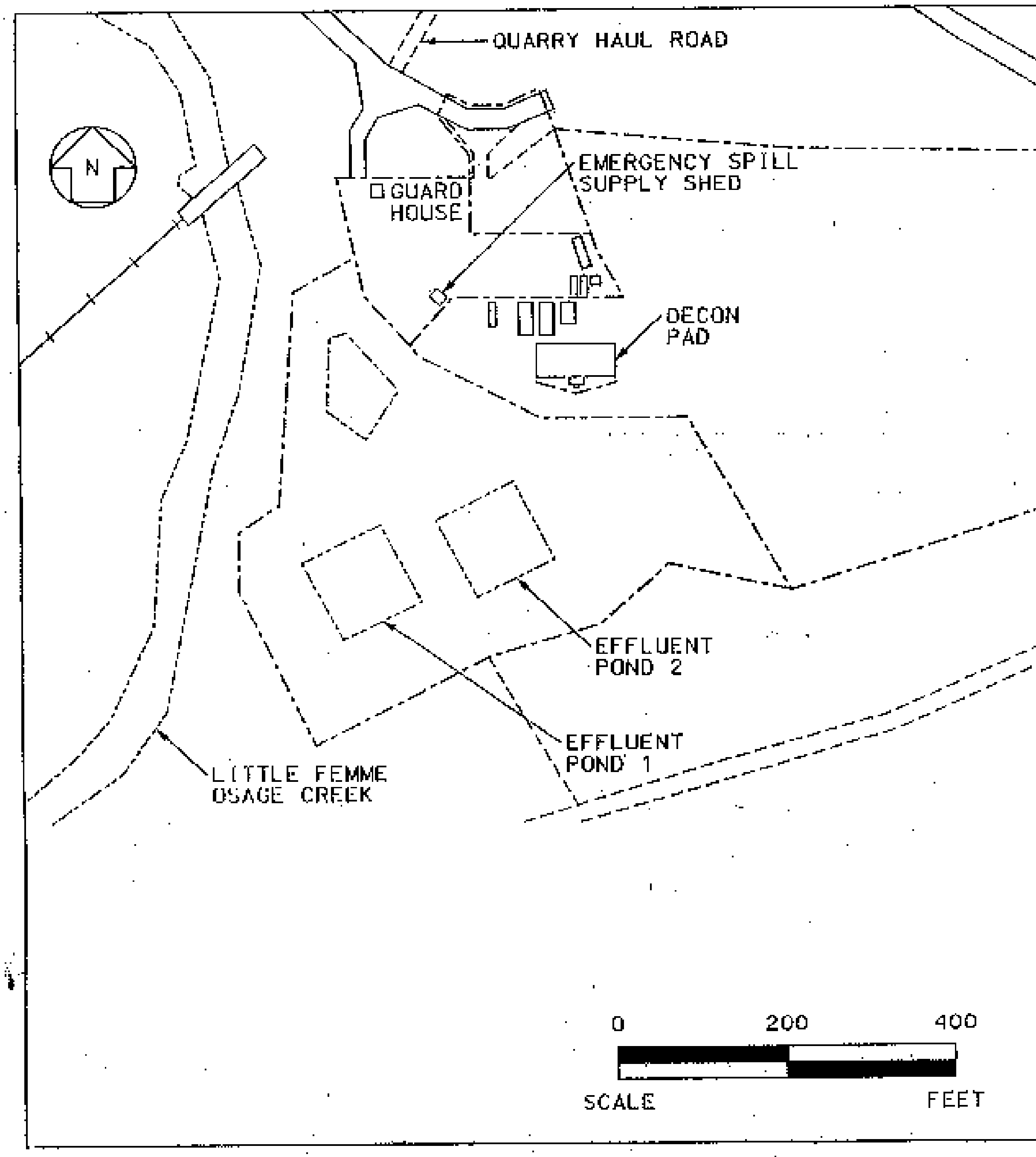


WELDON SPRING CHEMICAL PLANT AND RAFFINATE PIT AREAS

FIGURE 1-2

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/CP/124/1193	
ORIGINATOR: BWD	DRAWN BY: GLN	DATE: 5/29/02	



WELDON SPRING QUARRY AREA

FIGURE 1-3

REPORT NO.: DOE/OR/21548-917	EXHIBIT NO.: A/QY/007/0699	
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Through a Memorandum of Understanding between the Secretary of the Army and the General Manager of the Atomic Energy Commission (AEC), 83 ha (205 acres) of the former ordnance works property were transferred in May 1955 to the AEC for construction of the Weldon Spring Uranium Feed Materials Plant (WSUFMP), now referred to as the Weldon Spring Chemical Plant. Considerable explosives decontamination was performed by the Atlas Powder Company and the Army prior to WSUFMP construction. From 1958 until 1966, the WSUFMP 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 the four raffinate pits.

In 1958, the AEC acquired title to the Weldon Spring Quarry from the Army. The Army had used it since 1942 for burning wastes from the manufacture of TNT and DNT and disposal of TNT-contaminated rubble during the operation of the ordnance works. Prior to 1942, the quarry was mined for limestone aggregate used in the construction of the ordnance works. The AEC used the quarry from 1963 to 1969 as a disposal area for uranium residues and a small amount of thorium residue. Material disposed of in the quarry during this time consisted of building rubble and soils from the demolition of a uranium ore processing facility in St. Louis. These materials were contaminated with uranium and radium. Other radioactive materials in the quarry included drummed wastes, uncontained wastes, and contaminated process equipment.

The WSUFMP was shut down in 1966, and in 1967 the AEC returned the facility to the Army for use as a defoliant production plant to be known as the Weldon Spring Chemical Plant. The Army started removing equipment and decontaminating several buildings in 1968. However, the defoliant project was canceled in 1969 before any process equipment was installed. The Army retained responsibility for the land and facilities of the chemical plant, but the 20.6 ha (51 acre) tract encompassing the Weldon Spring raffinate pits was transferred back to the AEC.

The Weldon Spring site was placed in caretaker status from 1981 through 1985, when custody was transferred from the Army to the Department of Energy. In 1985, the DOE proposed designating control and decontamination of the chemical plant, raffinate pits, and quarry as a major project. A Project Management Contractor (PMC) for the Weldon Spring Site Remedial Action Project was selected in February 1986. In July 1986, a DOE project office was established on site, and the PMC, which consisted of MK-Ferguson Company and Jacobs Engineering Group, Inc., assumed control of the site on October 1, 1986. The quarry was placed on the Environmental Protection Agency's National Priorities List (NPL) in July 1987. The DOE redesignated the site as a Major System Acquisition in May 1988. The chemical plant and raffinate pits were added to the NPL in March 1989.

A more detailed presentation of the production, ownership, and waste history of the Weldon Spring site is available in the *Remedial Investigation for Quarry Bulk Wastes* (Ref. 1) and the *Remedial Investigation for the Chemical Plant Area of the Weldon Spring Site* (Ref. 2).

1.3 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 (Ref. 3).

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.

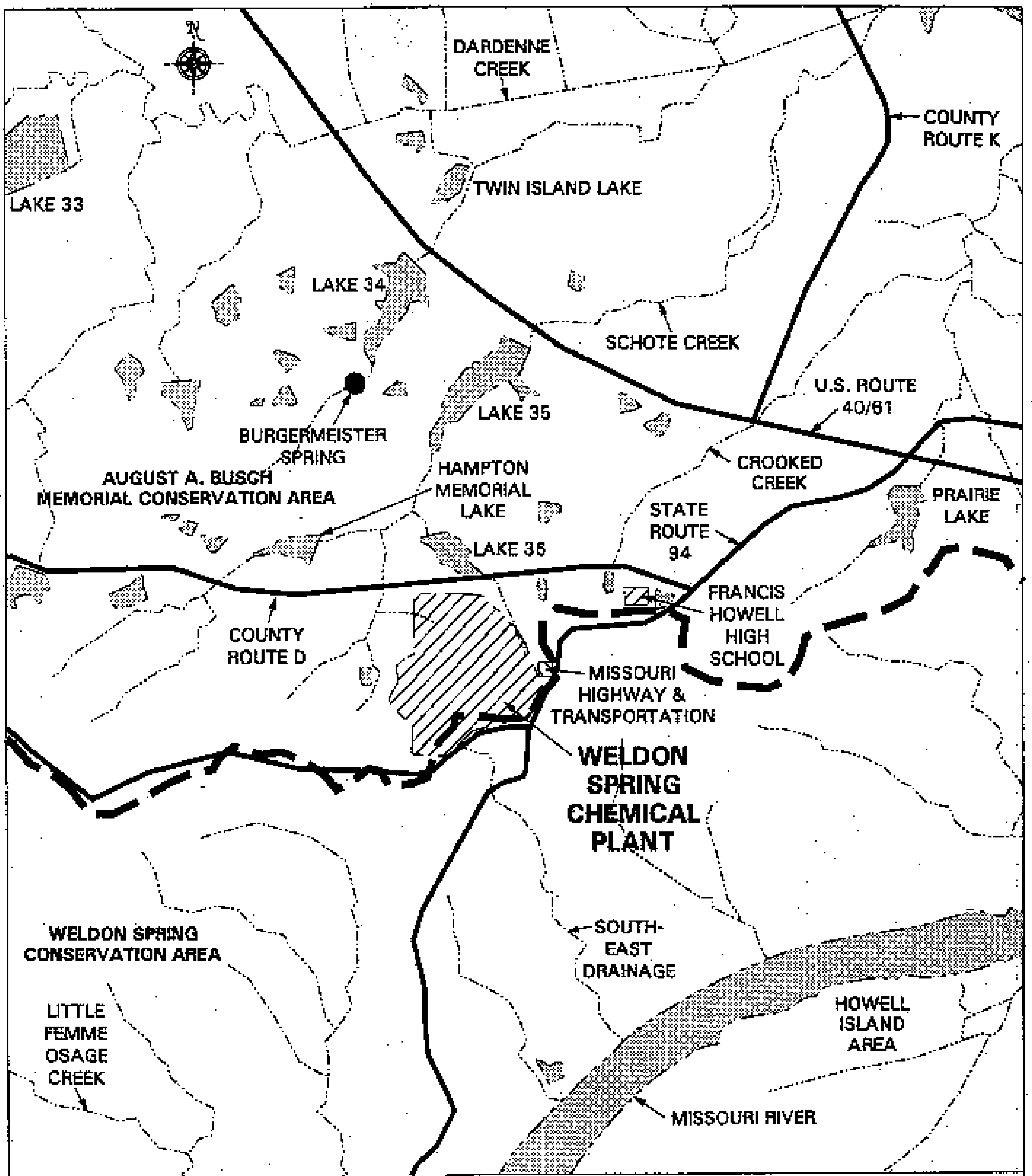
There are three bedrock aquifers underlying St. Charles County. The shallow aquifer consists of Mississippian Limestones, and the middle aquifer consists of the Ordovician Kimmswick Limestone. The deep aquifer includes formations from the top of the Ordovician St. Peter Sandstone to the base of the Cambrian 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) (Ref. 4). Massive quaternary deposits of Missouri River alluvium cover the bedrock to the south and east of the quarry.

1.4 Surface Water System and Use

The chemical plant and raffinate pits areas are on the Missouri –Mississippi River surface drainage divide, as shown in Figure 1-4. 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 (Ref. 3).

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.



LEGEND

- SURFACE WATER DIVIDE BETWEEN MISSISSIPPI RIVER AND MISSOURI RIVER
- CREEK OR SURFACE DRAINAGE
- POND OR LAKE

0 — 1 MI
0 — 1.6 KM
SCALE

PHYSICAL FEATURES OF WELDON SPRING AREA

FIGURE 1-4

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/VP/078/1193	
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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 in preparation for the final vegetation to be established during 2002. During remediation, some treated water was used for dust control in specified areas.

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 ground water. 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 partially backfilled during 2001. Storm water accumulating in the quarry after that was tested for uranium and released to the surface if concentrations were 100 pCi/l or less. The quarry pond was not used for any operational or public water supply and is maintained by the DOE within a fenced and restricted area.

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 (Ref 4). The slough is essentially land-locked and is currently used for recreational fishing. The slough is not used for drinking water or irrigation.

1.5 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 1-4).

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 (Ref. 5). 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 (Ref. 4).

1.6 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 (Ref. 6).

The National Oceanic and Atmospheric Administration has published the following information based on analysis of long-term meteorological records for the St. Louis area. Taking into account the past 30 years of data, the average annual temperature is 13.4°C (56.1°F). The average daily maximum and minimum temperatures are 18.6°C (65.4°F) and 8.2°C (46.7°F), respectively. Maximum temperatures above 32.2°C (90°F) occur about 40 days per year. Minimum daily temperatures below 0°C (32°F) occur about 100 days of the year. Temperatures below -18°C (0°F) are infrequent, occurring less than 5 days per year. Mean annual precipitation in the area is approximately 95.0 cm (37.5 in.).

Wind data recorded on site since 1994 indicate that prevailing winds are from the south and southwest. The average wind speed recorded during 2001 was 2.8 m/s (6.3 mph), and the predominant wind direction was from the south-southwest.

The meteorological station located at the chemical plant provides data to support site environmental monitoring programs. The station provides data on wind speed, wind direction, ambient air temperature, relative humidity, solar radiation, barometric pressure, and precipitation accumulation. Data from this station are used to assess meteorological conditions and air transport and diffusion characteristics, which help determine possible impacts of airborne contaminant releases. In addition, precipitation data are used to correlate water level fluctuations and contaminant concentrations in surface water and groundwater wells.

On-site meteorological data recovery exceeded 99% in 2001. Precipitation, temperature, wind speed, and wind direction results are in Table 1-1. Precipitation, average temperature, wind speed, and wind direction were all within historical ranges for the St. Louis area. An annual wind rose is presented in Figure 1-5.

Table 1-1 Monthly Meteorological Monitoring Results for 2001

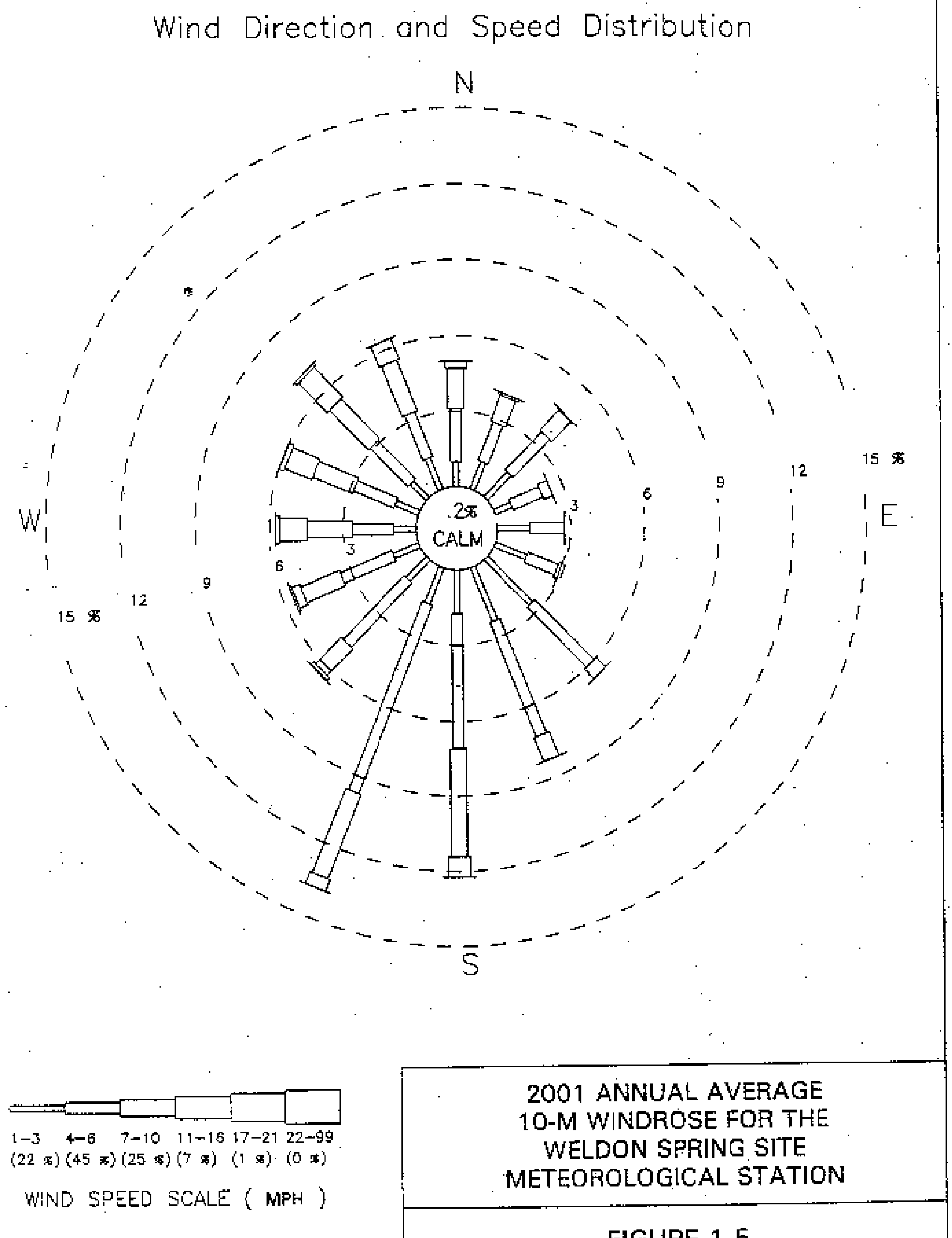
MONTH	TOTAL PRECIP (CM)	AVERAGE TEMP (DEGREES C)	AVERAGE WIND SPEED (M/SEC)	PREDOMINANT WIND DIRECTION
January	3.9	-0.9	2.9	SSW – 15.3%
February	7.6	1.7	3.3	S – 11.6%
March	4.0	4.8	3.1	NW – 17.1%
April	6.7	16.9	3.4	S – 20.4%
May	11.8	19.0	2.7	SSW – 16.0%
June	13.0	22.0	2.2	S – 17.0%
July	5.7	25.8	2.1	SSE – 13.8%
August	7.1	24.7	2.1	SSW – 10.9%
September	4.4	19.1	2.2	NE – 10.5%
October	13.9	13.7	3.2	SSW – 23.9%
November	9.5	11.3	2.8	SSW – 23.8%
December	9.0	4.0	3.1	SSW – 12.5%
Annual Average/Total	96.7	13.5	2.8	SSW (13.5)

1.7 Land Use and Demography

The population of St. Charles County is about 300,000. Twenty percent of the population lives in the city of St. Charles, approximately 22 km (14 mi) northeast of the Weldon Spring site. The population in St. Charles County has increased by about 30% over the past 10 years. 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% of county land, and nonurban areas occupy 90%; the remaining 4% is dedicated to transportation and water uses (Ref. 7).

Francis Howell High School (FHHS) is about 1 km (0.6 mi) northeast of the site along Missouri State Route 94 (Figure 1-4). The school employs approximately 150 faculty and staff, and about 1,500 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 Highway and Transportation Department (MHTD) 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 WSSRAP and periodically is visited by Department of the Army (DOA) trainees and law enforcement personnel (Ref. 7). 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 WSSRAP are operated by the Missouri Department of Conservation and employ about 50 people.



2001 ANNUAL AVERAGE 10-M WINDROSE FOR THE WELDON SPRING SITE METEOROLOGICAL STATION

FIGURE 1-5

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/PI/058/0502
ORIGINATOR: BWD	DRAWN BY: GLN	DATE: 5/29/02

2. ENVIRONMENTAL PROTECTION/RESTORATION PROGRAM OVERVIEW

2.1 Project Purpose

The U.S. Department of Energy (DOE) is responsible for the remedial action activities at the Weldon Spring Site Remedial Action Project (WSSRAP). The major goals of the WSSRAP are to eliminate potential hazards to the public and the environment posed by the waste materials on the Weldon Spring site and, to the extent possible, make surplus real property available for other uses.

Remedial actions are subject to U.S. Environmental Protection Agency (EPA) oversight under the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA). Remedial actions at the site are subject to CERCLA requirements because the site is listed on the EPA National Priorities List (NPL). Section 3 of this document further discusses applicable Federal, State, and local compliance requirements and the current status of compliance activities at the Weldon Spring site and incorporating *National Environment Policy Act* (NEPA) values into CERCLA documents as outlined in the DOE Secretarial Policy Statement on NEPA.

2.2 Project Management

In order to manage the WSSRAP under CERCLA, the proposed strategy for remedial activities at the Weldon Spring site is organized into the following four separate operable units: Weldon Spring Quarry Bulk Waste, Weldon Spring Chemical Plant, Groundwater, and Quarry Residuals. The Weldon Spring Quarry Bulk Waste Operable Unit included all wastes deposited in the quarry and their removal. The Weldon Spring Chemical Plant Operable Unit includes the original chemical plant buildings, contaminated soils, raffinate pits, quarry bulk wastes that were staged at the temporary storage area (TSA), vicinity properties, and surface waters within the chemical plant boundary. The Groundwater Operable Unit includes the groundwater at the chemical plant and vicinity areas. The Quarry Residuals Operable Unit includes the quarry proper (post-bulk waste removal), surface waters, and groundwater.

2.3 Environmental Monitoring Program Overview

The overall goal of the WSSRAP is different than that of most operating and production facilities for which DOE Order 5400.1, *General Environmental Protection Program*, was developed. At the WSSRAP, environmental monitoring is conducted as required by DOE Order 5400.1 to measure and monitor effluents and to provide surveillance of effects on the environment and public health. In addition to these objectives, environmental monitoring activities support remedial activities under CERCLA. This requires a careful integration of WSSRAP activities to implement all the environmental and public health requirements of CERCLA, DOE orders, and other relevant Federal and State regulations.

The WSSRAP complies with DOE Order 5400.1 requirements for preparation and maintenance of an *Environmental Monitoring Plan* (EMP) (Ref. 8). The EMP details the schedule and analyses required for performing effluent monitoring and surveillance activities.

The WSSRAP environmental protection program involves radiological and chemical environmental monitoring and is separated into two distinct functions: effluent monitoring and environmental surveillance. Effluent monitoring assesses the quantities of contaminants in environmental media at the facility boundary, in contaminant migration pathways, and in pathways subject to compliance with applicable regulations. Environmental surveillance consists of analyzing environmental conditions within or outside the facility boundary for the presence and concentrations of site contaminants. The purpose of this surveillance is to detect and/or track the migration of contaminants. Surveillance data are used to assess the presence and magnitude of radiological and chemical exposures and to assess the potential effects to the general public and the environment.

The WSSRAP radiological environmental monitoring program involves sampling various media for radiological constituents; primarily total uranium (U-234, U-235, and U-238) and/or Ra-226, Ra-228, Th-228, Th-230, and Th-232. These parameters are the primary radiological contaminants of concern at the Weldon Spring site. Radiological monitoring is conducted on National Pollutant Discharge Elimination System (NPDES) discharges, streams, lakes, ponds, groundwater, and springs. Radiological air monitoring was discontinued at the end of 2000 because radioactive waste handling activities were essentially complete and no critical receptor air monitoring data had ever demonstrated a dose to the public of greater than 10% of the 10 mrem standard (Ref. 7).

Chemical environmental monitoring is primarily conducted at the chemical plant and quarry areas, but also includes monitoring at off-site locations to confirm that no releases have occurred. The nonradiological compounds included in the routine 2001 monitoring program are metals, inorganic ions (nitrate and sulfate), TCE, and nitroaromatic compounds.

2.4 Project Accomplishments in 2001

Several activities were completed in 2001 under the overall plan for remediation of the site. Major accomplishments for the operable units are detailed below.

2.4.1 Weldon Spring Chemical Plant Operable Unit

The majority of the Chemical Plant Operable Unit remediation activities have been completed.

2.4.1.1 Site Water Treatment Plant and Quarry Water Treatment Plant

The Quarry Water Treatment Plant was dismantled in April and May of 2001 and placed into the dimple of the disposal cell in June 2001. Thus, neither the site nor quarry water treatment plants still exist.

Two mobile systems are permitted to replace the quarry and site water treatment plants. These are the Retention Basin Ion Exchange (RBIX) System and the Train 3 Mobile Treatment System. The RBIX has a nominal treatment capacity of 250 gallons per minute, and Train 3 has a nominal capacity of 50 gallons per minute. Both treatment systems utilize solid media cartridge filters to remove suspended solids and Dowex 21K Ion Exchange media to remove dissolved uranium. An additional precipitation treatment technology was added to Train 3 to treat for manganese. Train 3 was disassembled in 2001 to allow the components to be permanently installed in a building near the disposal cell Leachate Collection and Recovery System (LCRS).

2.4.1.2 Disposal Cell

- Completed remediation and confirmation of the stormwater drain in the administration work zone, which completed confirmation of chemical plant soils.
- Opened a small area of the cell for final waste acceptance, then closed with clean cover.
- Placed remaining 2 feet of the 3-foot radon barrier on top of waste in the disposal cell.
- Completed the final layers of the disposal cell cover.
- Upgraded the LCRS sump for methane control.
- Completed final site grading.
- Made progress toward restoration of the borrow area, including the watershed enhancement area.

Semi-annual groundwater compliance monitoring for the disposal cell continued in 2001. Analytical data for this effort can be found in Section 7, *Groundwater Monitoring*.

2.4.2 Weldon Spring Quarry Bulk Waste Operable Unit

This operable unit was officially closed in April 1997.

2.4.3 Weldon Spring Quarry Residuals Operable Unit

The Quarry Residuals Operable Unit (QROU) addresses contamination remaining in the quarry after the water and bulk wastes were removed. The following activities were completed:

- Demolition of the Quarry Water Treatment Plant (QWTP) and disposal in the cell.
- Operation of the Quarry Interceptor Trench System (QITS).
- Completion of the 75,000 cy of initial backfill.
- Finalization of the design and specifications for quarry reclamation.

The results of the QITS field study are published in the *Evaluation of the Performance of the Interceptor Trench Field Study* (Ref. 11), to be finalized in 2002. A brief summary is also provided in Section 10 of this report.

2.4.4 Weldon Spring Groundwater Operable Unit

The *Interim Record of Decision for Remedial Action for the Groundwater Operable Unit at the Chemical Plant Area of the Weldon Spring Site* (Ref. 20) was issued in September 2000. This document presents the selected interim remedial action for the Weldon Spring Groundwater Operable Unit. This action provides for remediation of trichloroethylene (TCE) contaminated groundwater in the chemical plant area. The other contaminants of concern will be addressed in the final Record of Decision that will be issued at a later time.

2.4.4.1 Groundwater Chemical In-Situ Oxidation Treatment

A bench testing subcontract for in-situ chemical oxidation of TCE in groundwater was awarded to four specialty contractors. The four subcontractors conducted bench-scale tests that were successful in removing TCE from site groundwater under laboratory conditions. The reports were received in May 2001.

A subcontract for performance of pilot scale treatment and delivery of a full-scale design for in-situ chemical oxidation of TCE in the groundwater was awarded on December 26, 2001. A brief summary is provided in Section 10 of this report.

2.4.4.2 Pump and Treat Study

Additional groundwater field studies were performed to determine whether enhancement by artificial recharge or angled extraction wells can significantly improve contaminant removal rates as compared to mass removal using a conventional pump and treat system. The design of the field studies, which is outlined in *Additional Groundwater Field Studies in Support of the Groundwater Operable Unit* (Ref. 13), included six staged studies. Stages 1, 2, 3, 4, and 5 were performed from March 9, 2001, through August 12, 2001. Stage 6 was omitted from the study.

The results of the study are documented in the *Completion Report for the Additional Groundwater Field Studies in Support of the Groundwater Operable Unit* (Ref. 17), to be finalized in 2002. A brief summary is also provided in Section 10 of this report.

2.5 Incident Reporting - Environmental Occurrences in 2001

In accordance with DOE Order 5400.1, Chapter II, 2.(b), field organizations are required to prepare annual summary reports on environmental occurrence activities and to report this information in the annual site environmental report.

In 2001, four off-normal occurrences of an environmental nature were reported under DOE Order 232.1A, *Occurrence Reporting and Processing of Operations Information.* Table 2-1 lists these occurrences, which are discussed in the following paragraphs. The locations of the outfalls mentioned are shown in Figure 6-2.

Table 2-1 Environmental Occurrences Calendar Year 2001

OCCURRENCE REPORT NUMBER	OCCURRENCE DATE	SUBJECT OF OCCURRENCE
2001-0001	01/30/2001	NPDES permit exceedance.
2001-0003	07/24/2001	Two NPDES permit exceedances.
2001-0005	08/06/2001	NPDES notification level.
2001-0006	10/10/2001	Two NPDES permit exceedances and three NPDES notification levels.

OCCURRENCE 2001-0001

A stormwater sample was collected at outfall NP-0002 on January 29, 2001, at approximately 1200 hours. The settleable solids were measured at 60 ml/l/hr, which exceeds the NPDES permit limit of 1.0 ml/l/hr. The sample was taken after the site had received approximately 0.90 inches of rainfall since 2100 hours the day before. The sample was collected downstream of the newly installed rock check dam. The sediment layer was light and fluffy. The water at the v-notch weir and downstream was heavily turbid.

This was the first appreciable precipitation that occurred after a heavy snow had melted and the site had gone through several freeze-thaw cycles. This, in addition to saturated ground conditions, may have caused the initial runoff to be heavily laden with solids. There was a fairly heavy flow from the cell area into the sedimentation basin. This water was heavily turbid and entered the sedimentation basin near the inlet of the discharge pipe. This may have contributed to elevated solids levels since the outlet pipe was opened to allow a flow of approximately 20 gallons per minute. There was also flow into the area behind the v-notch weir from an area to the west where a berm had been installed to divert water to the sedimentation basin. This water was flowing through the berm and was very turbid. Other factors that may have contributed to the NPDES exceedance include the accumulation of sediment behind the v-notch weir and salt from the adjacent Highway Department storage yard, which caused solids to settle that might not otherwise have settled.

A subsequent sample was collected from the weir on the day following the exceedance, January 30, 2001. The settleable solids level was 0.40 ml/l/hr.

A letter was sent to MDNR on February 2, 2001, addressing the exceedance of the settleable solids level for the NPDES permit MO-0107701.

The area was inspected, and it was observed that the gate valve at Sedimentation Basin 5 was being operated in a partially open position to keep the valve from freezing. As the storm event began, murky water flowed into the basin, and immediately flowed through the gate valve with little or no settling time. This was occurring when the sample on January 29, 2001, was collected. As stormwater filled up the basin, it began to flow over the rock berm. The sample on January 30, 2001, was collected when the water was coming not only through the valve gate but also over the berm.

For the remainder of the winter (6 to 8 weeks), the outlet pipe was plugged to prevent freezing of the gate valve, and the basin was allowed to fill and flow over the berm during storm events. After storm events, water from the basin was pumped over the berm (decanting from the top) to create additional holding capacity for the next storm event. In addition, sediment was removed from behind the weir, and access to the weir was upgraded.

OCCURRENCE 2001-0003

Storm water samples for July 2001 were collected at outfalls NP-0003 and NP-0005 during a storm event on July 20, 2001. There was approximately a 0.8 inch rainfall in less than 1 hour. This occurred after several days of spotty light showers, which were preceded by an extended dry period. Samples were collected near the peak runoff period of the storm.

Outfall NP-0003 is the outfall on the west side of the site, downstream of the remediated Ash Pond area. Most of the area was vegetated. The settleable solids were 13.0 ml/l/hr, which exceeded the NPDES permit limit of 1.0 ml/l/hr. Most of the area upstream of outfall NP-0003 was already stabilized, but there had been changes in the disposal cell area that involved disturbed soils. Erosion and sediment controls were apparently not adequate to handle such a large area.

Outfall NP-0005 is located on the southeast side of the site, at the head of the Southeast Drainage. The settleable solids were 15.0 ml/l/hr, which exceeded the NPDES permit limit of 1.0 ml/l/hr. Most of the flow goes to a sedimentation basin, is allowed to settle, and then is pumped off site. There was no flow from the sedimentation basin at the time the sample was collected. The small flow from which the sample was collected was from an existing roadway and another small area below the sedimentation basin berm that was not yet stabilized.

A letter was sent to MDNR on July 25, 2001, addressing the exceedances of the settleable solids level for NPDES permit MO-0107701. As corrective actions, several additional rock check dams were installed in the Ash Pond drainage, upstream of outfall NP-0003. Additional rock check dams were installed on either side of the rip rap outside the sedimentation basin watershed to improve the situation at outfall NP-0005. Also, in anticipation of removing the sedimentation basin, several small rock check dams were installed downstream of the perimeter road outside the site boundary.

OCCURRENCE 2001-0005

On June 11, 2001, a batch of treated groundwater (Site Batch S194) was sampled for priority pollutants. The chloroform concentration was 530 μg/l, which is greater than the 100 μg/l reporting level noted in the NPDES Permit MO-0107701 Special Condition C.2. This condition requires that the State be notified if the level for a toxic pollutant is above a specified level. The priority pollutants were sampled since this would be the first batch of treated groundwater to be discharged.

The pump-and-treat operation consisted of treatment of the groundwater by activated carbon, cartridge filtration, ion exchange, and then biodenitrification. After the water was biodenitrified it was transferred to a tank and shock chlorinated to reduce chemical oxygen demand (COD) levels. The sample was collected the day after the water was dosed with sodium hypochlorite. The chloroform is believed to have been generated by the action of the chlorine (from sodium hypochlorite) on organics in the water. Organics were present in the water prior to chlorination as demonstrated by elevated COD results. A whole effluent toxicity (WET) test was conducted on water collected on June 13, 2001, after chlorine levels were reduced, and there was no mortality of test organisms (Ceriodaphnia and Fathead minnows). The water was discharged on June 15, 2001. Chloroform is a volatile organic, and the water was aerated for several days after chlorination; therefore, it is likely that the chloroform would have been reduced to a much lower level prior to discharge.

OCCURRENCE 2001-0006

On October 5, 2001, storm water samples were collected at outfalls NP-0002 and NP-0003. The settleable solids were measured at 5.0 ml/l/hr and 2.0 ml/l/hr, respectively, which exceeded the NPDES permit limit of 1.0 ml/l/hr. The samples were taken after the first appreciable rainfall since September 18, 2001. The outfall NP-0002 watershed had received final grading and was seeded and mulched. The settled solids appeared to be a fluffy layer and, as in the past, may have been affected by the run-off from the road salt storage pile at the adjacent Highway Department. Another contributing factor may have been that the sedimentation basin above the outfall had been removed. In addition, this was the first rain since the site earth work was completed. There are two rock check dams downstream of this area. The sample was collected at the second dam.

The outfall NP-0003 watershed was undergoing final grading and had large areas that were still in the process of being graded. These areas had not yet been seeded or mulched. There were several check dams in the watershed. There was also a check dam on the east edge of the road at the outfall, and a new check dam had been installed on the west side of the road.

The fresh earth work and rain after a long dry period were also factors affecting the settleable solids. Settleable solids results for the other outfalls were below the permit limit.

Preliminary contract laboratory analytical results for outfalls NP-0003 and NP-0002 were received on October 23, 2001. Results indicated that chromium and lead concentrations were 230 µg/l and 105 µg/l, respectively, at outfall NP-0003.

Chromium was 144 µg/l at outfall NP-0002. Metals are analyzed for information only and do not have limits, therefore this was not a permit limit exceedance. However, Special Condition C.2.a.(1) of NPDES permit MO-0107701 required that the permittee notify the MDNR as soon as it is revealed that a concentration for any toxic parameter exceeds 100 µg/l.

Total suspended solids for outfalls NP-0002 and NP-0003 were 2,060 and 4,540 mg/l, respectively. Flows were approximately 420 gpm at outfall NP-0002 and 320 gpm at outfall NP-0003. The elevated metals are believed to be the result of elevated solids in the effluent. Causes for the elevated solids were discussed above. After the non-compliance, the outfall NP-0002 watershed was graded, and most of it was seeded. Straw bales were placed around the inlet to the outfall. Two rock check dams and several bale lines were placed across the channel on Army property downstream of the site property line.

2.6 Special DOE Order Related Programs

In addition to the direct program requirements and documentation required under DOE Order 5400.1, the DOE Order specifically requests that other programs be presented in the annual site environment report, including the groundwater protection management program, the meteorological monitoring program, and the waste minimization and pollution prevention program. This section also addresses other programs such as self assessments, the radiological control program, and the surface water management program at the WSSRAP.

2.6.1 Groundwater Protection Management Program

The WSSRAP has a formal groundwater protection and management program in place. The policies and practices are documented in the *Weldon Spring Site Remedial Action Project Groundwater Protection Management Program Plan* (Ref. 12). The plan outlines how monitoring programs will be developed to assess the nature and extent of contaminants in the groundwater, to evaluate potential impacts on public health, and to gather data for remedial decisions. All policies pertaining to groundwater monitoring, including well installation, decontamination, construction, sampling methods, and abandonment methods, are detailed in this plan. The plan outlines the hydrogeological characterization program conducted as part of CERCLA activities. These include groundwater sampling, water level monitoring, slug tests, tracer tests, and geologic logging. The plan also describes strategies for implementing site-wide groundwater protection practices and interdepartmental integration of these practices during all aspects of project management and development.

2.6.2 Meteorological Monitoring Program

During 2001, a meteorological station was located at the chemical plant to provide data to support the environmental monitoring programs. The meteorological station provided data on wind speed, wind direction, wind stability, ambient air temperature, relative humidity, barometric pressure, solar radiation, and precipitation accumulation. Data from this station was used to assess meteorological conditions and air transport and diffusion characteristics, which were used to support groundwater field studies, emergency response programs, worker protection programs, and surface water management programs. Since completion of a system upgrade in August 1994, meteorological data recovery has exceeded 99% each year.

The meteorological station will be dismantled in 2002 to allow for final site restoration. After this time, local metropolitan area data available from the National Weather Service will be used to support any remaining environmental programs.

2.6.3 Surface Water Management Program

The WSSRAP maintains a surface water management program to ensure effective implementation of policies detailed in DOE Order 5400.5 and documented in the *Surface Water Management Plan* (Ref. 14) and procedure ES&H 9.1.2, *Surface Water Management.* This program also incorporates the "as low as reasonably achievable" (ALARA) concept in the execution of the program.

This plan identifies existing and potential water sources and water quality categories, and provides the requirements and methodologies for proper control, management, and disposition of site waters. Erosion and water control, and water management for the quarry and site water treatment plants are also discussed. The key elements of the plan are source identification, characterization, monitoring, engineering controls, and management methods.

2.6.4 Radiation Protection Program

The U.S. Department of Energy issued 10 CFR 835, *Occupational Radiation Protection*, in December 1993. 10 CFR 835 sets the minimum acceptable occupational radiological control standards for DOE facilities. The regulation includes requirements for contamination control, ALARA practices, internal and external dosimetry, facility design and control, internal surveillances, instrumentation and calibration, worker training, posting and labeling, and release of materials from radiological areas to controlled areas.

As of December 31, 2001, the WSSRAP was in full compliance with all applicable sections of 10 CFR 835.

2.6.5 Waste Management Program

The waste management program encompasses all waste-related activities (both interim and long term) including characterization, treatment, storage, minimization, and disposal performed at the Weldon Spring site by project personnel, subcontractors, and subtier contractors. Hazardous, radioactive, toxic, mixed, special, and uncontaminated waste produced as a direct result of project cleanup activities are within the scope of this program. Garbage and refuse generated as a result of project administration are excluded.

Waste management activities for 2001 included:

- Shipment of incinerable waste to Diversified Scientific Services, Inc. (DSSI).
- Carbon adsorption treatment of TCE-tainted monitoring well purge water.
- Stabilization and neutralization of small quantities of miscellaneous hazardous waste.
- Collection and inventory of remaining chemical and laboratory wastes.
- Lab pack shipment of miscellaneous chemical wastes by Clean Harbors, etc.
- Management and planning for wastes generated after cell closure.

The waste management program also includes transportation activities such as packaging and shipping hazardous and nonhazardous wastes. The following transportation activities took place in 2001:

- Three shipments of hazardous waste were shipped off-site. These shipments included waste flammable liquids, chemical kits, toxic solids, corrosive liquids, oxidizing solids, cyanide solutions, mercury compounds, flammable solids, ammonium sulfide solutions, and toxic liquids.

- Five hundred and twenty seven light bulbs of various types were sent off site for recycling.

- Sixty-seven lead, 103 Ni-Cad, and 44 nickel metal hydride batteries were sent off site for recycling.

- Five pounds of mercury switches and 5 circuit boards were shipped off-site for recycling.

- Fifteen shipments totaling 7,340 gal of used oil were sent off site for recycling.

2.6.6 Waste Minimization/Pollution Prevention Program

The WSSRAP Waste Minimization Program is outlined in the *Waste Minimization/ Pollution Prevention Awareness Plan* (Ref. 15) in accordance with the requirements of DOE

Order 5400.1. Because long-term, volume-specific goals for waste minimization are not appropriate for nonoperational facilities, the WSSRAP has adopted ALARA goals.

The program is primarily geared toward material substitution and source or volume reduction methods to achieve minimization. This is accomplished by evaluating and reviewing all hazardous chemicals (as defined by 29 CFR 1926.59) before they are purchased or arrive on site, and recommending alternate materials or applying use restrictions. Additional methods routinely employed at the WSSRAP include removing packaging materials from products before they enter the radioactive materials management areas, limiting waste-generating activities during remediation and treatment, consolidating waste during storage, reviewing design specifications for possible methods to minimize waste generation, and segregating waste by waste types.

The following is a list of the different items which were recycled during 2001:

- Ni-Cad, lead, and nickel hydride batteries.
- Paper.
- Cardboard.
- Newspaper.
- Aluminum cans.
- Used tires.
- Mercury switches.
- Circuit boards.
- Toner cartridges.
- Light bulbs.
- Used oil.
- Various chemicals.

3. COMPLIANCE SUMMARY

3.1 Compliance Status for 2001

The Weldon Spring site is listed on the National Priorities List (NPL), and therefore the Weldon Spring Site Remedial Action Project (WSSRAP) is governed by the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) process. Under CERCLA, the WSSRAP is subject to meeting or exceeding the applicable or relevant and appropriate requirements of Federal, State, and local laws and statutes, such as the *Resource Conservation and Recovery Act* (RCRA), *Clean Water Act* (CWA), *Clean Air Act* (CAA), *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 3.1.1 is a summary of WSSRAP compliance with applicable Federal and State regulations, and Section 3.1.2 is a summary of WSSRAP compliance with major DOE Orders.

3.1.1 Federal and State Regulatory Compliance

Comprehensive Environmental Response, Compensation and Liability Act

The WSSRAP has integrated the procedural and documentation requirements of CERCLA, as amended by the *Superfund Amendments and Reauthorization Act* (SARA), and NEPA, as required by the policy stated in DOE Order 5400.4.

Resource Conservation and Recovery Act

Hazardous wastes at the Weldon Spring site are managed as required by RCRA as substantive, applicable, or relevant and appropriate requirements (ARARs). This includes 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 are generated during remedial activities. The majority of the hazardous waste activities at the site have been completed.

A RCRA treatment, storage, and disposal permit is not required at the site since remediation is being 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 RCRA was amended by the *Federal Facility Compliance Act* (FFCA), which was enacted on October 6, 1992. The site treatment plan for mixed waste, which was required by the FFCA was finalized with a consent agreement with the MDNR in October 1995. The *1998 Annual Update to the Site Treatment Plan for the Weldon Spring Site* (Ref. 16) was submitted to the MDNR October 15, 1998. In the update the WSSRAP reported that most of the mixed wastes had been treated. The actual completion of treatment of mixed wastes covered by the site treatment plan was accomplished on October 23, 1998.

RCRA groundwater monitoring for regulated units is discussed in detail in Chapter 7.

Clean Air Act

CAA compliance requirements pertaining to the site are found in Title I - Nonattainments, Title III - Hazardous Air Pollutants (including National Emission Standards for Hazardous Air Pollutants (NESHAP), and Title VI - Stratospheric Ozone Protection.

St. Charles County is classified in the Federal Register of November 6, 1991, 56 FR 215 as a moderate nonattainment area for ozone. As such, it is subject to requirements for sources emitting nitrogen oxides (NO_x) and volatile organic compounds (VOCs). At present, these sources do not exist at the WSSRAP.

St. Charles County is not subject to nonattainment area requirements for particulate matter (PM-10). However, the WSSRAP has instituted a voluntary program to monitor PM-10 on a regular basis in the vicinity of activities that generate dust. This program is discussed in Section 4.2.

Under Title III, asbestos and radionuclides are hazardous air pollutants that must be controlled in accordance with established standards. There were no potential sources of airborne asbestos or radionuclide emissions in 2001, so these contaminants were not monitored. The WSSRAP completed its critical receptor monitoring program for demonstrating compliance with the requirements of 40 CFR 61 Subpart H in 2000. No exceedances of the 10 mrem/yr standard were measured during the 11 years in which the program operated.

Clean Water Act

Effluents discharged to waters of the United States are regulated under the *Clean Water Act* (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 WSSRAP includes meeting parameter limits and permit conditions specified in five National Pollutant Discharge Elimination System (NPDES) permits. Under these permits, both effluent and erosion-control monitoring are performed. Section 6 provides additional details on the NPDES program.

Rivers and Harbors Act

No work was conducted during this reporting period that would fall under the jurisdiction of this Act.

Federal Insecticide, Fungicide, and Rodenticide Act

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

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.

Emergency Planning and Community Right-to-Know Act

The 2001 *Emergency Planning and Community Right-to-Know Act* (EPCRA) Tier II report was completed and provided on February 26, 2002, to the local emergency planning committee (LEPC), the Missouri State Emergency Response Commission (MERC), and Cottleville Fire Protection District.

The Toxic Release Inventory (TRI) report for 2001 is due on July 1, 2002. At this time the WSSRAP does not expect to be required to submit a TRI report.

Cultural Resources/National Historic Preservation Act

The FY00 Federal Archeological Activities Questionnaire was submitted on March 1, 2001. No archeological evaluations were performed at the WSSRAP during FY01.

Endangered Species Act

There was no activity this reporting period.

3.1.2 DOE Order Compliance

3.1.2.1 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 Burgermeister Spring. This dose was calculated to be 0.24 mrem, which is well below the 100 mrem (1 mSv) guideline for all potential exposure pathways.

The annual average uranium concentrations at all NPDES outfalls were well below the derived concentration guideline (DCG) of 600 pCi/l (22.2 Bq/l).

Records of all environmental monitoring and surveillance activities conducted at the Weldon Spring site during 2001 are maintained in accordance with the requirements of this Order. All reports and records generated at the WSSRAP during 2001, pursuant to DOE Order requirements, presented data in the units specified by the applicable regulation or Order.

3.1.2.2 DOE Order 5400.1, General Environmental Protection Program

The WSSRAP conducted both radiological and nonradiological environmental monitoring programs at the site and vicinity properties. Environmental monitoring required by DOE Order 5400.1 was conducted to measure and monitor effluents and to provide surveillance of their effects on the environment and public health.

The WSSRAP was in compliance with Order 5400.1 requirements for preparation of an *Environmental Monitoring Plan* (Ref. 8) that is reviewed annually and revised as necessary.

In addition to the plans developed for overall environmental monitoring and protection, the WSSRAP annually reviews and revises, as necessary, the *Weldon Spring Site Remedial Action Project Groundwater Protection Management Program Plan* (Ref. 12) and the *Waste Minimization/Pollution Prevention Awareness Plan* (Ref. 15). Refer to Sections 2.6.1 and 2.6.6 for additional details.

3.2 Summary of Permits for 2001

Various permits were maintained by the WSSRAP during 2001 for remedial activities including NPDES, excavation, and floodplain permits. Table 3-1 provides a summary of all NPDES permits. Five active NPDES operating permits covered discharges from the site water treatment plant (MO-0107701), quarry water treatment plant (MO-0108987), storm water discharges from the Borrow Area (MO-R100B69), hydrostatic test water from the site (MO-G670203) and quarry borrow area storm water (MO-R104031). An NPDES construction permit for the cell leachate collection and removal system was issued in January 1997. The construction is now complete and the permit expired on January 7, 2002.

Table 3-1 Summary of WSSRAP NPDES Operating and Construction Permits

PERMIT NO.	(a)	DATE ISSUED	EXPIRATION DATE	(b)	DATE RENEWAL OR EXTENSION REQUEST DUE	SCOPE AND COMMENTS
MO-0107701	O	07/14/00	07/13/05	N	01/13/05	Covers storm water, sanitary, and SWTP discharges.
MO-0108987	O	07/17/98	07/16/03	N	01/16/03	Covers QWTP discharge and stormwater.
MO-R100B69	O	01/06/97	01/02/02	Y	Renewal application submitted and pending.	Storm water discharges from Borrow Area and haul road operations.
MO-G670203	O	12/05/97	10/23/02	N	02/23/02 – (Will not submit extension.)	Covers hydrostatic test water at site.
MO-R104031	O	07/28/00	01/02/02	Y	Renewal application submitted and pending.	Covers quarry borrow area storm water land disturbance.
CP-22-5186	C	01/08/97	01/07/02	N	12/07/01	Covered construction of cell leachate collection system.

(a) Permit type, O = Operating, C = Construction
(b) Permit renewal application submitted N = No, Y = Yes.
QWTP Quarry water treatment plant
SWTP Site water treatment plant.

3.3 Site Mitigation Action Plan

Progress of mitigative actions for remediation of the Weldon Spring site is reported annually in this document, the site environmental report, in accordance with DOE Order 5440.1E. The *Mitigation Action Plan for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 19) was developed to present planned mitigation actions that provide protection for human health and the environment during remediation activities. The MAP is reviewed and updated, as necessary, to reflect site conditions. Mitigative actions for 2001 are described in the following paragraphs.

Construction activities at the Weldon Spring site are managed by using good engineering practices for control of surface water runoff at, and from, the site. Surface water protection during 2001 included erosion prevention and sediment control and monitoring. Monitoring was conducted at six outfall locations at the chemical plant and one at the quarry. The requirements of NPDES permits and the *Missouri Clean Water Act* were met during 2001. Further information on NPDES compliance issues is provided in Section 6.

Topsoils and subsoils from the Borrow Area that are being stored for use in restoration were stockpiled at the Borrow Area. Stockpile slopes were limited to 2.5:1 and stockpiles were seeded and mulched to control erosion. Erosion control measures were implemented at the Borrow Area and along the haul road. Stockpiles were routinely inspected for erosion. Two sedimentation ponds were constructed at the Borrow Area, and surface water was monitored to measure the effective removal of settleable materials. Specific NPDES compliance details for the Borrow Area are provided in Section 6. In 2001, the borrow area operations were completed and the area was reclaimed. The area was brought to final grade and the east side was permanently seeded. The west side received temporary seed and will receive permanent seeding in the spring of 2002.

Air, surface water, and groundwater were monitored as part of the routine environmental activities at the chemical plant area. The results of this monitoring are presented and discussed in the remaining sections of this report.

4. AIR MONITORING PROGRAMS

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* (Ref. 8). 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. With the final disposition of contaminated materials in the permanent disposal cell, the potential for airborne release of radionuclides has been eliminated. Thus, the environmental air monitoring program for 2001 consisted only of ambient dust monitoring.

4.1 Highlights of Air Monitoring

- All PM-10 measurements at the chemical plant, borrow area, borrow area haul road, quarry, and quarry borrow area were below the site action level of 150 $\mu g/m^3$.

4.2 PM-10 Monitoring

4.2.1 Program Overview

PM-10 consists of airborne particulate matter (PM) with an aerodynamic equivalent diameter of less than 10 µm. It is often referred to as respirable dust because it is the fraction of total suspended particulate matter that can be entrained by the lungs upon inhalation, thus causing a potential health concern.

PM-10 is emitted during many different types of construction activities, such as:

- Pulverization or abrasion of surface materials by mechanical means (e.g., soil excavation or treatment).
- Loading or unloading of bulk dry material (e.g., transfer of fly ash from trucks to storage silos).
- Movement of turbulent air currents over exposed surfaces (e.g., wind erosion of stockpiles).
- Re-entrainment of road dust due to vehicle or heavy equipment traffic (e.g., soil hauling activities).

- Combustion of fossil fuels (e.g., diesel-powered engines).

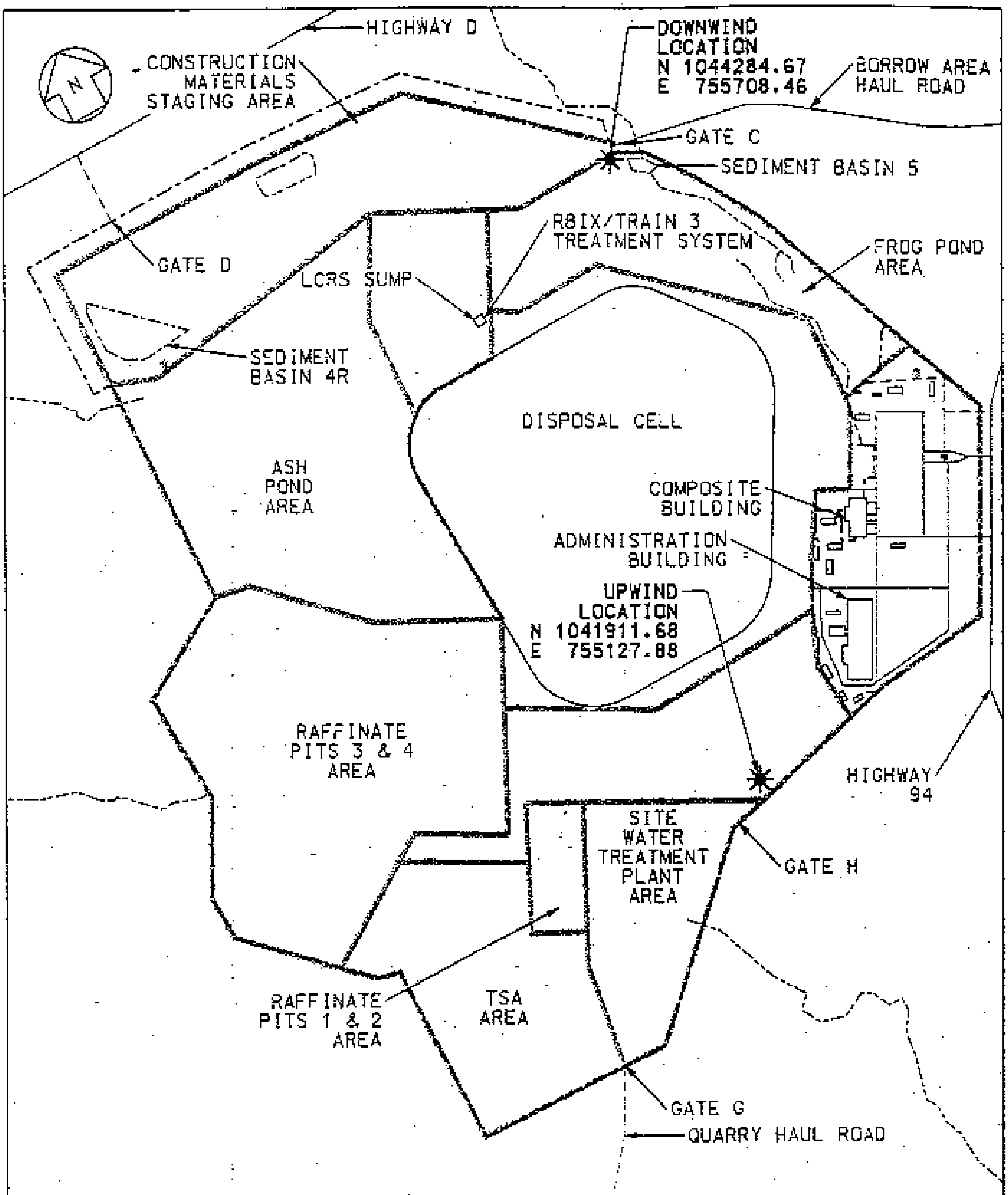
During 2001, the WSSRAP monitored ambient PM-10 levels at the perimeter of both the chemical plant area and the borrow area, along the borrow area haul road, at the Weldon Spring Quarry, and at the quarry borrow area. Portable monitoring stations, consisting of real-time aerosol monitors (RAMs) fitted with PM-10 impactor heads, were used to monitor ambient dust concentrations over a 24-hour period, both upwind and downwind of work activities. The chemical plant area map in Figure 4-1 shows the permanent locations established to monitor PM-10 emissions from disposal cell operations. These locations are based on historical prevailing wind patterns. Borrow Area locations were determined each monitoring period, based on the local National Weather Service forecasted wind direction. Figure 4-2 shows the eight designated locations along the Borrow Area perimeter where monitors could be placed, depending on predicted wind directions for the monitoring period. Figure 4-3 shows the locations at the Weldon Spring Quarry and quarry borrow area where monitors were placed, based on the assumption that prevailing winds would be from the south-southwest.

PM-10 monitoring was conducted weekly during the construction season (i.e., April to October) at both the chemical plant and borrow area perimeters. In addition, monthly measurements were made along the haul road between the borrow area and the disposal cell, at the Weldon Spring Quarry and at the quarry borrow area. Occasionally, severe weather conditions such as high winds, below-freezing temperatures, or significant precipitation precluded the use of the monitoring equipment, and the affected monitoring period was skipped. Since this usually coincided with the curtailment of excavation and hauling activities, it is unlikely that any exceedances of the site action level would have occurred during these times.

4.2.2 Applicable Standards

PM-10 monitoring is conducted at the WSSRAP to assess the ambient effects of construction and remedial activities, as committed to in the *Record of Decision for Remedial Action at the Chemical Plant of the Weldon Spring Site* (ROD) (Ref. 9, pp 55-56). The ROD states that although the National Ambient Air Quality Standards (NAAQS) "are not applicable and/or relevant and appropriate requirements (ARARs), the standards provide a sound technical basis for ensuring protection of public health and welfare during implementation and will be considered for components of the remedial action involving potential air releases."

While not specifically subject to the PM-10 NAAQS, the WSSRAP instituted a voluntary PM-10 monitoring program in April 1998, based on the results of screening models and discussions with the Missouri Department of Natural Resources (MDNR). The program is designed to assess the effectiveness of dust control measures and provide a basis for modifying them as necessary during remedial activities. A site action level of 150 $\mu g/m^3$ has been established for 24-hour average concentrations of PM-10 at the WSSRAP perimeter. Any exceedances of this limit would trigger the actions outlined in Procedure ES&H 1.1.7, *Environmental Data Review and Above Normal Reporting*.



LEGEND

✳ – PM-10 MONITORING LOCATION

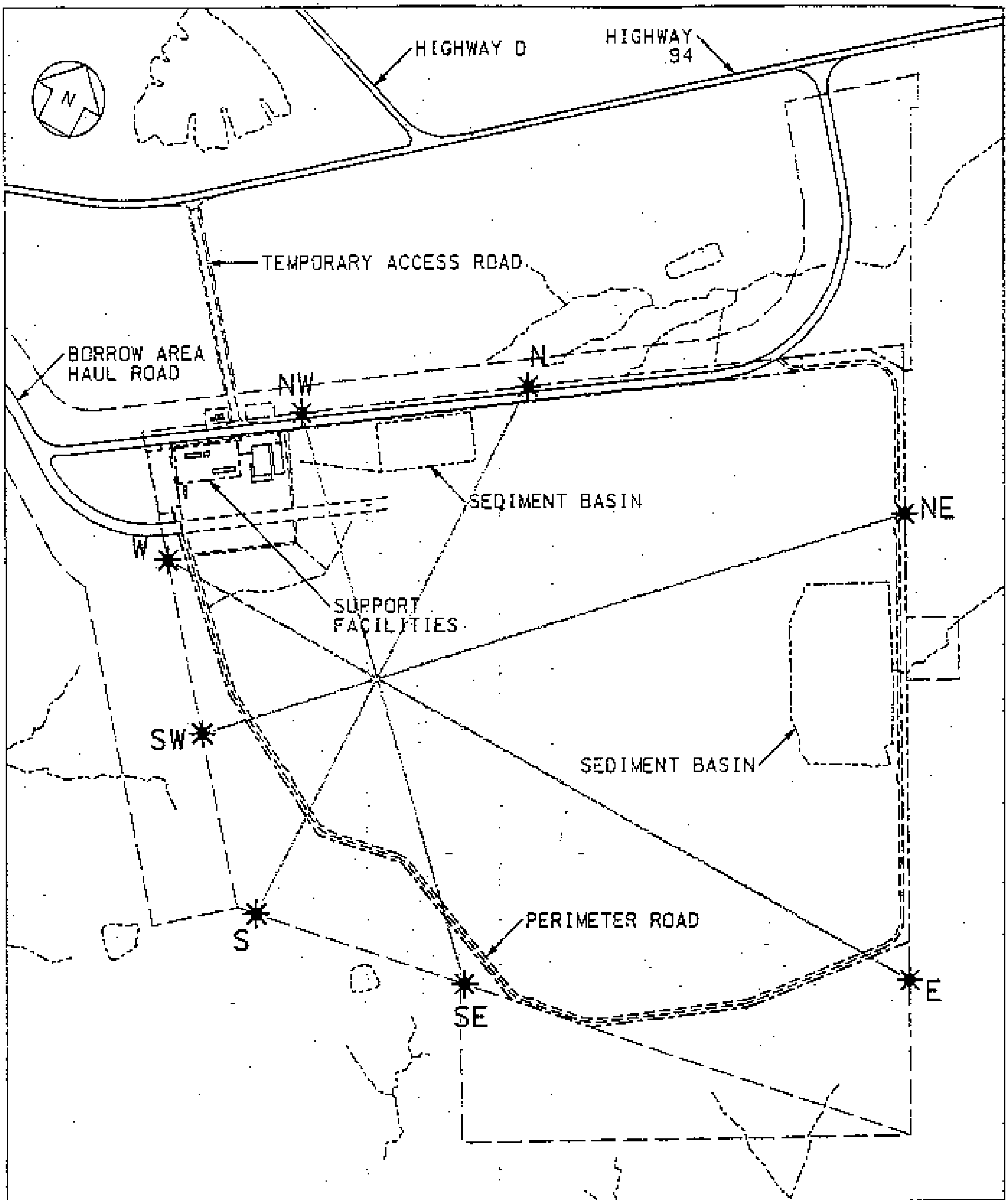
0 600 1200

SCALE FEET

PM-10 MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT SITE AND RAFFINATE PIT AREA

FIGURE 4-1

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/CP/013/0298	
ORIGINATOR: BWD	DRAWN BY: GLN	DATE: 3/28/02	



LEGEND

✱ – PM-10 MONITORING LOCATION

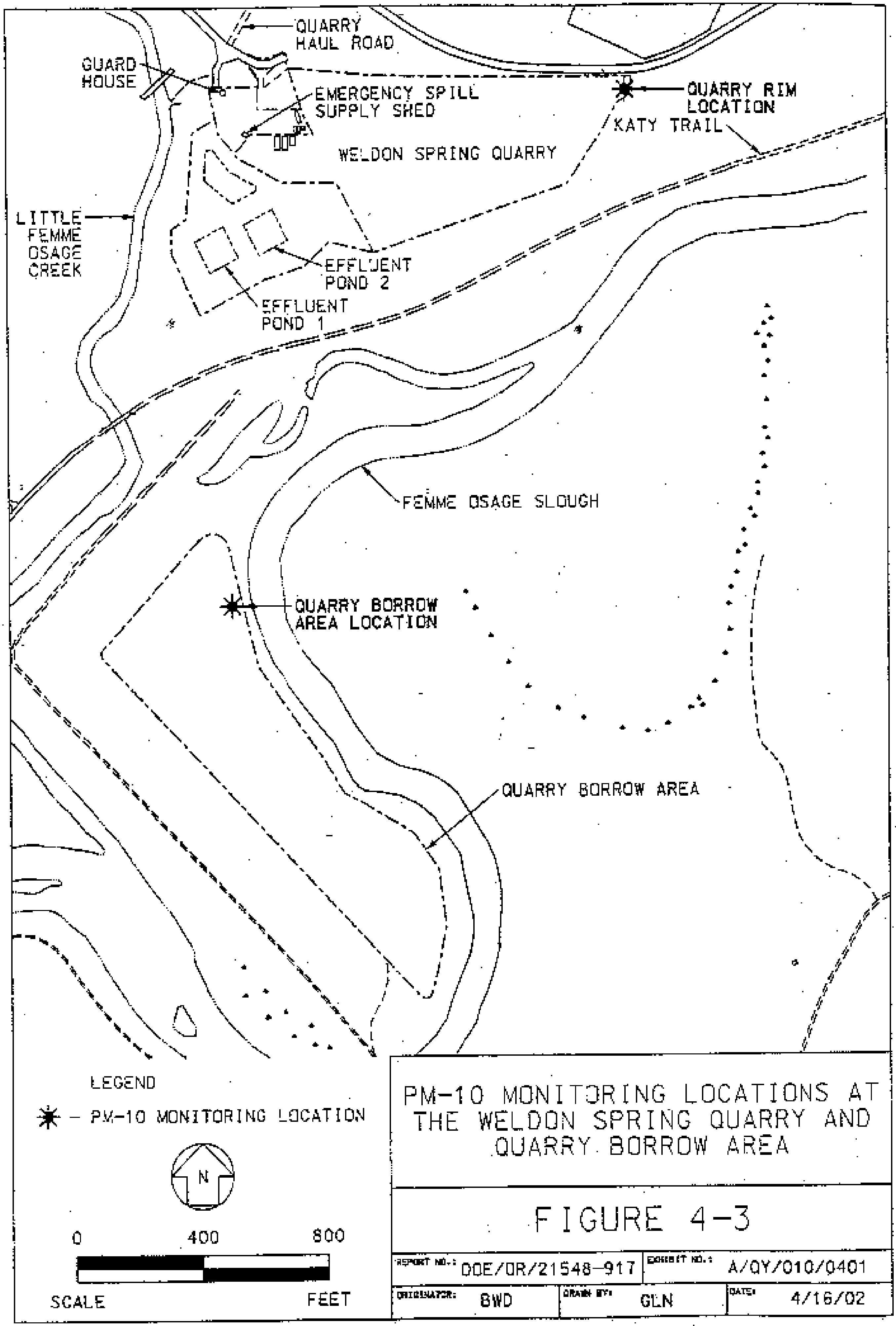
0 500 1000

SCALE FEET

PM-10 MONITORING LOCATIONS AT THE WELDON SPRING BORROW AREA

FIGURE 4-2

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/DC/012/0298	
ORIGINATOR: BWD	DRAWN BY: GLN	DATE: 3/28/02	



PM-10 MONITORING LOCATIONS AT THE WELDON SPRING QUARRY AND QUARRY BORROW AREA

FIGURE 4-3

REPORT NO.:	DOE/OR/21548-917	EXHIBIT NO.:	A/QY/010/0401
ORIGINATOR: BWD	DRAWN BY: GLN	DATE:	4/16/02

4.2.3 Monitoring Results

Data loggers attached to the RAMs recorded ambient PM-10 concentrations once per second. Hourly minimum, maximum, and average, as well as 15-minute STEL values were calculated and reported for each monitoring period. The resulting 24-hour average concentrations were all below the site action level of 150 μg/m^3. Table 4-1 shows the monthly average concentrations measured at the chemical plant, borrow area, borrow area haul road, quarry, and quarry borrow area. The highest 24-hour average concentrations of PM-10 recorded at any location during 2001 was 50 μg/m^3.

Table 4-1 2001 PM-10 Data for the Weldon Spring Site Remedial Action Project

LOCATION	NUMBER OF SAMPLING EVENTS (UPWIND/DOWNWIND)	MONTHLY AVERAGE OF MEASURED 24-HOUR CONCENTRATIONS (μg/m^3)	
		UPWIND	DOWNWIND
WSCP			
April	3/2	15	14
May	3/3	22	21
June	2/2	24	29
July	3/0*	27	ND
August	4/3	10	4
September	2/2	5	11
October	5/5	10	17
November	1/1	32	50
BORROW AREA			
April	1/1	31	15
May	2/2	24	20
June	1/1	39	31
July	1/1	9	14
August	3/2	7	5
September	2/3	16	3
BORROW AREA HAUL ROAD			
May	0/2	N/A	11
July	0/1	N/A	13
QUARRY N/A			
May	0/2	N/A	12
June	0/2	N/A	31
August	0/1	N/A	19
QUARRY BORROW AREA			
June	0/2	N/A	22

N/A Not applicable
ND No data recorded
* Attempts were made to monitor downwind concentrations three times in July; however, no valid data were recorded due to equipment malfunction.

4.2.4 Data Analysis

Results of the 2001 PM-10 monitoring program demonstrate that remediation activities conducted at the WSSRAP have had no significant impact on ambient dust levels. Monitoring stations near the site perimeter have recorded minor fluctuations in PM-10, but all results have been substantially below the 150-$\mu g/m^3$ standard for 24-hour average concentrations.

5. RADIATION DOSE ANALYSIS

This section evaluates the potential effects of surface and groundwater discharges of radiological contaminants from the Weldon Spring Site Remedial Action Project (WSSRAP). Effective dose equivalents to the general public have been calculated for 2001 based on all applicable exposure pathways. The calculations are compared to U.S. Department of Energy (DOE) limits contained in DOE Order 5400.5 to demonstrate compliance with regulatory requirements.

Exposure scenarios and dose calculations are presented both for a hypothetical maximally exposed individual and for a collective population. 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 no longer apply. 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.

5.1 Highlights

- The estimated total effective dose equivalent (TEDE) to the maximally exposed individual, which was due to consumption of water from Burgermeister Spring, was 0.24 mrem (2.4 E-3 mSv).
- The collective population effective dose equivalent (CPEDE) was estimated to be 0.103 person-rem (1.03 E-3 person-Sv) for users of the Busch Memorial Conservation Area.

5.2 Pathway Analysis

In developing specific elements of the WSSRAP environmental monitoring program, potential exposure pathways and health effects of the radioactive and chemical materials present on site are evaluated to determine which pathways are complete. This pathway analysis is detailed in the site *Environmental Monitoring Plan* (Ref. 8). As required by DOE Order 5400.1, evaluation of each exposure pathway is based on the sources, release mechanisms, types, and probable environmental fates of contaminants, and the locations and activities of potential receptors. If a link exists between one or more contaminant sources, or between one or more environmental transport processes and an exposure point where human or ecological receptors are present, the pathway is termed "complete." Complete pathways are used to assess radiological and nonradiological exposures. Each complete pathway is reviewed annually to determine whether a potential for exposure still exists. If it does, the pathway is termed "applicable." Only applicable pathways are considered in estimates of dose.

Table 5-1 lists the six complete pathways for exposure to radiological contaminants evaluated under the WSSRAP environmental monitoring program. These pathways are used to evaluate monitoring requirements and to determine radiological exposures from the site. Assessments of potential exposure routes in the *Feasibility Study for Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 25) have shown that the dose potential for pathways not listed in Table 5-1 is miniscule. Of the six complete pathways, two were applicable in 2001 and were incorporated into radiological dose estimates. These are Liquid (B) and Liquid (C).

Table 5-1 Complete Radiological Exposure Pathways for the Weldon Spring Site

EXPOSURE PATHWAY	PATHWAY DESCRIPTION	APPLICABLE TO 2001 DOSE ESTIMATE
Liquid(A)	Ingestion of contaminated groundwater from local wells downgradient from the site.	N
Liquid(B)	Ingestion of game and fish inhabiting wildlife area.	Y
Liquid(C)	Ingestion of surface water and sediments.	Y
Airborne(A)	Inhalation of particulates dispersed through wind erosion and remedial activities.	N
Airborne(B)	Inhalation of radon and radon decay products emitted from contaminated soils/wastes.	N
External	Direct gamma radiation from contaminated soils/wastes.	N

As shown in Table 5-1, the Liquid (A) pathway is not applicable to the 2001 dose estimate for the WSSRAP. Concentrations of radioactive contaminants in the production wells near the Weldon Spring Quarry are currently comparable to background concentrations (see Section 7.5). In addition, no drinking water wells are located in the vicinity of the contaminated groundwater in the chemical plant and raffinate pits area.

The airborne and external pathways are also not applicable to the 2001 dose estimate since the potential for airborne releases and direct gamma radiation have been eliminated.

DOE Order 5400.5 contains the applicable radiological public dose guideline for the WSSRAP, which is an annual limit of 100 mrem (1 mSv) total effective dose equivalent for all exposure pathways (excluding background).

5.3 Radiological Release Estimates

During 2001, intermittent surface water runoff transported isotopes of uranium, thorium, and radium from the site through six major discharge routes. These include two water treatment plant outfalls and seven storm water outfalls (see Section 6: Tables 6-3, 6-4, and 6-5). The outfalls were monitored monthly in accordance with National Pollutant Discharge Elimination System (NPDES) requirements. Total uranium concentrations measured in runoff water were multiplied by the natural uranium activity ratios for U-234, U-235, and U-238 (49.1%, 2.3%, and 48.6%, respectively) to determine the waterborne releases of those isotopes. Table 5-2 shows the estimated activity release of radionuclides to the environment, the corresponding mass released, and the half-life for each radionuclide present at the Weldon Spring site.

Table 5-2 Radionuclide Releases to the Environment

RADIONUCLIDE	ACTIVITY OF RADIONUCLIDES RELEASED TO WATER (Ci)	MASS OF RADIONUCLIDE RELEASED (grams)	HALF-LIFE (Yrs)
U-238	1.10E-3	3.24E+3	4.47E+09
U-235	5.22E-5	2.37E+1	7.04E+08
U-234	1.12E-3	1.77E-1	2.46E+05
Ra-226	2.37E-4	2.37E-4	1,600
Ra-228	2.57E-4	9.19E-7	5.76
Th-230	2.08E-4	1.04E-2	7.54E+04
Th-228	9.62E-5	1.16E-07	1.91
Th-232	8.34E-5	3.79E-4	1.40E+10
Total	3.15E-3	3.27E+3	N/A

N/A Not applicable.
Multiply by 3.7E10 to convert Ci to Bq.

5.4 Exposure Scenarios

Dose calculations were performed for maximally exposed individuals and for the collective population based on the applicable exposure pathways in Table 5-1 to assess dose due to radiological releases from the Weldon Spring site. Since inhalation is no longer an applicable pathway, incorporating a dose calculation for a population within 80 km (49.6 mi) of the site is unnecessary. Rather, the collective population dose equivalent was calculated for specific target populations where complete exposure pathways currently exist.

The scenarios and models used to evaluate these radiological exposures are conservative but appropriate. Although radiation doses can be calculated or measured for individuals, it is not appropriate to predict the health risk to a single individual using the methods prescribed here. Estimates of health risks are based on statistical models using epidemiological data collected from large groups of people exposed to radiation under various circumstances; therefore, they are not applicable to single individuals. Dose equivalents to a single individual are estimated by hypothesizing a maximally exposed individual and placing this individual in a reasonable but conservative scenario. This method is acceptable when the magnitude of the dose to a hypothetical maximally exposed individual is small, as is the case for the WSSRAP. The scenarios used in the calculations and the resulting estimated doses are outlined in Table 5-3. In addition, the percentage of the DOE limit of 100 mrem (1.0 mSv) TEDE is provided.

The collective population effective dose equivalent, provided in units of person-rem (person-Sv), is the product of the effective dose equivalent estimate at an exposure point and the number of persons potentially exposed. For the WSSRAP, exposure points for 2001 are locations where members of the public can be potentially exposed to above-background radionuclide concentrations in water or food. The committed effective dose equivalent is calculated by measuring radionuclide concentrations in the water and food at a given exposure point and applying standard ingestion rates and dose equivalent conversion factors. These concentrations and exposure scenarios are used to estimate the amount of radioactivity ingested by the potentially exposed population.

All ingestion calculations were performed using the methodology described in International Commission on Radiation Protection (ICRP) Reports 26 (Ref. 26) and 30 (Ref. 27) for a 50-year committed effective dose equivalent (CEDE). Dose conversion factors were obtained from the EPA Federal Guidance Report No. 11 (Ref. 28).

5.5 Dose Equivalent Estimates

Total effective dose equivalent (TEDE) estimates for the exposure scenarios were calculated using 2001 environmental monitoring data. Doses are well below the standards set by the DOE for annual public exposure.

In 2001, the TEDE for a hypothetical maximally exposed individual near the vicinity properties was 0.24 mrem (2.4 E-3 mSv). This value represents less than 0.3% of the DOE standard of 100 mrem (1 mSv) TEDE above background for all exposure pathways. In comparison, the annual average exposure to natural background radiation in the United States results in a TEDE of approximately 300 mrem (3 mSv) (Ref. 36). The collective population effective dose equivalent is 0.103 person-rem (1.03 E-3 person-Sv) for recreational users of the Busch Memorial Conservation Area. Assumptions upon which these doses are based are discussed below.

Table 5-3 Exposure Scenarios for Weldon Spring Site Radiological Dose Estimates

EXPOSURE SCENARIO	PATHWAY	ACTIVITY	MEDIA	EXPOSURE DURATION	EXPOSURE/ INTAKE RATE	CONCENTRATION	ESTIMATED EFFECTIVE DOSE EQUIVALENT	PERCENT OF DOE LIMIT
WSCP/WSRP Hypothetical Individual	Liquid(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSQ Hypothetical Individual	Liquid(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
WSVP Hypothetical Individual	Liquid(B)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Liquid(C)	Drinking water from Burgermeister Spring	Water	Once per week	0.237 l/week	See Table 5-4 for list of radionuclide concentrations	0.24 mrem	0.24%
Collective Population	Liquid(B)	Ingestion of fish from Busch Lake 35 (population = 100,000)	Fish	N/A	0.55 g/day	0.019 pCi/g-Natural Uranium	0.103 person – rem	N/A
	Liquid(C)	Swimming at Busch Lake 34 (population = 7,480)	Water	0.285 hr	0.05 liters/hour	8.2 pCi/l-Natural Uranium	0.0002 person – rem	N/A

N/A Scenario is not applicable to the hypothetical individual.
WSCP Weldon Spring Chemical Plant.
WSRP Weldon Spring raffinate pits.
WSQ Weldon Spring Quarry.
WSVP Weldon Spring vicinity properties.
Multiply by 0.037 to convert pCi to Bq.
Multiply by 0.01 to convert mrem to mSv.
Multiply by 0.01 to convert person-rem to person-Sv.

5.5.1 Radiation Dose from Vicinity Properties to a Hypothetical Maximally Exposed Individual

This section discusses the estimated total effective dose equivalent to a hypothetical individual assumed to frequent the Burgermeister Spring area of the Busch Memorial Conservation Area. No private residences are adjacent to Burgermeister Spring, which is situated on land currently managed by the Missouri Department of Conservation (MDC). Therefore, the calculation of dose equivalent due to the applicable pathway of water ingestion (Liquid C) is based on a recreational user of the Conservation Area who drank from Burgermeister Spring on a weekly basis in 2001.

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

- The maximally exposed individual drank one cup (0.237 l) of water from Burgermeister Spring each week (equivalent to 3.25 gal (12.3 l) of water for the year).
- Maximum radionuclide concentrations in water samples taken from Burgermeister Spring during 2001 (see Table 5-4) were assumed to be present in all of the water ingested by the maximally exposed individual.
- The dose conversion factors (DCFs) for ingestion (Ref. 28) listed in Table 5-4 apply.

(The DCF for total soluble uranium was calculated using isotopic dose conversion factors for ingestion and the natural uranium activity ratios listed in Section 5.3.)

Table 5-4 Maximum 2001 Radioisotope Concentrations and DCF's

RADIONUCLIDE	2001 MAXIMUM RECORDED CONCENTRATION (pCi/l)	DOSE CONVERSION FACTOR FOR INGESTION (mrem/pCi)
Total Uranium (soluble)	55.2	2.69E-4 (Soluble)
Ra-226	0.59	1.33E-3
Ra-228	2.38	1.44E-3
Th-228	<0.154[a]	3.96E-4
Th-230	<0.216[a]	5.48E-4
Th-232	<0.136[a]	2.73E-3
Ra-224	<0.154[a][b]	3.66E-4
Pb-212	<0.154[a][b]	4.56E-5

(a) Value represents the highest detection limit reported in 2001 since thorium isotopes were reported to be either below detection limits or non-detect.

(b) Ra-224 and Pb-212 concentrations are derived from measured Th-228 concentration, based on the assumption of secular equilibrium.

The total effective dose equivalent (TEDE) is calculated by summing the doses contributed by each radionuclide in the water, as shown below:

TEDE (ingestion of contaminated water) = TEDE (total uranium) + TEDE (Ra-226) + TEDE (Ra-228) + TEDE (Th-228) + TEDE (Th-230) + TEDE (Th-232) + TEDE (Ra-224) + TEDE (Pb-212)

where:

TEDE (ingestion of contaminated water for a given radionuclide) = Concentration (pCi/l) x Volume of Water Ingested (l) x Dose Conversion Factor (mrem/pCi)

TEDE (total uranium) = 55.2 pCi/l x 12.3 l x 2.69E-4 mrem/pCi

= 0.18 mrem

TEDE (Ra-226) = 0.59 pCi/l x 12.3 l x 1.33E-3 mrem/pCi

= 0.01 mrem

TEDE (Ra-228) = 2.38 pCi/l x 12.3 l x 1.44E-3 mrem/pCi

= 0.04 mrem

TEDE (Th-228) = 0.154 pCi/l x 12.3 l x 3.96E-4 mrem/pCi

= 0.0008 mrem

TEDE (Th-230) = 0.216 pCi/l x 12.3 l x 5.48E-4 mrem/pCi

= 0.001 mrem

TEDE (Th-232) = 0.136 pCi/l x 12.3 l x 2.73E-3 mrem/pCi

= 0.005 mrem

TEDE (Ra-224) = 0.154 pCi/l x 12.3 l x 3.66E-4 mrem/pCi

= 0.0007 mrem

TEDE (Pb-212) = 0.154 pCi/l x 12.3 l x 4.56E-5 mrem/pCi

= 0.00009 mrem

Thus, the TEDE for all radionuclides combined is (0.18 + 0.01 + 0.04 + 0.0008 + 0.001 + 0.005 + 0.0007 + 0.00009) mrem, or 0.24 mrem (2.4E-3 mSv).

5.5.2 Collective Population Effective Dose Equivalent

This section discusses the estimated CPEDE to the population assumed to be exposed to radioactive releases from the WSSRAP. The only potential general population exposure is from the consumption of water, sediment, and fish from the August A. Busch Memorial Conservation Area. Three lakes at the conservation area (i.e., Lakes 34, 35, and 36) receive runoff from the Weldon Spring site and are used for fishing and boating. The scenario used for the conservation area is based on recreational use for fishing, boating, and swimming activities. Only the ingestion pathways Liquid (B) and Liquid (C) were considered plausible for this assessment. Exposure scenario assumptions particular to this dose calculation are as follows:

- It is estimated that there are approximately 200,000 fishing visits per year at the Busch Memorial Conservation Area, which is adjacent to the chemical plant and raffinate pits area. In addition, approximately 7,480 persons per year participate in recreational boating activities. These figures represent a 25% increase over data in an eleven-year old survey conducted by the Missouri Department of Conservation (Ref. 29).

- The ratio of fish caught to time spent is 0.4 fish/hour, and the ratio of fish kept to fish caught is 0.5. The average duration of each visit is assumed to be 2.5 hours. If each fish caught is consumed by a different person, the affected population would be 100,000 persons.

- The highest average total uranium concentration in a composite sunfish sample collected from Lake 35 in 1998 (the last year for which data are available) was 0.019 pCi/g (7.0E-4 Bq/g). The edible portion of a fish is assumed to have a mass of 200 g. Over one year, the consumption rate would be 0.55 g per person per day.

- The average time spent at the Busch Conservation Area per boating trip was approximately 5.7 hours (Ref. 31). Each of 7,480 boaters made only one visit to the area and spent 5% of the time swimming.

- The maximum concentration of total uranium in surface water at the Conservation Area (Lake 34) was 8.2 pCi/l (0.31 Bq/l) (Table 6-10).

The CPEDE is calculated by summing the doses contributed by each ingestion pathway, as shown below:

Population Dose Equivalent (fish ingestion)

= consumption rate x total uranium concentration in fish x exposure time x total soluble uranium dose conversion factor x persons

= 0.55 g/day x 0.019 pCi/g x 365 day x 2.69 E-4 mrem/pCi x 100,000 persons x 1 rem/1,000 mrem

= 0.103 person-rem (1.03 E-3 person-Sv)

Population Dose Equivalent (water ingestion)

= ingestion rate x average total uranium concentration in Lake 34 water x exposure time x total soluble uranium dose conversion factor x number of individuals

= 0.05 l/hr x 8.2 pCi/l x 0.285 hr x 2.69E-4 mrem/pCi x 7,480 persons x 1 rem/1,000 mrem

= 0.0002 person-rem (2.4E-6 person-Sv)

Therefore, the CPEDE obtained from ingestion of food and/or water from the Busch Memorial Conservation Area in 2001 is:

Dose (fish ingestion) + Dose (water ingestion)

= 0.103 + 0.0002 person-rem

= 0.103 person-rem (1.03E-3 person-Sv)

6. SURFACE WATER PROTECTION

6.1 Highlights of the Surface Water Program

During 2001, most final grading and temporary seeding were completed at the chemical plant site. These items, and others, are discussed in detail in this chapter.

- The mass of uranium migrating off site in storm water and treated effluent, 3.34 kg/yr (7.35 lb/yr), was a 37.9% reduction from the 2000 mass of 5.38 kg/yr (11.84 lb/yr) (see Tables 6-5 and 10-1) and a 99.2% reduction from the 1987 mass of 442 kg.
- Nine samples of treatment plant effluent were collected at the site and quarry during 2001. All parameters monitored in treatment plant effluent were in compliance with National Pollutant Discharge Elimination System (NPDES) permit limits and conditions.
- The annual average concentration of uranium in storm water was reduced to less than 7.6 pCi/l at all outfalls (Table 6-3).
- The overall results of the whole effluent toxicity (WET) tests indicated that the site and quarry water treatment plant effluents were not toxic to test organisms during 2001 (Table 6-8).
- All contaminated surface water sources have been remediated.
- Surface water bodies downstream of the chemical plant site continue to show declining uranium levels (Figure 6-1 and Table 6-10).
- Surface water bodies downstream of the quarry continue to show declining uranium levels (Figure 6.3 and Table 6-11).

6.2 Program Overview

The environmental monitoring and protection program for surface waters at the Weldon Spring Site Remedial Action Project (WSSRAP) is described in the *Environmental Monitoring Plan* (Ref. 8) and includes discharge points permitted under the NPDES program and streams, ponds, and lakes under the surface water monitoring program.

The NPDES effluent monitoring program establishes sampling requirements for discharge points (outfalls) at the chemical plant, quarry, site and quarry borrow areas and hydrostatic test discharges. The goals of this program are to maintain compliance with the NPDES permit requirements and to protect the health of downstream water users and the environment by characterizing water released from the site. In accordance with the WSSRAP policy that all surface water be closely monitored and treated (as necessary) to meet Federal and State requirements, the Project Management Contractor (PMC) uses the water sample data to develop strategies to minimize the discharge of waterborne contaminants from the site and to measure the effectiveness of remediation.

In addition, the surface water monitoring program monitors off-site water bodies for uranium levels and temporal changes in uranium levels. The data generated from this monitoring are used in conjunction with NPDES monitoring to measure the success of the project goal of cleaning up the site with no long-term increase in contaminant discharge or degradation of off-site water bodies.

6.3 Applicable Standards

The WSSRAP is subject to, and complies with, Executive Order 12088, which requires all Federal facilities to comply with applicable pollution control standards. Effluent discharges from the site for 2001 were authorized by five NPDES permits issued by the Missouri Department of Natural Resources (MDNR). The MDNR requires specific parameters to be monitored at outfalls listed in each permit. Each parameter is assigned either effluent limits or a "monitoring only" status, which means the concentrations are reported but not limited by the permit. In addition, the WSSRAP monitors and reports some parameters on an informational basis. Sampling frequencies and reporting requirements for the two major permits, MO-0107701 (at the chemical plant site) and MO-0108987 (at the quarry), are summarized in Tables 6-1 and 6-2. These permits were reissued on July 14, 2000, and June 17, 1998, respectively. Permit MO-0108987 was revised on April 21, 2000.

The Site Borrow Area land disturbance storm water permit, MO-R100B69, issued on September 1, 1994, and reissued on May 29, 1998, has no specified monitoring or reporting requirements. A program was developed in the *Environmental Monitoring Plan* (Ref. 8) for monitoring settleable solids and, under certain circumstances, oil and grease. The results of this monitoring were used to measure the effectiveness of erosion controls and to improve them, if required.

Permit MO-G670203 was issued on December 5, 1997, for discharge of hydrostatic test water from the chemical plant site. Hydrostatic test water is water used to test tanks, pipes, etc., for leaks. It may also be used to test pumps, valves, etc. Sampling frequency and reporting requirements and results are discussed in Section 6.6.1.2.4.

The Quarry Borrow Area land disturbance storm water permit, MO-R104031, issued to the WSSRAP on July 28, 2000, has no specified monitoring or reporting requirements. Settleable solids will be monitored if adverse effects are noted at the Borrow Area.

Effluent discharges are also regulated by Department of Energy (DOE) Order 5400.5, which calls for a best available technology evaluation if the annual average uranium concentration at an outfall exceeds the derived concentration guideline (DCG) for natural uranium (600 pCi/l [22.2 Bq/l]). Measures are taken to keep uranium concentrations as low as reasonably achievable (ALARA), not just below the DCG.

The primary criteria used to develop the surface water monitoring program were the Missouri Water Quality Standards for drinking water supplies established under the Missouri Clean Water Commission Regulation 10 CSR 20-7.031 and the U.S. Environmental Protection Agency primary and secondary maximum contaminant level concentrations for drinking water. A table of applicable drinking water standards that includes contaminants routinely monitored in the surface water program can be found in Table 7-1.

Surface water other than NPDES outfalls is also monitored under the requirements of DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* which designates DCGs for ingestion of water.

Table 6-1 Weldon Spring Chemical Plant Storm and Sanitary Water (NPDES Permit MO-0107701) and Quarry Storm Water (MO-0108987) Monitoring Requirements

PARAMETER	LOCATION	
	NP-0002, NP-0003, NP-0004, NP-0005, NP-0010, NP-0050[a] NP-1005	NP-0006
Sampling Frequency	once/month	Once/quarter
Flow	GPD (monitor only)	GPD (monitor only)[b]
Settleable Solids	1.0 ml/l/hr	—
Total Suspended Solids	mg/l (monitor only)[c]	30/45 mg/l[d]
Nitrate and Nitrite as N**	mg/l (monitor only)	—
Uranium, total	mg/l (monitor only)*	—
Gross alpha, beta	pCi/l (monitor only)	—
PH	6 - 9 standard units	6 - 9 standard units
Fecal coliform	—	400/1000 colonies/ 100 ml[e]
Biochemical Oxygen Demand	—	30/45 mg/l[d]
Total Residual Chlorine	—	1.0 mg/l

NOTE: Refer to Figure 7-1 for NPDES monitoring locations.

* Permit requires reporting in both mg/l and pCi/l and notification of MDNR if uranium concentration in any sample exceeds 2 mg/l.

** Does not apply to quarry storm water Outfall NP-1005.

(a) Outfall NP-0050 represents two outfalls from the TSA area.

(b) Frequency is once/month.

(c) Limit is 50 mg/l if erosion control is not designed for a one in 10 year, 24-hour storm.

(d) Monthly average/weekly average

(e) Monthly average/daily maximum.

--- Not Applicable.

Table 6-2 Effluent Parameter Limits and Monitoring Requirements for Site Water Treatment Plant (NPDES Permit MO-0107701) and Quarry Water Treatment Plant (NPDES Permit MO-0108987) Outfalls*

PARAMETER	LOCATION NP-0007/NP-1001	PARAMETER	LOCATION NP-0007/NP-1001
Gross α	pCi/l[a]	Pb, total	0.20/0.10 mg/l
Gross β	pCi/l[a]	Mn, total	0.50/0.10 mg/l
Uranium, total	pCi/l[a](b)	Hg, total	0.005/0.004 mg/l
Ra-226[c]	pCi/l[a]	Se, total	0.05 mg/l/NA
Ra-228[c]	pCi/l[a]	Cyanide, amenable	0.05 mg/l/NA
Th-230[c]	pCi/l[a]	2,4-DNT	1.1/0.22 μg/l
Th-232[c]	pCi/l[a]	Fluoride, total	12 mg/l/NA
Flow	GPD[a]	Nitrate and Nitrite as N	100 mg/l[g]
COD	90 (60) mg/l [e]	Sulfate as SO_4	1000/500 mg/l
TSS	50 (30) mg/l[e]	Chloride	mg/l[a]/NA
pH	6-9 standard units	Priority Pollutants[f]	mg/l[a](h)(d)
Al, total	7.5 mg/l/NA	Whole Effluent Toxicity	[i](j)
As, total	0.20 mg/l/NA		
Cr, total	0.40 mg/l/NA		

NOTE: Refer to Figures 6-2 and 6-3 for NPDES monitoring locations.
NA Not applicable
* Frequency = once per batch unless otherwise noted.
(a) Monitoring only.
(b) Water treatment plants designed for an average concentration of 30 pCi/l (1.11 Bq/l) and never to exceed concentrations of 100 pCi/l (3.7 Bq/l).
(c) Once/month.
(d) Polychlorinated biphenyls (PCBs) have a limit of 0.5 μg/l.
(e) Daily maximum (monthly average).
(f) Priority pollutants are listed in 40 CFR 122.21 Appendix D, Tables II and III.
(g) Limit applies to chemical plant; monitoring only at quarry.
(h) Annual monitoring.
(i) Quarterly monitoring.
(j) "No statistical difference between effluent and upstream results at 95% confidence level."

6.4 Hydrology Description of the Site and Quarry

Separate surface water monitoring programs have been developed at the chemical plant and quarry due to differences in the topography and hydrologic conditions. Both programs take into account the mechanisms controlling surface water source areas.

6.4.1 Weldon Spring Chemical Plant and Raffinate Pits

The chemical plant area is located on the Missouri-Mississippi River surface drainage divide (Figures 6-1 and 6-2). The topography is gently undulating and generally slopes northward to the Mississippi River and, more steeply, southward to the Missouri River. Streams do not run through the property, but because the site is elevated above surrounding areas, drainageways originate on the property and convey storm water off site. Surface drainage from the western portion of the site, which included Ash Pond, the south and north dump areas, the temporary storage area, and raffinate pits, drains to tributaries of Busch Lake 35 and then to Schote Creek, which in turn enters Dardenne Creek, ultimately draining to the Mississippi River

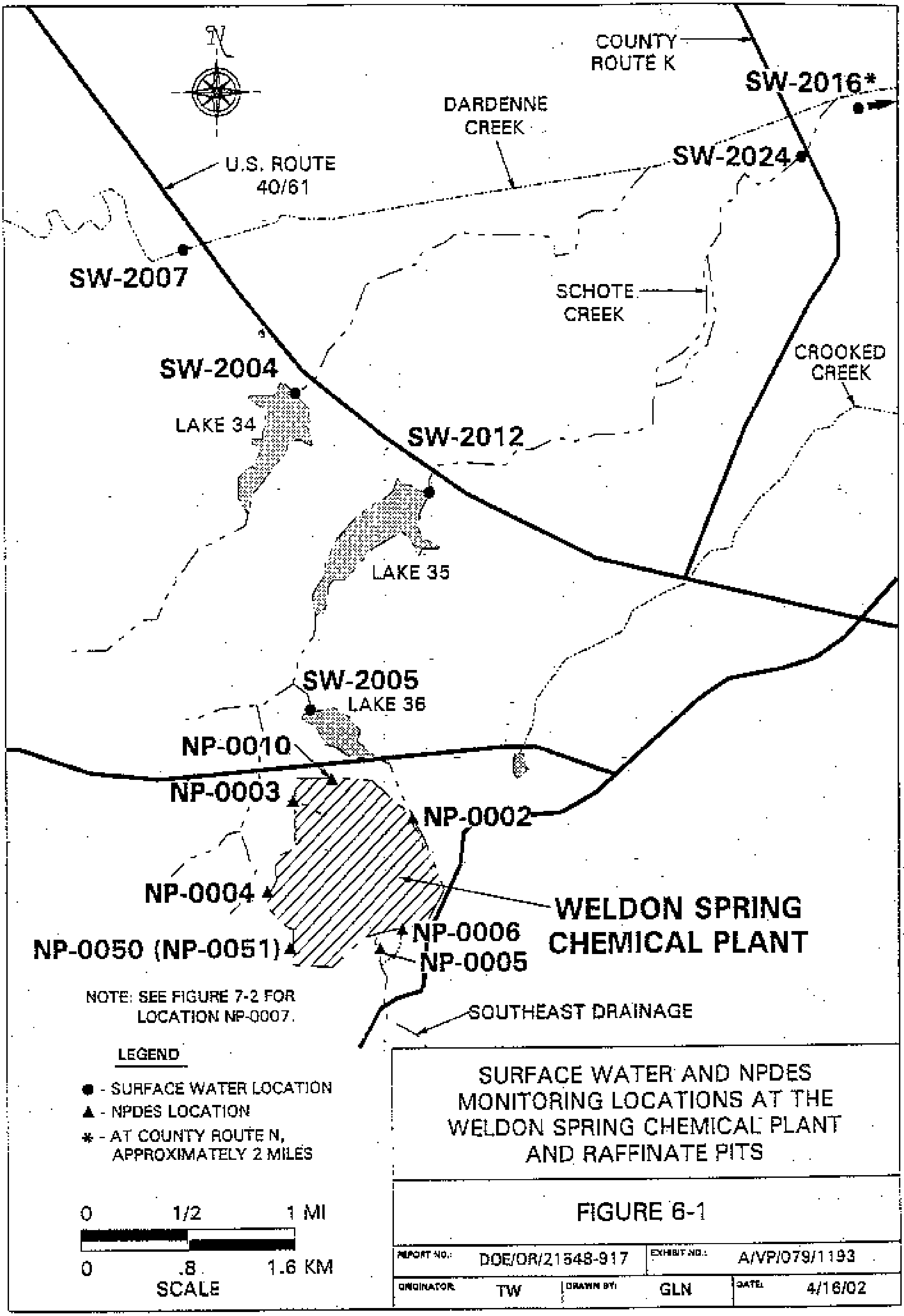
(Figure 6-1). In this watershed during 1999, Ash Pond, Raffinate Pits 3 and 4, the chipped wood storage area, and the south end of the temporary storage area were completely remediated and confirmed clean. The remainder of this watershed was remediated and confirmed clean during 2000. Final grading was completed during 2001 and the area received temporary seeding.

Surface water drainage from the northeast section of the chemical plant site, which includes the administration building and subcontractor parking lots, the construction material staging area (CMSA), and part of the disposal cell, discharges to Dardenne Creek from Schote Creek, after first flowing through Busch Lakes 36 and 35 (Figures 6-1 and 6-2). In the past, storm water runoff from open portions of the cell was collected in Retention Basin 2 for sampling and/or treatment. The cell was closed and Retention Basin 2 was remediated during 2001. Leachate from the cell is collected in the Leachate Collection and Removal System (LCRS) sump.

Runoff from the southern portion of the chemical plant site (Figures 6-1 and 6-2), which historically included the site water treatment plant, Building 434, and parking and equipment areas for the former chemical stabilization and solidification facility, flows southeast to the Missouri River via the Southeast Drainage (Valley 5300). The site water treatment plant, effluent basins, equalization basin, Raffinate Pits 1 and 2, and Building 434 were removed and the area was remediated and confirmed clean during 2000. By the end of 2001, final grade was achieved and the area was temporarily seeded.

6.4.2 Weldon Spring Quarry

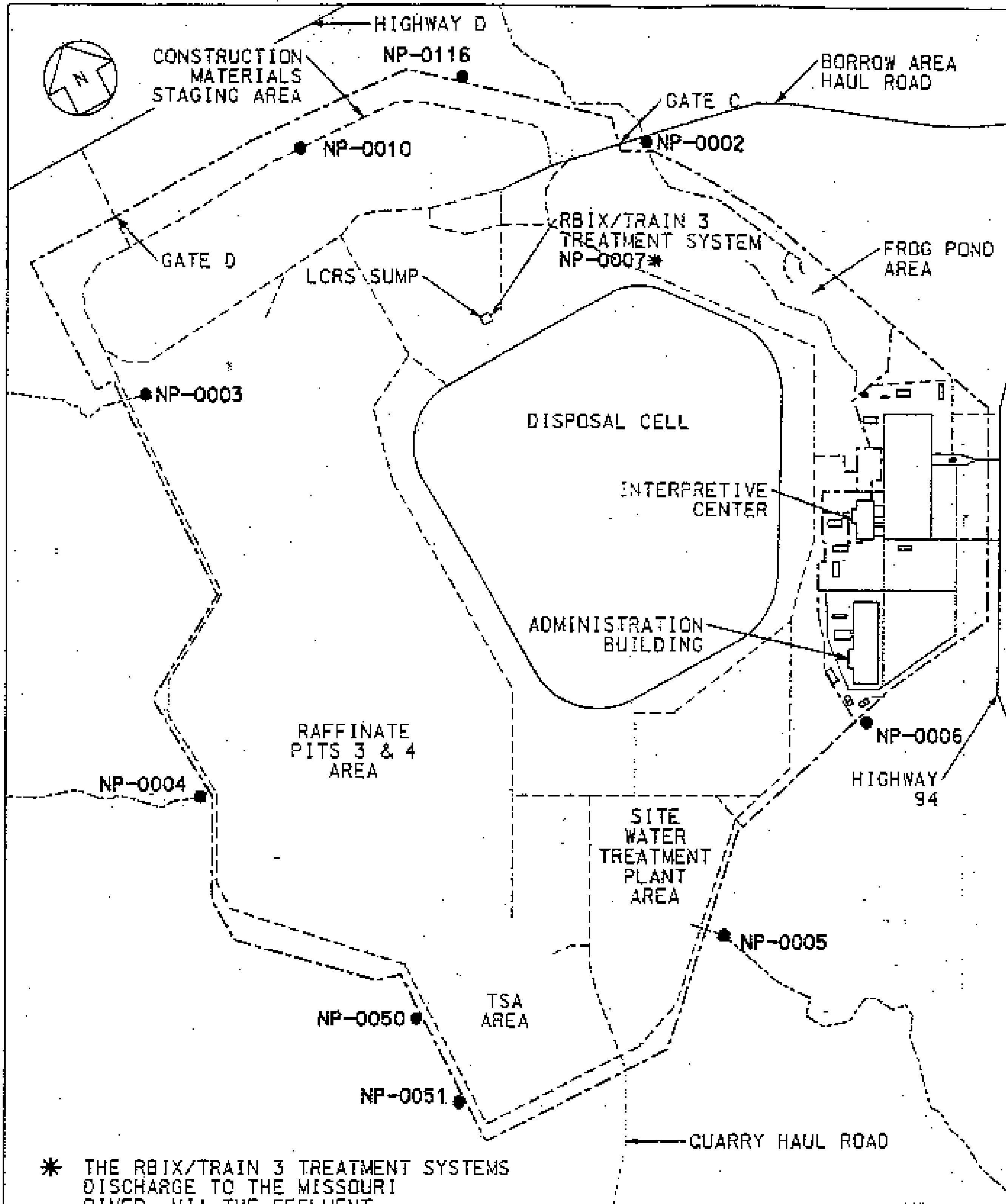
Surface water bodies in the quarry area are the Femme Osage Slough, Little Femme Osage Creek, and Femme Osage Creek (Figure 6-3). These water bodies do not receive direct runoff from the quarry, but are sampled to monitor potential changes due to movement of contaminated groundwater from the fractured bedrock of the quarry through fine-grained alluvial materials.



SURFACE WATER AND NPDES MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT AND RAFFINATE PITS

FIGURE 6-1

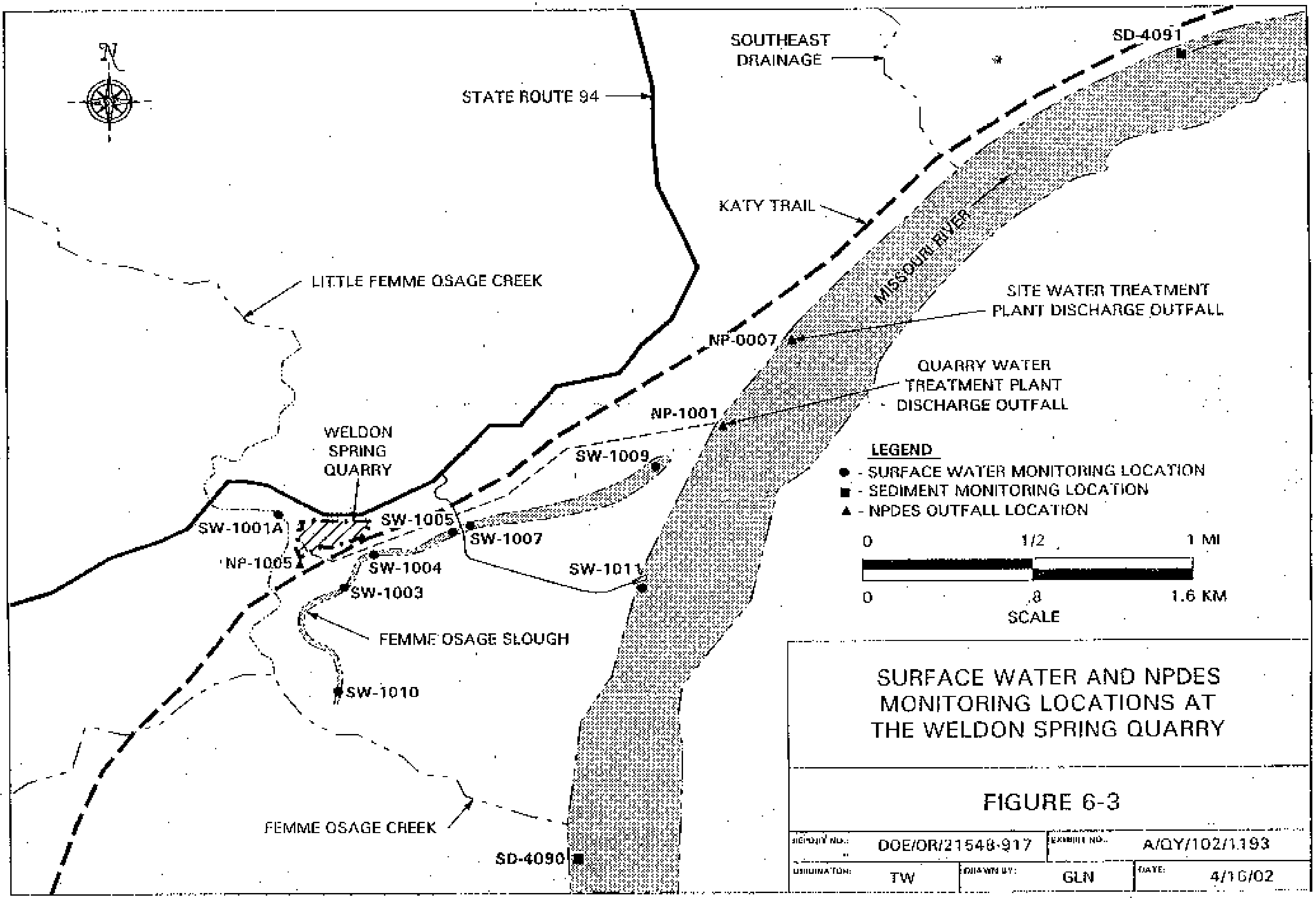
REPORT NO.:	DOE/OR/21548-917	EXHIBIT NO.:	A/VP/079/1193
ORIGINATOR: TW	DRAWN BY: GLN	DATE:	4/16/02



SURFACE WATER AND NPDES MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT 1/1/2002

FIGURE 6-2

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/CP/086/0993	
ORIGINATOR: TW	DRAWN BY: GLN	DATE: 7/9/02	



SURFACE WATER AND NPDES MONITORING LOCATIONS AT THE WELDON SPRING QUARRY

FIGURE 6-3

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/QY/102/1193	
ORIGINATOR: TW	DRAWN BY: GLN		DATE: 4/16/02

The Femme Osage Slough is directly south of the quarry and is known to receive contaminated groundwater from the quarry through subsurface recharge. There is no natural surface flow from the slough; it is essentially land locked. Little Femme Osage Creek is located west of the quarry and discharges into Femme Osage Creek approximately 0.5 km (0.3 mi) southwest of the quarry. Femme Osage Creek flows into the Missouri River. Although there has been no evidence of impact from contaminated groundwater on the creeks via stream emergence, they are monitored to detect changes in the system.

6.5 Monitoring

Sections 6.5.1 and 6.5.2 discuss monitoring requirements at NPDES outfalls and surface water locations at the chemical plant site and the quarry.

6.5.1 National Pollutant Discharge Elimination System Monitoring

The NPDES permits issued to the site identify the parameters to be monitored. The requirements for the two major permits are shown in Tables 6-1 and 6-2, and the requirements for the three minor permits are discussed in the following text. Physical, chemical, and radiological parameters were monitored at all storm water outfalls, as well as the quarry and site water treatment plant outfalls. The *Environmental Monitoring Plan* (Ref. 8) reflects the requirements of the NPDES permits.

6.5.2 Surface Water Monitoring

The following two subsections discuss surface water monitoring requirements at the chemical plant site and the quarry.

6.5.2.1 Weldon Spring Chemical Plant and Raffinate Pits

In accordance with the surface water monitoring program, Schote Creek, Dardenne Creek, and Busch Lakes 34, 35, and 36 were sampled quarterly, at five locations (Figure 6-1) for total uranium (Ref. 8). This monitoring was conducted to measure the effects of surface water discharges from the site on the quality of downstream surface water.

6.5.2.2 Weldon Spring Quarry

Six locations within the Femme Osage Slough were monitored to determine the impact of groundwater migration from the quarry. These locations, which are shown on Figure 6-3, were monitored quarterly for total uranium.

6.6 Monitoring Results

Analytical results of the monitoring of surface water and NPDES outfalls are presented in the following subsections.

6.6.1 National Pollutant Discharge Elimination System Program Monitoring Results

Radiochemical, chemical, and physical analytical results for NPDES outfalls are presented in subsections 6.6.1.1 and 6.6.1.2.

6.6.1.1 Radiochemical Analysis

For 2001, the annual average uranium concentrations at the storm water discharge points ranged from 1.8 pCi/l (0.07 Bq/l) at NP-0004 to 7.6 pCi/l (0.28 Bq/l) at NP-0051, which are 0.3% and 1.3%, respectively, of the DCG for natural uranium. Average annual gross alpha concentrations ranged from 10.3 pCi/l (0.38 Bq/l) at NP-0010 to 36.0 pCi/l (1.33 Bq/l) at NP-0003. The year 2001 annual average radionuclide concentrations for all the permitted storm water outfalls are shown in Table 6-3.

Uranium concentration averages were calculated on a flow weighted basis for storm water Outfalls NP-0002, NP-0003, NP-0004, NP-0005, and NP-0010. Flow was measured at these outfalls by flowmeters, v-notch weirs, or visual estimates. Beginning January 1, 2000, total flows were calculated using watershed areas, precipitation measurements, and runoff coefficients. Flow weighted averages (rather than straight averages) were calculated for uranium levels at these outfalls to estimate the total uranium that migrated off site during 2001. The flow-weighted average for the year was calculated by summing the total activity (pCi) for the days the samples were collected and dividing by the sum of the total daily flows (liters) for the same days. A straight average was used for outfalls NP-0050 (and NP-0051) and NP-1005 because the areas are relatively flat and the flow is diffuse, so it was difficult to get total flow measurements accurate enough for averaging.

Treatment plants at both the site and quarry were in operation during 2001. Five batches were discharged from the quarry plant, and 4 batches were discharged from the site plant. A batch discharge is treated water that is stored, sampled, and then discharged after compliance is demonstrated. A continuous discharge is discharged immediately upon treatment and sampled during discharge. Analytical results are received after the discharge. All discharges for 2001 were batch discharges. No daily maximum or monthly average limits are established for uranium in treated water; however, the design of the treatment plants is based on achieving an average of 30 pCi/l (1.11 Bq/l) uranium, with a maximum never to exceed 100 pCi/l (3.7 Bq/l). The average uranium concentrations for the site and quarry water treatment plants were well below this level at 2.2 pCi/l (0.08 Bq/l) and 6.4 pCi/l (0.02 Bq/l), respectively (Table 6-5). In addition, the site water treatment plant averaged 8.0 pCi/l (0.30 Bq/l) for gross alpha and 19.6

pCi/l (0.73 Bq/l) for gross beta. The quarry water treatment plant averaged 5.4 pCi/l (0.20 Bq/l) and 12.1 pCi/l (0.45 Bq/l), respectively for these same parameters (Table 6-4).

Table 6-3 2001 Annual Average NPDES Results for the Weldon Spring Chemical Plant and Quarry Storm Water Outfalls[c]

PARAMETER	LOCATIONS						
	NP-0002	NP-0003	NP-0004	NP-0005	NP-0010	NP-1005	NP-0050, 51
Number of sample events	12	12	11	11	10	11	9
pH range	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Nitrate as N (mg/l)	2.2	1.4	6.7	1.4	0.9	NS	0.8
Total suspended solids (mg/l)	316	1353	312	256	470	43.3	354
Settleable solids (ml/l/hr)	14/2[b]	12/2[b]	11/0[b]	13/1[b]	10/0[b]	11/0[b]	9/0[b]
Arsenic (mg/l)	0.002(10)	0.012(10)	0.009(2)	0.004(3)	NS	.002(1)	NS
Chromium (mg/l)	0.023(10)	0.038	.022(2)	0.005(3)	NS	.009(1)	NS
Lead (mg/l)	0.012(10)	0.019	.009(2)	0.002(3)	NS	.001(1)	NS
Thallium (mg/l)	0.005(10)	0.004	.003(2)	0.004(3)	NS	.004(1)	NS
Total uranium (pCi/l)	5.7*	4.7*	1.8*	7.2*	3.2*	3.5	7.6
Gross alpha (pCi/l)	19.3	36.0	11.3	16.8	10.3	11.7	17.5
Gross beta (pCi/l)	16.7	58.7	17.1	17.5	11.3	10.3	18.3
Radium-226 (pCi/l)	0.6(9)	0.9(12)	NS	0.27(2)	NS	NS	NS
Radium-228 (pCi/l)	0.6(9)	1.0(12)	NS	0.24(2)	NS	NS	NS
Thorium-228 pCi/l)	0.2(9)	0.4(12)	NS	0.21(2)	NS	NS	NS
Thorium-230 pCi/l)	0.5(9)	0.7(12)	NS	0.72(2)	NS	NS	NS
Thorium-232 pCi/l)	0.2(9)	0.3(12)	NS	0.21(2)	NS	NS	NS

(a) All pH readings were in the permitted range of 6.0 to 9.0 standard units.
(b) Number of samples/number of results above daily maximum limit of 1.0 ml/l/hr.
(c) The number in parentheses indicates the number of samples analyzed for the specified parameter, if it differs from the number of sample events.
* Flow proportional averages.
NS Not Sampled.
Note: 1 pCi/l = 0.037 Bq/l.

Radium and thorium were monitored once per month, as required by the permit, in both site and quarry water treatment plant batches. Annual averages for radium and thorium at both plants are shown in Table 6-4. Radium and thorium levels were all well below the DCGs, at annual averages less than 1.0 pCi/l.

In addition to effluent monitoring, the NPDES permit for the quarry, MO-0108987, required that river sediment sampling be conducted upstream and downstream of the quarry water treatment plant outfall (NP-1001) on an annual basis. The river sediment was sampled for uranium upstream at location SD-4090 and downstream at location SD-4091 (see Figure 6-3). The one-time sampling results were 1.88 pCi/g (0.07 Bq/g) at SD-4090 and 1.67 pCi/g (0.06 Bq/g) at SD-4091. These concentrations are an indication that discharges from the site have not had a deleterious effect on river sediment.

Table 6-4 Site and Quarry Water Treatment Plant Annual Averages for Radium and Thorium (pCi/l)

PARAMETER	SITE WTP (NP-0007)*	QUARRY WTP (NP-1001)*
Ra-226	0.08 (4/4)	0.13 (4/5)
Ra-228	0.83 (2/4)	0.33 (4/5)
Th-228	0.05 (4/4)	0.08 (5/5)
Th-230	0.5 (0/4)	0.49 (1/5)
Th-232	0.09 (3/4)	0.11 (4/5)
Gross alpha	8.0 (3/4)	6.4 (1/5)
Gross beta	19.6 (2/4)	12.1 (0/5)

* Number in parentheses represents the number of results below detection limit (including uncensored values)/total number of samples.

Note: 1 pCi/l = 0.037 Bq/l

Estimated quantities of total natural uranium released off site through surface water runoff and treatment plant discharges are in Table 6-5. The total volume of storm water at all the outfalls was calculated using watershed area, total precipitation, and runoff curve numbers. Runoff curve numbers are cited in the U.S. Department of Transportation *Design of Roadside Drainage Channels* (Ref. 31). Best professional judgement was used in determining runoff curve numbers. The estimated mass of uranium released off site in storm water and treated effluent during 2001 was 3.34 kg (7.35 lb) and was calculated by multiplying the total runoff volume by the average uranium concentration. This is a substantial decrease from the estimated amount released during 2000, which was 5.38 kg (11.84 lb). Table 6-6 shows the annual average uranium concentrations at NPDES outfalls from 1987 to 2001. Average uranium concentrations for 2001, in comparison to levels for 2000, have decreased or remained the same at all outfalls except NP-1005. Historical trends of uranium at Outfalls NP-0002, NP-0003, and NP-0005 are discussed in Section 10.1. Radium and thorium were measured at Outfalls NP-0002, NP-0003, and NP-0005 periodically throughout the year to monitor the effects and effectiveness of remediation. Descriptions of each outfall are discussed in the following paragraphs.

Table 6-5 2001 Estimated Annual Release of Natural Uranium from NPDES Outfalls

OUTFALL	DRAINAGE AREA HECTARES (ACRES)	ESTIMATED % OF PRECIPITATION AS RUNOFF[a]	AVERAGE URANIUM CONCENTRATION (pCi/l)	TOTAL RAINFALL VOLUME Ml/yr (Mgal/yr)	TOTAL RUNOFF VOLUME Ml/yr (Mgal/yr)	TOTAL U RELEASE (Ci/yr)	TOTAL U RELEASE (kg/yr)
NP-0002	30.6 (75.7)	60	5.7*	296.32 (78.28)	177.79 (46.97)	1.01E-3	1.485
NP-0003	27.8 (68.6)	50	4.7*	268.47 (70.93)	134.25 (35.46)	0.63E-3	0.926
NP-0004	11.3 (28)	30	1.8*	109.60 (28.95)	32.88 (8.67)	0.059E-3	0.087
NP-0005	9.1 (22.4)	30	7.2*	87.68 (23.16)	26.30 (6.95)	0.189E-3	0.278
NP-0010	5.7 (14)	30	3.2*	54.68 (14.46)	16.44 (4.34)	0.05E-3	0.074
NP-0050, 51[b]	5 (12.4)	30	7.6	48.54 (12.82)	14.56 (3.85)	0.111E-3	0.163
NP-1005	6.0 (15)	60	3.5	58.72 (15.51)	35.23 (9.31)	0.123E-3	0.181
NP-0007	N/A	N/A	2.2	N/A	7.06 (1.86)	0.016E-3	0.023
NP-1001	N/A	N/A	6.4	N/A	12.80 (3.38)	0.082E-3	0.120
TOTAL	N/A	N/A	N/A	924.01 (244.13)	457.31 (130.79)	2.27E-3	3.337

* Flow-weighted average.

(a) Runoff curve number estimated from U.S. Department of Transportation *Design of Roadside Drainage Channels* (Ref. 31).

(b) One outfall is monitored to represent both.

N/A Not Applicable.

Note: To convert from Ci/yr to Bq/yr, multiply Ci/yr by 3.7×10^{10}

Table 6-6 Fifteen-Year Annual Average Uranium Concentrations (pCi/l) at NPDES Outfalls

	NP-0001	NP-0002	NP-0003	NP-0004	NP-0005	NP-0010	NP-0007	NP-1001	NP-1005	NP-0050,NP-0051
1987	680	210	2240	9.5	780	---	---	---	---	---
1988	539	141	1178	6.2	497	---	---	---	---	---
1989	368	145	280	6.5	347	---	---	---	---	---
1990	413	139	89	7.6	364	---	---	---	---	---
1991	475	158	456	6.4	581	---	---	---	---	---
1992	516	228	478	6	296	---	---	<0.0003	---	---
1993	1003*	230*	607*	9	133*	---	---	1.9	---	---
1994	1226*	182*	332*	12	347*	82	0.74	1.6	---	---
1995	(a)	124*	67*	(b)	128*	107	0.46	1.8	---	---
1996	(a)	54*	88*	(b)	107*	50	1.37	1.1	---	---
1997	(a)	14*	143*	(b)	19*	2.7	1.50	0.5	---	---
1998	(a)	22*	83*	23	10*	10.7*	3.11	0.4	1.0[c]	---
1999	(a)	8.0*	38.3*	3.5*	20.3*	7.3	17.1	1.1	1.9	2.7[d]
2000	(a)	5.6*	15.6*	6.0*	6.9*	6.1*	2.7	0.8	1.0*	8.4
2001	(a)	5.7*	4.7*	1.8*	7.2*	3.2*	2.2	8.4	3.5	7.6

* Flow weighted average.
-- Not applicable.
(a) Outfall removed, flow diverted to NP-0005.
(b) Outfall removed from permit in 1995, added in 1998.
(c) Outfall added in 1998.
(d) Outfall added in 1999.

Outfall NP-0001 was the outlet of the abandoned process sewer line. This outfall was physically removed in May 1994 and was officially eliminated from the permit on August 4, 1995.

Outfall NP-0002 is at the north perimeter near gate C, downstream of the Frog Pond watershed. The average uranium concentration for Outfall NP-0002 in 2001 was 5.7 pCi/l (0.21 Bq/l), essentially the same as the 2000 average of 5.6 pCi/l (0.21 Bq/l). One Th-230 level was detected above baseline value. Baseline values for contaminants in storm water were set before soil and foundation removal started and the site was still stabilized with vegetation. Baseline monitoring and values are in table E-6, Appendix E, of the EMP (Ref. 8). All levels were well below the DCGs. Annual average NPDES results for Outfall NP-0002 are in Table 6-3.

Outfall NP-0003 is at the west perimeter, downstream of the Ash Pond watershed. The average uranium concentration for Outfall NP-0003 was 4.7 pCi/l (0.17 Bq/l), which was much less than the 2000 average of 15.6 pCi/l (0.58 Bq/l). The decrease may be the result of completing remediation and establishing some vegetation in the watershed. Although numerous thorium and radium levels were above baseline levels, they were well below the DCGs for the specific parameters. The highest level was 3.83 pCi/l for Ra-228. During 2001, Sedimentation Basin 4 and the V-notch weir were removed for the watershed. The areas were brought to final grade and temporarily seeded. Baseline values are in Table E-6, Appendix E, of the EMP (Ref. 8). Annual average values for uranium, radium, thorium, gross alpha, and gross beta are shown in Table 6-3.

Outfall NP-0004 is at the west perimeter, downstream of the old Raffinate Pit 4 location. Outfall NP-0004 was eliminated from NPDES permit MO-0107701 on March 4, 1994, but was repermitted on May 22, 1998. The annual average for uranium at NP-0004 was 1.8 pCi/l (0.07 Bq/l), which was less than the 2000 annual average of 6.0 pCi/l (0.22 Bq/l). The decrease was most likely due to establishment of vegetation after final grading was completed.

Outfall NP-0005 is at the south perimeter, at the head of the southeast drainage. The annual average uranium concentration at Outfall NP-0005 for 2001 was 7.2 pCi/l (0.27 Bq/l), which is similar to the 2000 average of 6.9 pCi/l (0.26 Bq/l). There was one instance of Th-230 being above the baseline value but still well below DCG. Baseline monitoring and values are in Table E-6, Appendix E, of the EMP (Ref. 8). Annual average NPDES results are in Table 6-3.

Outfall NP-0010 is near the west end of the north perimeter fence in the construction material staging area, and drains a portion of that area (Figure 6-2). Clean soil, gravel, and other construction material were stored there. All materials were removed during 2001 and the area received final grading and temporary vegetation. The annual average uranium concentration for 2001 was 3.2 pCi/l (0.12 Bq/l), well below the DCG of 600 pCi/l (22.2 Bq/l) and less than the 2000 average of 6.1 pCi/l (0.23 Bq/l). The annual average NPDES results are in Table 6-3.

Outfall NP-0051 is on the west side of the temporary storage area. Before the temporary storage area was remediated, this outfall was actually two separate outfalls (NP-0050 and NP-0051) that served its north and south ends, respectively. After the remediation, sheet flow was established, and only one outfall is now being sampled at the property line. The annual average uranium concentration for 2001 was 7.6 pCi/l (0.28 Bq/l), well below the DCG of 600 pCi/l (22.2 Bq/l) and slightly lower than the 2000 average of 8.4 pCi/l (0.31 Bq/l). The slight decrease is suspected to be the result of natural variations and established vegetation. The annual average NPDES results are in Table 6-3.

Outfall NP-1005 is the storm water outfall at the quarry. During 2001 the flow was from a hillside and a ditch along the effluent ponds from the quarry water treatment plant and in some instances, stormwater pumped from the quarry and a retention basin. In the future this outfall will discharge water from the quarry area after the quarry is backfilled and graded. The annual average uranium concentration for 2001 was 3.5 pCi/l (0.13 Bq/l), a slight increase from the 2000 average of 1.0 pCi/l (0.037 Bq/l). The slight increase is suspected to be because of some samples of quarry pond stormwater were collected during 2001. In previous years before remediation, the quarry pond water was treated prior to discharge. The annual average NPDES results are reported in Table 6-3.

6.6.1.2 Physical and Chemical Results

Analytical results for physical and chemical parameters at NPDES outfalls and other sample locations are discussed in Subsections 6.6.1.2.1 through 6.6.1.2.4.

6.6.1.2.1 Chemical Plant and Quarry Storm Water

The annual averages for the physical and chemical parameters for storm water Outfalls NP-0002, NP-0003, NP-0004, NP-0005, NP-0010, NP-0050, NP-0051, and NP-1005 are in Table 6-3. In addition to the permitted parameters, arsenic, chromium, lead, and thallium were periodically monitored at some outfalls. There were two instances at outfall NP-0003 and one instance at outfall NP-0002 of metals that do not have permit limits having levels above the 100 µg/l reporting levels for toxic pollutants. These elevated levels were suspected of being caused by elevated solids levels in the samples.

There were also five samples where settleable solids were above the 1.0 ml/l/hr limit. These results are shown in Table 6-3 and further discussed in Section 2.5.

6.6.1.2.2 Administration Building Sewage Treatment Plant

Monitoring results for the sewage treatment plant, Outfall NP-0006, are in Table 6-7. All parameters were in compliance for the year.

6.6.1.2.3 Site and Quarry Water Treatment Plant Physical and Chemical Parameters

Physical and chemical parameters were all within permitted limits (where limits were assigned) for water treatment plants at the site and quarry. Therefore, the parameter levels are not summarized here.

During 2001, whole effluent toxicity (WET) tests were required quarterly for effluent from both the site and quarry water treatment plants. Because neither the quarry nor the site plant was in operation during each quarter, there are not four sample results for each site. There were, inadvertently, two WET tests conducted during the second quarter at the quarry. The WET test is a measure of toxicity without quantifying or identifying the toxic constituents. Tests were conducted on both Ceriodaphnia dubia (water flea) and Pimephales promelas (fathead minnow). The tests were conducted in effluents and in test controls of upstream river water and laboratory control water. No samples failed the WET tests during 2001, indicating that the site and quarry water treatment plant effluents did not cause the receiving stream to be toxic to test organisms (see Table 6-2). WET test results are summarized in Table 6-8.

Table 6-7 NP-0006, Sewage Treatment Plant Outfall, Monthly Averages of Permitted Parameters

	PARAMETER [a] (PERMIT LIMITS)				
MONTH (QUARTER)	TSS (30/45 mg/l)*	BOD (30/45 mg/l)*	FC [b] (400/1000 col/100 ml)**	pH (6.0 – 9.0 SU)	TOTAL RESIDUAL CHLORINE (1.0/1.0 mg/l)**
February (1)	< 5	8	< 4	7.89	0.07
April (2)	< 5	6	32	6.86	0.18
July (3)	11	6	12	7.52	0.52
October (4)	22	12	50	6.85	0.48

(a) One sample analysis required for each calendar quarter.
(b) FC – Fecal Coliform
* Monthly average/Weekly average
** Monthly average/daily maximum

Table 6-8 2001 Whole Effluent Toxicity Test Results for the Site and Quarry Water Treatment Plants

BATCH	DATE	DAPHNIA (D) % MORTALITY	PIMEPHALES (P) % MORTALITY	RIVER CONTROL D,P % MORTALITY	LAB CONTROL D,P % MORTALITY
S193	6/6/01	0	0	0,0	0,0
S197	8/20/01	0	0	0,0	0,0
Q072	2/14/01	0	0	0,0	0,0
Q073	4/5/01	0	0	0,0	0,0
Q074	5/2/01	0	0	0,0	0,0
Q076	8/2/01	0	5	0,0	0,0

* Each test is on four replicates of 10 organisms. % mortality is based on 40 organisms.
S Site
Q Quarry
P Pimephales
D Daphnia (Ceriodaphnia)

6.6.1.2.4 Hydrostatic Test Water Results

NPDES permit MO-G670203 was issued on December 5, 1997, for the discharge of hydrostatic test water. The permit requires that a sample be collected during the first 60 minutes of each discharge. It also requires that flow, total petroleum hydrocarbons (TPH), total suspended solids (TSS), and pH be monitored. There is a daily maximum and monthly average for TSS and TPH; however, the monthly average and daily maximum are the same. The limit for TPH is 10 mg/l and for TSS, 100 mg/l. The pH is limited to a range of 6.0 to 9.0. During calendar year 2001, there were three hydrostatic test water discharges from the piping and modular tanks at the Groundwater Operable Unit pump and treat study. All parameters were in compliance with permitted limits.

6.6.1.2.5 Borrow Area Land Disturbance Results

NPDES permit MO-R100B69 was reissued on May 29, 1998, for storm water at the borrow area and has no specified monitoring or reporting requirements. The *Environmental Monitoring Plan* (Ref. 8), however, requires that settleable solids be monitored once every calendar quarter, and that oil and grease be monitored as indicated by operations at the facility. Settleable solids and oil and grease results are shown in Table 6-9. Settleable solids were all less than 0.2 ml/l/hr.

Oil and grease were monitored ten times at the NP-0040 outfall, which is the outfall from the vehicle maintenance area sedimentation basin. Two results were above the 10 mg/l water quality standard for oil and grease. There was no noticeable sheen or odor when these samples were collected. The elevated results were suspected of being in error. Split and duplicate samples indicated that one particular laboratory returned erratic results. The laboratory also stated that they had problems with the analyses. The lab was not used after the problems were discovered. In addition, sorbent booms have been kept in place throughout the year. With completion of the cell, activity at the maintenance building was greatly reduced, with fewer pieces of heavy equipment being serviced.

The borrow area was graded and seeded during 2001, with the east side receiving final seeding and the rest temporary seeding. The entire area will be permanently seeded during 2002. When vegetation is well established, a request will be made to terminate the permit.

Table 6-9 Borrow Area Settleable Solids (ml/l/hr) and Oil and Grease (mg/l)

DATE	LOCATIONS		
	NP-0040*		NP-0046**
	SETTLEABLE SOLIDS	OIL AND GREASE	SETTLEABLE SOLIDS
1/29/01	<0.1	3.3	<0.1
2/14/01	NS	46	NS
3/16/01	NS	<1.5	NS
3/19/01	NS	NS	0.1
4/11/01	<0.1	<1.6	NS
5/10/01	NS	<1.68	NS
5/21/01	<0.1	1800	<0.1
6/4/10	NS	2.18	NS
7/20/01	0.2	<1.55	NS
8/24/01	<0.1	4.10	NS
10/10/01	<0.1	3.16	NS

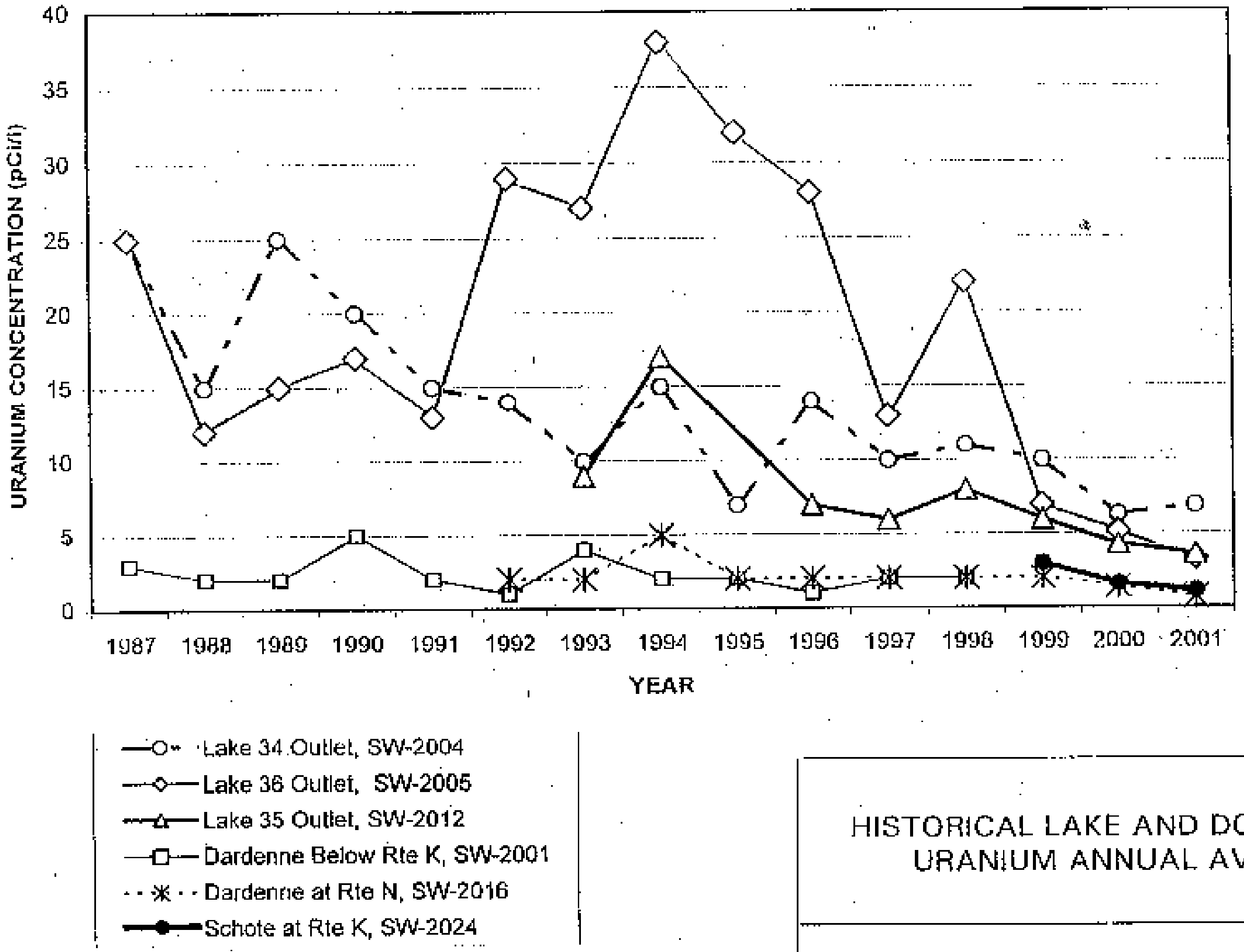
N.S. Not Sampled
* North Borrow Area sedimentation basin.
** East Borrow Area sedimentation basin.

6.6.2 Surface Water Monitoring Results

Analytical results for surface water monitoring locations at the chemical plant site and quarry are in Subsections 6.6.2.1 and 6.6.2.2.

6.6.2.1 Weldon Spring Chemical Plant and Raffinate Pits

Average uranium levels at the off-site surface water locations were lower than the 2000 annual averages at four of five locations, and slightly higher at one location. This reflects the lower levels seen at the NPDES outfalls. Average annual uranium concentrations for surface water are in Table 6-10, along with the 2000 figures and the historic high for each location for comparison. The historical concentrations for the background location, SW-2007, are also shown. Surface water locations are shown in Figure 6-1. Historic annual averages for Lakes 34, 35, and 36 outlets, as well as locations in Schote Creek and Dardenne Creek, are plotted in Figure 6-4. 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. Data points are shown from the date the samples were first collected. No samples were collected for SW-2012 during 1995 because there was no flow from the lake. The historic high of 326 pCi/l at location SW-2012, the outlet of Lake 35, is considered an outlier and is not graphed. An outlier is a sample result that does not fit the rest of the uranium results for the location. It does not necessarily mean that the result was not real, but that it is an anomaly and is suspect. This was an isolated sample with no samples collected before or after (until 1993). This location is downstream of Lake 36, which showed no similar elevated levels. The second highest uranium concentration at SW-2012 was 17 pCi/l during 1994.



HISTORICAL LAKE AND DOWNSTREAM
URANIUM ANNUAL AVERAGES

FIGURE 6-4

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/PI/061/0702	
ORIGINATOR: BD	DRAWN BY: GLN	DATE: 7/9/02	

Table 6-10 2001 Annual Averages for Total Uranium (pCi/l) Concentrations at Weldon Spring Chemical Plant Area Surface Water Locations

LOCATION	AVERAGE	MAXIMUM	MINIMUM	HISTORIC HIGH
SW-2004	6.9(6.3)	8.2(11.5)	5.8(<0.7)	39(1989)
SW-2005	3.3(5.2)	4.1(8.0)	2.8(3.3)	53.7(1996)
SW-2012	3.6(4.3)	4.7(7.5)	1.6(<0.7)	326(1991)*
SW-2016	0.7(1.4)	1.2(3.1)	0.1(<0.7)	7.8(1994)
SW-2024	1.2(1.1)	1.7(1.9)	0.6(0.9)	5.3(1999)
SW-2007 (Historical)	1.2	8.2	0.1	8.2(1990)

* This historic high is considered an outlier.

Note 1: 2000 results are given in parentheses.

Note 2: 1 pCi/l = 0.037 Bq/l.

Note 3: Four samples were collected from each location during the year.

6.6.2.2 Weldon Spring Quarry

The annual averages for the surface water locations are summarized in Table 6-11. Uranium levels in the Femme Osage Slough remain within historical ranges. No new historic total uranium high concentrations were reported for quarry surface water during 2001. Historic annual average concentrations for uranium in the Femme Osage Slough are presented in Figure 6-5.

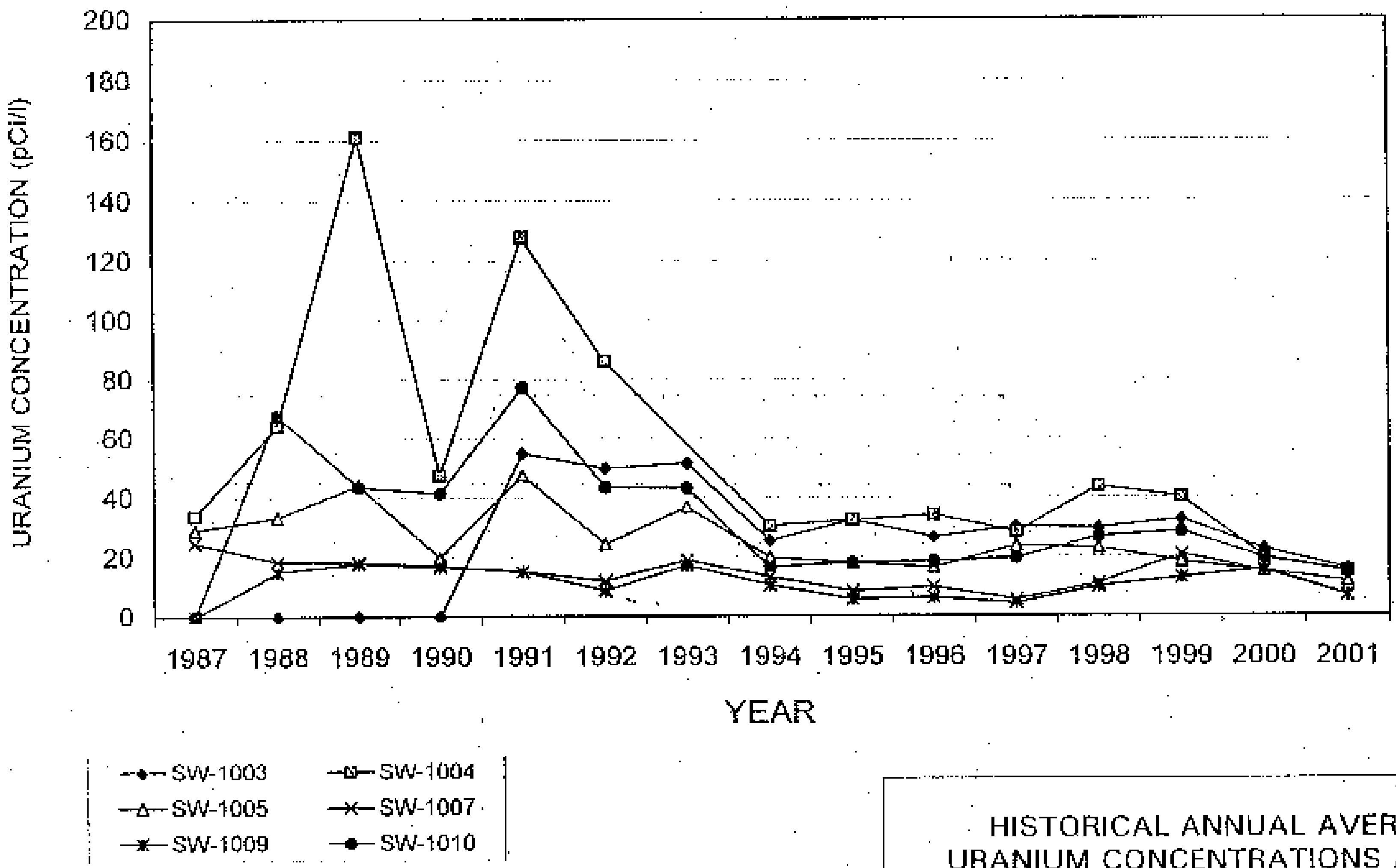
Table 6-11 2001 Annual Averages for Total Uranium (pCi/l) at Weldon Spring Quarry Surface Water Locations

LOCATION	ANNUAL AVERAGE	MAXIMUM	MINIMUM	HISTORIC HIGH
SW-1003	15.9(22.6)	25.5(23.3)	10.1(21.9)	252 (1989)
SW-1004	15.1(19.9)	24.6(21.8)	8.3(17.9)	362 (1991) [a]
SW-1005	11.5(15.0)	21.0(18.3)	5.2(11.6)	116 (1991)
SW-1007	6.8(15.2)	11.5(19.8)	2.5(10.5)	89 (1992)
SW-1009	6.8(15.7)	12.1(20.4)	2.1(11.0)	28.8 (1991)
SW-1010	15.0(19.6)	27.5(23.4)	6.6(15.8)	156 (1991)

Note 1: 2000 results given in parentheses

Note 2: 1 pCi/l = 0.037 Bq/l

(a) A sample collected during 1993 flood conditions, which represented groundwater discharge to the surface, had a result of 4,000 pCi/l. This value is not reported as the historic high since it represents groundwater, not surface water. It also is not included on Figure 6-5.



HISTORICAL ANNUAL AVERAGE URANIUM CONCENTRATIONS AT THE FEMME OSAGE SLOUGH					
FIGURE 6-5					
REPORT NO.:	DOE/OR/21548-917	EXHIBIT NO.:	A/PI/062/0702		
ORIGINATOR:	BD	DRAWN BY:	GLN	DATE:	7/9/02

7. GROUNDWATER MONITORING

7.1 Highlights of the Groundwater Monitoring Program

The following are highlights of the 2001 groundwater monitoring program. These items, and others, are discussed in detail in this chapter.

- Contaminant levels generally remained within historic ranges at all chemical plant and quarry groundwater monitoring locations.
- High concentrations of nitroaromatic compounds reported in groundwater monitoring locations in the vicinity of Frog Pond continued to be monitored during 2001. Four new monitoring wells were installed in this area during 2001 to further define the extent of contamination.
- Volatile organic compounds (VOC) trichloroethene (TCE) and 1,2-dichloroethene (DCE), which were detected in groundwater in 1996 at the chemical plant, continued to be under investigation during 2001. Thirteen new monitoring wells were installed in this area to further define the extent of contamination. Four additional wells were installed to support the pump and treat field studies.
- Groundwater detection monitoring for the disposal cell, which was initiated in June 1998, continued in 2001. Two new monitoring wells were installed during 2001 and will become part of the cell well network after baseline is established.
- Monitoring results for Burgermeister Spring were within historical ranges. No new highs or lows were recorded, although average annual concentrations of contaminants are decreasing.
- Uranium concentrations were within background ranges, and no detectable concentrations of nitroaromatic compounds were observed south of the Femme Osage Slough.

7.2 Program Overview

The groundwater monitoring and protection program at the Weldon Spring Site Remedial Action Project (WSSRAP) includes sampling and analysis of water collected from wells at the chemical plant and raffinate pits site, the quarry site, adjacent properties, and selected springs in the vicinity of the chemical plant site. The groundwater protection program is formally defined in the *Weldon Spring Site Remedial Action Project Groundwater Protection Management Program Plan* (Ref. 12). The groundwater monitoring portion of the program is detailed in the *Environmental Monitoring Plan* (EMP) (Ref. 8).

Due to lithologic differences, including geologic features that influence groundwater flow mechanics, 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 1.3. A generalized stratigraphic column for reference is provided in Figure 7-1, and hydrogeologic descriptions of lithologies monitored for the program are in Sections 7.4 and 7.5.

7.3 Referenced Standards

Two references used to develop the criteria for the groundwater monitoring program are: (1) the U.S. Environmental Protection Agency (EPA) *Quality Criteria for Water 1986* (Ref. 32), which is intended to protect public groundwater resources, and (2) the Missouri Drinking Water Standards (Ref. 33). Table 7-1 identifies EPA water quality standards and Missouri Drinking Water Standards for contaminants that are routinely monitored in the groundwater program. Maximum contaminant levels (MCLs) and other drinking water standards are used only as references by the WSSRAP since the affected groundwater aquifer underlying the site is not a public drinking water source as defined in 40 CFR, Part 141, Subpart A - General.

Table 7-1 Referenced Federal and State Water Standards

PARAMETER		LEVEL	REFERENCE STANDARD	
Radiochemical	Uranium, total	30 pCi/l [b]	Groundwater Standards for Remedial Actions at Inactive Uranium Processing Sites - 40 CFR 192 [b]	
	Gross Alpha	15 pCi/l	Primary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 141.15
	Radium [a]	5 pCi/l	Primary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 141.15
Misc.	2,4-DNT	0.11 µg/l	Criteria for use:	MGWQS - 10 CSR 20-7
	TCE	5 µg/l	Criteria for use: Primary MCL:	MGWQS - 10 CSR 20-7 EPA - 40 CFR 141.61
Metals	As	50 µg/l	Primary MCL: Primary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 141.11
	Ba	2 mg/l	Primary MCL: Primary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 141.62
Anions	NO_3	10 mg/l	Primary MCL: Primary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 141.62
	SO_4	250 mg/l	Secondary MCL: Secondary MCL:	MDWS - 10 CSR 60-4 EPA - 40 CFR 143.3

(a) Standard for combined Ra-226 and Ra-228

(b) EPA promulgated a drinking water MCL of 30 µg/l (20 pCi/l) December 7, 2000. The new regulation, 40 CFR 141.66, will take effect December 8, 2003.

EPA U. S. Environmental Protection Agency
MCL Maximum Contaminant Level
MDWS Missouri Drinking Water Standard
MGWQS Missouri Ground Water Quality Standard

SYSTEM	SERIES	STRATIGRAPHIC UNIT	TYPICAL THICKNESS (FT.)(1)	LITHOLOGY	PHYSICAL CHARACTERISTICS	HYDROSTRATIGRAHIC UNIT
QUATERNARY	HOLOCENE	ALLUVIUM	0 - 120		GRAVELLY, SILTY LOAM.	ALLUVIAL AQUIFER
	PLEISTOCENE	LOESS AND GLACIAL DRIFT (2)	10 - 60	VARIABLE	SILTY CLAY, GRAVELLY CLAY, SILTY LOAM, OR LOAM OVER RESIDUUM FROM WEATHERED BEDROCK.	(UNSATURATED)(2)
MISSISSIPPIAN	MERAMECIAN	SALEM FORMATION (3)	0 - 15		LIMESTONE, LIMEY DOLOMITE, FINELY TO COARSELY CRYSTALINE, MASSIVELY BEDDED, AND THIN BEDDED SHALE.	
		WARSAW FORMATION (3)	60 - 80		SHALE AND THIN TO MEDIUM BEDDED FINELY CRYSTALINE LIMESTONE WITH INTERBEDDED CHERT.	
	OSAGEAN	BURLINGTON AND KEOKUK LIMESTONES	100 - 200		CHERTY LIMESTONE, VERY FINE TO VERY COARSELY CRYSTALINE, FOSSILIFEROUS, THICKLY BEDDED TO MASSIVE	SHALLOW AQUIFER SYSTEM
		FERN GLEN LIMESTONE	45 - 70		CHERTY LIMESTONE, DOLOMITIC IN PART, VERY FINE TO VERY COARSELY CRYSTALINE, MEDIUM TO THICKLY BEDDED.	
	KINDERHOOKIAN	CHOUTEAU LIMESTONE	20 - 50		DOLOMITIC, ARGILLACEOUS LIMESTONE; FINELY CRYSTALINE; THIN TO MEDIUM BEDDED.	UPPER LEAKY CONFINING UNIT
DEVONIAN	UPPER	SULPHUR SPRINGS GROUP BUSHBERG SANDSTONE (4)	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 (5)	10 - 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 CRYSTALINE LIMESTONE.	LOWER CONFINING UNIT
		PLATTIN LIMESTONE	100 - 130		DOLOMITIC LIMESTONE, VERY FINELY CRYSTALLINE, FOSSILIFEROUS, THINLY BEDDED.	
		JOACHIM DOLOMITE	80 - 105		INTERBEDDED VERY FINELY CRYSTALLINE, 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 CRYSTALINE, MINOR CHERT AND SHALE.	
		COTTER DOLOMITE	200 - 250		ARGILLACEOUS, CHERTY DOLOMITE; FINE TO MEDIUM CRYSTALINE. INTERBEDDED WITH SHALE.	
		JEFFERSON CITY DOLOMITE	160 - 180		DOLOMITE, FINE TO MEDIUM CRYSTALINE.	
		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.	

(1) THICKNESS DATA SOURCES VARY. QUATERNARY UNIT THICKNESS BASED ON ON-SITE DRILLING AND TRENCHING. BURLINGTON AND KEOKUK THROUGH JOACHIM DOLOMITE BASED ON USGS WELLS MW-GS02 AND GS05. ST. PETER SANDSTONE AND BELOW FROM KLEESCHULTE AND EMMETT (REF 54). WARSAW AND SALEM FORMATIONS FROM MISSOURI DNR-DGLS GEOLOGIC MAP OFM-89-252-GI (REF 53).

(2) GLACIAL DRIFT UNIT SATURATED IN NORTHERN PORTION OF ORDNANCE WORKS WHERE THIS UNIT BEHAVES LOCALLY AS A LEAKY CONFINING UNIT. (GEOLOGIC LOG)

(3) THE WARSAW AND SALEM FORMATIONS ARE CONSIDERED TO BE ABSENT FROM THE WELDON SPRING AREA DUE TO EROSION.

(4) THE SULPHUR SPRINGS GROUP ALSO INCLUDES THE BACHELOR SANDSTONE AND THE GLEN PARK LIMESTONE-MISSOURI DIVISION OF GEOLOGY AND LAND SURVEY. (REF 53)

(5) THE MAQUOKETA SHALE IS NOT PRESENT IN THE WELDON SPRING AREA BASED ON GEOLOGIC LOGS.

GENERALIZED STRATIGRAPHY AND HYDROSTRATIGRAPHY OF THE WELDON SPRING AREA

FIGURE 7-1

REPORT NO.	EXHIBIT NO.
DOE/OR/21548-917	A/PI/047/0391

ORIGINATOR	DRAWN BY	DATE
BWD	GLN	4/16/02

Groundwater is also monitored under the requirements of Department of Energy Order 5400.5, *Radiation Protection of the Public and the Environment*, which designates derived concentration guidelines (DCGs) for ingestion of water equivalent to 100 mrem (1.0 mSv) effective dose equivalent, based on the consumption of 730 liters/year (193 gal/year) (Table 7-2). As specified in Department of Energy Order 5400.5, liquid effluent from U.S. Department of Energy (DOE) activities may not cause private or public drinking waters to exceed the radiological limit of an effective dose equivalent greater than 4 mrem (0.04 mSv/year) per year or 4% of the DCG.

Table 7-2 Derived Concentration Guidelines for Discharge Waters

PARAMETER	DERIVED CONCENTRATION GUIDELINE
Natural Uranium	600 pCi/l
Ra-226	100 pCi/l
Ra-228	100 pCi/l
Th-230	300 pCi/l
Th-232	50 pCi/l

Note: 1 pCi/l = 0.037 Bq/l.

7.4 Weldon Spring Chemical Plant

Since remediation activities began in 1987, more than 100 monitoring locations have been used for groundwater observations and sampling. Each year, wells are installed and/or abandoned to support the changing needs of the project. During 2001, 23 new wells were installed, and one damaged well was abandoned. A total of 68 wells and 4 springs were sampled to monitor the groundwater impacts of historical chemical plant operations, recent remedial activities, and ongoing field studies.

7.4.1 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.

The site is on a groundwater divide from which groundwater flows north toward Dardenne Creek and then ultimately to the Mississippi River, or 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. Groundwater movement is generally by diffuse flow with localized zones of discrete fracture-controlled flow.

The chemical plant and raffinate pit area lithologies consist of two major geologic units; unconsolidated surficial material and carbonate bedrock. The unconsolidated surficial materials are clay-rich, mostly glacially derived units, which are generally unsaturated. Thicknesses range from 6.1 m to 15.3 m (20 ft to 50 ft) (Ref. 2).

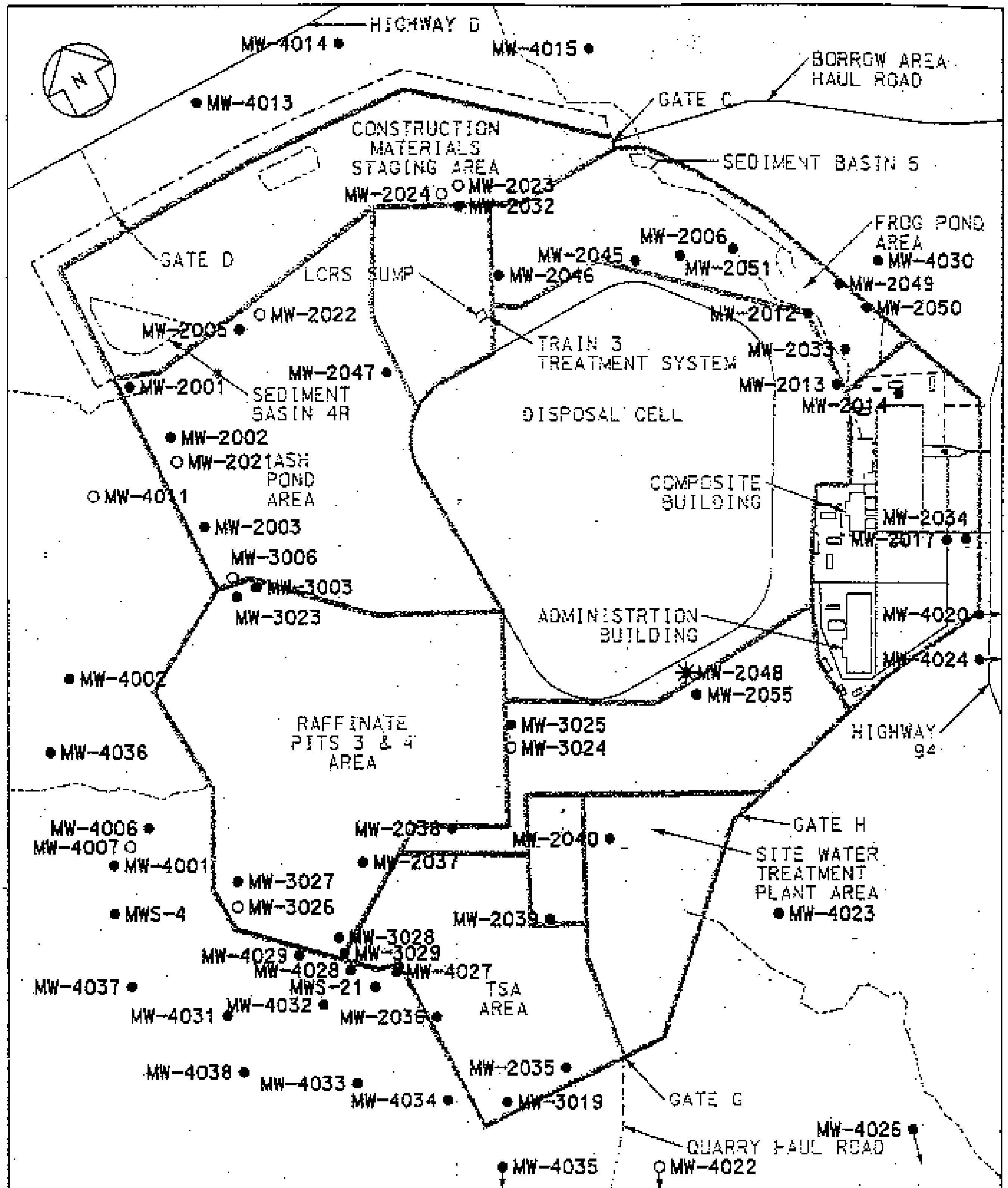
Potential groundwater impacts are assessed by monitoring groundwater from the monitoring well network at the site. The aquifer of concern beneath the chemical plant, raffinate pits, and vicinity properties is the shallow bedrock aquifer comprised of Mississippian-age Burlington-Keokuk Limestone (the uppermost bedrock unit). The Burlington-Keokuk Limestone is composed of two different lithologic zones, a shallow weathered zone underlaid by an 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-unconsolidated material interface.

All monitoring wells are completed in the Burlington-Keokuk Limestone. Some wells that are screened in the unweathered zone of the Burlington-Keokuk Limestone are used to assess the vertical migration of contaminants. Most of the wells are completed in the weathered unit of the bedrock where groundwater has the greatest potential to be contaminated. Where possible, monitoring wells within the boundaries of the chemical plant area are located near potential contaminant sources to assess migration into the groundwater system. Additional wells are located outside the chemical plant boundary to detect and evaluate potential off-site migration of contaminants (Figure 7-2).

Upgradient-downgradient water quality comparisons are not practical for the chemical plant site because it straddles the regional groundwater divide. Background values developed by the U.S. Geological Survey (USGS) for uranium and sulfate in the shallow aquifer were previously used as reference levels in lieu of these comparisons (Ref. 34). In this year's report, as in last year's, the site-specific background levels established in the Groundwater Operable Unit (GWOU) *Remedial Investigation* are used instead (Ref. 30).

Springs, a common feature in carbonate terrains, are present in the vicinity of the site. Four springs are monitored routinely as part of the EMP (Ref. 8). These springs, which are shown on Figure 7-3, have been historically influenced by chemical plant discharge water and/or groundwater that contained one or more of the contaminants of concern.

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 (Ref. 30) indicated that a discrete and rapid hydraulic connection exists between the northern portion of the chemical plant and Burgermeister Spring.



LEGEND
- ● WEATHERED ZONE
- ○ UNWEATHERED ZONE
- ✳ ABANDONED DURING 2001

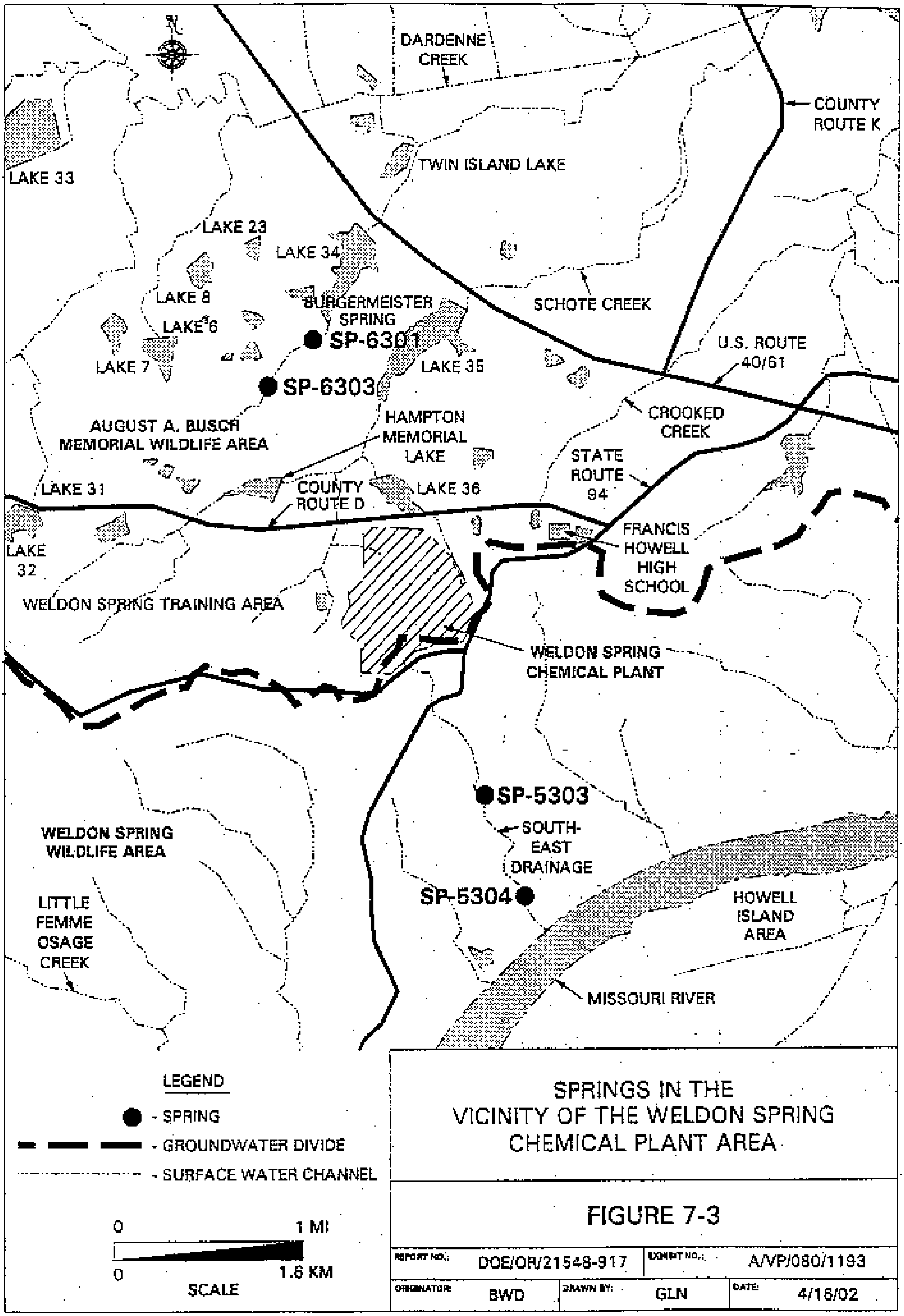
0 600 1200

SCALE FEET

GROUNDWATER MONITORING LOCATIONS AT THE WELDON SPRING CHEMICAL PLANT MONITORING WELL NETWORK

FIGURE 7-2

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/CP/077/1295	
ORIGINATOR: BWD	DRAWN BY: GLN	DATE: 4/16/02	



SPRINGS IN THE VICINITY OF THE WELDON SPRING CHEMICAL PLANT AREA

FIGURE 7-3

REPORT NO.:	DOE/OR/21548-917		EXHIBIT NO.:	A/VP/080/1193	
ORIGINATOR:	BWD	DRAWN BY:	GLN	DATE:	4/16/02

7.4.2 Monitoring Program

The 2001 groundwater monitoring program at the former chemical plant and raffinate pits area focused on monitoring known contaminants and determining any groundwater impacts which may have resulted from remedial action (e.g., soil excavation and sludge removal) at the site. A summary of monitoring locations and parameters may be found in the *Environmental Monitoring Plan* (Ref. 8). The EMP includes provisions for initiation of special environmental studies if evidence or conditions arise that warrant investigation beyond the scope of the EMP sampling schedule.

Total uranium, nitroaromatic compounds, VOCs, and nitrate were monitored at selected locations throughout the chemical plant area. The frequency and type of sampling performed at each location were based on recent concentrations of contaminants in the groundwater at each location and on the likelihood of remedial activities causing mobilization of contaminants into the groundwater. Analytical results for all monitored parameters are summarized and discussed in Section 7.4.3.

Prior to construction of the chemical plant, the site was part of a Department of the Army Ordnance Works complex for production of the nitroaromatic compounds trinitrotoluene (TNT) and dinitrotoluene (DNT). The first four nitroaromatic production lines were located within the boundaries of the former chemical plant and raffinate pits area. Wastes generated from the initial operation of these early production lines were disposed of in open earthen pits which released contaminated seepage to groundwater. One such pit, Lagoon 1, was located along the northeast boundary of the chemical plant. Wastewater containing nitroaromatic compounds was transported through wooden pipe networks. Discrete locations at the chemical plant known to be impacted by nitroaromatics were sampled and analyzed for these compounds in 2001.

Monitoring wells in the vicinity of Frog Pond, which began demonstrating elevated concentrations of nitroaromatic compounds in 1999, were sampled bimonthly in 2001. In addition, four new wells were installed at the end of 2001 to further define the extent of nitroaromatic contamination in this area. Data from the new wells will be available in the 2002 site environmental report.

Groundwater in the vicinity of the former raffinate pits has been impacted with elevated nitroaromatic compounds, nitrate, and uranium concentrations. The pits contained ore-refining wastes from uranium ore concentrates that were digested with nitric acid during the original chemical plant operations. Some of the wastes generated and disposed of as raffinate also contained isotopes of thorium and radium. During 2001, groundwater samples from selected locations near the raffinate pits were analyzed for nitrate, total uranium, and nitroaromatic compounds. Thorium and radium were not monitored since previous data did not indicate above-background levels of these parameters.

Trichloroethene (TCE) was detected in groundwater southeast of Raffinate Pit 4 during 1996. VOC monitoring was conducted quarterly at selected wells during 2001 to evaluate potential trends in the area of TCE impact, assess the mobility of the contaminant, and evaluate the effect of remediation activities on VOC contamination levels. In addition, thirteen new monitoring wells were installed in this area in 2001 to further define the extent of contamination. Four additional wells were installed to support the pump and treat field studies, which are discussed in Section 10.

Groundwater in the vicinity of the former Ash Pond has been impacted with elevated nitrate, as well as some uranium and nitroaromatic compounds. Since remedial activities may have mobilized more of these contaminants into the groundwater, wells in this area were monitored quarterly or semiannually for nitrate, uranium, and nitroaromatics.

Sulfate was monitored at many of the chemical plant wells to determine whether a correlation existed between sulfate and uranium concentrations. This potential correlation, which has been observed due to the geochemistry downgradient from the quarry, was not observed at the chemical plant during 2001 and will not be pursued in 2002.

Groundwater moves under the chemical plant by both diffuse and discrete flow components. In order to monitor the discrete flow component, four springs were monitored during 2001 for total uranium, nitroaromatic compounds, and VOCs. The springs were sampled during high- and base-flow conditions to monitor the potential impacts from surface water runoff in the vicinity of the chemical plant. Burgermeister Spring was also monitored semiannually as part of the cell well sampling network.

7.4.3 Chemical Plant Monitoring Results

7.4.3.1 Groundwater Monitoring Wells

Analytical data for contaminants monitored during 2001 (e.g., uranium, nitrate, sulfate, volatile organic compounds, and nitroaromatics) are summarized and compared with background levels and water quality standards in the following paragraphs. Comparisons to drinking water standards are for reference purposes only, and are not intended to imply that groundwater from WSSRAP monitoring wells must be in compliance with drinking water standards. Average annual concentrations are compared to background levels established during the GWOU remedial investigation (Ref. 30).

Uranium. Total uranium, which is measured at all active monitoring wells, continues to be present in the groundwater near the raffinate pits. In 2001, groundwater from 38 monitoring well locations exceeded the average background level of 0.93 pCi/l (0.03 Bq/l) established during the GWOU remedial investigation (Ref. 30). Only two wells exceeded the groundwater standard of 30 pCi/l (40 CFR 192). Average measured values from wells exceeding background are shown in Table 7-3.

Nitrate and Sulfate. In 2001, nitrate was measured at 54 monitoring wells in the chemical plant area. Nitrate levels exceeded the Missouri drinking water primary MCL (10 mg/l) at 36 of those locations (see Table 7-4).

Sulfate was measured at 47 monitoring wells in the chemical plant area. Average sulfate concentrations exceeded the background level (12 mg/l), established during the GWOU remedial investigation (Ref. 30), at 42 locations. (See Table 7-5.) Three wells indicated sulfate concentrations above the Missouri drinking water secondary MCL (250 mg/l).

Table 7-3 Annual Averages for Total Uranium (pCi/l) Above Background at the Weldon Spring Chemical Plant

LOCATION	AVERAGE (pCi/l)	SAMPLE POPULATION
MW-2003	4.29	2
MW-2012	1.25	1
MW-2017	6.78	4
MW-2032	1.42	2
MW-2034	2.90	1
MW-2038	1.75	4
MW-2040	2.26	2
MW-2047	1.92	3
MW-2048	1.30	1
MW-2049	4.27	1
MW-2050	1.38	1
MW-2051	1.33	3
MW-3003	14.95	4
MW-3023	12.20	4
MW-3024	59.82*	4
MW-3025	2.26	4
MW-3026	1.74	2
MW-3030	52.92*	4
MW-3031	4.96	4
MW-3034	2.1	4
MW-3036	1.12	4
MW-3037	1.65	1
MW-3038	1.25	1
MW-3039	1.10	1
MW-4007	0.97	2
MW-4013	1.47	2
MW-4020	8.43	4
MW-4022	4.49	4
MW-4023	2.29	4
MW-4024	5.36	4
MW-4027	1.00	4
MW-4030	1.91	1
MW-4034	2.47	1
MW-4036	15.40	1
MW-4037	3.85	1
MW-4038	1.47	1
MW-S004	8.85	2
MW-S021	1.04	4

* Concentration exceeds the groundwater standard of 30 pCi/l.

Note 1: Background uranium concentration equals 0.93 pCi/l.

Note 2: 1 pCi/l = 0.037 Bq/l.

Table 7-4 Annual Values of Nitrate (mg/l) Exceeding Drinking Water Quality Standard at the Weldon Spring Chemical Plant

LOCATION	AVERAGE (mg/l)	SAMPLE POPULATION
MW-2001	120.75	4
MW-2002	194.25	4
MW-2003	296.00	4
MW-2005	90.46(a)	4
MW-2037	90.6	4
MW-2038	551.5	4
MW-2040	235.25(b)	4
MW-2047	69.95	2
MW-3003	339.50	4
MW-3023	236.50	4
MW-3024	275.75	4
MW-3025	309.50	4
MW-3026	162.75	4
MW-3027	186.02(c)	4
MW-3029	290.25	4
MW-3030	194.75	4
MW-3031	47.22	4
MW-3032	15.07	4
MW-3034	549.00	4
MW-3035	100.35(d)	4
MW-3036	216.10(e)	4
MW-3037	149.00	1
MW-3038	13.30	1
MW-3039	495.00	1
MW-4001	58.18	4
MW-4007	31.84(f)	2
MW-4011	60.82	4
MW-4027	29.07	4
MW-4028	189.50	4
MW-4029	421.25	4
MW-4031	260.25	4
MW-4032	168.50	4
MW-4036	48.90	1
MW-4037	92.20	1
MW-4038	125.00	1
MW-S021	148.18	4

Note : Missouri Drinking Water Standards designate the primary maximum contaminant level as 10 mg/l.

(a) This value contains an outlier of 2.84 mg/l. When this value is disregarded, the average concentration is 119.67 mg/l.

(b) This value contains an outlier of 545 mg/l. When this value is disregarded, the average concentration is 132.0 mg/l.

(c) This value contains an outlier of 639 mg/l. When this value is disregarded, the average concentration is 35.03 mg/l.

(d) This value contains an outlier of 259 mg/l. When this value is disregarded, the average concentration is 47.47 mg/l.

(e) This value contains an outlier of 619 mg/l. When this value is disregarded, the average concentration is 81.80 mg/l.

(f) This value contains an outlier of 63.3 mg/l. When this value is disregarded, the average concentration is 0.39 mg/l.

Table 7-5 Annual Values of Sulfate (mg/l) Above Background at the Weldon Spring Chemical Plant

LOCATION	AVERAGE (mg/l)	SAMPLE POPULATION
MW-2001	19.3	1
MW-2002	101.0	2
MW-2003	207.0	2
MW-2005	99.0	2
MW-2017	662.5*	2
MW-2021	11.5	1
MW-2032	31.85	2
MW-2037	83.15	2
MW-2038	29.53	3
MW-2040	12.2	1
MW-2045	19.05	2
MW-2046	44.9	2
MW-2047	26.9	2
MW-2048	293.0*	3
MW-2051=	60.5	3
MW-3003	156.0	2
MW-3023	1728(a)*	2
MW-3024	60.5	2
MW-3025	36.5	2
MW-3026	15.7	1
MW-3029	72.9	1
MW-3030	130.93	3
MW-3031	26.0	3
MW-3032	80.45	2
MW-3034	106.0	1
MW-3035	113.0	1
MW-3036	58.2	1
MW-3037	31.1	1
MW-3038	43.9	1
MW-3039	94.5	1
MW-4001	46.0	1
MW-4011	23.25	2
MW-4027	16.4	1
MW-4028	86.73	3
MW-4029	90.0	3
MW-4031	48.63	3
MW-4032	90.0	1
MW-4033	20.9	1
MW-4035	25.3	1
MW-4036	32.3	1
MW-4037	79.0	1
MW-4038	31.2	1

* Concentration exceeds the Missouri Drinking Water Secondary MCL of 250 mg/l.

Note : Background sulfate concentration equals 12 mg/l.

(a) This value contains an outlier of 3,310 mg/l. When this value is disregarded, the average concentration is 146 mg/l.

Nitroaromatic Compounds Nitroaromatic compounds, which are not naturally occurring, were detected in 42 monitoring wells (Table 7-6). New historic highs were reported during 2001 at several wells in the vicinity of Frog Pond, most notably at MW-2012. Levels of nitroaromatics have increased at this well since 1997, most likely as a result of remedial activities in this area. Additional wells were installed in the vicinity of Frog Pond in 2000 and 2001 to further define the extent of contamination in this area; however, MW-2012 continues to demonstrate the highest concentrations of nitroaromatic compounds.

The Missouri drinking water quality standard for 2,4-DNT of 0.11 μg/l was equaled or exceeded in 14 locations at the chemical plant (see Table 7-6).

Table 7-6 Annual Averages for Monitoring Locations with at Least One Detectable Concentration of a Nitroaromatic Compound (μg/l) at the Weldon Spring Chemical Plant

LOCATION	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
2001	0.05	<0.09	<0.03	<0.04	0.08	<0.03
2002	0.03	<0.09	<0.03	<0.04	0.2	<0.03
2003	<0.03	<0.09	<0.03	0.06	0.52	<0.03
2005	0.2	0.09	<0.03	0.05	0.18	<0.03
2006	4.22	<0.09	<0.03	0.1	0.58	<0.03
2012	82.29	2.25	154.29	735.7*	681.43	<0.03
2013	1.42	<0.09	0.13	0.14*	0.96	<0.03
2014	1.67	<0.09	<0.03	0.08	0.35	0.08
2021	<0.03	<0.09	0.04	<0.04	<0.06	<0.03
2033	1.49	<0.09	0.45	0.04	0.69	<0.03
2037	<0.03	<0.09	<0.03	0.04	<0.06	<0.03
2038	0.03	<0.09	<0.03	0.22*	<0.06	0.03
2045	0.11	<0.10	<0.10	<0.10	0.74	<0.10
2046	2.65	<0.10	3.25	1.12*	1.90	<0.10
2047	<0.10	<0.10	<0.10	0.16*	0.30	<0.10
2049	0.32	<0.09	1.33	34.46*	82.00	<0.03
2050	3.00	<0.09	0.08	11.65*	2.29	<0.03
2051	<0.03	<0.09	0.05	0.04	0.08	<0.03
3003	<0.03	<0.09	<0.03	0.13*	0.20	<0.03
3023	<0.03	<0.09	<0.03	0.09	0.92	<0.03
3025	<0.03	<0.09	<0.03	<0.04	0.08	<0.03
3026	0.07	<0.09	<0.03	<0.04	<0.06	<0.03
3027	0.07	<0.09	<0.03	<0.04	<0.06	<0.03
3029	0.34	<0.09	<0.03	0.10	<0.06	<0.03
3030	<0.03	<0.09	<0.03	0.80*	0.30	<0.03
3032	<0.03	<0.09	<0.03	0.04	<0.06	<0.03
3034	0.13	<0.09	<0.03	0.25*	0.10	<0.03
3035	<0.03	0.11	<0.03	<0.04	<0.06	0.06
3036	0.12	<0.09	<0.03	0.09	<0.06	<0.03
3038	0.16	<0.09	<0.03	0.86*	0.13	<0.03

Table 7-6 Annual Averages for Monitoring Locations with at Least One Detectable Concentration of a Nitroaromatic Compound (µg/l) at the Weldon Spring Chemical Plant (Continued)

LOCATION	1,3,5-TNB	1,3-DNB	2,4,6-TNT	2,4-DNT	2,6-DNT	NB
3039	0.11	<0.09	<0.03	0.90*	0.15	<0.03
4001	24.25	<0.09	1.68	0.06	1.35	<0.03
4006	6.59	<0.09	<0.03	0.06	0.22	<0.03
4015	4.6	<0.09	<0.03	0.04	0.6	<0.03
4027	0.04	<0.09	<0.03	0.05	<0.06	<0.03
4028	0.32	<0.09	<0.03	0.08	0.09	<0.03
4029	0.60	<0.09	<0.03	0.26*	0.25	<0.03
4030	1.66	0.10	1.08	0.13*	0.37	<0.03
4031	1.83	<0.09	0.62	0.07	0.17	<0.03
4032	0.53	<0.09	<0.03	0.07	0.10	<0.03
S004	3.85	<0.09	0.27	<0.04	0.30	<0.03
S021	0.08	<0.09	<0.03	0.1	<0.06	<0.03

< All samples less than the highest detection limit.

* Equals or exceeds the Missouri water quality standard of 0.11 µg/l.

Volatile Organic Compounds. VOC monitoring continued through 2001 to monitor the extent of contamination and changes in concentration that may have resulted from remedial activities and groundwater field studies. Twenty-four wells demonstrated detectable levels of at least one VOC. The analytical results for all wells with detectable levels of either 1,2-DCE, PCE, or TCE are summarized in Table 7-7. Eighteen of these wells exceeded the Missouri water quality standard of 5 µg/l for TCE.

Table 7-7 Annual Average VOC (µg/l) Exceeding Detection Limits at the Weldon Spring Chemical Plant

LOCATION	1,2-DCE	PCE	TCE	SAMPLE POPULATION
MW-2013	1.52	<DL	<DL	4
MW-2037	7.75	<DL	324.98*	4
MW-2038	<DL	<DL	30.75*	4
MW-3024	<DL	<DL	1.5	4
MW-3025	<DL	<DL	5.12*	4
MW-3028	<DL	<DL	263.33*	4
MW-3029	<DL	<DL	370.25*	4
MW-3030	<DL	<DL	220.0*	4
MW-3032	<DL	<DL	1.2	4
MW-3034	<DL	<DL	557.5*	4
MW-3035	<DL	<DL	54.3*	4
MW-3036	<DL	<DL	9.3*	4
MW-3037	<DL	1.6	DL	1
MW-3038	<DL	2.4	DL	1
MW-3039	<DL	<DL	80.0*	1
MW-4001	<DL	<DL	5.95*	4
MW-4027	<DL	5.28	1.98	4
MW-4028	<DL	<DL	262.75*	4
MW-4029	<DL	<DL	543.50*	4
MW-4031	<DL	<DL	175.0*	4

Table 7-7 Annual Average VOC (µg/l) Exceeding Detection Limits at the Weldon Spring Chemical Plant (Continued)

LOCATION	1,2-DCE	PCE	TCE	SAMPLE POPULATION
MW-4032	<DL	<DL	105.45*	4
MW-4037	<DL	<DL	27.0*	1
MW-4038	<DL	<DL	27.0*	1
MW-S021	<DL	<DL	73.75*	4

<DL All samples less than highest detection limit.
* Concentration exceeds the Missouri water quality standard of 5 µg/l.

Groundwater Overview. Contaminant levels generally remained within recent historical ranges at the monitoring wells sampled under the environmental monitoring program during 2001. Data from new wells provided further delineation of the TCE contamination in the raffinate pits area and the nitroaromatics contamination in the Frog Pond area.

7.4.3.2 Springs

Burgermeister Spring (SP-6301) is a perennial spring that represents a localized emergence of groundwater impacted by a recognizable contribution of contaminants from the chemical plant throughout the year. The highest contaminant concentrations occur during base flow stages. During high flow conditions, surface water recharge along the stream segments mixes with contaminated groundwater from the site, and the concentrations are effectively lowered. This spring (SP-6301) was monitored during both high and base stages during 2001.

Annual average concentrations for nitrate, sulfate, uranium, and nitroaromatic compounds are presented in Table 7-8. Compared to concentrations reported for Burgermeister Spring in 2000, these concentrations were in the same general range, with uranium being slightly lower during base flow and slightly higher during high flow. Of the nitroaromatic compounds analyzed, only 2,6-DNT was reported above detection limits. No VOCs were reported above detection limits at this spring.

Table 7-8 2001 Monitoring Data for Burgermeister Spring

PARAMETER	HIGH FLOW			LOW (BASE) FLOW		
	MIN	MAX	AVG	MIN	MAX	AVG
Nitrate (mg/l)	2.6	6.6	4.6	1.7	48.5	16.2
Sulfate (mg/l)	27.6	36.6	32.1	24.6	28.6	26.2
U-total (pCi/l)	16.0	32.1	24.1	8.8	56.2	34.7
2,6-DNT (µg/l)	<0.06	0.11	0.07	<0.06	0.14	0.09

< All samples less than the highest detection limit.

Three other springs, which are located in Valley 5300 (SP-5303 and SP-5304) and Valley 6300 (SP-6303), were monitored during 2001 to assess the potential for off-site migration of contaminants. These locations were sampled during base flow for VOCs, uranium, and nitroaromatic compounds, and at high flow for uranium and nitroaromatic compounds. Annual average concentrations of parameters for which detection limits were exceeded are presented in Table 7-9. No VOCs were reported above detection limits at any of the springs.

Table 7-9 2001 Annual Average Monitoring Data for Springs

PARAMETER	HIGH FLOW			LOW (BASE) FLOW		
	SP-5303	SP-5304	SP-6303	SP-5303	SP-5304	SP-6303
U-total (pCi/l)	17.79	66.35	1.17	71.85	85.25	1.89
1,3,5-TNB (µg/l)	<0.03	<0.03	<0.03	0.16	<0.03	<0.03
2,4,6-TNT (µg/l)	1.91	0.09	<0.09	20.35	0.04	<0.03
2,6-DNT (µg/l)	<0.06	<0.06	<0.06	0.18	<0.06	0.25

< All samples less than the highest detection limit.

7.4.4 Trend Analysis

The computer program TREND, developed at Pacific Northwest Laboratory, was used to perform the formal groundwater trend testing. Results of the TREND analyses indicated the potential presence of statistically-significant trends, as well as their direction and magnitude. The trend testing output data are to be interpreted as screening indicators based on existing cumulative data. Results of the analyses are not intended to be used for the prediction of future concentrations, but they may be used to indicate areas that should be more closely monitored in the future.

7.4.4.1 Statistical Methods

The TREND program was selected because it does not require the data to conform to a particular distribution (such as a normal or lognormal distribution). The nonparametric method used in this program is valid for scenarios where there are a high number of non-detect 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 quantitation limit). This approach is valid since only the relative magnitudes of the data, rather than their measured values, are used in the method. The TREND program was also used in past analyses of the site groundwater data. Thus, use of the TREND program offered the advantage of maintaining continuity in the analysis methodology.

The two-tailed version of the Mann-Kendall test was employed to detect either an upward or downward trend for each data set. In this approach, a test statistic, Z, is calculated based on the mean and variance of the data set. A positive value of Z indicates that the data are skewed in an upward direction, and a negative value of Z indicates that the data are skewed in a downward direction. The alpha value (or error limit) used to identify a significant trend was 0.05. In the two-tailed test at the 0.05 alpha level of significance, the null hypothesis of "no trend" was rejected if the absolute value of the Z statistic was greater than $Z_1\text{-}\alpha/_2$, where $Z_1\text{-}\alpha/_2$ was obtained from a cumulative normal distribution table. In other words, the absolute value of the TREND output statistic, Z was compared to the table $Z_{.975}$ value of 1.96. If the absolute value of the Z output statistic was greater than 1.96, then a significant trend was reported.

The linear slope, which is calculated independently of the trend, was estimated for all data sets. The slope was estimated using a nonparametric procedure included in the computer code for the TREND program. A 95% two-sided confidence interval about the true slope was calculated to indicate the variability of the values upon which the line was based. The direction and magnitude of the slope, along with the upper and lower 95% confidence limit estimates, are included in the summary tables at the end of this section.

One-half the specified quantitation limit (on the date of analysis) was used in the trend analysis for all data reported as below the detection limit. The purpose of using one-half the quantitation limit for non-detect data was to minimize the potential bias of the data. However, a consequence of this approach may be that, in some instances, the results may have been impacted by quantitation limits changing over time. The effect of varying quantitation limits is more likely to impact the trending analysis in instances where a large number of non-detect data are present within a given time series. The summary tables include the total number of data observations and the total number of non-detect data points for each data set so that this factor may be considered.

In cases where both filtered and unfiltered samples were collected for uranium analysis, the unfiltered sample data were used in the trend analysis. Filtered sample data were typically used only for evaluating whether a particular parameter (e.g., metals) exceeded baseline conditions established under the detection monitoring program at one of the former on-site waste treatment facilities. (Baseline levels were based on 1993 to 1994 data collected from filtered samples.) For trending purposes, the unfiltered sample data are used because the 1998 to 2001 data are based predominantly on unfiltered samples.

No statistical tests were conducted for suspect outliers. Data that were suspect were flagged and rechecked for potential data transcription errors. Outliers were included in the analysis since the TREND program corrects for these.

7.4.4.2 Chemical Plant Trend Results

The selected wells from the chemical plant were trended for nitrate and nitroaromatic compounds. Uranium was not trended since only 2 wells at the chemical plant exceeded the groundwater standard. Trichloroethene was not trended because contaminant levels in the area of impact (former raffinate pits) were artificially influenced by the pump and treat study that was conducted in 2001 (see Section 10). The cumulative results for the time period 1998 through 2001 were evaluated using the TREND program and are summarized below.

Nitrate

Five locations near the former chemical plant were selected for nitrate trend analyses. These locations consisted of both weathered and unweathered bedrock wells in the Ash Pond area, where nitrate is the primary contaminant of concern.

Nitrate trends for 1998 through 2001 data are shown in Table 7-10. One of these locations, MW-2005, was not previously trended for nitrate. The stationary trend is a change from the analyses using the 1997 through 2000 data where the location MW-2002 previously indicated an upward trend. Nitrate trends remained upward for well MW-2001, stationary for well MW-2003, and downward for well MW-4011.

One of the five locations that were evaluated for the 1998 through 2001 time frame has a reported concentration in 2001 that exceeds all past 1998, 1999, and 2000 data for the specific sampling location. The nitrate level is 127 mg/L at MW-2001.

Nitroaromatic Compounds

Nine locations near the former chemical plant were selected for trend analyses of nitroaromatic compounds. All nine of these locations are weathered bedrock wells in the Frog Pond area, where nitroaromatic compounds are the primary contaminant of concern. The results of these analyses are in Table 7-11. Each location was trended for the following compounds: 2,4-DNT, 2,6-dinitrotoluene (2,6-DNT), 1,3,5-trinitrobenzene (1,3,5-TNB), and 2,4,6-trinitrotoluene (2,4,6-TNT). A total of 32 trend analyses were performed on the nitroaromatic compounds at the nine groundwater monitoring well locations. Trending was not performed on 2,4,6-TNT at MW-2006, MW-2014, MW-2049, and MW-2050 because fewer than three detected concentrations were reported for the time period between 1998 and 2001.

One location, MW-2012, has upward trends indicated for 2,4-DNT and 1,3,5-TNB. This is a change from previous analyses for 2,4-DNT, which indicated a stationary trend but is consistent with past trends for 1,3,5-TNB. The results of analyses from the two other nitroaromatic compounds trended for this location previously indicated and continue to indicate stationary trends. No other upward trends were identified.

The downward trend for 2,4,6-TNT at MW-2013 remained unchanged from previous analyses using the 1997 through 2000 data. Downward trends were also indicated for the following nitroaromatic compounds at their respective locations: 2,4-DNT at MW-2014, 2,6-DNT at MW-2006 and MW-2033, and 1,3,5-TNB at MW-2013 and MW-2014. The analyses for these nitroaromatic compounds at their respective locations previously indicated a stationary trend.

All other results of the trend analyses indicated stationary trends. This is consistent with prior analyses with the exception of all four nitroaromatic compounds at MW-2032 and 2,4,6-TNT at MW-2033 which all previously indicated downward trends. Wells MW-2049, MW-2050, and

MW-4030 were not included in last year's scope of work since not enough data were available; thus, no comparison to past trends regarding these three wells could be made.

As shown in Table 7-11, all four nitroaromatic compounds at MW-2012 have reported concentrations in 2001 that exceed all past 1998, 1999, and 2000 data for their respective sampling locations. The new high concentrations reported for all four nitroaromatic compounds at MW-2049, MW-2050, and MW-4030 are actually the highs for 2001 only, since these wells were installed during fourth quarter 2000.

Table 7-10 Chemical Plant Groundwater Wells Nitrate Trend Analysis Summary for 1998 to 2001

Well ID	Location	No. of Observations	No. of Non-Detect Data	Trend Direction (Alpha = 0.05)	Slope (mg/l/yr)	95% Upper & Lower Confidence Intervals on Slope (mg/l/yr)	2001 New High Concentration (mg/l)
MW2001	Weathered bedrock, west of Ash Pond	10	0	U	13.500	8.199, 17.101	127
MW2002	Weathered bedrock, west of Ash Pond	10	0	S	18.000	-34.034, 58.186	No
MW2003	Weathered bedrock, west of Ash Pond	10	0	S	-30.000	-67.207, -0.793	No
MW2005	Weathered bedrock, north of Ash Pond	10	0	S	-7.000	-74.220, 14.005	No
MW4011	Unweathered bedrock, west of chemical plant	11	0	D	-45.300	-71.392, -33.302	No

D = Downward
S = Stationary
U = Upward

Table 7-11 Chemical Plant Groundwater Wells Nitroaromatics Trend Analysis Summary for 1998 to 2001

Well ID	Location	Compound	No. of Observations	No. of Non-Detect Data	Trend Direction (Alpha = 0.05)	Slope (µg/l/yr)	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr)	2001 New High Concentration (µg/l)
MW2006	Weathered bedrock –	2,4-DNT	13	5	S	-0.027	-0.100, 0.018	No
	frog pond area	2,6-DNT	13	2	D	-0.238	-0.550, -0.100	No
		1,3,5-TNB	13	1	S	-1.000	-1.747, -0.237	No
		2,4,6-TNT	13	12	(a)	(a)	(a)	No
MW2012	Weathered bedrock -	2,4-DNT	15	0	U	130.000	23.355, 274.250	950
	frog pond area	2,6-DNT	15	0	S	50.000	0.693, 119.307	800
		1,3,5-TNB	15	0	U	16.000	7.000, 30.209	150
		2,4,6-TNT	15	0	S	10.000	-10.000, 29.499	220
MW2013	Weathered bedrock -	2,4-DNT	13	1	S	-0.033	-0.063, 0.028	No
	SE of frog pond	2,6-DNT	13	0	S	-0.443	-0.830, 0.100	No
		1,3,5-TNB	13	0	D	-1.400	-2.894, -0.611	No
		2,4,6-TNT	13	3	D	-0.143	-0.193, -0.073	No
MW2014	Weathered bedrock -	2,4-DNT	13	1	D	-0.036	-0.061, -0.017	No
	SE of disposal cell	2,6-DNT	13	1	S	-0.063	-0.175, 0.054	No
		1,3,5-TNB	13	0	D	-0.600	-1.340, -0.187	No
		2,4,6-TNT	13	13	(a)	(a)	(a)	No
MW2032	Weathered bedrock -	2,4-DNT	10	3	S	-0.008	-0.021, 0.008	No
	north of disposal cell	2,6-DNT	10	3	S	-0.043	-0.085, -0.006	No
		1,3,5-TNB	9	2	S	-0.008	-0.031, 0.001	No
		2,4,6-TNT	10	3	S	-0.032	-0.078, -0.005	No
MW2033	Weathered bedrock -	2,4-DNT	13	4	S	-0.051	-0.117, 0.002	No
	south of frog pond	2,6-DNT	13	1	D	-0.257	-0.642, -0.105	No
		1,3,5-TNB	13	0	S	-1.050	-1.500, -0.084	No
		2,4,6-TNT	13	2	S	-0.020	-0.154, 0.024	No
MW2049	Weathered bedrock -	2,4-DNT	8	1	S	36.700	n too small, n too small	78
	frog pond area	2,6-DNT	8	0	S	-49.000	n too small, n too small	160
		1,3,5-TNB	8	2	S	0.010	n too small, n too small	0.81
		2,4,6-TNT	8	6	(a)	(a)	(a)	5.5

Table 7-11 Chemical Plant Groundwater Wells Nitroaromatics Trend Analysis Summary for 1998 to 2001 (Continued)

Well ID	Location	Compound	No. of Observations	No. of Non-Detect Data	Trend Direction (Alpha = 0.05)	Slope (µg/l/yr)	95% Upper & Lower Confidence Intervals on Slope (µg/l/yr)	2001 New High Concentration (µg/l)
MW2050	Weathered bedrock -	2,4-DNT	8	0	S	7.400	n too small, n too small	32
	frog pond area	2,6-DNT	8	0	S	-1.700	n too small, n too small	4.70
		1,3,5-TNB	8	1	S	1.885	n too small, n too small	7.30
		2,4,6-TNT	8	7	(a)	(a)	(a)	0.46
MW4030	Weathered bedrock -	2,4-DNT	8	1	S	0.010	n too small, n too small	0.21
	frog pond area	2,6-DNT	8	1	S	0.240	n too small, n too small	0.81
		1,3,5-TNB	8	0	S	1.540	n too small, n too small	3.70
		2,4,6-TNT	8	0	S	0.490	n too small, n too small	2.20

D = Downward 2,4-DNT 2,4-Dinitrotoluene
S = Stationary 2,6-DNT 2,6-Dinitrotoluene
U = Upward 2,4,6-TNT 2,4,6-Trinitrotoluene
1,3,5-TNB 1,3,5-Trinitrobenzene

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

[1]Data from 1998 and 1999 are not available for wells MW2049, MW2050, and MW4030.

7.5 Weldon Spring Quarry

7.5.1 Hydrogeologic Description

The geology of the quarry area is separated into three units; upland overburden, Missouri River alluvium, and bedrock. The unconsolidated upland material overlying bedrock consists of up to 9.2 m (30 ft) of silty clay soil and loess deposits and is not saturated (Ref. 1). Three Ordovician-age formations comprise the bedrock: the Kimmswick Limestone, the limestone and shale of the Decorah Group, and the Plattin Limestone. The alluvium along the Missouri River consists of clays, silts, sands, and gravels above the bedrock. The alluvium thickness increases with distance from the bluff towards the river where the maximum thickness is approximately 31 m (100 ft). The alluvium is truncated at the erosional contact with the Ordovician bedrock bluff (Kimmswick, Decorah, and Plattin formations), which also composes the rim wall of the quarry. The bedrock unit underlying the alluvial materials north of the Femme Osage Slough is the Decorah Group. Primary sediments between the bluff and the Femme Osage Slough are intermixed and interlayered clays, silts, and sands. Organic materials are intermixed throughout the sediments.

The uppermost groundwater flow systems at the quarry are composed of alluvial and bedrock aquifers. The alluvial aquifer is predominantly controlled by recharge from the Missouri River, and the bedrock aquifer is chiefly recharged by precipitation and overland runoff.

At the quarry, 15 monitoring wells are screened within either the Kimmswick-Decorah (upper unit) or Plattin Formations (lower unit) to monitor contaminants near the quarry within the bedrock (Figure 7-4). Ten of the 15 monitoring wells were installed to monitor contaminants within the Kimmswick-Decorah Formations comprising and surrounding the quarry. The remaining five monitoring wells are located south of the quarry within the Plattin Limestone to assess vertical contaminant migration.

There are 15 monitoring wells completed into the alluvium near the quarry and the Missouri River. Those north of the Femme Osage Slough monitor contaminant migration south of the quarry, while those south of the slough monitor for possible migration of contaminants toward the well field.

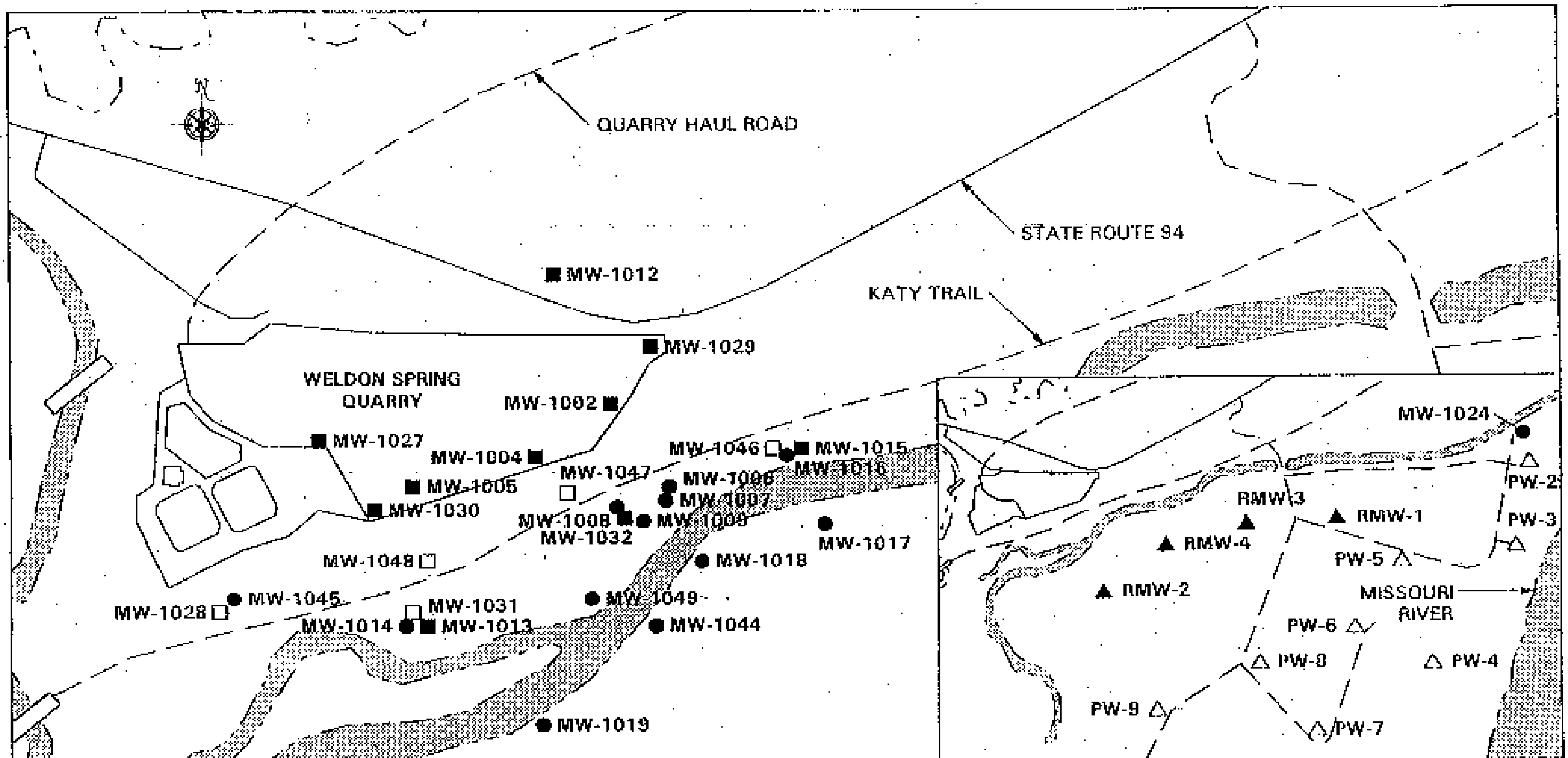
The St. Charles County monitoring wells, the RMW series wells, were designed to provide an early warning of contaminant migration toward the county production well field. The county production wells were monitored to verify the quality of the municipal well field water supply.

Eight groundwater monitoring wells located in the Darst Bottom area approximately 1.6 km (1 mi) southwest of the St. Charles County well field were utilized to study the upgradient characteristics of the Missouri River alluvium in the vicinity of the quarry. These wells provided a reference for background values in the well field area and have been sampled by both the USGS (1992) and the DOE (1994). These wells have since been abandoned. A summary of background values used at the quarry is provided in Table 7-12 (Ref. 35).

Table 7-12 Average Background Values (pCi/l) for Quarry Monitoring Locations

PARAMETER	ALLUVIUM [a]	KIMMSWICK/DECORAH [b]	PLATTIN [c]
Total Uranium (pCi/l)	2.77	3.41	12.30
Ra-226 (pCi/l)	0.61	0.41	3.01
Ra-228 (pCi/l)	2.15	1.06	2.95
Th-228 (pCi/l)	0.33	0.33	4.25
Th-230 (pCi/l)	1.59	0.61	11.20
Th-232 (pCi/l)	0.28	0.38	3.02
Gross Alpha (pCi/l)	4.32	15.80	NA
Gross Beta (pCi/l)	6.82	19.30	NA
Nitroaromatics (µg/l)	NA	NA	NA
Arsenic (µg/l)	5.15	1.48	10.90
Barium (µg/l)	463.00	147.00	109.00
Sulfate (mg/l)	44.20	95.90	165.00

(a) Darst Bottom Wells (USGS and DOE)
(b) MW-1034 and MW-1043 (DOE)
(c) MW-1042 (DOE)
NA Not analyzed



GROUNDWATER MONITORING LOCATIONS AT THE WELDON SPRING QUARRY AND ST. CHARLES COUNTY WELL FIELD

FIGURE 7-4

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/QY/103/1193	
ORIGINATOR: CO	DRAWN BY: GLN		DATE: 4/16/02

7.5.2 Monitoring Program

Two separate programs were employed in 2001 to monitor groundwater near the quarry. The first program involved sampling the Department of Energy wells in the quarry area to continue monitoring the effects of quarry dewatering and bulk waste removal on groundwater quality. These activities began in mid-1993 and were completed in late-1995.

The frequency of sampling for each location was based on the distance of the well from the source or migration pathway. Monitoring wells on the quarry rim were sampled quarterly for total uranium, due to the changes in concentrations over time, to establish the trend in concentrations at these locations, and to monitor the effects of quarry dewatering and bulk waste removal activities on the groundwater system. All quarry locations were sampled at least annually for radiochemical parameters, nitroaromatic compounds, and sulfate.

The second program monitors the St. Charles County well field and the associated water treatment plant. Active production wells, the St. Charles County RMW-series monitoring wells, and untreated and treated water from the County public drinking water treatment plant were sampled quarterly or semiannually for selected parameters. This portion of the monitoring program was developed by representatives of the DOE, EPA, several State regulatory agencies, and St. Charles County.

7.5.3 Weldon Spring Quarry Monitoring Results

7.5.3.1 Quarry

Radiochemical Parameters. Groundwater monitoring wells at the quarry were sampled for the following radiochemical parameters: total uranium, Ra-226, Ra-228, and isotopic thorium.

The uranium values continue to indicate that the highest levels occur in the bedrock downgradient from the quarry and in the alluvial material north of the Femme Osage Slough. The 2001 annual averages for the locations that exceed background for total uranium are summarized in Table 7-13. No locations south of the Femme Osage Slough exceeded background.

Table 7-13 Annual Averages for Total Uranium (pCi/l) Above Background at the Weldon Spring Quarry

LOCATION	AVERAGE	(n)	BACKGROUND VALUE
MW-1002	6	3	3.41
MW-1004	1,797*	3	3.41
MW-1005	1,527*	3	3.41
MW-1006	1,221*	3	2.77
MW-1007	21	3	2.77
MW-1008	2,077*	5	2.77

Table 7-13 Annual Averages for Total Uranium (pCi/l) Above Background at the Weldon Spring Quarry (Continued)

LOCATION	AVERAGE	(n)	BACKGROUND VALUE
MW-1009	28	6	2.77
MW-1013	389*	6	3.41
MW-1014	481*	6	2.77
MW-1015	180*	3	3.41
MW-1016	79*	3	2.77
MW-1027	384*	3	3.41
MW-1030	17	3	3.41
MW-1031	20	6	12.30
MW-1032	1,216*	6	3.41
MW-1045	11	3	2.77
MW-1048	377*	6	12.30

NOTE: 1 pCi/l = 0.037 Bq/l
(n) Sample population.
* Exceeds groundwater standard of 30 pCi/l.

The groundwater standard of 30 pCi/l (40 CFR 192) was exceeded at 11 locations. 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. The standard, while used as a reference level, is not applicable to groundwater north of the slough because this area is not considered a usable groundwater source. Locations exceeding background remained unchanged from 2000 with only a few exceptions. MW-1012 no longer had an average greater than background. MW-1009 was added to the list with an average exceeding background.

Ra-226, Ra-228, and isotopic thorium (Th-228, Th-230, and Th-232) were analyzed at all groundwater monitoring locations at the quarry. The 2001 annual averages for the 14 locations that exceeded background are summarized in Table 7-14.

Table 7-14 Annual Averages for Isotopic Radionuclides (pCi/l) Above Average Background at the Weldon Spring Quarry

LOCATION	Ra-226	(n)	Ra-228	(n)	Th-228	(n)	Th-230	(n)	Th-232	(n)
MW-1002	-	-	1.60	1	-	-	-	-	-	-
MW-1004	-	-	2.76	1	-	-	-	-	-	-
MW-1005	1.71	1	1.71	1	0.42	1	0.66	1	-	-
MW-1006	-	-	-	-	-	-	-	-	0.60	1
MW-1007	-	-	-	-	0.38	1	-	-	-	-
MW-1008	-	-	2.85	1	-	-	-	-	-	-
MW-1009	0.83	1	-	-	-	-	-	-	-	-
MW-1012	-	-	-	-	-	-	0.65	1	-	-
MW-1013			1.12	1	-	-	-	-	0.42	1
MW-1019	0.65	1	-	-	0.47	1	-	-	-	-
MW-1021	0.66	1	2.75	1	0.35	1	-	-	-	-
MW-1027	-	-	-	-	-	-	1.56	2	1.02	2

Table 7-14 Annual Averages for Isotopic Radionuclides (pCi/l) Above Average Background at the Weldon Spring Quarry (Continued)

LOCATION	Ra-226	(n)	Ra-228	(n)	Th-228	(n)	Th-230	(n)	Th-232	(n)
MW-1030	0.57	1	-	-	0.71	1	0.79	-	0.58	1
MW-1050	-	-	2.45	2	-	-	-	-	-	-

NOTE: 1 pCi/l = 0.037 Bq/l.
(n) Sample population.
\- Average did not exceed background.
Background values are presented in Table 7-12.

Nitroaromatic Compounds. In 2001, samples from quarry monitoring wells were analyzed for nitroaromatic compounds. The monitoring wells, which have historically been impacted with nitroaromatics, are situated in the alluvial materials or bedrock downgradient of the quarry and north of the Femme Osage Slough. Results were similar to those reported in 2000. No detectable concentrations were observed south of the Femme Osage Slough. A summary of the annual averages for all locations where at least one nitroaromatic compound was measured above the detection limit is provided in Table 7-15. The 2,4-DNT average concentration for location MW-1027 remained above the Missouri drinking water standard of 0.11 µg/l during 2001.

Table 7-15 Annual Averages for Monitoring Locations with at Least One Detectable Concentration of a Nitroaromatic Compound (µg/l) at the Weldon Spring Quarry

LOCATION	1,3,5-TNB	(n)	1,3-DNB	(n)	2,4,6-TNT	(n)	2,4-DNT	(n)	2,6-DNT	(n)	NB	(n)
MW-1002	2.60	2	<0.09	2	1.01	2	<0.04	2	1.75	2	<0.03	2
MW-1004	0.11	2	<0.09	2	0.16	2	<0.04	2	0.12	2	<0.03	2
MW-1005	<0.03	2	<0.09	2	<0.03	2	0.10	2	0.01	2	<0.03	2
MW-1006	<0.20	2	<0.20	2	<0.20	2	<0.20	2	<0.20	2	<0.20	2
MW-1015	0.15	2	<0.20	2	0.20	2	<0.20	2	<0.20	2	<0.20	2
MW-1027	<0.20	4	<0.20	4	0.50	4	4.48*	4	2.85	4	<0.20	4

< All samples less than highest detection limit.
(n) Sample population.
* Exceeds the Missouri Water Quality Standard of 0.11 µg/l for 2,4-DNT.

Sulfate. Groundwater analyses in 2001 continued to indicate elevated sulfate levels in the monitoring wells in the bedrock of the quarry rim and in the alluvial materials north of the Femme Osage Slough. Those wells with annual averages above background are summarized in Table 7-16. One location, MW-1005, had an annual average which exceeded the secondary MCL of 250 mg/l in 2001. Overall, only 9 monitoring wells had averages above background, which is just slightly lower than the 11 monitoring wells from 2000.

Table 7-16 Annual Averages for Sulfate (mg/l) Above Background at the Weldon Spring Quarry

LOCATION	ANNUAL AVERAGE	(n)	BACKGROUND VALUE
MW-1004	109	2	95.90
MW-1005	618*	2	95.90
MW-1006	131	2	44.20
MW-1008	89	2	44.20
MW-1014	103	5	44.20
MW-1016	96	2	44.20
MW-1029	101	2	95.90
MW-1032	138	5	95.90
MW-1045	55	1	44.20

* Exceeds secondary MCL of 250 mg/l.

(n) Sample population

7.5.3.2 St. Charles County Well Field

Radiochemical Parameters. The St. Charles County production wells, the RMW-series monitoring wells, pretreated (MW-RAWW) and treated water (MW-FINW) from the St. Charles County water treatment plant and DOE well MW-1024, were sampled semiannually during 2001 for the radiochemical parameters Ra-226, Ra-228, and isotopic thorium. Gross alpha, gross beta, and total uranium were analyzed quarterly. A summary of the radiochemical annual averages is provided in Table 7-17. The annual averages for total uranium in the well field remain at background. No production well exceeded the groundwater standard of 30 pCi/l as established in 40 CFR 192.

The annual averages for these locations are within the statistical variation of background ranges for groundwater in the Missouri River alluvium. The Missouri Drinking Water Standard of 15 pCi/l (0.555 Bq/l) for gross alpha was not exceeded at any of the production wells. The St. Charles County treatment plant finished waters were in compliance with the gross alpha level of 10 pCi/l as established in 40 CFR 141 and endorsed in Department of Energy Order 5400.5. The Missouri Drinking Water Standard of 5 pCi/l (0.185 Bq/l) for combined Ra-226 and Ra-228 was not exceeded at any of the St. Charles County production well locations. No water quality standards have been established for isotopic thorium in drinking water.

Nitroaromatic Compounds. The St. Charles County production wells and the RMW-series monitoring wells were sampled quarterly for six nitroaromatic compounds. No detectable concentrations were observed at any of these locations.

Table 7-17 Summary of Annual Averages of Radiochemical Parameters (pCi/l) for the St. Charles County Well Field

LOCATION	TOTAL URANIUM		GROSS ALPHA		GROSS BETA		Ra-226		Ra-228		Th-228		Th-230		Th-232	
	AVG	(n)	AVG	(n)	AVG	(n)	AVG	(n)	AVG	(n)	AVG	(n)	AVG	(n)	AVG	(n)
MW-1024	<0.68	4	<4.55	4	8.90	4	2.16	2	<0.49	2	<0.15	2	0.58	2	<0.20	2
MW-RMW1	0.49	4	<5.20	4	<11.50	4	0.31	2	1.16	2	0.11	2	0.36	2	<0.12	2
MW-RMW2	2.09	4	<5.07	4	5.87	4	0.19	2	<0.49	2	<0.08	2	0.17	2	<0.11	2
MW-RMW3	<0.68	4	<6.62	4	<16.60	4	0.30	2	0.48	2	<0.14	2	0.18	2	<0.11	2
MW-RMW4	1.03	4	<5.57	4	<12.30	4	<0.19	2	0.52	2	<0.11	2	0.17	2	<0.10	2
MW-PW02	<0.68	4	1.68	4	4.36	4	0.32	2	<0.49	2	<0.20	2	0.38	2	<0.17	2
MW-PW03	<0.68	4	<2.75	4	5.16	4	0.29	2	<0.49	2	<0.18	2	1.19	2	<0.14	2
MW-PW04	<0.68	4	2.17	4	5.76	4	0.38	2	1.10	2	<0.20	2	0.26	2	<0.23	2
MW-PW05	<0.68	4	<3.85	4	<8.58	4	0.43	2	0.92	2	<0.14	2	0.30	2	<0.12	2
MW-PW06	<0.68	4	<4.55	4	<7.35	4	0.43	2	<0.49	2	<0.09	2	<0.57	2	<0.21	2
MW-PW07	<0.68	4	<3.73	4	5.32	4	0.63	2	1.33	2	<0.19	2	0.17	2	<0.11	2
MW-PW08[a]	<0.68	3	3.04	3	<7.98	3	0.64	1	<0.49	1	<0.08	1	0.24	1	<0.10	1
MW-PW09	<0.68	4	<4.43	3	5.57	3	0.54	2	0.42	2	<0.16	1	0.15	1	<0.13	2
MW-RAWW	<0.68	4	<4.10	4	4.74	4	0.58	2	<0.49	2	<0.20	2	1.26	2	0.15	2
MW-FINW	<0.68	4	<1.63	4	4.33	4	<0.20	2	<0.49	2	<0.11	2	0.22	2	<0.11	2

Note 1: 1 pCi/l = 0.037 Bq/l.

(n) Sample population.

< All samples less than highest detection limit.

(a) PW08 was off-line during fourth quarter, therefore no samples was collected. This production well is being replaced by a new well -- PW10 during 2002.

Sulfate. The St. Charles County production wells were sampled semiannually and the RMW-series monitoring wells were sampled quarterly for sulfate. The 2001 annual averages for the well field are summarized in Table 7-18. The secondary MCL for sulfate of 250 mg/l was not exceeded at any location in the well field.

Table 7-18 Annual Averages for Sulfate (mg/l), Arsenic (µg/l), and Barium (µg/l) in the St. Charles County Well Field

LOCATION	SULFATE		ARSENIC		BARIUM	
	AVERAGE	(n)	AVERAGE	(n)	AVERAGE	(n)
MW-1024	26	4	12.9	4	393	4
MW-RMW1	20	4	10.5	4	479	4
MW-RMW2	14	4	142	4	319	4
MW-RMW3	27	4	34.7	4	637	4
MW-RMW4	35	4	15.2	4	229	4
MW-PW02	108	2	1.7	2	312	2
MW-PW03	98	2	1.0	2	244	2
MW-PW04	100	2	<1.4	2	248	2
MW-PW05	100	2	2.6	2	380	2
MW-PW06	101	2	2.6	2	305	2
MW-PW07	83	2	2.9	2	416	2
MW-PW08	34	1	3.8	1	507	1
MW-PW09	35	2	5.2	2	464	2
MW-RAWW	96	2	2.3	2	317	2
MW-FINW	95	2	2.2	2	81	2

(n) Sample population.
< All samples less than highest detection limit.

Metals. Arsenic and barium were monitored during 2001 at the St. Charles County well field. The primary MCL for arsenic (50 µg/l) was exceeded only at location RMW-2. The MCL for barium (2,000 µg/l) was not exceeded at any location. None of the values for either metal exceeded their respective MCLs in samples from the public water supply wells or from the St. Charles County water treatment plant (see Table 7-18). The 2001 results were similar to those reported for 2000, and within historical ranges of those reported since monitoring began.

7.5.4 Trend Analysis

Statistical tests for time-dependent trends at the quarry were performed on historical data from select groundwater wells. Trending was performed on total uranium and nitroaromatic data collected from 1998 to 2001. The analyses were performed at specific monitoring locations based on historical data and knowledge of the quarry groundwater system. Total uranium trends were analyzed at locations down-gradient of former bulk waste sources and in areas of possible impact south of the slough. Nitroaromatic compounds were analyzed for locations down-gradient of former bulk waste sources. Remedial actions that addressed contamination source areas in the quarry were completed in 1995.

The computer program, TREND, which is described in detail in Section 7.4.4, was used for this trend analysis. The method employed was the nonparametric Mann-Kendall test.

7.5.4.1 Quarry Trend Results

The cumulative results for the period 1998 through 2001 for each parameter that was evaluated using the TREND program are summarized below. The trending results for the period 1998 through 2001 for the quarry area were compared to past trending results performed for the period 1997 through 2000. The results of these analyses are also summarized below.

Total Uranium

Nineteen locations near the quarry were selected for total uranium trend analyses. Of these, 12 were bedrock wells and seven were alluvial wells. These locations have been designated as long-term monitoring wells.

Total uranium trends for 1998 through 2001 are shown in Table 7-19. Trends were all stationary except at three locations. These three locations, bedrock wells MW-1013, MW-1031, and MW-1048, previously reported as indicating a stationary trend, indicate a change to a downward trend.

The recent data for the bedrock well MW-1004 and the alluvial well MW-1016, previously reported as indicating a downward trend based on the 1997 through 2000 data, indicate a change to a stationary trend. Wells MW-1005, MW-1028, and MW-1046 were not included in last year's scope of work. Therefore their current trend direction cannot be compared with past analyses.

As shown in Table 7-19, two of the 19 locations that were evaluated for the 1998 through 2001 time frame have reported uranium concentrations in 2001 that exceed all past 1998 through 2000 data for the specific sampling location.

Table 7-19 Quarry Groundwater Wells Uranium Trend Analysis Summary for 1998 to 2001

Well ID	Location	No. of Observations	No. of Non-Detect Data	Trend Direction (Alpha = 0.05)	Slope (pCi/l/yr)	95% Upper & Lower Confidence Intervals on Slope (pCi/l/yr)	2001 New High Concentration (pCi/l)
MW1002	Bedrock – east rim	8	0	S	-0.933	-4.676, 1.242	No
MW1004	Bedrock – rim	8	0	S	-72.500	-230.077, 102.640	No
MW1005[1]	Bedrock – south rim	6	0	S	70.000	-148.826, 236.275	No
MW1006	Alluvium – north of slough	8	0	S	-216.000	-589.402, 327.335	No
MW1007	Alluvium - north of slough	8	0	S	-12.250	-150.677, 41.026	No
MW1008	Alluvium – north of slough	23	0	S	-10.000	-314.842, 294.842	No
MW1009	Alluvium - north of slough	25	6	S	0.070	-0.191, 4.252	101
MW1013	Bedrock – north of slough	25	0	D	-112.000	-174.710, -45.586	No
MW1014	Alluvium - north of slough	25	0	S	-84.000	-165.344, -2.256	No
MW1015	Bedrock – north of slough	8	0	S	-16.000	-49.848, 19.632	No
MW1016	Alluvium - north of slough	8	0	S	-15.750	-28.486, 4.243	No
MW1027	Bedrock – west of quarry	8	0	S	82.000	-32.807, 152.343	No
MW1028	Bedrock – north of slough	5	0	S	-0.420	-5.230, 1.872	No
MW1030	Bedrock – south rim	8	0	S	-5.225	-6.722, 4.198	No
MW1031	Bedrock - north of slough	12	0	D	-37.700	-46.907, -16.258	No
MW1032	Bedrock – north of slough	25	0	S	0.000	-102.320, 101.708	2150
MW1045[2]	Alluvium – north of slough	4	0	S	2.085	n too small, n too small	14.90
MW1046	Bedrock – north of slough	7	0	S	-2.423	-73.174, 2.689	No
MW1048	Bedrock – north of slough	24	0	D	-91.000	-122.825, -66.526	No

D = Downward
S = Stationary
U = Upward

[1]Data from 1998 are not available for well MW1005.
[2]Data from 1998 and 1999 are not available for well MW1045.

Table 7-20 Quarry Groundwater Wells Nitroaromatic Trend Analysis Summary for 1998 to 2001

Well ID	Location	Compound	No. of Observations	No. of Non-Detect Data	Trend Direction (Alpha = 0.05)	Slope (ug/l/yr)	95% Upper & Lower Confidence Intervals on Slope (pCi/l/yr) Slope (ug/l/yr)	2001 New High Concentration (ug/l)
MW1002	Bedrock – east rim	2,4-DNT	10	2	D	-0.010	-0.014, -0.004	No
MW1004	Bedrock – south rim	2,4-DNT	10	2	D	-0.025	-0.034, -0.011	No
MW1005[1]	Bedrock – south rim	2,4-DNT	5	3	(a)	(a)	(a)	No
MW1006	Alluvium - north of slough	2,4-DNT	10	3	S	-0.009	-0.062, 0.024	No
MW1015	Bedrock – north of slough	2,4-DNT	10	2	S	0.001	-0.005, 0.023	0.10[2]
MW1027	Bedrock – rim	2,4-DNT	12	0	U	1.093	0.407, 1.923	6.70
MW1030	Bedrock – south rim	2,4-DNT	7	5	(a)	(a)	(a)	0.02[2]
MW1032	Bedrock – north of slough	2,4-DNT	16	14	(a)	(a)	(a)	No

D = Downward
S = Stationary
U = Upward
2,4-DNT 2,4-Dinitrotoluene

(a) Fewer than three detected concentrations were reported for the time period; therefore, no trending was performed.

[1]Data from 1998 are not available for well MW1005.
[2]The value listed is computed from one-half the detection limit. Due to a change in detection limits from year to year, this computed value is higher than any previous detected concentration.

Nitroaromatic Compounds

Eight locations near the quarry that have historically demonstrated elevated levels of 2,4-DNT were selected for trend analyses. Of these locations, seven were bedrock wells and one was an alluvial well.

The results of the 2,4-DNT analyses are presented in Table 7-20. Based on the results of the analyses, an upward trend was identified in groundwater from the bedrock well MW-1027. This is a change from the stationary trend of MW-1027 indicated by the 1997 through 2000 data.

The most recent analyses of MW-1006 indicate a change from a downward to a stationary trend. The stationary trend identified at MW-1015 could not be compared with past results since MW-1015 was not included in last year's scope of work. The most recent analyses of MW-1004 indicate a change from a stationary to a downward trend. The downward trend of MW-1002 remained unchanged from last year's analyses.

Trending was not performed at MW-1005, MW-1030, and MW-1032 because fewer than three detected concentrations were reported for the time period between 1998 and 2001. These three wells were not included in last year's scope of work.

As shown in Table 7-20, three of the eight locations that were evaluated for the 1998 through 2001 time frame have reported concentrations in 2001 that exceed all past 1998, 1999 and 2000 data for their respective sampling locations. However, only one of these values represents an actual new high concentration. The other two are calculated values that are based on higher detection limits than in previous years.

7.6 Disposal Cell Monitoring

Five groundwater monitoring wells and one spring were monitored during 2001 to detect contaminants in the uppermost water unit beneath the permanent disposal cell in order to meet the substantive requirements of 40 CFR 264, Subpart F, and 10 CSR 264, Subpart F. The monitoring parameters were derived from previous evaluations documented in the *Weldon Spring Site Disposal Cell Groundwater Monitoring Plan* (Ref. 37) and the *Weldon Spring Site Cell Groundwater Monitoring Demonstration Report* (Ref. 10).

The detection monitoring program for the disposal cell consisted of semi-annual sampling for the following parameters:

- Total uranium.
- Anions (nitrate, sulfate, chloride, and fluoride).

- Metals (aluminum, antimony, arsenic, barium, chromium, cobalt, copper, lead, lithium, magnesium, molybdenum, nickel, selenium, silver, vanadium, and zinc).
- Nitroaromatic compounds.
- Radiochemical parameters (Ra-226, Ra-228, Th-228, Th-230, and Th-232).
- Miscellaneous indicator parameters (chemical oxygen demand, total cyanide, total dissolved solids, total organic carbon, and total organic halogen).

After each sampling event, the concentrations of constituents in the cell well network were compared with previously established baseline concentrations for each location. By definition, any exceedance of baseline was determined to be statistically significant, and triggered certain reporting requirements. These requirements involved evaluation of historical and analytical data, and leachate volumes collected within the cell liners, to confirm the integrity of the disposal cell.

7.6.1 Monitoring Program

In the *Record of Decision for the Remedial Action at the Chemical Plant Area of the Weldon Spring Site* (Ref. 9), substantive requirements of Federal and State hazardous and/or solid waste regulations are identified as applicable or relevant and appropriate requirements (ARARs) for the selected remedy. 40 CFR 264, Subpart F, 10 CSR 25-7.264(2)(F), and 10 CSR 80-3.010(8) are identified as relevant and appropriate requirements for the disposal cell.

Groundwater monitoring requirements under the *Resource Conservation and Recovery Act* (RCRA) (40 CFR 264) specify that a monitoring system must consist of a sufficient number of wells installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that represent the quality of background water and provide detection of contamination. No set number of wells is required under the RCRA, but the Missouri Sanitary Landfill regulations (10 CSR 80.3) specify a minimum of one upgradient and three downgradient wells.

The disposal cell groundwater detection monitoring network consists of one upgradient well (MW-2048), four downgradient wells (MW-2032, MW-2045 through MW-2047), and one downgradient spring (SP-6301). All six monitoring locations were sampled quarterly during all of 1997 and early 1998 to provide baseline data. Semi-annual detection monitoring began in mid-1998, after cell construction had begun and waste placement activities were initiated. In accordance with Missouri hazardous waste management regulations (10 CSR 25-7.264(2)(F)), a surface water component is included in the detection monitoring program. Spring 6301 (Burgermeister Spring) has been identified as the appropriate downgradient location for surface water monitoring. Sampling of this spring yields samples representative of the quality of surface water hydraulically downgradient of the disposal cell.

7.6.1.1 Baseline Conditions

Prior to waste placement, the disposal cell monitoring wells and SP-6301 were sampled on a quarterly basis for 1 year in order to establish baseline water quality conditions. A comprehensive list of parameters was analyzed at this time. Baseline conditions for each location were determined by generating an upper bound value for each parameter based on a 95% tolerance interval calculated for each data set.

The *Disposal Cell Groundwater Monitoring Plan* (Ref. 37) indicates that the analysis of variance (ANOVA) procedure was the preferred method for data comparisons between the upgradient well and the compliance wells. However, subsequent monitoring results have shown that, due to the presence of preexisting groundwater contamination, such inter-well comparisons cannot provide conclusive results. Instead, an intra-well comparison of baseline conditions with detection monitoring results is performed using the tolerance interval approach. This method is an accepted alternative procedure, as discussed in the *Disposal Cell Groundwater Monitoring Plan* (Ref. 37) and recommended in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (Ref. 38).

Table 7-21 presents the baseline values for each monitoring well in the cell well network and SP-6301. No baseline values are presented for volatiles, PCBs, PAHs, and nitrobenzene, as these parameters were not detected during baseline sampling. The baseline values in Table 7-21 represent a revision to baseline values used from 1998 until mid-2000, based on a re-interpretation of the applicable guidance (Ref. 10).

7.6.1.2 Monitoring Results

The detection monitoring program for the cell well network provides for semi-annual sampling at each location. The 2001 monitoring results are presented in Tables 7-22 and 7-23. Results are reported for all parameters that exceeded the detection limit in at least one location.

Results of the first semi-annual sampling event, as shown in Table 7-22, indicated that several parameters exceeded baseline. Upon resampling for those parameters, the following baseline exceedances were confirmed:

- MW-2045 chromium, molybdenum
- MW-2048 sulfate

Results of the second semi-annual sampling event, as shown in Table 7-23, indicated that several parameters exceeded baseline. Upon resampling for those parameters, the following baseline exceedances were confirmed:

- MW-2045 chromium, molybdenum, nickel
- MW-2046 nickel, 2,4,6-TNT

These above-baseline data are most likely a result of natural variations in the existing groundwater contamination underlying the site. Evaluation of the disposal cell leachate water quality and volume confirm that the elevated groundwater data are not the result of adverse impacts from the disposal cell. A demonstration report was prepared in November 2000 to identify the contributing factors to recurring above-baseline conditions, such as chromium and molybedenum in MW-2045. The report evaluated historical site-wide water quality, analyzed disposal cell leachate data and flow rates, and reviewed cell well hydraulic performance characteristics (Ref. 10).

One of the recommendations in the demonstration report was to install a new monitoring well to replace MW-2045, since recurring metals exceedances in MW-2045 were thought to be attributable to poor hydraulic performance and resulting turbidity of the sample water. During 2001, a new well (MW-2051) was installed about 200 feet southeast of MW-2045. The new well has been monitored bimonthly to establish "baseline" levels and will be incorporated into the cell well monitoring network in 2002.

The upgradient monitoring well (MW-2048) was damaged during construction activities in October 2001. The well was determined to be damaged beyond repair and was abandoned in November 2001. Thus, there are no data available for this well for the December 2001 sampling event. A new well (MW-2055) was installed about 20 feet upgradient from MW-2048 and is being sampled bimonthly to establish "baseline" levels prior to being incorporated into the cell well network.

Table 7-21 Baseline Values for the Disposal Cell Monitoring Locations

PARAMETER	MW-2032	MW-2045	MW-2046	MW-2047	MW-2048	SP-6301
Chloride (mg/l)	30.55	87.26	19.66	13.10	16.09	29.21
Fluoride (mg/l)	1.64	0.25	0.26	1.28	0.49	0.57
Nitrate (mg/l)	163.32	3.04	3.64	150.42	2.11	35.28
Sulfate (mg/l)	91.53	69.43	71.56	52.98	270.88	121.35
Aluminum (µg/l)	3546.22	342.84	472.97	858.76	129.15	1,711.84
Antimony (µg/l)	9.93	15.59	28.07	27.20	13.47	13.57
Arsenic (µg/l)	4.74	3.80	4.45	4.59	3.80	3.90
Barium (µg/l)	547.66	304.62	319.96	501.17	59.20	280.81
Chromium (µg/l)	11.91	61.34	9.56	12.54	2.38	10.96
Cobalt (µg/l)	2.79	14.14	2.71	2.46	2.73	13.12
Copper (µg/l)	28.89	42.22	18.01	48.56	10.34	6.64
Lead (µg/l)	15.70	1.78	4.27	4.43	2.02	4.27
Lithium (µg/l)	25.13	35.31	17.43	87.30	14.56	44.41
Magnesium (µg/l)	68,895	60,867	66,642	94,431	47,493	54,057
Molybdenum (µg/l)	7.05	10.75	7.65	23.06	8.13	6.49
Nickel (µg/l)	22.62	1161.79	22.10	56.41	3.33	19.40
Selenium (µg/l)	9.57	5.12	5.08	8.64	17.74	5.91
Silver (µg/l)	17.73	3.77	6.12	5.41	4.87	2.75
Vanadium (µg/l)	8.29	7.97	13.69	13.09	2.73	20.78
Zinc (µg/l)	61.07	30.24	45.86	40.25	53.49	53.03
C.O.D. (mg/l)	3.94	8.44	8.45	5.74	10.54	29.84
Cyanide (µg/l)	138.71	4.73	3.94	5.70	5.53	4.88
T.D.S (µg/l)	1,262	568	637	1,051	913	552
T.O.X (µg/l)	0.07	0.07	0.05	0.06	0.82	0.04
T.O.C.(mg/l)	49.55	56.35	109.75	102.94	57.51	46.32
1,3,5-TNB (µg/l)	7.80	0.03	4.74	<DL	<DL	0.156
1,3-DNB (µg/l)	1.18	0.18	0.75	0.075	<DL	0.10
2,4,6-TNT (µg/l)	12.94	<DL	3.93	<DL	<DL	0.357
2,4-DNT (µg/l)	1.04	0.18	1.12	0.56	<DL	0.151
2,6-DNT (µg/l)	7.08	1.12	129.23	1.25	<DL	0.508
Radium-226 (pCi/l)	1.02	1.03	0.45	0.70	1.11	0.50
Radium-228 (pCi/l)	3.62	2.79	4.11	2.12	7.20	6.17
Thorium-228 (pCi/l)	0.38	0.87	0.21	0.27	0.22	1.13
Thorium-230 (pCi/l)	0.35	0.91	0.29	0.68	0.60	1.74
Thorium-232 (pCi/l)	0.15	0.36	0.19	0.19	0.22	0.74
Uranium, Total (pCi/l)	6.56	1.76	2.13	1.69	2.39	203.73
pH (Std. Units)	7.81	7.46	7.33	7.80	7.36	7.12
Specific Conductance (umhos/cm)	2,021	1,114	1,061	1,545	1,122	543

Table 7-22 Summary of Detection Monitoring Data for Cell Well Network (June 2001)

	CONCENTRATION					
PARAMETER	MW-2032	MW-2045	MW-2046	MW-2047	MW-2048	SP-6301
Chloride (mg/l)	6.6	56.9	13.5	6.5	6.3	22.4
Fluoride (mg/l)	0.18	0.11	0.02	<DL	0.15	0.15
Nitrate-N (mg/l)	6.9	1.2	2.1	61.0	1.1	48.5
Sulfate (mg/l)	46.6	17.4	44.6	30.0	302	28.6
Aluminum (µg/l)	19.1	28.3	21.8	43.8	12.9	467
Antimony (µg/l)	<DL	3.0	<DL	4.5	<DL	<DL
Barium (µg/l)	192	180	185	406	35.7	119
Chromium (µg/l)	6.4	67.3	1.8	3.7	2.2	0.79
Cobalt (µg/l)	1.8	3.7	2.0	<DL	3.8	<DL
Copper (µg/l)	<DL	1.7	<DL	2.0	0.86	0.62
Lithium (µg/l)	8.7	3.5	6.4	69.9	8.3	6.9
Magnesium (µg/l)	27,700	48,700	37,200	82,600	56,600	13,900
Molybdenum (µg/l)	3.9	24.9	<ND	3.8	<DL	<DL
Nickel (µg/l)	<DL	929	6.7	4.9	<DL	<DL
Selenium (µg/l)	<DL	<DL	5.8	6.2	15.5	<DL
Zinc (µg/l)	3.0	2.5	7.7	<DL	<DL	4.0
Vanadium (µg/l)	<DL	<DL	<DL	<DL	<DL	1.0
Chemical Oxygen Demand (mg/l)	3.6	<DL	<DL	<DL	5.8	3.3
Total Dissolved Solids (mg/l)	444	461	556	890	660	276
Total Organic Carbon (mg/l)	1.5	2.4	2.3	2.4	1.8	2.6
TOX (mg/l)	0.004	<DL	0.006	<DL	0.004	<DL
1,3,5-Trinitrobenzene (µg/l)	<DL	0.2	2.7	0.15	<DL	<DL
2,4,6-Trinitrotoluene (µg/l)	<DL	<DL	1.6	<DL	<DL	<DL
2,4-Dinitrotoluene (µg/l)	<DL	<DL	2.0	0.21	<DL	<DL
2,6-Dinitrotoluene (µg/l)	<DL	0.73	2.4	0.39	<DL	<DL
Radium-226 (pCi/l)	0.72	0.67	0.99	0.80	0.89	0.59
Radium-228 (pCi/l)	<DL	1.84	1.26	<DL	<DL	<DL
Thorium-230 (pCi/l)	0.06	0.07	0.11	0.10	0.02	0.15
Thorium-232 (pCi/l)	<DL	<DL	0.01	<DL	<DL	<DL
Uranium, Total (pCi/l)	1.7	0.53	0.73	4.6	1.3	26.9

Note: Parameters for which average concentration was below the highest detection limit for each sampling location are not included in table.

<DL Average concentration was less than highest detection limit.

Table 7-23 Summary of Detection Monitoring Data for Cell Well Network (December 2001)

	CONCENTRATION					
PARAMETER	MW-2032	MW-2045	MW-2046	MW-2047	MW-2048*	SP-6301
Chloride (mg/l)	2.2	68.3	16.4	7.6	NS	19.7
Fluoride (mg/l)	0.21	0.14	0.15	0.16	NS	0.23
Nitrate-N (mg/l)	1.82	1.58	2.45	78.9	NS	48.5
Sulfate (mg/l)	17.1	20.7	45.2	23.8	NS	24.6
Aluminum (µg/l)	97.1	38.1	134	143	NS	568
Antimony (µg/l)	<DL	5.0	<DL	<DL	NS	<DL
Arsenic (µg/l)	1.9	<DL	2.7	2.0	NS	<DL
Barium (µg/l)	169	172	196	386	NS	120
Chromium (µg/l)	4.9	665	5.1	3.8	NS	0.85
Cobalt (µg/l)	1.9	6.0	2.5	2.0	NS	<DL
Copper (µg/l)	<DL	9.8	<DL	<DL	NS	<DL
Lead (µg/l)	<DL	<DL	5.0	<DL	NS	<DL
Lithium (µg/l)	46.4	33.4	38.0	37.3	NS	36.8
Magnesium (µg/l)	33,600	49,600	39,100	63,800	NS	14,800
Molybdenum (µg/l)	<DL	7.35	<DL	<DL	NS	<DL
Nickel (µg/l)	6.9	1550	72.8	7.0	NS	3.2
Selenium (µg/l)	<DL	<DL	2.5	2.7	NS	<DL
Silver (µg/l)	4.5	<DL	<DL	<DL	NS	4.6
Vanadium (µg/l)	1.5	3.5	1.9	<DL	NS	1.4
Zinc (µg/l)	6.3	<DL	9.2	<DL	NS	4.9
Chemical Oxygen Demand (mg/l)	<DL	6.0	<DL	7.0	NS	8.0
Total Dissolved Solids (mg/l)	268	492	535	634	NS	271
Total Organic Carbon (mg/l)	<DL	<DL	1.5	<DL	NS	2.5
TOX (mg/l)	0.008	0.005	0.01	0.01	NS	0.007
1,3,5-Trinitrobenzene (µg/l)	<DL	<DL	2.6	<DL	NS	<DL
1,3-Dinitrobenzene (µg/l)	<DL	0.099	0.11	<DL	NS	<DL
2,4,6-Trinitrotoluene (µg/l)	0.07	0.13	4.9	<DL	NS	<DL
2,4-Dinitrotoluene (µg/l)	0.04	0.08	0.25	0.11	NS	<DL
2,6-Dinitrotoluene (µg/l)	0.09	0.76	1.4	0.21	NS	0.10
Radium-228 (pCi/l)	<DL	2.14	1.64	1.8	NS	2.38
Thorium-230 (pCi/l)	<DL	<DL	0.64	<DL	NS	<DL
Uranium, Total (pCi/l)	1.17	1.23	<DL	<DL	NS	34.0

Note: Parameters for which average concentration was below the highest detection limit for each sampling location are not included in table.

NS Parameter was not sampled.

<DL Average concentration was less than highest detection limit.

* MW-2048 was irreparably damaged in 2001 and could not be sampled during the December 2001 event. A new upgradient well (MW-2055) has been installed and will replace MW-2048 as part of the cell well sampling network as soon as its "baseline" is established.

8. BIOLOGICAL MONITORING PROGRAM

DOE Order 5400.1, 5400.5, and the *Regulatory Guide* (Ref. 24) have requirements for monitoring contaminant levels in terrestrial foodstuffs as well as in aquatic biota in the water column and sediments of affected surface waters. Past monitoring focused primarily on properties that received effluent from the site such as Busch Lakes 34, 35, and 36; Femme Osage Slough, and associated drainages.

Historical calculations have shown that the radiation dose to native aquatic organisms in water influenced by the Weldon Spring site has never exceeded 0.1 rad/day, which is well within the protective guidelines of <1 rad/day established in DOE Order 5400.5. Over the past few years, biological monitoring was reduced to surveillance levels, with air and surface water results being used to determine the need for additional sampling. Statistical analyses of annual effluent sample results for both air and surface water indicated there was no need for further biological sampling. In addition, the total uranium migrating off site in surface water has steadily decreased since 1987 and is approaching background levels. The air monitoring program has been discontinued since the WSSRAP has no remaining sources of airborne radiological emissions. Based upon this information, no further biological monitoring will be conducted.

9. ENVIRONMENTAL QUALITY ASSURANCE PROGRAM INFORMATION

9.1 Highlights of the Quality Assurance Program

- Average relative percent differences calculated for groundwater, surface water, National Pollutant Discharge Elimination System (NPDES) samples, and springs were within the 20% criterion recommended by the Contract Laboratory Program (CLP).
- The data validation program accepted 99.2% of the data selected for validation qualifying in 2001.

9.2 Program Overview

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

The environmental quality assurance program provides the WSSRAP 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; personnel training; compliance assessments; use of quality control samples; complete documentation of field activities and laboratory analyses; and review of data documentation for precision, accuracy, and completeness.

9.2.1 Quality Assurance Program

The *Project Management Contractor Quality Assurance Program* (QAP) (Ref. 39) establishes the quality assurance program for activities performed by the Project Management Contractor (PMC). The QAP requires compliance with the criteria of DOE Order 414.1A.

9.2.2 Environmental Quality Assurance Project Plan

The quality assurance requirements for WSSRAP environmental data operations are addressed in the WSSRAP *Environmental Quality Assurance Project Plan* (EQAPjP) (Ref. 40). The EQAPjP outlines the appropriate requirements of U.S. Environmental Protection Agency (EPA) QA/R-5 (Ref. 41) for characterization and routine monitoring at the WSSRAP. The EQAPjP does not supersede the QAP, but rather expands on the specific requirements of environmental monitoring and characterization activities.

The primary purpose of the EQAPjP is to specify the quality assurance requirements for environmental data operations of the WSSRAP. The document is also supported by standard operating procedures (SOPs), the *Sample Management Guide* (Ref. 42), the *Environmental Safety and Health Department Plan* (Ref. 43), the *Environmental Monitoring Plan* (EMP) (Ref. 8), and sampling plans written for specific environmental sampling tasks.

9.2.3 Sample Management Guide

The *Sample Management Guide* summarizes the data quality requirements for collecting and analyzing environmental data. The guide describes administrative procedures for managing environmental data and governs sampling plan preparation, data verification and validation, database administration, and data archiving. Guidance on developing data quality objectives for specific investigations is also detailed. The guide details the specific requirements of the EQAPjP.

9.2.4 Environmental Monitoring and Quality Assurance Standard Operating Procedures

SOPs have been developed for routine activities at the WSSRAP. Environmental monitoring SOPs are generally administered by the Environmental Safety and Health (ES&H) Department, and Quality Assurance SOPs are administered by the Project Quality Department. These two departments are responsible for most SOPs used to administer the environmental quality assurance program described in this section. Controlled copies of SOPs are maintained in accordance with the document control requirements of the QAP (Ref. 39).

9.2.5 Evaluation and Presentation of Data

Analytical data are received from subcontracted analytical laboratories. Uncensored data have been used in reporting and calculations of annual averages where available. Uncensored data are data that do not represent an ND (nondetect) and instead report instrument responses that quantitate to values below the reported detection limit. These types of data are designated by parentheses around the data value, for example "(1.17)". When there was no instrument response, nondetect data were used in calculations of averages at a value of one-half the detection limit (DL/2), as specified in Procedure ES&H 1.1.7, *Environmental Data Review and Above Normal Reporting*.

9.2.6 Independent Assessments and Appraisals

The environmental programs and contract laboratories are assessed periodically by the Project Quality Department. They evaluate compliance by performing surveillances and independent assessments of the environmental programs and generate assessment reports to track deficiencies and corrective actions.

9.2.7 Subcontracted Off-Site Laboratories Programs

Subcontracted off-site laboratories that performed analyses used for the preparation of this report use Contract Laboratory Program (CLP) methodologies when applicable. For certain analyses (such as radiochemical and wet chemistry) the laboratories use EPA 600 (drinking water), or methods that are reviewed and approved by the Project Management Contractor (PMC) prior to analysis. Each of the subcontracted off-site laboratories has submitted to the WSSRAP a site-specific Quality Assurance Project Plan (QAPjP) and controlled copies of their SOPs. The QAPjPs and SOPs are reviewed and approved by the PMC before any samples are shipped to the laboratory. Changes to the standard analytical protocols or methodology are documented in the controlled SOPs. All of the laboratories currently being used by the WSSRAP have had a preliminary assessment of their facilities to make sure that they have the capability to perform work according to the specifications of their contracts. Quality assurance assessments are performed routinely to inspect the laboratory facilities and operations, to ensure that the laboratories are performing analyses as specified in their contracts, and to check that WSSRAP data documentation and records are being properly maintained.

9.3 Applicable Standards

Applicable standards for environmental quality assurance include: (1) use of the appropriate 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.

9.3.1 Analytical and Field Measurement Methodologies

Analytical and field measurement methodologies used at the WSSRAP comply with applicable standards required by the DOE, EPA, and the American Public Health Association. Analytical methodologies used by subcontracted laboratories for environmental monitoring follow the EPA CLP requirements (metal and organic methodologies) (Ref. 44 and Ref. 46), and the EPA drinking water and radiochemical methodologies or methods that are reviewed and approved by the PMC prior to analysis of each sample. Field measurement methodologies typically follow the American Public Health Association *Standard Methods for the Examination of Water and Wastewater* (Ref. 45).

9.3.2 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 in the EPA CLP (Ref. 46).

Descriptions of the Quality Control samples collected at the WSSRAP are detailed in Table 9-1.

9.3.3 Accuracy, Precision, and Completeness

At a minimum, the WSSRAP Data Validation Group determines the analytical accuracy, precision, and completeness of 10% of the environmental data collected. Data validation is required under DOE Order 5400.1.

9.3.4 Preservation and Security of Documents and Records

Requirements for preservation and security of documents and records are specified in DOE Order 414.1A. All documents pertinent to environmental monitoring are preserved and secured by the departments that produce them.

9.4 Quality Assurance Sample Results

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

9.4.1 Duplicate Results Evaluation

Two kinds of duplicate analyses were evaluated in 2001, matrix duplicates and secondary duplicates. The matrix duplicate analyses were performed at subcontracted laboratories from aliquots of original samples collected at the Weldon Spring site. A secondary duplicate is an additional aliquot of the original sample that is split by the WSSRAP, placed in a separate container, and sent to a secondary laboratory. Matrix duplicates were used to assess the precision of analyses and also to aid in evaluating the homogeneity of samples or analytical interferences of sample matrixes.

Table 9-1 Quality Control Sample Description

TYPE OF QC SAMPLE	DESCRIPTION
Water Blank (WB)	Monitors the purity of distilled water used for field blanks and decontamination of sampling equipment. Water blanks are collected directly from the distilled water reservoir in the WSSRAP laboratory.
Equipment Blank (EB)	Monitors the effectiveness of decontamination procedures used on non-dedicated sampling equipment. Equipment blanks include rinsate and filter blanks.
Trip Blank (TB)	Monitors volatile organic compounds that may be introduced during transportation or handling at the laboratory. Trip blanks are collected in the WSSRAP laboratory with prepurged distilled water.
Field Replicate (FR)	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.
Blind Duplicate	A duplicate that provides an unbiased measure of laboratory precision. Blind duplicates are additional aliquots of routine samples taken in the field and given altered identification codes to conceal each sample's identity from the laboratory.
Matrix Spike* (MS)	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* (DU)	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* (MD)	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.
Secondary Duplicate (SD)	A duplicate that compares the primary laboratory with a secondary laboratory, providing an additional check on the performance of the primary laboratory. The secondary duplicate is an additional aliquot of the routine sample that is sent to a secondary laboratory.

* A laboratory sample is split from the parent sample.

Generally, matrix duplicate samples were analyzed for the same parameters as the original samples at the rate of approximately one for every 20 samples. Secondary duplicate samples were collected on a monthly basis. Typically, duplicate samples were analyzed for more common parameters (e.g., uranium, inorganic anions, and metals).

When matrix and secondary duplicate samples were available, the average relative percent difference was calculated. This difference represents an estimate of precision. The equation used, (RPD) as specified in the *USEPA Contract Laboratory Program, Inorganic Scope of Work*, (Ref. 46), was:

$$RPD = |S-D| / ((S+D)/2) \times 100\%$$

where S = concentration in the normal sample
D = concentration in the duplicate analysis

The RPD was calculated only for samples whose analytical results exceeded five times the detection limit.

Table 9-2 summarizes the data of calculated RPD for groundwater (including springs) and surface water (including National Pollutant Discharge Elimination System [NPDES]) samples. Both the matrix duplicates and the secondary duplicates are summarized together. Parameters that were not commonly analyzed for and/or were not contaminants of concern were not evaluated.

Table 9-2 Summary of Calculated Relative Percent Differences

PARAMETER	N	AVG. RPD	MIN. RPD	MAX. RPD
Aluminum	7	13.2	0.4	63.0
Arsenic	17	19.6	0.0	82.7
Barium	7	3.0	0.2	7.4
Chemical Oxygen Demand	9	25.4	1.9	67.0
Chloride	9	3.1	0.0	10.0
Chromium	19	15.5	0.0	79.0
Fluoride	5	13.5	0.13	32.0
Gross Alpha	14	17.0	0.1	48.6
Gross Beta	14	13.2	2.4	54.0
Lead	13	22.1	0.0	103.0
Manganese	11	3.8	0.2	10.0
Nitrate-N	54	4.6	0.0	29.0
Selenium	4	27.9	12.0	71.3
Sulfate	23	2.6	0.0	12.0
Total Suspended Solids	17	10.4	0.0	40.0
Trichloroethene	7	9.6	0.0	17.3
Uranium, Total	54	4.3	0.0	28.1

N = Data Population

The results in Table 9-2 demonstrate that most average relative percent differences (RPDs) calculated were within the 20% criterion as recommended in the CLP (Ref. 44 and Ref. 46). Chemical oxygen demand, lead and selenium exceeded the 20% criteria, but a majority of the RPDs were acceptable, and several outliers were present in the data sets. As a result, duplicate sample analyses in 2001 were of acceptable quality.

9.4.2 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 (field/trip blanks).

- Effectiveness of the decontamination procedure for sampling equipment used to collect samples (equipment blanks).

- Quality of water used to decontaminate sampling equipment and/or assess the ambient conditions (distilled water blanks).

- Presence or absence of contamination potentially introduced through sample preservation and/or sample containers.

Sections 9.4.2.1 through 9.4.2.4 discuss the sample blank analyses and the potential impact of blank contamination upon the associated samples.

To evaluate whether samples were potentially impacted by blank contamination, all samples in the same analytical batch as the blank were reviewed. If the samples and blank had roughly the same concentration, the samples were considered to be potentially contaminated. For all parameters except radiochemical, the sample concentration had to be above the detection limit and less than five times the blank concentration to be potentially contaminated. For radiochemical parameters to be potentially impacted by blank contamination, the concentration had to be above the detection limit, and the normalized absolute difference (NAD) had to be less than 2.58. The NAD was calculated as follows:

$$NAD = \frac{|S - B|}{\sqrt{Err_S^2 + Err_B^2}}$$

where:

S	= concentration of the sample
B	= concentration of the blank
Err_S	= error associated with the sample
Err_B	= error associated with the blank

9.4.2.1 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 2001, 90 trip blanks were analyzed for volatile organic compounds. A large portion of these trip blanks were to support the groundwater pump and treat study. Detections for acetone were found in two blanks, methylene chloride in one blank, and toluene in one blank. All environmental samples associated with these 4 blank samples were evaluated. Five samples were potentially impacted where methylene chloride had been detected, 10 where acetone had been detected, and seven where toluene had been detected. None of the other samples evaluated exceeded the recommended CLP criterion. All of the parameters found in the trip blanks were associated with common laboratory solvents and are probably not associated with transportation or field contamination.

9.4.2.2 Equipment and Bailer Blank Evaluation

Equipment and bailer blanks are collected by rinsing decontaminated equipment and bailers with distilled water and collecting the rinse water. This procedure is used to determine the effectiveness of the decontamination process. At the WSSRAP, most of the groundwater samples are collected from dedicated equipment, and surface water is collected by placing the sample directly into a sample container. One equipment blank was collected in 2001 for surface water sampling. Uranium was detected in this blank, however, it did not significantly impact the associated environmental samples.

9.4.2.3 Distilled Water Blank Evaluation

Water blank samples are collected to evaluate the quality of the distilled water used to decontaminate sampling equipment and to assess whether contaminants are present in the water used for field and trip blanks. Water blank samples also serve as laboratory blanks. Generally, the water blanks were analyzed for contaminants of concern.

In 2001, three water blanks were collected. Table 9-3 presents the ratio of detects to the total number of blanks collected for each parameter that had results above the detection limit. The table also presents the ratio of potentially impacted samples to the total number of samples analyzed with the blank. In cases where there were no detects in any blank, the ratio of potentially impacted samples to the total number of samples is not applicable. In cases where no samples were analyzed with the blank, a zero has been placed in that column, and no percentage has been shown.

Table 9-3 Summary of Distilled Water Blank Parameter Results

PARAMETER	NUMBER OF DETECTS/NUMBER OF BLANK ANALYSES	NUMBER OF POTENTIALLY IMPACTED SAMPLES
Arsenic	0 of 3 (0%)	N/A
Barium	0 of 3 (0%)	N/A
Cadmium	2 of 3 (66%)	1 of 1 (100%)
Chloride	0 of 3 (0%)	N/A
Chromium	1 of 3 (33%)	1 of 1 (100%)
Fluoride	0 of 3 (0%)	N/A
Lead	1 of 3 (33%)	1 of 1 (100%)
Mercury	0 of 3 (0%)	N/A
Nitrate as N	0 of 3 (0%)	N/A
Nitroaromatics	0 of 3 (0%)	N/A
PAHs	0 of 3 (0%)	N/A
PCBs	0 of 3 (0%)	N/A
Radium-226	0 of 3 (0%)	N/A
Radium-228	0 of 3 (0%)	N/A
Selenium	0 of 3 (0%)	N/A
Silver	1 of 3 (33%)	0
Sulfate	0 of 3 (0%)	N/A
Thorium-228	0 of 3 (0%)	N/A
Thorium-230	3 of 3 (100%)	1 of 3 (33%)
Thorium-232	0 of 3 (0%)	N/A
Uranium, Total	0 of 3 (0%)	N/A
Volatiles	0 of 3 (0%)	N/A

N/A Not Applicable

9.5 Data Validation Program Summary

Data validation programs at the WSSRAP involve reviewing and qualifying at least 10% 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 9-4 identifies the number of quarterly and total data points that were selected for data validation in 2001, and indicates the percentage of those selected that were complete. Data points in this table include all sample types.

Table 9-4 WSSRAP Validation Summary for Calendar Year 2001

CALENDAR QUARTER	NO. OF DATA POINTS COLLECTED	NO. OF DATA POINTS SELECTED FOR VALIDATION	PERCENT SELECTED	NO. OF VALIDATED DATA POINTS REJECTED	COMPLETENESS[a]
Quarter 1	4,278	466	10.9%	9	98.1%
Quarter 2	9,061	970	10.7	10	99.0%
Quarter 3	4,723	484	10.2	0	100.0%
Quarter 4	4,171	492	11.8	0	100%
2001 Total	22,233	2,412	10.8	19	99.2%

(a) Completeness is a measure of acceptable data. The value is given by:

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

Reflects all validatable data for the calendar year.

Table 9-5 identifies validation qualifiers assigned to the selected data points as a result of data validation. The WSSRAP validation technical review was performed in accordance with the U.S. EPA *Contract Laboratory Program Statement of Work for Inorganics Analysis* (Ref. 46), the U.S. EPA Contract Laboratory Program *Statement of Work for Organic Analysis* (Ref. 44), and the *Laboratory Data Validation Guidelines for Evaluating Radionuclide Analysis* (Ref. 18). For calendar year 2001, 100% of data validation has been completed. Data points in this table include groundwater, surface water, spring and seep water, and NPDES samples only.

Table 9-6 identifies the average accuracy and precision for anion, metals, nitroaromatic, radiochemical, volatiles, and miscellaneous parameters. The accuracy values are based on the percent recoveries of the laboratory control samples, and the precision values are based on the relative percent difference between laboratory control sample duplicates. The data population size associated with each accuracy and precision value is listed as "N." Data points presented in this table include groundwater, surface water, spring and seep water, and NPDES samples only.

Table 9-5 WSSRAP Validation Qualifier Summary for Calendar Year 2001

	NO. OF DATA POINTS								
	ANIONS	METALS	MISC.	NITRO-AROMATICS	PESTICIDES /PCBs	RADIO-CHEMICAL	SEMI-VOLATILES	VOLATILES	TOTAL
Accepted	114	315	20	486	83	640	150	555	2,363
Rejected	0	0	0	0	0	13	2	4	19
Not Validatable	0	0	0	0	0	0	0	0	0
Total	114	315	20	486	83	653	152	559	2,382
	PERCENTAGES								
Accepted	100%	100%	100%	100%	100%	98.0%	98.7%	99.3%	99.2%
Rejected	0%	0%	0%	0%	0%	2.0%	1.3%	0.7%	0.8%
Not Validatable	100%	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 9-6 Laboratory Accuracy and Precision Summary for Calendar Year 2001

		LABORATORY ACCURACY			LABORATORY PRECISION		
PARAMETER	N	AVERAGE	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM
IONS							
Chloride	2	96.8	94.5	99.0	0.4	0.2	0.53
Fluoride	2	89.0	86.0	92.0	3.0	2.5	3.4
Nitrate-N	5	93.8	88.0	98.1	1.5	0.0	4.6
Sulfate	5	94.0	92.0	96.4	0.9	0.05	2.1
METALS							
Aluminum	1	108	NA	108.0	0.0	NA	0.0
Antimony	1	93.7	NA	93.7	0.3	NA	0.3
Arsenic	2	102.2	101.4	103	4.2	0.7	7.6
Barium	1	100.7	NA	100.7	13	NA	13
Beryllium	1	104.3	NA	104.3	0.1	NA	0.1
Cadmium	1	99.1	NA	99.1	0.0	NA	0.0
Calcium	1	98.4	NA	98.4	415.2	NA	415.2
Chromium	2	98.4	94.5	102.3	3.8	0.2	7.3
Cobalt	1	95.8	NA	95.8	0.1	NA	0.1
Copper	1	97.2	NA	97.2	1.4	NA	1.4
Iron	3	107.8	98.7	116.6	3.2	1.9	4.9
Lead	2	98.8	96.2	101.4	3.5	0.2	6.8
Lithium	1	97.0	NA	97.0	2.5	NA	2.5
Magnesium	1	97.6	NA	97.6	483.1	NA	483.1
Manganese	1	99.0	NA	99.0	0.4	NA	0.4
Mercury	2	97.2	95.9	98.5	6.9	2.26	11.5
Molybdenum	1	102.2	NA	102.2	0.1	NA	0.1
Nickel	1	96.1	NA	96.1	0.2	NA	0.2
Potassium	1	96.3	NA	96.3	901	NA	901
Selenium	1	98.6	NA	98.6	1.3	NA	1.3
Silver	1	97.6	NA	97.6	1.4	NA	1.4
Sodium	1	95.6	NA	95.6	469.4	NA	469.4
Thallium	2	99.0	96.4	101.5	3.9	0.4	7.4
Vanadium	1	96.0	NA	96.0	0.5	NA	0.5
Zinc	1	99.5	NA	99.5	0.3	NA	0.3

Table 9-6 Laboratory Accuracy and Precision Summary for Calendar Year 2001 (Continued)

		LABORATORY ACCURACY			LABORATORY PRECISION		
PARAMETER	N	AVERAGE	MINIMUM	MAXIMUM	AVERAGE	MINIMUM	MAXIMUM
MISC.							
Total suspended solids	1	100.6	NA	100.6	1.2	NA	1.2
Oil and Grease	3	92.5	86.0	96.8	3.5	0.63	5.3
NITROAROMATICS							
2,4,6-Trinitrotoluene	6	63.2	47.0	93.0	12.6	3.5	22
2,4-Dinitrotoluene	6	61.2	48.0	92.0	12.0	3.6	22
1,3,5-Trinitrobenzene	6	56.3	43	89	9.7	0.0	32
1,3-Dinitrobenzene	6	55.8	43	92	9.9	2.1	28
2,6-Dinitrotoluene	6	53.3	49	101	12.0	3.4	20
Nitrobenzene	6	50.1	35	84	11.5	2.3	29
PCBS							
Aroclor-1016	1	76.0	NA	76.0	3.1	NA	3.1
Aroclor-1260	1	93.0	NA	93.0	6.9	NA	6.9
RADIOCHEMICAL							
Gross Alpha	4	91.6	68.9	112.4	11.4	4.0	29
Gross Beta	4	94.8	75.4	107	9.6	3.6	15.8
Radium-226	3	100.2	89.0	114	18.9	5.0	32.8
Radium-228	3	88.3	79.6	94.1	4.9	1.6	9.6
Thorium-228	2	94.4	94.1	94.6	7.1	3.1	11.0
Thorium-232	3	88.5	81.6	100	7.4	5.1	10.3
Uranium, total	12	91.4	76.1	99.3	3.1	0.4	6.9
VOLATILES							
1,1-Dichloroethene	1	84	NA	84	8.9	NA	8.9
Benzene	1	83	NA	83	4.7	NA	4.7
Chlorobenzene	1	93	NA	93	5.5	NA	5.5
Toluene	1	86	NA	86	0.9	NA	0.9
Trichloroethene	1	84	NA	84	8.2	NA	8.2
Trichloroethene (TCE)	1	116	NA	116	0.9	NA	0.9

N = Data population.
NA = Not Applicable

10. SPECIAL STUDIES

This section highlights significant activities and efforts at the Weldon Spring Site Remedial Action Project (WSSRAP) that support implementation of environmental protection policies. In addition, short term environmental studies are described that support implementation of regulatory requirements not specifically covered by U.S. Department of Energy (DOE) Order 5400.1 or that were not planned in the *Environmental Monitoring Plan* (Ref. 8).

10.1 Off-Site Migration of Uranium in Storm Water

In an effort to determine the effect of site activities and annual rainfall on the off-site migration of uranium in storm water at the three major National Pollutant Discharge Elimination System (NPDES) outfalls (NP-0002, NP-0003, NP-0005), the annual mass migrating from each outfall is plotted against annual precipitation. The mass per inch of precipitation for each outfall is also plotted against precipitation. The uranium data for the years 1987 through 1994 were reviewed previously and corrected for several factors, as required, to normalize the data. The corrections were for precipitation, watershed areas, and runoff coefficients and are outlined in the *Weldon Spring Site Environmental Report for Calendar Year 1994* (Ref. 23).

These data have been updated with the inclusion of data for 1995 through 2001. The recent data did not require correction. The annual mass, annual precipitation, and mass per inch of precipitation are in Table 10-1. The annual precipitation and total annual mass discharged off site through 2001 are plotted in Figure 10-1, Figure 10-2, and Figure 10-3. The mass per inch of precipitation and annual precipitation are plotted for 1987 through 2001 for all three outfalls in Figure 10-4.

Because remediation has been completed and the site will soon be stabilized the following data gives a good overall view of how effective the project has been in cleaning up stormwater runoff from the site.

Table 10-1 Mass of Uranium Discharged from NPDES Storm Water Outfalls[a]

		OUTFALL						
		NP-0002		NP-0003		NP-0005		
YEAR	PPT (inches)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	TOTAL MASS/YEAR (kg)[a]
1987	35.8	42	1.17	362	10.11	38	1.06	442
1988	33.9	25	0.74	176	5.19	26	0.77	227
1989	28.5	22	0.77	35	1.23	15	0.53	72
1990	45.1	33	0.73	17.7	0.39	25	0.55	75.7
1991	36.9	32	0.87	73	1.98	27	0.73	132
1992	33.4	41	1.23	75	2.25	16	0.48	132

Table 10-1 Mass of Uranium Discharged from NPDES Storm Water Outfalls [a] (Continued)

		OUTFALL						
		NP-0002		NP-0003		NP-0005		
YEAR	PPT (Inches)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	MASS (kg)	MASS/INCH OF PPT (kg/inch)	TOTAL MASS/YEAR (kg)[a]
1993	54.7	66	1.21	163	2.98	31	0.57	260
1994	34.7	36	1.03	49	1.41	12	0.34	97
1995	39.3	20.6	0.52	12.6	0.32	5	0.13	38.2
1996	43.9	14.3	0.33	19.1	0.44	4	0.09	37.4
1997	31.5	2.3	0.07	19.2	0.61	0.5	0.02	22.0
1998	49.6	8.4	0.17	13.3	0.27	0.57	0.01	22.3
1999	34.1	0.83	0.02	3.9	0.11	0.67	0.02	5.4
2000	41	1.6	0.04	2.3	0.06	0.5	0.01	4.4
2001	38.1	1.49	0.04	0.93	0.02	0.28	0.01	2.7

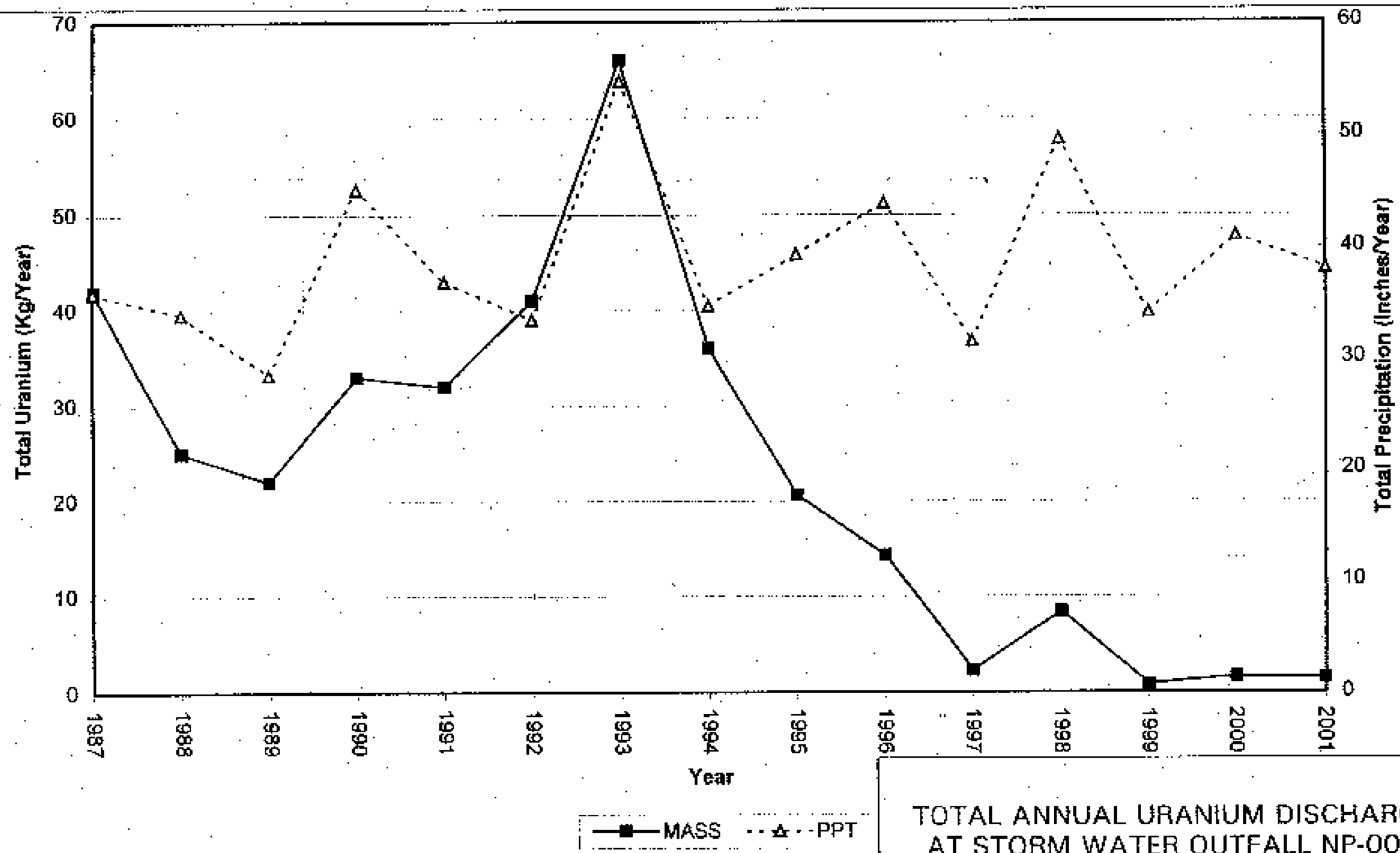
(a) Includes Outfalls NP-0002, NP-0003, and NP-0005. Other outfalls have historically contributed negligible amounts.
PPT Precipitation

10.1.1 Storm Water Outfall NP-0002

Outfall NP-0002 is downstream of the Frog Pond area and receives runoff from the northeast section of the chemical plant area (see Figure 6-2). Figure 10-1 indicates that before remediation started, uranium migrating off site initially decreased or increased in relative proportion to annual precipitation. Building dismantlement in 1992 appears to have increased the mass of uranium migrating off site, although precipitation was less than the previous year. With the completion of building dismantlement, the positive correlation of uranium versus precipitation resumed until 1995 when precipitation increased and uranium decreased. This trend continued into 1996.

Mass reduction in 1995 was presumed to be due to precipitation patterns, since the reductions were similar at all three outfalls, although activities in the three watersheds differed. The reduction in 1996 is believed to be due to action of the sedimentation basin in addition to the removal of contaminated soil and building foundations. The downward trend continued in 1997. During 1997, storm water was diverted around Frog Pond, and the pond was removed in mid 1998. Total mass at Outfall NP-0002 increased slightly in 1998. An increase in precipitation during 1998 is suspected to be the cause.

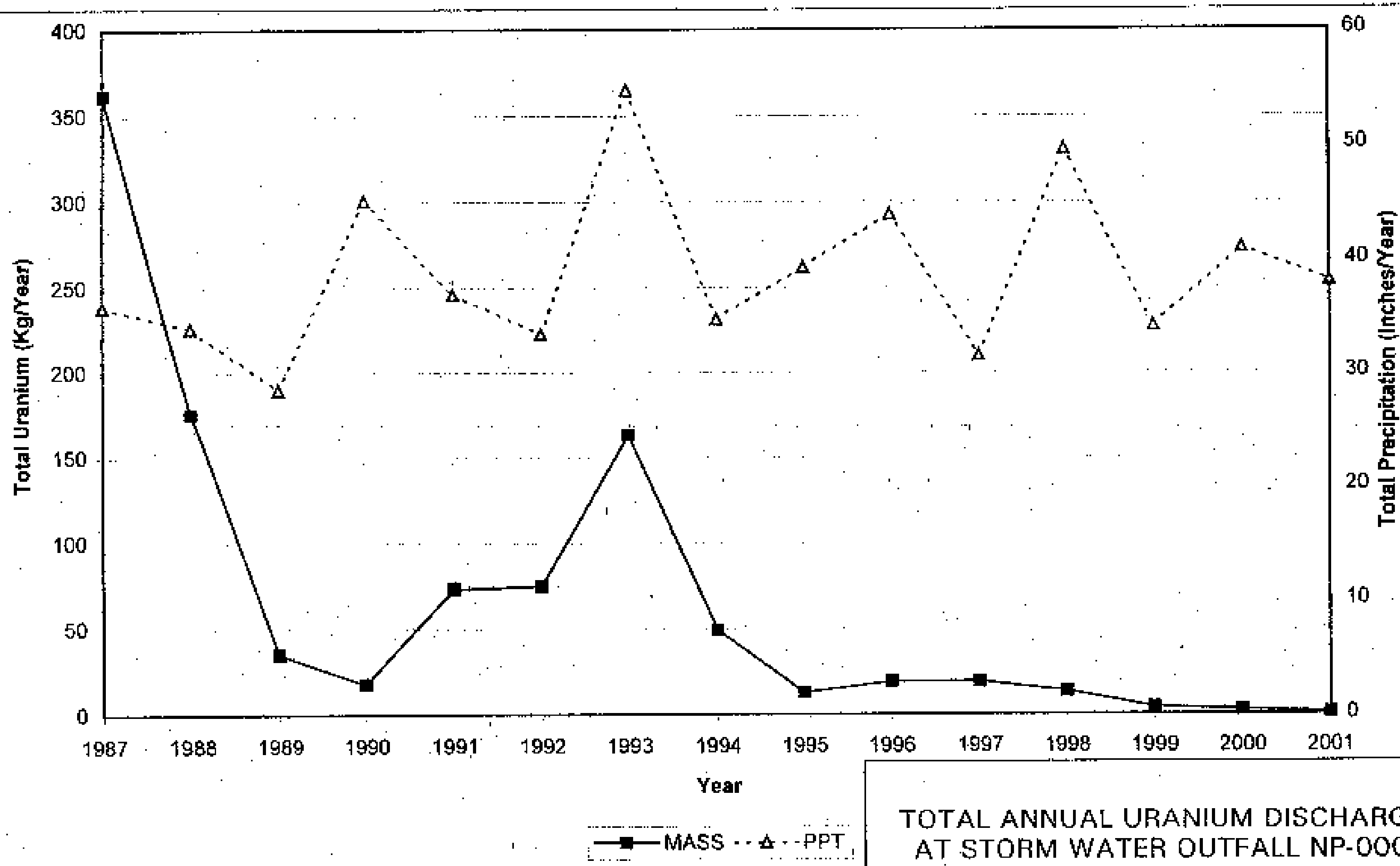
The mass for 1999 was much reduced, as was the mass per inch of precipitation. This reduction is attributed to the NP-0002 watershed being almost completely remediated, and a significant reduction in rainfall from 1998 levels. Precipitation in 1999 was not only less than in 1998, but there were few major storm events, which reduced runoff from the site.



TOTAL ANNUAL URANIUM DISCHARGED AT STORM WATER OUTFALL NP-0002

FIGURE 10-1

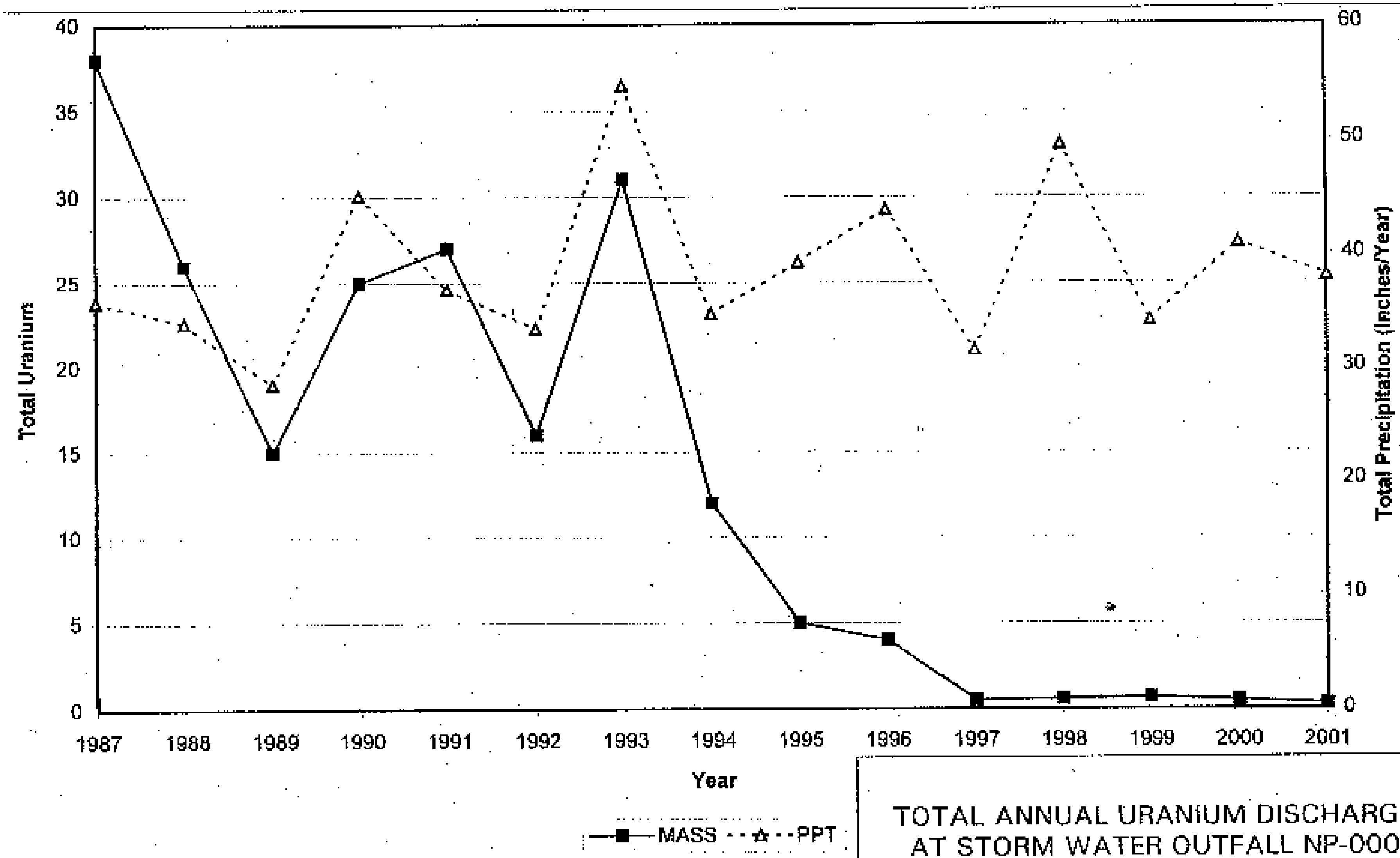
REPORT NO: DOE/OR/21548-917		EXHIBIT NO.: A/PI/020/0598	
ORIGINATOR: TW	DRAWN BY: GLN	DATE: 4/16/02	



TOTAL ANNUAL URANIUM DISCHARGED
AT STORM WATER OUTFALL NP-0003

FIGURE 10-2

REPORT NO:	DOE/OR/21548-917	EXHIBIT NO:	A/PI/021/0598		
ORIGINATOR:	TW	DRAWN BY:	GLN	DATE:	4/16/02



TOTAL ANNUAL URANIUM DISCHARGED AT STORM WATER OUTFALL NP-0005

FIGURE 10-3

REPORT NO.:	DOE/OR/21548-917		EXHIBIT NO.	A/PI/022/0598	
ORIGINATOR:	RC	DRAWN BY:	GLN	DATE:	4/16/02

There was a slight increase in total mass at outfall NP-0002 during 2000. Although the area was completely remediated, there was a large area of unvegetated soil which increased the runoff. In addition, precipitation was greater in 2000 than in 1999. The cell and parking areas have high runoff coefficients which also added to the increase in runoff and subsequently, mass.

For 2001 there was a slight decrease in uranium mass. This is suspected to be a natural variation because the watershed has been remediated. When vegetation is permanently established the mass of uranium migrating off site should be reduced even further.

10.1.2 Storm Water Outfall NP-0003

Figure 10-2 indicates that uranium migrating off site sharply decreased from 1987 through 1989 at Outfall NP-0003. The reduction for 1988 is assumed to be due to precipitation patterns since there was no other activity in the watershed. The reduction in 1989 was due to construction of the Ash Pond diversion channel, which began in November of 1988 and was completed in April of 1989, along with lower precipitation in 1989. Prior to construction of the diversion channel, most of the water in the watershed flowed through Ash Pond, which was a highly contaminated area. Following construction of the diversion channel, the only water that flowed from Ash Pond was precipitation that fell directly on the pond area.

Construction of the diversion channel made the fluctuations in annual uranium mass at Outfall NP-0003 highly dependent on the flow from Ash Pond. During the summer and other dry periods, there was little or no flow from the pond. As a result, the diversion channel flow (from a much less contaminated area of the site) made up the bulk of the flow. This caused lower overall uranium levels at the outfall during periods of normal precipitation. During winter, when the Ash Pond soils may have become saturated and precipitation amounts generally have been higher and evaporation lower, flow from Ash Pond increased and concentrations at the outfall trended higher.

The mass in 1990 was again reduced over the previous year, although precipitation was much higher. This may have been a result of precipitation patterns and/or the times the samples were taken (i.e., no flow from Ash Pond). During 1991 and 1992, precipitation was less than in 1990, but uranium mass was higher. Again, this presumably was due to precipitation patterns and the time of sample collection.

Uranium mass increased greatly in 1993 because precipitation increased dramatically and Ash Pond discharged throughout the year. Mass decreased in 1994 with the decrease in precipitation, and a soil cover was placed over the South Dump area of Ash Pond during the middle of the year. Mass was again reduced in 1995 with an increase in precipitation. This was likely the result of precipitation patterns (because reductions were similar at all three outfalls) and construction during 1995 of a sedimentation basin immediately upstream of Outfall NP-0003. Mass increased slightly in 1996 due to increased precipitation and the storage of contaminated soil and debris in Ash Pond. With this storage, the water was managed and was not discharged to the sedimentation basin unless it was less than the 600 pCi/l (22.2 Bq/l) Derived Concentration Guideline (DCG). With the storage of contaminated materials in Ash Pond, the mass of uranium at Outfall NP-0003 was expected to be highly dependent on precipitation and water discharged from the pond. The mass of uranium discharged during 1997 was slightly higher than that discharged during 1996, even though precipitation was much less. This was likely the result of the storage of contaminated materials in the pond area. During 1998, total mass at Outfall NP-0003 was less than during 1997, even though precipitation was much higher. The decrease is assumed to be the result of management of the pond water and the removal of contaminated materials from the pond during 1998.

The 1999 mass of uranium migrating off site at Outfall NP-0003 was less than the 1998 mass. This reduction is attributed to a reduction in precipitation and remediation efforts in the Ash Pond area. The entire Ash Pond area and the chipped wood storage area were remediated and confirmed clean during 1999.

During 2000 the NP-0003 watershed was largely vegetated, and uranium mass migration was slightly decreased compared to 1999 levels, as was expected, even though there was an increase in precipitation. The outfall NP-0003 watershed was brought to final grade, seeded, and mulched during late 2001. The mass of uranium for 2001 was less than for 2000 because the watershed was completely remediated and stabilized with vegetation during a large part of the year. The establishment of permanent vegetation will stabilize the mass of uranium migrating off site at a low level.

10.1.3 Storm Water Outfall NP-0005

Figure 10-3 indicates that the mass of uranium migrating off site at Outfall NP-0005 has been generally proportional with annual precipitation through 1994. Construction of the site water treatment plant, which began in 1992, appeared to have had little effect on the outfall, even though it involved substantial earth disturbance for construction of the effluent and equalization basins. A siltation basin was constructed during treatment plant construction to settle sediments from the water flowing off the treatment plant area. Stormwater from the siltation basin historically contained less than 10 pCi/l (0.37 Bq/l) uranium. The other major source for the outfall (until it was remediated in 1996) was a watershed that drained the highly contaminated Building 301 area. This area was partially capped during 1994 to decrease the concentration of uranium in storm water leaving the area.

The concentration of uranium in storm water from individual sampling events was highly dependent on precipitation rates, periods between precipitation, and the ratio of flow from the sedimentation basin and the Building 301 area. The mass of uranium migrating off site was reduced in 1995 and again in 1996. The reduction in 1995 was likely the result of precipitation patterns because all three outfalls had similar reductions. The watershed for NP-0005 was remediated during 1996. This resulted in another reduction in uranium mass leaving the site. The mass of uranium migrating off site at Outfall NP-0005 for 1997 was much reduced compared to 1996 most likely due to the near complete remediation of the watershed. Because of the remediation uranium mass was expected to remain near background levels at Outfall NP-0005. The total mass at the outfall remained low for 1998, despite the increased precipitation. There was very little soil disturbance in the watershed during 1998.

There was a slight increase in mass at Outfall NP-0005 in 1999 although the total mass remained low. This increase is attributed to a collection sump near the chemical stabilization and solidification (CSS) plant area that prevented water from flowing to the NP-0003 watershed. The water was collected to allow construction of the cell berm. The water was then pumped to Outfall NP-0005. The water that collected in the sump was from an area that was only partially remediated and slightly higher in uranium than other NP-0005 waters, thus causing the slight increase.

Mass at Outfall NP-0005 for 2000 decreased from 1999 levels despite an increase in precipitation and earth disturbance caused by the removal of the site water treatment plant and ponds. Complete remediation of the watershed contributed to the reduction.

Final grading and establishment of vegetation in the NP-0005 watershed contributed to a reduction in 2001 mass over the 2000 levels. Uranium should stabilize at low levels and remain low in the future.

10.1.4 Mass of Uranium Per Inch of Precipitation

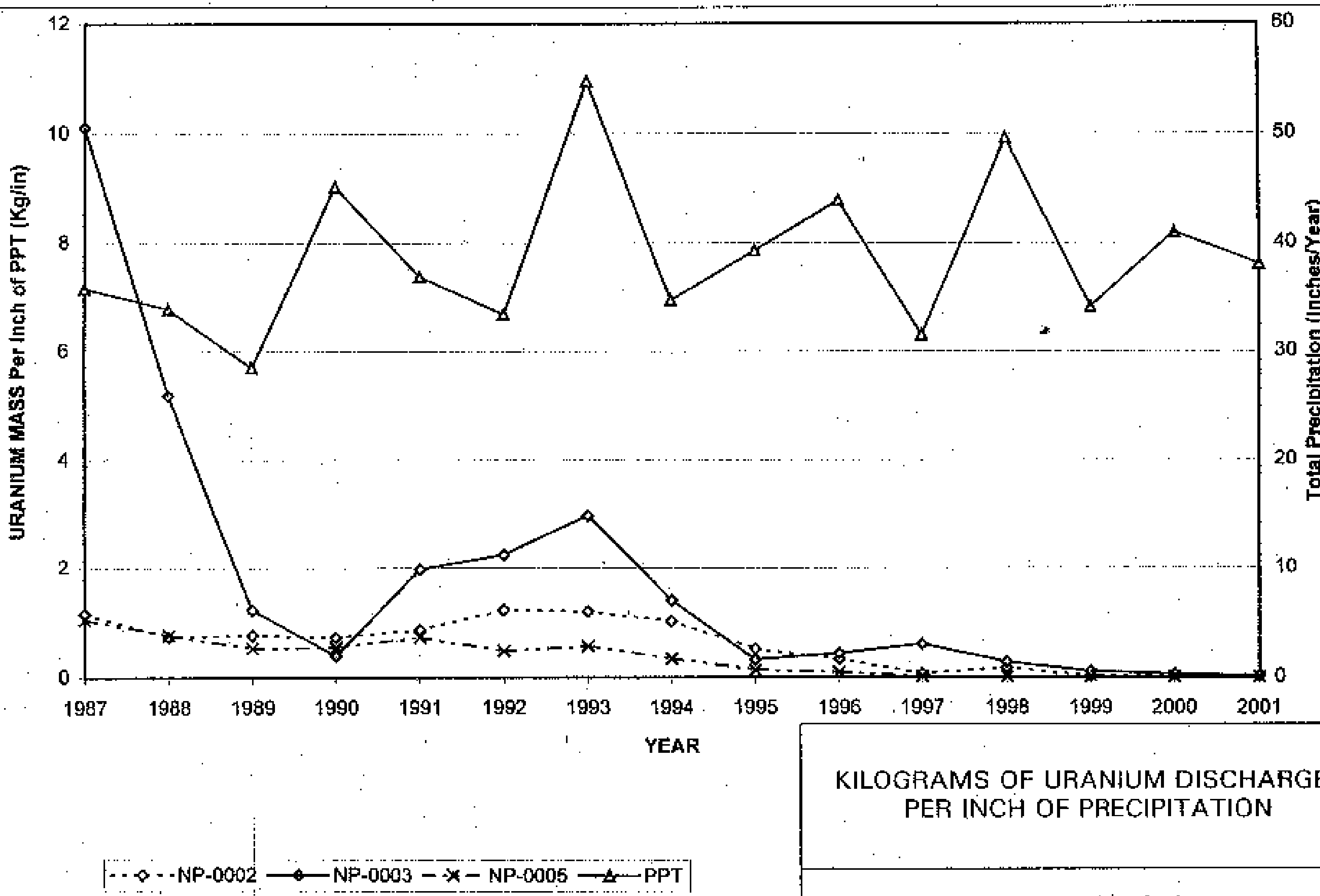
Figure 10-4 and Table 10-1 indicate that the mass of uranium migrating from the site per inch of precipitation was greatly reduced for all three outfalls in 1995 over previous years. By 1997, the levels at NP-0002 and NP-0005 were reduced and stabilized at low levels. Except for one instance at outfall NP-0002 levels were less that 0.1 kg/in. Outfall NP-0003 continued to decline but did not reach levels of 0.1 or less until 2000. Outfall NP-0003 was a more highly contaminated area and was one of the last watersheds to be completely remediated. These results provide additional evidence that the uranium concentration in watershed soils at all three outfalls have been reduced to below clean up standards.

Variations may be due to precipitation patterns, soil disturbance, or remediation, and in the case of Outfall NP-0003, the storage of contaminated materials in Ash Pond. Outfalls NP-0002 and NP-0005 have trended downward as a result of remediation in the watershed. Outfall NP-0003 increased slightly for 1997 because of the storage of contaminated materials in Ash Pond, but decreased during 1998 despite the increase in precipitation. With remediation of the Ash Pond area in 1999, the mass per inch of precipitation was reduced at Outfall NP-0003. The mass per inch of precipitation continued to trend downward during 2000 at outfalls NP-0003 and NP-0005 but increased at NP-0002. During 2001, uranium mass per inch of precipitation remained the same or decreased at all three outfalls.

10.1.5 Annual Migration of Uranium Mass from the Chemical Plant Site

The mass of uranium that migrated off site from the three major outfalls in 1987, before any remedial actions were taken, was 442 kg (972 lb). During 2001, 2.7 kg (5.94 lb) of uranium migrated off site, a 99% reduction from the 1987 mass. Table 10-1 shows the mass of uranium that migrated off site during the intervening years. Mass has fluctuated from year to year with precipitation levels, remedial actions, land disturbance, and foundation and contaminated soil removal. The masses during 1995 and 1996 were at similar levels of 38.2 kg (84 lb) and 37.4 kg (82 lb). Because contaminated soil removal was completed for major sections of the site during 1996, levels for 1997 were reduced even further from the 1995 and 1996 levels. The slight increase for 1998 may be attributed to increased precipitation. Masses have declined every year for 1999, 2000, and 2001, which is the expected result of extensive site remediation and soil stabilization.

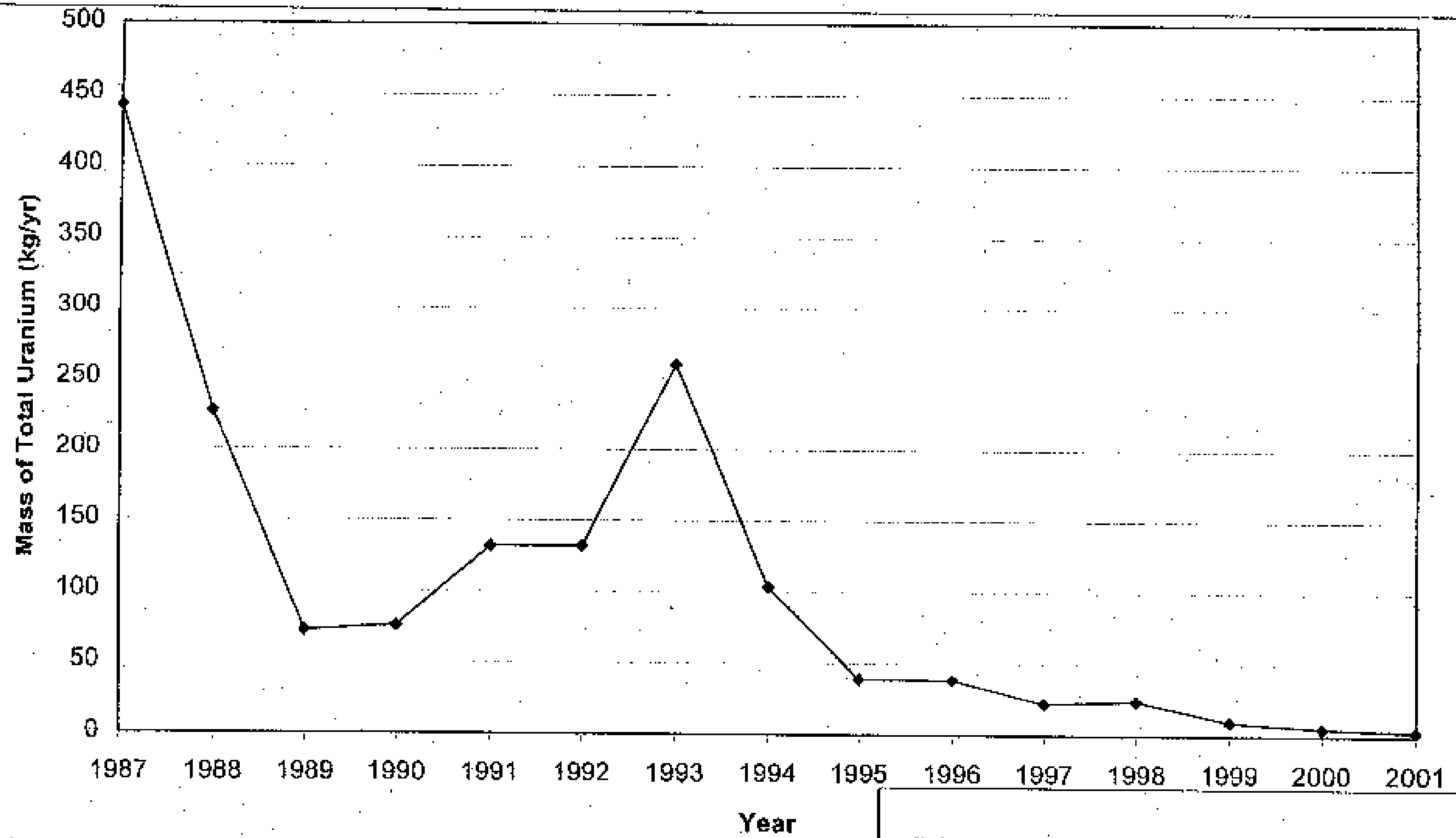
The total annual uranium discharged from NPDES outfalls during 1987 through 2001 is shown in Figure 10-5. These values include uranium discharged at the three major outfalls discussed above, as well as at other minor storm water outfalls and in the water treatment plant effluents. As shown on the graph, total uranium migrating off site in surface water has steadily decreased since 1987, and is expected to decrease further still when the site has final vegetation established.



KILOGRAMS OF URANIUM DISCHARGED PER INCH OF PRECIPITATION

FIGURE 10-4

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/PI/023/0598
ORIGINATOR: TW	DRAWN BY: GLN	DATE: 4/16/02



TOTAL ANNUAL URANIUM DISCHARGED AT NPDES OUTFALLS

FIGURE 10-5

REPORT NO.:	DOE/OR/21548-917	EXHIBIT NO.:	A/PI/019/0401
ORIGINATOR: TW	DRAWN BY: GLN	DATE:	4/16/02

10.2 Quarry Interceptor Trench

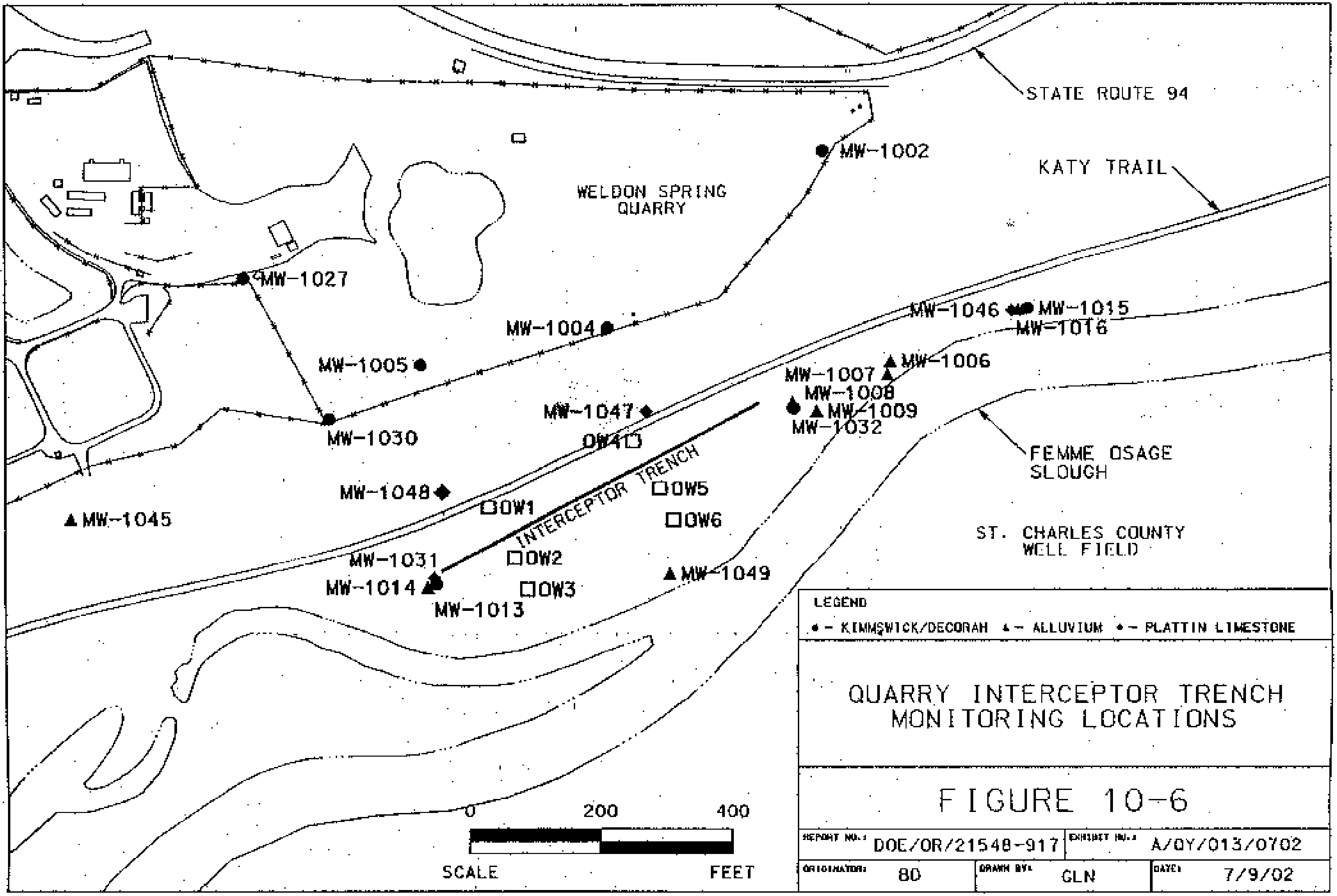
A field test was performed southeast of the quarry to quantify the mass of uranium that could be removed from the aquifer by pumping contaminated groundwater from an interceptor trench located between the quarry and the Femme Osage Slough (see Figure 10-6). The trench was installed and became operational on April 27, 2000. Sampling of groundwater from the trench and nearby monitoring wells was conducted according to the *Sampling Plan for the QROU Interceptor Trench Field Study* (Ref. 21).

As of December 31, 2001, a total of 4.35 x 10^6 liters (1.50 x 10^6 gal) of water had been pumped from the interceptor trench. Pumps were operational only during periods of flow from the respective sumps. Samples were collected daily from the operating pumps for onsite analysis of uranium, and weekly for off-site analysis of uranium and nitroaromatic compounds. Based on the analytical results, the total mass of uranium removed from the shallow aquifer as of December 31, 2001, was 10.2 kg. A summary of the groundwater production and resulting uranium mass removed from each sump is provided in Table 10-2.

Table 10-2 Quarry Interceptor Trench Groundwater Production and Uranium Mass Removal Summary

Sump	Production as of 12/31/2001 (1,000 liters)	Production as of 12/31/2001 (1,000 gallons)	Mass Removed (kg) as of 12/31/2001
3004	1.0	0.3	0.002
3104	409	108	1.4
3204	599	158	1.6
3304	3,345	884	7.1
Total	4,353	1,150	10.2

Nearby monitoring wells, which are shown on Figure 10-6, were sampled weekly for the first three months of the field study for uranium, nitroaromatic compounds, and geochemical parameters. After the first three months, the six OW-series monitoring wells were sampled biweekly for onsite analysis of uranium and monthly for off-site analysis of uranium, nitroaromatic compounds, and geochemical parameters. The remainder of the nearby monitoring wells were sampled monthly. A summary of the analytical data as of December 31, 2001, is provided in Table 10-3.



QUARRY INTERCEPTOR TRENCH MONITORING LOCATIONS

FIGURE 10-6

REPORT NO.: DOE/OR/21548-917		EXHIBIT NO.: A/QY/013/0702
ORIGINATOR: BD	DRAWN BY: GLN	DATE: 7/9/02

Table 10-3 Summary of Uranium and Nitroaromatic Data for Quarry Monitoring Wells

Location	Uranium (pCi/l)			Nitroaromatic Compounds (µg/l)
	Average	Maximum	Minimum	
OW01	328	473	152	ND
OW02	198	326	88	ND
OW03	906	1,121	474	ND
OW04	2,415	3,013	1,310	ND
OW05	32.4	78.8	<0.7	ND
OW06	7.2	25.4	<0.7	ND
1008	2,314	4,180	960	ND
1009	13.5	101	<0.7	ND
1013	504	691	337	ND
1014	578	812	355	ND
1031	24.6	40.4	12.7	ND
1032	1,182	2,150	796	ND
1047	4.1	35.1	0.7	ND
1048	448	672	347	ND
1049	2.0	12.4	<0.7	ND

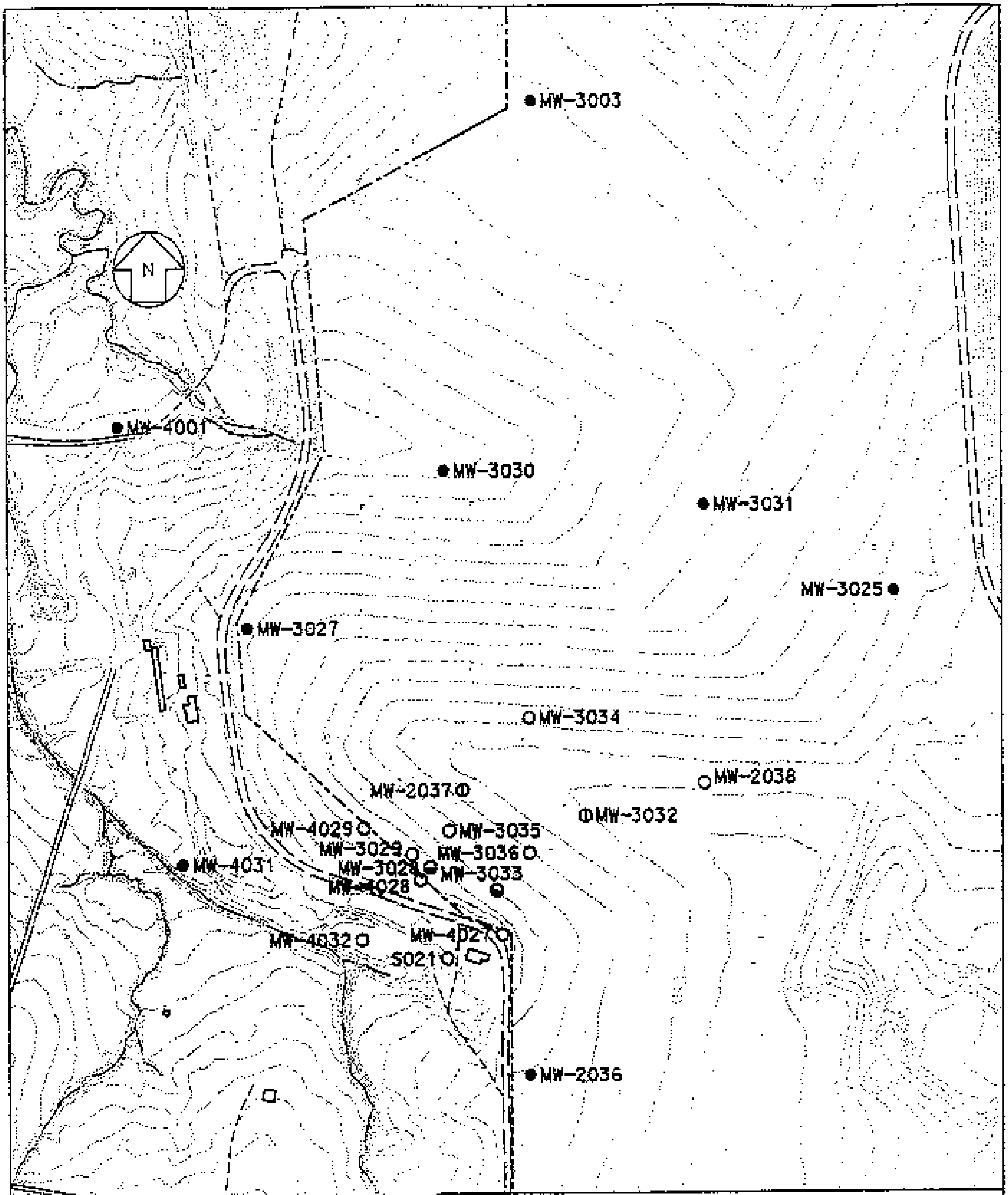
ND Not detected

The interceptor trench was operated and monitored until late April 2002, as discussed in the *Sampling Plan for the QROU Interceptor Trench Field Study* (Ref. 21). A completion report is being prepared to document the final analytical results and evaluate the success of the study.

10.3 Groundwater Operable Unit Pump-and-Treat Field Test

A field test was performed in the southwest portion of the chemical plant to compare the effectiveness of several scenarios proposed for pump-and-treat remediation of contaminated groundwater. The test was conducted in accordance with *Additional Groundwater Pump and Treat Studies in Support of the Feasibility Study for the Groundwater Operable Unit* (Ref. 13). The locations of the wells used for the field test are shown on Figure 10-7.

The objective of the field test was to determine whether enhancement by artificial recharge or use of angled extraction wells could significantly improve contaminant removal rates compared to those achievable by a conventional pump-and-treat system. The test was designed to include six operational stages of 20 days each, followed by a 90-day recovery period. During each stage, physical and analytical parameters of the groundwater were monitored at the locations shown on Figure 10-7 to accomplish the following objectives: 1) establish a hydraulic capture zone, 2) determine the response of the aquifer, and 3) quantify the mass of contaminants removed.



LEGEND

- ⊖ – PUMPING WELL
- Φ – INJECTION WELL
- O – OBSERVATION WELL
- ● – MONITORING WELL

0 300 600

SCALE FEET

WELL LOCATIONS FOR GROUNDWATER PUMP AND TREAT FIELD STUDIES

FIGURE 10-7

REPORT NO.:	DOE/OR/21548-917	EXHIBIT NO.:	A/CP/047/0702		
ORIGINATOR:	BD	DRAWN BY:	GLN	DATE:	7/9/02

The six planned stages of the study were as follows:

- Stage 1: Determine the sustainable yield of the shallow aquifer by establishing the maximum pumping rate sustainable at a vertical well (MW-3028).
- Stage 2: Extract water at the sustainable yield from a vertical well (MW-3028).
- Stage 3: Extract water from a vertical well (MW-3028) while introducing an artificial recharge of 5 gpm at two upgradient locations (MW-2037 and MW-3032).
- Stage 4: Extract water from a vertical well (MW-3028) while introducing an artificial recharge of 10 gpm at two upgradient locations (MW-2037 and MW-3032).
- Stage 5: Extract water from an angled well (MW-3033) while introducing an artificial recharge of 5 gpm at two upgradient locations (MW-2037 and MW-3032).
- Stage 6: Extract water from an angled well (MW-3033) while introducing an artificial recharge of 10 gpm at two upgradient locations (MW-2037 and MW-3032).

Stages 1 through 5 of the study were performed from March 2001 through August 2001. Stage 6 was omitted from the study due to the low sustainable yield in the angled well. The recovery monitoring period started on August 13, 2001, and was concluded on November 12, 2001.

The mass of contaminants removed from the aquifer was determined from the measured contaminant concentrations and groundwater volumes extracted each day. A summary of the mass of contaminants removed during the test is presented in Table 10-4.

Table 10-4 Summary of Contaminant Mass Removed During Pump-and-Treat Field Test

Stage	Nitrate (kg)	TCE (g)	2,4-DNT (g)	Uranium (g)
2	219	228	0.14	1.1
3	216	309	0.08	1.2
4	280	269	0.14	1.3
5	37	42	0.02	0.6

Complete analytical results of the field tests are presented in the *Completion Report for the Additional Groundwater Field Studies in Support of the Groundwater Operable Unit* (Ref. 17).

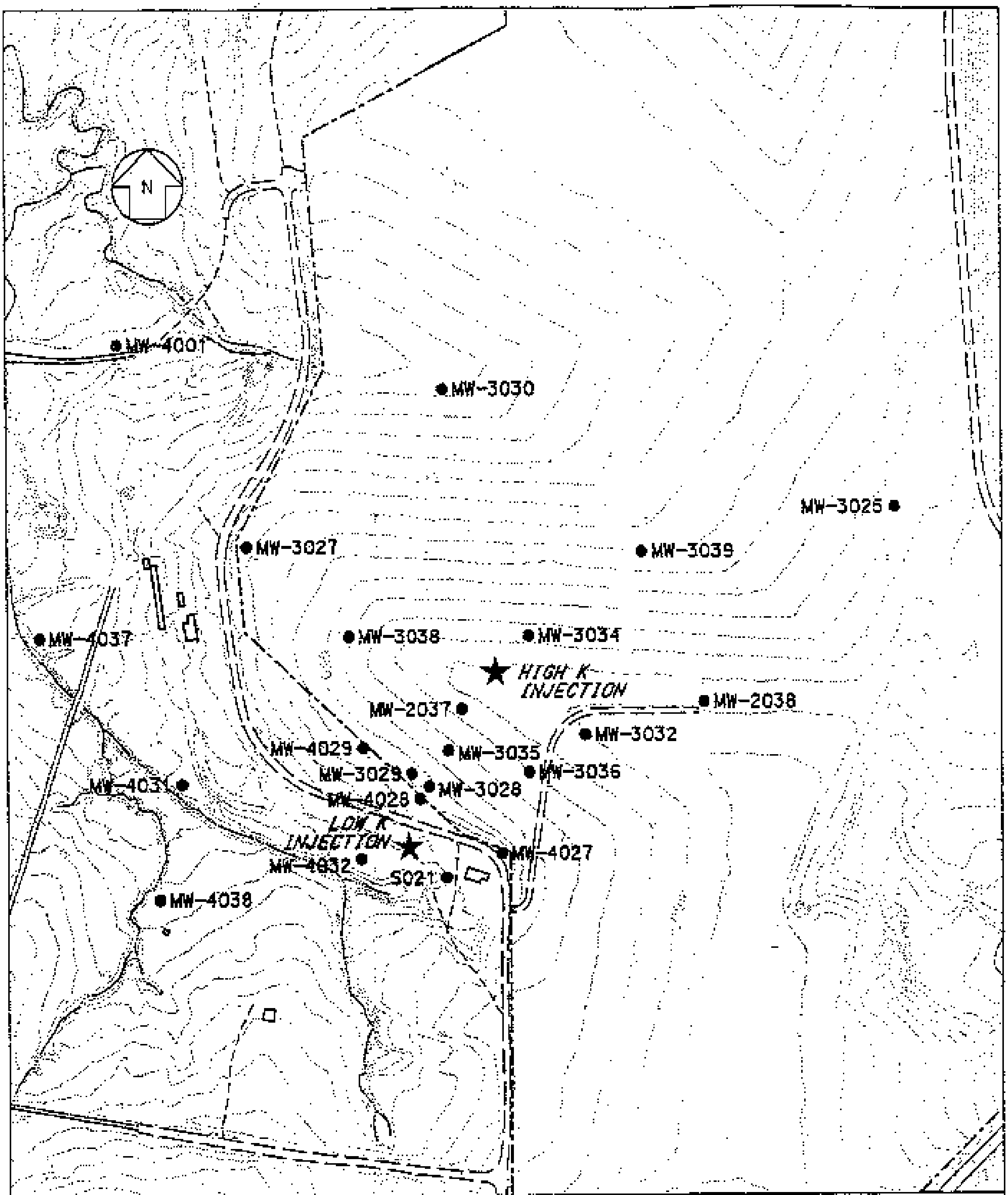
10.4 Groundwater Operable Unit Insitu Chemical Oxidation Testing

The *Interim Record of Decision (IROD) for Remedial Action for the Groundwater Operable Unit (GWOU) at the Chemical Plant Area of the Weldon Spring Site* (Ref. 20) specifies the use of insitu chemical oxidation (ICO) to treat groundwater contaminated with trichloroethene (TCE) in the vicinity of the former raffinate pits. Bench-scale testing was conducted in the spring of 2001 to evaluate the effectiveness of several different oxidants in destroying TCE in groundwater samples collected from this area of the site. Tests by four different subcontractors demonstrated that, under laboratory conditions, oxidation chemistry was able to destroy TCE without significantly affecting the concentrations of other contaminants.

Following the successful bench-scale testing, technical specifications were prepared for field implementation of a pilot-scale treatment system. One subcontract was awarded in December 2001 to evaluate the effectiveness of ICO under actual field conditions and to assess the feasibility of implementing ICO on a full-scale basis. The pilot-scale injection was performed in April and May 2002 at two specified locations within the area of TCE impact: one location with relatively high hydraulic conductivity (i.e., $K \approx 10^{-3}$ cm/sec) and one location with relatively low hydraulic conductivity (i.e., $K \approx 10^{-4}$ cm/sec). These locations, which are designated the "High K" and "Low K" injection points, are shown in Figure 10-8 along with the locations of monitoring wells in the TCE-impact area and their respective baseline TCE concentrations.

Design, installation, and operation of the ICO pilot-scale system was performed by a specialty subcontractor. Approximately 15,000 gallons of 0.1% sodium permanganate solution were introduced to the aquifer during the first injection. Groundwater sampling ten days after the injection indicated that a second treatment was necessary to achieve the 5-µg/l remediation goal specified in the IROD (Ref. 20). Thus, a second injection, consisting of approximately 25,000 gallons of additional permanganate solution, was performed.

Groundwater monitoring was conducted before, during, and after the pilot-scale treatment, as described in *Groundwater Sampling Plan for In Situ Chemical Oxidation Pilot-Scale Testing* (Ref. 22). Preliminary monitoring results have demonstrated that permanganate is able to destroy TCE up to 30 meters (100 feet) away from the injection points in both the High K and Low K areas. Continued groundwater monitoring at locations within and beyond the subcontractor's immediate test area will be used to determine the extent to which ICO affects any other physical or chemical characteristics of the aquifer. Monitoring results will be compiled in a completion report during the summer of 2002, which will be used to assess the technical feasibility of implementing ICO on a full-scale basis at the WSSRAP.



WELL LOCATIONS FOR ICO
PILOT-SCALE TESTING

FIGURE 10-8

REPORT NO.: DOE/OR/21548-917	EXHIBIT NO.: A/CP/048/0702	
ORIGINATOR: BD	DRAWN BY: GLN	DATE: 7/9/02

11. LONG TERM STEWARDSHIP

The project has been preparing to transfer stewardship responsibility for the Weldon Spring Site Remedial Action Project from DOE-Oak Ridge to the DOE-Grand Junction Office (GJO) on October 1, 2002. The GJO office is responsible for the Long-term Surveillance and Maintenance (LTSM) Program at DOE facilities, providing long-term care for low-level radioactive material disposal sites. The sites must meet two criteria: (1) the site must not be physically a part of a major DOE facility and (2) the site can not have a DOE mission after cleanup. For additional information on the DOE-GJO LTSM Program, visit the internet site at www.gjo.doe.gov/programs/ltsm.

In 1998, the Weldon Spring site Department of Energy staff began coordinating with the GJO to identify issues related to site transition activities. A series of stewardship documents were drafted between 1998 and 2000 and issued to the regulatory agencies and the Weldon Spring Citizen's Commission for review and comment. These documents address general stewardship issues as well as the development of institutional controls and long-term monitoring activities at the site. Comments were received from agencies such as the U.S. Environmental Protection Agency, the Missouri Department of Natural Resources, the St. Charles County government, and the Weldon Spring Citizen's Commission on the various drafts. Comments were incorporated into the current revision of the stewardship plan, which was issued during the summer of 2001.

In general, the comments focused on insuring adequate funding and enforceability of institutional controls. Stewardship concerns were elevated to U.S. Department of Energy Headquarters for resolution. In May 2002, DOE headquarters issued specific direction regarding the site's transition to stewardship. One outcome is that public involvement in the stewardship planning process will be enhanced through open workshops beginning in June 2002.

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